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EFFoST2022 Conference Abstracts

Oral Presentations

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Protein extraction from tomato leaves

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Aim:
Production of proteins from agricultural sides streams aids in the final aim of total crop valorisation. Tomato leaves (*Solanum lycopersicum*), the waste stream of tomato production, are currently unutilized as a human food source, and therefore provide potential as a new protein source. However, extraction of proteins from tomato leaves is not straightforward. As tomato is part of the nightshade family, the leaves not only contain protein, but also toxins, which hamper their use as a human food source. The presented research aimed to valorise tomato leaves for protein, and testing the application of the protein product in meat replacers.
Method:
Protein isolation with simultaneous toxin removal was researched to obtain a safe protein isolate. Tomato plant leaf protein was isolated through three methods; (1) pH precipitation, (2) ethanol precipitation, and (3) a combination of heat coagulation and filtration. Protein extraction focussed on obtaining soluble protein, and more specifically Rubisco. The products were evaluated for gelling properties, and a meat analogue product was produced using a high temperature shear cell.
Results:
Although Rubisco is the most abundant protein on earth, it is currently an underutilized source of protein as it is poorly recoverable. Our results show that it is possible to obtain protein fractions without the presence of toxins. Protein yield and purity were determined for the different extraction methods. In addition, the different protein fractions were tested for their gelling properties, and compared to other more commonly-used plant proteins. Selected fractions were tested in a closed cavity rheometer to obtain a recipe suitable for testing in the high temperature shear cell. The results will be presented in pictures.
Conclusion:
Soluble protein in the form of rubisco was obtained from tomato leaves while removing over 90% of the toxins present in these leaves. The produced protein product shows good gelling properties and the potential application in meat replacers will be discussed.

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Exploiting the potential of electrohydrodynamic drying as a green alternative for batch-mode drying of foods

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Aim:
Electrohydrodynamic drying (EHDD) is a green yet not commercialized technology for drying foods. Despite all the promising characteristics of this drying technique, researchers and industry have not yet been able to implement EHDD as an industrial scale unit. Uncertainties on scalability and added values of this technology are the main challenges that hinder industrial implementation. This presentation addresses these issues by introducing a scalable EHDD configuration and quantifying the Key Performance Indicators (KPIs) for EHDD and other conventional methods.
Method:
The three main tools of a scientific approach, namely theoretical development, modeling and simulation, and experimental verification, are employed. First, a physics-based model was developed to design, test and optimize a scalable configuration in silico. Then, a lab-scale setup was developed to experimentally verify the scalability of this novel configuration. Finally, the performance of this scalable EHDD device is evaluated by quantifying the KPIs. The performance indicators were selected based on the current concerns and interests of the food industry, namely, drying kinetics, product quality, economics, environmental impact, energy, and exergy efficiencies. Each of these categories includes several minor indicators. These indicators are quantified for EHDD and other conventional drying methods, including hot-air, microwave, solar, infrared, oven, and freeze-drying.
Results:
The new EHDD design shows better scalability in terms of production capacity compared to the conventional EHDD configurations. In addition, it significantly improves the drying rate and energy consumption by more than 60%. Comparing the KPIs of EHDD and conventional drying methods shows the high potential of EHDD to be used as green food processing technology. In energy consumption indices, EHDD and microwave drying perform significantly better than other drying methods. EHDD and freeze-drying show superior results in product quality. Regarding the drying kinetics, EHDD performance is the second-best after microwave drying. Solar drying and EHDD are the most economical drying solutions regarding both capital and maintenance costs.
Conclusion:
This presentation provides a clear overview for industry, farmers, and other stakeholders about the advantages of using EHDD as an affordable green drying technology. Introducing EHDD to small-scale farmers could help to reduce food waste with a low carbon footprint.

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Towards the use of protein microgels as multifunction additives

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Aim:
Polysaccharides are often used as rheology modifiers in food systems. The aim of this study was to assess whether proteinaceous microgels can be used to replace polysaccharides to minimize the usage of food additive whilst imparting the rheological properties often obtained with polysaccharides, improved nutritional profile and enhanced oral lubricity without compromising the consumer perception.

Method:
The rheological and oral-tribological behaviour of dextran polysaccharide (D at 1-11 wt%) when combined with a dispersion of whey protein isolate (W, 1-13 wt%) or whey protein microgel (WPM, 41.7 vol%) were compared with dispersions of WPM in W solutions. A rheometer was used for the flow measurements. The oral-tribological tests were conducted using a conventional setup (MTM, PCS Instruments on polydimethylsiloxane surfaces) and a novel approach using biomimetic tongue surfaces which emulate the stiffness, roughness and wettability of a real human tongue in orally-relevant conditions (temperature, contact pressure, etc.)[1, 2].

Results:
Our results showed that the dispersions of WPM (41.7 vol%) deliver the same high shear-rate flow and viscous-friction behaviour to that of D (5 wt%) and excel in thin-film lubricity where contacting surfaces are in close proximity (*i.e.* the boundary lubrication regime). The measurements with both tribo setups showed that the WPM (41.7 vol%) + W and D (5wt%) + W mixtures at various comparable concentrations of W, deliver similar frictional behaviour in elasto-hydrodynamic and hydrodynamic lubrication regimes (*i.e.* viscous lubricity) whilst, replacement of D with WPM provided improved the boundary lubricity[2].

Conclusion:
By optimising a combination of WPM and (non-microgelled) W, combined viscous and thin-film lubricity could be achieved through a single-component, i.e., whey protein, without the need of any polysaccharide. Therefore, this work advances the design of processed foods with clean labels taking advantage of ingredients that improve nutritional profile and reduce additivation (e.g. polysaccharide or lipid).

Acknowledgement:
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Online Food Shoppers: Pattern of behaviour and sustainability practices

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Online Food Shoppers: Pattern of behaviour and sustainability practices
Mary McCarthy, Claire O'Neill, Seamus O'Reilly and Frode Alfnes

Consumers' sustainable food practices vary across the population. Indeed, individuals and households can be at various points on a pathway to more sustainable practices due to a myriad of situational and personal influences. Online food shopping is one of the solutions that consumers might leverage in managing their food lives and may offer the potential benefit of reducing impulsive food purchases which in turn could reduce food waste.

Aim

In this research we sought to explore characterises of online food shoppers, to understand their pattern of behaviours and sustainability practices.

Method

Data were collected through an online survey in December 2020 and included questions addressing online food purchase behaviour, purchasing patterns, and food interest, preferences and behaviours that are linked to food sustainability. A valid sample of 281 respondents were included for analysis. Descriptive and frequency analysis were undertaken followed by an ex-ante (level of spend) and ex-post (food interest, preferences and behaviours) segmentation analyses.

Findings

The majority (52%) commenced online grocery food shopping in 2020, 39% had done so between 2015 and 2019 while the remainder commenced prior to 2015. Generally few differences were noted in sustainability related consumption behaviours based on level of spend (low/moderate/high) but some attitudinal/practice differences were observed (e.g. cooking practice, preference for domestic foods). Ex-post segmentation identified 4 segments that were at difference stages on their sustainability journey. At one end the pressured segment was preoccupied with managing busy lives with little attention given to sustainability while at the other end the "pro sus" segment embraced many aspects of sustainable practices including food curtailment, product choice adjustment, and greater level of household food management.

Conclusion

Online food shopping increased dramatically in 2020. Level of use does not appear to be linked to sustainable food choices. Notwithstanding this, there was a general willingness to engage in environmentally friendly behaviours. However, findings highlight that the online food shopper population is not homogeneous in their responses to the call for more environmentally sustainable household food practices. This draws attention to the need for targeted initiatives that take account of consumers' everyday lives.

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Capillary suspensions for oil structuring with agri-food residues micronized via high-pressure homogenization in oil

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Abstract

Oleogels have been proposed as novel systems for replacing unhealthy saturated fats in food preparations with vegetable oils while enhancing their nutritional value without penalizing taste and mouthfeel. This work aimed at structuring sunflower oil through the formation of capillary suspensions using wheat middlings (WM) as a structuring solid fraction. The use of WM enables also to reduce the caloric content of the oil, while sustainably valorizing an agri-food residue (AFR) of the wheat milling process, hence contributing to implementing the circular economy across the food chain. High-pressure homogenization (HPH), which is an emerging, purely mechanical cell disruption technology, was used as a wet milling technique directly applied on WM-in-oil-dispersion, at 80 MPa and 25 °C for 20 passes. The HPH treatment enabled the reduction of the WM particle size by one order of magnitude, causing, at the same time, WM fiber activation and the release of high value-added intracellular compounds (such as phenolic compounds with high antioxidant activity) into the sunflower oil. The addition under high-shear mixing (HSM) of a secondary immiscible fluid (i.e. water) in a continuous phase (i.e. oil) of HPH-treated particle suspension drastically altered the rheological behavior, evaluated by using a rotational rheometer equipped with a concentric cylinder, and the strength of these suspensions due to the formation of a sample-spanning particulate 3D network. This phenomenon can be attributed to the capillary bridge forces of the two fluids acting on the fibrous solid particles, which cause the transition from liquid to gel-like state. The WM-in-oil-dispersion at 30 wt% of particle fraction treated by HPH with the addition of 50 wt% of water exhibited a high apparent viscosity and apparent yield stress (about 300 Pa). Remarkably, the antioxidant compounds released in the oil contributed to slowing down the oil oxidation phenomena. In conclusion, the obtained oleogels are very promising materials for the formulation of healthier and more sustainable food products in replacement of solid fats, enabling to reduce the overall caloric content while adding the benefits related to the dietary fiber content, as well as exploit the recovery of valuable bioactive compounds still present in the AFRs.

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Conversion of Xylan to Xylose from Pistachio Shell by Microwave/CO_2 Assisted Hydrolysis

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Aim: Pistachio shell is a solid waste generated during the processing of pistachio into pistachio kernel. Pistachio shell is a unique lignocellulosic biomass with its hemicellulose fraction that is almost (90%) xylan. Xylan is a valuble source which can be converted into high value-added compounds such as xylooligosaccarides, xylose, xylitol, and furfural. The general practice applied in hydrolysis of lignocellulosic biomass is acid or base treatments which are environmentally hazardous processes. Therefore, it is essential to apply noval alternative methods on hydrolysis of lignocellulosic biomass. Hence, in this present work, a green approach microwave/CO_2 assisted hydrolysis, was used to hydrolyse pistachio shell into xylose. The effect of microwave energy and dissolved CO_2 have been combined in hydrolysis of pistachio shell in this study.
Method: In microwave/CO_2 assisted hydrolysis experiments, a high pressure microwave system (SynthWAVE, Milestone Srl, Italy) was used. Briefly, the reaction chamber was first filled with water and lignocellulosic biomass and sealed, then the chamber was pressurized with CO_2 up to 50 bar. After that microwave was applied to reach desired temperature. The effect of hydrolysis parameters, temperature (175-210°C), time (15-30 min) and pistachio shell:water ratio (1:5-1:20) were evaluated and optimized by using Box-Behnken design of RSM.
Results: The optimum hydrolysis conditions were found as 190°C, 30 min and 1:18 g/mL for temperature, time and ratio of pistachio shell:water, respectively. Under optimum conditions the concentration of xylose, acetic acid, 5-hydroxymethylfurfural and furfural in the hydrolysate were obtained as 14.32 g/L (25.8 g xylose/100 g pistachio shell), 3 g/L, 0.04 g/L and 1.59 g/L, respectively. The hydrolysis performance of microwave/CO_2 were compared with the microwave assisted hydrolysis without CO_2. The results shown that microwave/CO_2 was superior with its higher xylose and lower by product yield compared to microwave application without CO_2.
Conclusion: These findings demonstrate that microwave/CO_2 hydrolysis can be considered as a promising green alternative to acid and/or base hydrolysis of lignocellulosic biomass. However, further studies on the reaction kinetics in this system are recommended.

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Split-stream processing of asparagus side-streams improves the flavour of dried asparagus food ingredients

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Aim: White asparagus (*A. officinalis*) is a popular vegetable consumed worldwide and its cooked spears are appreciated for their distinct flavour profile. During asparagus harvesting, around one-third of the total material is usually discarded. This significant waste stream partially consists of the stem bases which are cut off to produce spears of equal length (Pegiou et al., 2020). These stem parts are, however, still rich in flavour compounds (Pegiou et al., 2021) and valorisation of these materials to aroma-rich natural food ingredients (e.g., dried powders for soups) could reduce the amount of agricultural waste. Split-stream processing of the asparagus side-streams is a novel approach to produce spray-dried powder from concentrated juice and asparagus fibre (Siccama et al., 2021).
Method: Newly-processed asparagus ingredients generated by the split-stream processing and a conventionally dried asparagus powder were compared by evaluating their flavour profile in an instant-soup formulation. Professional sensory panel, untargeted metabolomics and multivariate regression analyses (Random Forest) supplied information about important sensory-relevant compounds.
Results: The essential role of previously-reported key asparagus odorants was confirmed. Seven new volatile compounds are proposed to also positively contribute to key asparagus flavour notes, some of which were more abundant in the spray-dried powder. The spray-dried powder scored significantly higher on asparagus odour and taste attributes compared to the commercial powder. The fibre had a negative impact both on the taste (e.g. 'cardboard' and 'off-taste') and mouthfeel of the soups and could also be linked to deviations in the metabolite profile.
Conclusion: Performing untargeted metabolomics and sensory evaluation of the soup formulations and integrating the data using Random Forest approaches proved the split-stream process to be effective for the production of asparagus ingredients, which were richer in flavours than the conventionally hot air-dried asparagus powder. This research demonstrates the feasibility of upcycling asparagus side-streams into flavour-rich ingredients with good sensorial properties for food formulations.

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High Molecular Weight Polymers as Natural Aroma Modulators in Red Wine

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Aim:
How can the sensory perception of red wine be improved in a natural, sustainable way? Due to the great popularity of red wine worldwide, this question is of high interest in food science. The natural, non-volatile red wine matrix is discussed to change the aroma perception but the knowledge about molecular mechanisms behind the odorant polymer interactions are rather fragmentary. Therefore, this study aimed to develop a screening tool for the so-called aroma-binding effect using ^{1}H NMR spectroscopy combined with human sensory experiments.
Method:
High molecular weight (HMW) fractions with different molecular weight cut-offs were isolated directly from non-treated red wine by ultrafiltration. Qualitative, and quantitative NMR-based interaction studies between polymers and red wine key odorants over time allowed the direct and noninvasive analysis of the aroma-binding effect of red wine polymers. Human sensory experiments complemented the analytical data on a molecular sensory level. After alkaline, acidic, and thiolytic degradation of the HMW fractions, the reaction products were analyzed by LC-MS/MS and ion chromatography to get an insight into the molecular mechanisms of odorant polymer interactions in red wine.
Results:
A quantitative ^{1}H NMR-based approach revealed clear structure activity relationships between structural properties of aroma compounds and their interaction type with HMW polymers. In detail, various noncovalent interaction scenarios were investigated for single compound classes, explaining changes in the sensory perception of an aroma reconstitution model after the addition of polymers. Further, NMR interaction studies with degraded HMW fractions showed the importance of single structural features for the binding affinity of polymers, e.g., phenolic acids. Additionally, human sensory experiments confirmed that targeted treatment of natural HMW polymers can influence the aroma perception of red wine.
Conclusion:
For the first time, a direct NMR screening tool enabled the prediction of aroma changes in red wine caused by HMW polymers. In addition, targeted degradation of polymers demonstrated the opportunity to influence the odorant polymer interactions and, further, the aroma perception itself. Based on these results, in the future, the aroma of red wine could be improved in an easy, natural, and sustainable way according to costumer’s desires.

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Designing plant-based protein oleogels as potential solid fat replacers in food products

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Aim:
Due to health and sustainability aspects, there is a high interest in replacing solid fats in food products. One possible approach is the use of structured oils, so called oleogels. Whey proteins were recently shown to be a suitable structuring agent. Proteins have benefits over other structuring agents due to their high nutritional value, high consumer acceptance and label-friendliness. In this research, the aim was to investigate whether proteins from plant origin can also be used to prepare protein oleogels, and how differences in the protein characteristics lead to differences in the physical properties of the oleogels.

Method:
A solvent transfer method was used to stepwise transfer protein aggregates of submicron size from water to oil. This slow change in solvent polarity makes it possible to introduce hydrophilic protein aggregates into oil whilst preventing extensive agglomeration. Already at low concentrations of protein ($\sim$ 5-10%), network formation occurs, and oleogels with solid-like properties are obtained.

Results:
Our results show that the solvent transfer method can indeed be applied to a range of different globular proteins, including different plant-based proteins. The oleogel properties were shown to depend on the protein aggregate size and hydrophobicity. Moreover, we found that addition of water leads to the formation of capillary bridges between the protein aggregates, which increases the gel strength significantly. Compared to other methods, this method promises high flexibility regarding the use of different protein sources, and the possibility to control the gel properties by adjusting the interactions between the protein aggregates.

Conclusion:
The solvent transfer method is a suitable method to be generally applied to globular proteins, including plant proteins. Using plant proteins, we can obtain vegan oleogels, which only consist of oil and protein. Such plant-based oleogels can potentially be used as an alternative for animal-based solid fats or palm fat. The gel properties, such as gel strength and plasticity, can be adjusted by tuning the interactions between the protein aggregates. Controlling the properties of such oleogels provides great potential for their use in different types of food products.

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Oleosomes: natural oil droplets for dairy alternatives - studied by lubrication behaviour (tribology)

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Aim:
To show the potential of oleosomes (natural oil droplets) as a substitute for milk fat globules in dairy alternatives.
Method:
Oleosomes (a.k.a. lipid droplets or oil bodies) are omnipresent natural oil droplets in plant seeds. In this work, we extracted these oleosomes from rapeseeds and studied their lubrication behaviour by tribology. Proper lubrication (i.e. friction reduction) during oral processing is crucial in the sensory perception of food products, especially dairy alternatives. We have studied the friction-reducing properties of oleosomes by using an Anton Paar Tribocell setup. In addition, we created full-fat and skimmed dairy alternative model systems by creating oleosome–whey protein and oleosome–pea protein mixtures. The tribological properties of these systems were evaluated and compared to pea protein emulsion droplets.
Results:
Oleosomes can reduce friction by a mechanism called ball bearing (i.e. rolling). Oleosomes seem to remain largely intact after the analysis, which can be related to their special membrane containing proteins and phospholipids. In a mixture with proteins (at neutral pH), the proteins can dominate the lubricating properties in a skimmed dairy alternative system, while the oleosomes dominate the full-fat system. At an acidic pH of 4, the oleosomes possess a great feature, as the droplets remain single droplets, while pea protein emulsions flocculate. This gives oleosomes significantly better lubricating properties.
Conclusion:
Oleosomes have excellent lubricating properties and possess the potential to substitute fat globules and even plant protein-stabilized oil droplets in dairy alternatives.

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Ultra-high-pressure homogenization (UHPH) in the preparation of spray-dried functional emulsion: application in dairy-based products

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Aim

Combining functional compounds like omega-3 rich oils and buttermilk (BM) in spray-dried emulsions (SDE) is a suitable technique for incorporating these ingredients as alternative dairy fats and enhancing their functional properties. In comparison to conventional homogenization (CH) of liquid emulsions, ultra-high-pressure homogenization (UHPH) remarkably improves emulsion stability. In the food industry, spray drying is the most widely used method to fabricate SDE due to its low cost, availability, and diversity. The addition of them to dairy products can help to acquire functional foods that are commonly consumed by consumers, like yogurt. The aim of this study was to evaluate the main characteristics of yogurts with SDE incorporated at different concentrations to develop a functional dairy product which is frequently consumed.

Method

Feed emulsions were produced by CH and UHPH at 30 MPa and 100-200 MPa, respectively. Emulsions were formulated with a 10% oil mixture of chia seed (*Salvia hispanica* L.) and sunflower (*Helianthus annuus* L.) oils in 1:1 ratio, commercial BM was added at 7% (w/w) as emulsifying agent and maltodextrin (30% w/w) as carrier material of SDE. Yogurts were produced according to the following formulation: 3% skimmed milk powder (SMP), 2% starter and 4 or 6% SDE. The particle size, physical stability, and rheological characterizations of the feed emulsions were evaluated. The encapsulation efficiency (EE), oxidation stability, and water solubility for SDE were analized, and rheological, textural, water holding capacity (WHC), and sensory properties of the yogurts were investigated.

Results and conclusion

Results showed that the UHPH improved stability of feed emulsion by reducing considerably the individual particle size of oil droplets and colloidal particles such as aggregates which significantly increased the EE of SDE. The 7% BM UHPH-treated SDE indicated the best primary oxidation stability during storage, while the 4% BM-UHPH-treated SDE had better secondary oxidative stability. On the other hand, quality characteristics of yogurts in terms of WHC, texture and sensory perception were improved in UHPH-SDE yogurts compared to CH. However no significant differences were observed in the percentage of UHPH-SDE added (4 or 6%), which means that the highest concentration of UHPH-SDE would be used for fortifying yogurts with omeg-3 oil.

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Decarbonisation in food supply chain: a review of current European initiatives

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Aim:
The aim of this study is to review current European policies, regulations, food standards and eco-labels and analyze how these initiatives contribute to decarbonization in food supply chain and achieving carbon neutrality by 2050.

Method:
A systematic analysis is performed to review European initiatives linked to decarbonisation in food sector from 2000 to date. To this end, eight categories and more than 50 sub-categories are defined to extract and categorize European policies, governance activities, standards, and eco-labels. The categorization allows to extract information related to the policy context by identifying the applicable food sector, the stage in the food chain and timeline. The study also includes categories related to technical aspects of decarbonization and how to achieve it.

Results:
More than 40 regulations, food standards and eco-labels are reviewed. Most of the European strategies and policies have a broad scope and include decarbonization and energy efficiency among other environmental goals. In addition, most have long term frameworks, such as 2030 and 2050. When it comes to eco-labels and food standards, there is no common framework that allows consumers to compare different food groups and product categories. Most of the food eco-labels are related to organic farming, rather than carbon footprint.

Conclusion:
There is a gap between the regulatory level that sets the objectives for decarbonisation and the implementation of these policies. In most cases, it is poorly specified how the targets will be achieved, making it difficult to put the policies in practice and to analyse their effectiveness. The current voluntary scheme for eco-labels is changing towards a more regulated and mandatory scheme. There is a trend towards a more integrated and multi-indicator labelling, meaning that food labels include not only carbon footprint but also other environmental aspects, such as water consumption and biodiversity. This brings some clear advantages since environmental challenges are addressed in an integrated manner; however, it comes with a more challenging quantification and risks losing focus on carbon emissions.

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Carbon nanotube-based sensors for intelligent packaging

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Aim:

The aim of this project is to develop an optical oxygen sensor for applications in intelligent packaging. The optical sensor will be based on near-infrared light that can penetrate through visibly opaque materials, including plastics, paper, and cardboard. An automated near-infrared camera will be used to precisely and quickly inform the user of any change in the integrity of packages that are vacuum-sealed or atmospherically modified.

Method:

The optical sensor is based on near-infrared fluorescence that is emitted from carbon nanotubes (CNTs). CNTs exhibit a sensitive and photostable fluorescence that is well suited for sensing applications. The CNTs are wrapped by one of two types of DNA, $AT_{(15)}$ and $GT_{(15)}$, through sonication. These wrappings control the responsivity of the CNTs to different gases while also solubilizing them for further processing. The resulting solutions are then drop-casted into a film. We subsequently investigate the response of the film in the presence of the target gas, oxygen, at different concentrations. Finally, we evaluate the selectivity of the sensor in the presence other gases including carbon dioxide, ethylene, and ammonia.

Results:

Our results reveal that the florescence intensity of the $AT_{(15)}$ and $GT_{(15)}$-wrapped CNTs quenches upon the exposure of oxygen. Interestingly, we observe that the different CNT chiralities respond distinctly to the presence of oxygen. In particular, whereas some chiralities undergo an irreversible loss in fluorescence after several oxygen exposure cycles, the (8,6) chirality demonstrates stability over multiple cycles for both $AT_{(15)}$ and $GT_{(15)}$-wrapped CNTs. Finally, our results show a concentration-dependent and selective response of both the $AT_{(15)}$- or $GT_{(15)}$-wrapped CNT sensors to the oxygen, as we observed no significant response to the other studied gases.

Conclusion:

We developed an optical sensor based on CNT fluorescence for intelligent food packaging. The sensor is selective to oxygen and demonstrates reversibility over multiple oxygen exposure cycles. These sensors can be used to monitor the integrity of packages that are vacuum-sealed or otherwise atmospherically modified. This technology can thus provide consumers and manufactures a means of preventing early spoilage and ensuring food quality.

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Broad-spectrum antimicrobial coatings for food safety

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Aim:

Guaranteeing food safety is a key aspect, from supply chain to processing of raw materials and product packaging. Surfaces are a notorious source of contamination as they can host microbiota, including human pathogens, that can potentially be transmitted to the food chain and be responsible of outbreaks of infective diseases in the population. In this scenario, we developed a coating that can easily be applied to a variety of materials and successfully deactivate viruses and bacteria.

Method:

A semicontinuous seeded emulsion polymerization was employed to synthetize a latex formulation. The latex was applied to plastic surfaces and dried overnight. Then, an active compound was added by impregnation and successfully immobilized on the coating. The antimicrobial activity of the coated surfaces was tested against model viruses and bacteria. In a typical experiment, the viral/bacterial inoculum was added to the surface ($2x2cm^2$) and left to dry for 30 min. The residue was immediately collected with a swab. The residual virus titer was obtained by performing plaque assay, whereas the survived bacteria were determined by growing colonies on agar plates.

Results:

The latex formulation was used to coat plastic surface samples and served as a platform to immobilize antimicrobial compounds via supramolecular interactions. Latex-coated surfaces successfully deactivated more than 99.9% of the model enveloped virus HSV-2 in 30 min. Further experiments carried out on an alternative enveloped virus, i.e., Influenza A, suggested the broad-spectrum antiviral action of the coating. The coating was also able to inhibit the growth of both Gram+ (*S. aureus*) and Gram- (*E. coli*) model bacteria.
Coated surfaces were washed multiple times to test the lifetime of the antimicrobial activity. It was found that the surfaces partially lost their antibacterial action after 90 washes. Nevertheless, it was possible to fully recover the antimicrobial performance of the coating after its reloading with the active compound.

Conclusion:

A low-cost and easily scalable coating formulation was developed to guarantee microbiological safety in food factories. Its broad-spectrum antimicrobial activity was demonstrated by testing the surfaces against different kinds of viruses and bacteria.

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Nutrient-dense, texture-modified and portion-sized hybrid meat designed for senior consumers: perception and behaviour.

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Aim: European population is growing older. Healthy food impacts on healthier ageing. Reducing portion size of meat products, increasing nutrient-density per portion (protein, dietary fibre and micronutrients) and replacing meat with plant-based ingredients are among the strategies for sustainable nutrition targeted for senior consumers. Method: Three types of hybrid meat products (75:25) were developed using two mincing speeds (200 and 2400 rpm), two types of meat (beef or lamb), mushrooms and upcycled fibre ingredients, as sources of protein (15.9 – 17.9 g/ 100 g), selenium (11.0 – 13.8 mg/ 100 g) and dietary fibre (3.1 – 3.4 g/ 100 g), respectively. Compression blade, multiple penetration and tenderness tests were carried out. Eighty senior consumers segmented in two age ranges (50-59 and over 60 years) tested the hybrid prototypes. Perception of ease of chewing and swallowing, inclusion in the diet, purchase intention, suggested improvements and preferences were analysed. Results: This sustainable nutrition strategy allowed claiming "*source of*" protein, fibre, selenium and zinc per portion. Differences in texture-modified meat products, varying in type of meat and cutting speed were detected by the multiple penetration test and the compression blade test, respectively. An overall liking around 6/9 points was the average score. In general, female participants liked appearance and odour more than male. Age-wise, participants from 50-59 years liked appearance and odour more than participants over 60 years. The latter found more difficulties in chewing and swallowing the hybrid meat products, meaning that this perception decreased with age. Chewing and swallowing easiness was mostly perceived in samples with lamb meat and higher degree of mincing. Finally, when nutritional information was given to the consumers, the percentage of diet inclusion increased significantly for the three types of hybrid meat. Over 65% of participants claimed improvements in the hybrid products, especially in texture, taste and appearance, and around 45% preferred lamb sample as first choice.
Conclusion: Although there is further research needed to improve the sensory properties of portion-sized meat targeted for senior consumers, this study shows the potential of naturally-rich sources of micronutrients and fibre to develop nutrient-dense food for a healthy aging and a sustainable food system.

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Incorporating zinc into provitamin A, quality protein maize and normal maize hybrids

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Aim: The aim of this study was to incorporate Zn into maize already biofortified with provitamin A, lysine and tryptophan (quality protein maize) and in normal (non-biofortified) maize, and to test these hybrids under small-scale farmer production conditions of drought stress and low nitrogen to determine if nutrient levels are maintained.

Introduction: The negative impacts of Zn, Fe, vitamin A and essential amino acid deficiency, due to over-reliance on monotonous cereal-based diets in many African countries, are well-documented. Previously biofortification (the genetic improvement of nutritional value of crops) was usually done for single nutrients, but there is now a trend to combine different nutrients into varieties. The question then arises how these “stacked” biofortified varieties perform under small-scale farmer production conditions and whether the enhanced nutritional levels are maintained.

Methods: Hybrids were constituted from 11 Zn donors derived from CIMMYT-Mexico and IITA-West Africa crossed with seven testers from normal maize, provitamin A and QPM backgrounds, all from CIMMYT-Southern Africa, creating 77 hybrids. These hybrids, together with seven commercial checks were evaluated for grain Zn and Fe concentration and yield under optimum, low nitrogen and managed drought conditions

Results: Notable differences for Zn concentration were observed between the Zn-enhanced QPM (31.5 mg kg^{-1}), Zn-enhanced provitamin A maize (28.5 mg kg^{-1}), Zn-enhanced normal maize (26.0 mg kg^{-1}) and checks (22.9 mg kg^{-1}). The checks had the highest grain yield (GY), followed by Zn-enhanced normal hybrids. Genotypes grown optimally had higher micronutrient concentrations than those grown under stress. The correlation between grain Zn and Fe was highly significant ($r = 0.97$). However, the negative correlation between GY and grain Zn ($r = -0.44$; $p \leq 0.01$) and between GY and grain Fe concentration ($r = -0.43$; $p \leq 0.01$) was significant.

Conclusion: QPM and provitamin A biofortification enhanced Zn and Fe biofortification. Drought stress and low nitrogen conditions reduced levels of Fe and Zn in all hybrids. There was a yield penalty associated with biofortification, although some hybrids had yield levels comparable to commercial checks.

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Processing improves physical and oxidative stability of cricket protein emulsions

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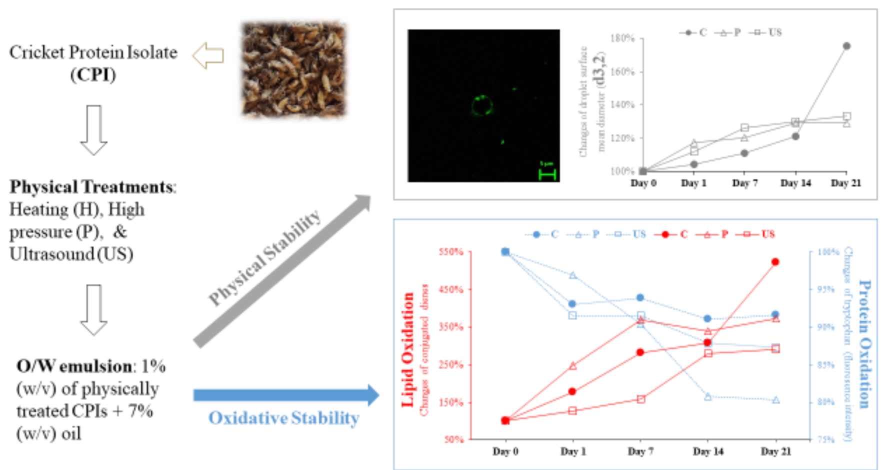
Aim:
This study expanded the knowledge on food applications of isolated insect protein with focusing on house cricket (*Acheta domesticus*). The aims were to (1) study how physical treatments affect the physicochemical properties and the emulsifying capacity (EC) of cricket protein isolate (CPI) and (2) investigate whether the modified CPI improves the physical and oxidative stability of oil-in-water (O/W) emulsions.

Method:
CPI was obtained by isoelectric precipitation. Three treatments: heat (H), high pressure (P), and ultrasound (US), were applied to CPI dispersion (1%, w/v). The effect of the treatments on the physiochemical properties of CPIs was evaluated by measuring their molecular weight (MW) distribution, surface charge, surface hydrophobicity, and solubility. The effect of the treatments on the EC of CPI was evaluated by monitoring the stability of CPI-emulsions. Four emulsions, control (C-), H-, P-, and US-, were prepared by mixing 1% (w/v) CPI with purified rapeseed oil and Milli-Q water. CPIs at the surface of the droplets were visualized using confocal lazer scanning microscopy. All four emulsions were monitored for physical and oxidative stability at 4 °C for 21 days.

Results:
Both P- and US-treatments resulted in breakdown of larger proteins into smaller fractions as well as increased solubility, negative surface charge, and hydrophobicity of CPIs, which positively affected the EC. In comparison to C- and H-, both P- and US-treatments resulted in emulsions with reduced droplet size on day 0, with better physical stability during 21-day storage indicated by changes of droplet surface mean diameter, and morphology. Both P- and US-treatments slowed down the lipid oxidation in emulsions, however with accelerating protein oxidation.

Conclusion:
This study showed that CPI can be applied as an emulsifier in O/W emulsion. Both the physical and oxidative stability of emulsions could be improved by physically modified CPIs. Especially P or US improved the emulsifying performance of CPIs as evidenced by the smaller oil droplet size of fresh emulsions and less oxidative changes during storage. P and US resulted in modification of CPI with lower MW proteins that contributed to increased solubility, negative surface charge, and hydrophobicity, all linked to a better emulsifying activity.


Cricket Protein Isolate (CPI)
Physical Treatments: Heating (H), High pressure (P), & Ultrasound (US)
O/W emulsion: 1% (w/v) of physically treated CPIs + 7% (w/v) oil
Physical Stability
Oxidative Stability
C P US
Changes of droplet surface mean diameter (d3,2)
180%
160%
140%
120%
100%
Day 0
Day 1
Day 7
Day 14
Day 21
Lipid Oxidation
Changes of conjugated dienes
Protein Oxidation
Changes of tryptophan (fluorescence intensity)
550%
450%
350%
250%
150%
50%
100%
95%
90%
85%
80%
75%

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Enhancing the safety and quality of marinated small pelagic fish

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Enhancing the safety and quality of marinated small pelagic fish: Establishing the critical elements of quality loss and fraud causes from catch to consumption

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Aim

Fish, especially small pelagic species is highly recommended in food diet, but it is an extremely perishable food product, thus particular caution is essential at harvesting and over the supply chain in order to preserve its quality and nutritional attributes, and to avoid contamination, mislabeling, waste and loss. The purpose of this study is to determine the critical elements of quality loss (CEoQL) and of fraud causes (CeoFC) for a processed pilot species such as *Engraulis encrasicolus*, greatly appreciated in the Mediterranean countries.

Method

The determination of the CEoQL/CeoFC for anchovy included input variables such as the raw material attributes (i.e., fish origin, proximate composition) and the process parameters (marinating effect), while outputs are the critical quality attributes of the final fish product (i.e., nutritional and microbial values, authenticity of the fish product). Two optical technologies (Near Infrared Spectroscopy (NIR) and Hyperspectral Imaging (HIS) were used to build predictive methods able to detect either the origin and the storage conditions of the fish. Analysis were performed in three Mediterranean laboratories (Tunisia, Spain and Italy) using shared fish samples from different region and taken at different points along the marinated anchovy production process.

Results
Among the input variables that were determined in anchovy flesh including the proximate composition as well as amino and fatty acids; the levels of lipids and polyunsaturated fatty acids (PUFA) showed significant changes according to season and region and therefore can be considered as CEoQL.
The analysis of pH, proximate composition, trimethylamine (TMA), biogenic amines during post-harvesting practice (from fishing to the plant); revealed significant increases of TMA and histamine and can be used as CEoQL. However, following marinating step, histamine levels were undetectable. HSI and NIR allowed the differentiation of both origin (Mediterranean and Cantabric Sea) and fresh from thawed anchovy' samples.
Conclusion
By linking the input variables and the process parameters to generate the critical quality attributes of the final product, it can be concluded that for marinated anchovy; the CEoQLto be considered are principally agmatine, mesophilic flora, and nutritional values. HSI and NIR devices can be used to determine the CEoFC at different points along the food chain from the harbour reception, in fish markets, supermarkets, along the distribution chain to the final consumer.

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Evaluation of different strategies to reduce the microbial load of fresh fruits and vegetables

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Aim:
This contribution will give an overview on selected results from the research project "produce safety", funded by the Austrian Research Promotion Agency (FFG).
Ready-to-eat and fresh-cut fruit and vegetable products become increasingly popular among consumers, as they can contribute to a healthy, yet convenient lifestyle. However, due to their agricultural origin and minimum level of processing, the microbial load of the final products is fluctuating and often relatively high.
Method:
Different strategies to reduce microbial loads on fresh-cut salad and fresh raspberries were evaluated. The raw materials were inoculated with *Enterococcus faecium* NRRL B-2354 (as a surrogate for pathogenic enterobacteriaceae) and microbial inactivation was evaluated. For the most promising technologies, the raspberries were subsequently inoculated with bacteriophage MS2 (as a surrogate for norovirus). Technologies used included short-time heat treatment, H_2O_2 vapor and pulsed light for surface decontamination of salad and berries, as well as washing water additives for fresh-cut salad.
Results:
Results showed that short-time heat treatment (up to 60 °C, 5 s) was able to effectively inactivate microbial counts, however quality of salad and berries was unacceptable. H_2O_2 vapor was ineffective against *E. faecium* contamination on salad (>1200 ppm, 5 min; < 1 log), but promising for the surface decontamination of raspberries (800 ppm, 5 min; 2.5 log). However, inactivation of bacteriophage MS2 was not sufficient (800 ppm; < 1 log) and H_2O_2 residues remained. Similarly, pulsed light treatment (up to 20 J/cm²) was shown to have a limited decontamination effect on fresh-cut salad, most likely due to the rough surface of the salad leaves. In case of raspberries, pulsed light treatment up to 20 J/cm² was effective against *E. faecium* (2.5 log) and bacteriophage MS2 (3.5 log). Therefore, corresponding upscaling trials were carried out in an industrial environment. For fresh-cut salad, washing water additives (antimicrobial plant extracts, acids, chlorine-based agents) were shown to be effective in reducing the microbial load.
Conclusion:
Different surface decontamination strategies were evaluated considering their ability to reduce microbial counts but also considering their individual influence on product quality. Subsequently, particularly pulsed light treatment and washing water additives were shown to make fresh fruits and vegetables not just convenient and healthy, but also microbiologically safe.

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Ball milling as a tool to alter the extractability and colloidal state of oat proteins

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Aim
To increase the extractability of oat proteins and to understand process-induced changes in their physicochemical and colloidal properties. It is hypothesized that these insights will allow directing the functionality of oat proteins in liquid and semi-solid foods.
Method
Defatted whole meal oat (DWO) was subjected to dry ball milling prior to alkaline extraction (at pH 9.0) and centrifugation at low (2,000 x *g*) or high (12,500 x *g*) centrifugal force. The obtained extracts were characterized for their protein recovery (via nitrogen determination), particle size distribution (by dynamic light scattering [DLS]) and protein apparent molecular weight distribution (by size exclusion high performance liquid chromatography [SE-HPLC].
Results
Ball milled wholemeal oat (BDWO) had a considerably lower average particle size than DWO. As a result, the protein recovery was considerably higher in BDWO extracts than in DWO extracts. Interestingly, more proteins were recovered in extracts centrifuged at 2,000 x *g* (38 and 64% in DWO and BDWO extracts, respectively) than at 12,500 x *g* (29 and 44% in DWO and BDWO extracts, respectively). This indicates that a fraction of oat proteins remains in dispersion at low centrifugal force but precipitates (and thus is colloidally unstable) at high centrifugal force. Nitrogen determination and SE-HPLC analyses showed that this protein fraction mainly consists of (aggregates of) oat globulins. Moreover, that the decrease of the protein recovery upon applying a higher centrifugal force was more pronounced for BDWO than for DWO extracts suggests that ball milling changes the colloidal (aggregation) state of the extract proteins. This was further supported by the observation that, even though DWO and BDWO extracts had similar particle size distributions, membrane filtration (450 nm pore size) of BDWO extracts led to a more pronounced loss of protein material in comparison with DWO extracts.
Conclusion
Our findings show that it is possible to increase the protein recovery and to direct the protein colloidal (aggregation) state of aqueous extracts of defatted wholemeal oat by varying the centrifugal force and/or by including a ball mill step prior to extraction. This can have important implications for the production of oat based liquid and semi-solid foods.

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Enrichment of DPP-IV inhibitory peptides in quinoa for the treatment of type II diabetes mellitus

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Aim:
Various studies demonstrated that peptides from different foods possess an inhibitory effect towards the enzyme dipeptidylpeptidase IV (DPP-IV). Inhibition of this enzyme is crucial for insulin secretion in diabetics. According to literature, absorption of these peptides occurs in the small intestine and their inhibitory potential is dependent on protein hydrolysis and gastrointestinal digestion. The aim of this study was to investigate the effect of malting and simulated human digestion on the accumulation of DPP-IV inhibitory peptides in quinoa. Furthermore, a robust and sensitive method should be developed for the identification and quantification of literature known DPP-IV inhibitory peptides in quinoa.

Method:
Quinoa, showing high inhibitory potential, was treated at different malting conditions (time, humidity, and temperature). All malted samples were hydrolyzed using pepsin, trypsin and chymotrypsin. Subsequently, the DPP-IV inhibitory effect was measured of the digested and undigested quinoa malt samples. Furthermore, literature-known DPP-IV inhibitory peptides were quantitated in these samples by means of UHPLC-MS/MS.

Results: Statistical analysis of the data revealed a decrease in the inhibitory potential against DPP-IV in malted quinoa upon *in vitro* human digestion, except for quinoa, which was malted at 48 % moisture, 11.5 °C, and seven days. This sample had the highest inhibitory activity of 18.55 ± 3.48% among all digested and undigested samples. Using a newly developed, robust and sensitive UHPLC-MS/MS method, seven DPP-IV inhibitory di- and tripeptides were identified and quantified in digested, and five in undigested quinoa malt for the first time. However, the peptide concentrations and the overall inhibitory effects of the samples correlated only slightly.

Conclusion:
In conclusion, malting has a beneficial effect on the presence of DPP-IV inhibitory peptides in quinoa. After gastrointestinal digestion of these samples, the concentrations of literature known DPP-IV inhibitory peptides increased. Based on the discrepancy between the peptide concentrations and the inhibitory effect of the samples, further unknown DPP-IV inhibitory peptides are expected to be present in quinoa.

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From microscopic to macroscopic descriptions of the contamination of food by recycled papers and boards

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Introduction

Contrarily to recycled plastics, recycled cellulosic materials are not decontaminated before being incorporated into food packaging. As a result, recycled paper and board are systematically contaminated by mineral oils, possibly carcinogenic, and phthalates, recognized as endocrine disruptors. To address these issues, France established severe restrictions to limit the exposure of its consumers to these substances. The MCDA sheet N°4 (01/01/2019) of the French DGCCRF enforces strict control migration of these substances from packaging, even without contact. More recently, and under the French anti-waste law N°2020-105, the phasing out of mineral oils from all printing ink applications is scheduled by 2023 (draft order TREP2105211A). This study explores the mass transfer conditions of these substances at the macroscopic and microscopic scales.

Method

Mass transfers were studied at the scale of fibers via microscopic Raman spectroscopy and laser scanning confocal microscopy. Macroscopic mass transfers were studied from mass balance and analyzed concentration profiles in stacked paper sheets. Blotting paper, fully characterized in scanned electron microscopy and X-ray microcomputed tomography, was used as reference material. Contaminated materials were obtained either by dipping (surface adhesion) or by impregnating (surface and internal impregnation) fibers with the desired substances by choosing a non-wetting and wetting solvent, respectively. The initial and final distributions of substances were reconstructed from 2D and 3D image analysis.

Results

The initial distribution of chemicals was affected by two independent factors: the method of incorporation and the intrinsic properties of the substance. Molecules with high melting points tend to crystallize in non-wetting droplets, whereas they are more spread on all fiber surfaces using a wetting solvent. A significant discrepancy in initial chemical potentials was identified between both configurations and confirmed by the extent of mass transfer, with well-dispersed mineral oils giving the fastest mass transfer. Substances with a liquid reference state were dispersed more homogeneously at the surface and resulted in a faster mass transfer.

Conclusion

A first mass transfer study integrating a vaporization/condensation scenario between fibers is presented and discussed based on the contamination of recycled paper and board by mineral oils reported in the literature.

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Development of intelligent packaging to monitor food degradation and reduce food waste.

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Aim: Intelligent packaging are materials 'which monitor the condition of packaged food or the environment surrounding the food' (EC 450/2009). Many examples have been developed in recent years such as time-temperature indicators to help consumers know the ideal temperature to drink a cold beverage; cold-chain break indicators, which are labels that are able to change colour if the cold chain has been broken; or Radio-Frequency Identification (RFID) tags to allow better traceability of products. The aim of our research is to develop an intelligent packaging able to inform its user about food freshness in real time in order to ensure food safety while reducing food waste. Indeed, many products are wasted due to a misunderstanding of the "Best-before" date and excessive precautions.

Method: The project consists in the design, synthesis, characterization and testing of an intelligent material which can be integrated into conventional food packaging. The resulting intelligent packaging is capable of monitoring markers released by food products during degradation. The interaction between the polymer material and the markers leads to a modification of the fluorescence properties of the material.

Results: In the case of direct contact between the material and the food product, the developed sensor allows a rapid detection (less than 5 minutes) of food spoilage markers with low detection limits (from 25 to 100 mg/L). Food degradation can also be monitored by indirect contact between the material and the food product.

Conclusion: Developing an intelligent packaging to monitor food spoilage could be an asset for the food industry.

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Future cheeses produced by extrusion of renneted curds

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Aim:
The possibility to structure milk curds by extrusion, in order to create cheeses with customized properties in terms of texture and meltability has not been studied. Hence, the aim of this study was to investigate the shearing process of renneted curds in an twin-screw extruder, and understand the effect of the extrusion parameters on cheese composition, structure and texture.
Method:
A lab twin-screw extruder with a cylindrical cooling die was used for the shearing process. Four parameters at two levels were selected: heating temperature (T_h, 80 or 90 °C), screw speed (SP, 50 or 150 rpm), barrel length (L, half or full) and cooling temperature (T_c, 10 or 30°C). Residence time (RT) and specific mechanical energy (SME) were calculated. Exit temperature (T_{exit}) of the extrudates was measured at the exit of the cooling die. The effect of controllable parameters (T_h, SP, L and T_c) on measured and calculated parameters (SME, T_{exit} and RT) and curd properties (water content and distribution, textural properties – elasticity and melt strength, and microstructure by X-ray micro-computed tomography) were evaluated.
Results:
Extruded curd products with a variety of properties were obtained, which were significantly influenced by controllable extrusion parameters T_h and T_c. A higher T_h enhanced curd elasticity and reduced melt strength while a higher T_c induced lower water content (42.8–48.6%) and melt strength. The measured and calculated parameters could comprehensively summarize the effect of multiple controllable parameters and their interactions. Easily separated, longer and finer fibers were formed at lower SME 23–27 $kJ \cdot kg^{-1}$, higher T_{exit} 50–54 °C and shorter RT 55–60 s, conditions that were reached at T_h of 90 °C, SP of 150 rpm and full-L of the extruder. Microstructure of the parallel protein fibers separated by fat particles was clearly observed.
Conclusion:
The relation between controllable extrusion parameters, characteristics of the extrusion process and properties of the curd provided new insigths that can be further explored to produce structured cheese products with customized properties.
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Development of antioxidant-rich sweet potato yoghurt using the orange-fleshed 'Bophelo' sweet potato (Impomea batatas)

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Aim
Determination of whether plain yoghurt bio-fortification with antioxidant-rich 'Bophelo' sweet potato (orange fleshed) cultivar will produce antioxidant-rich sweet potato (SP) yoghurt.

Method
Four cups of 250 ml plain yoghurt (PY) were incorporated with 5 g of raw, boiled and baked processed powder from unpeeled (UP) 'Bophelo' SP. The 4 treatments [250 ml PY (standard), 250 ml PY + 5 g raw SP powder, 250 ml PY + 5 g boiled SP powder and 250 ml PY + 5 g baked SP powder] were arranged in CRD in triplicates. The treatments were processed in a food-blender for 2 min prior to transferring into 250 ml bottles and incubated at 43°C until pH 4.7. After coagulation, samples were stored in a refrigerator at 5°C for 10 days and thereafter subjected to microbial and antioxidant analysis. *Escherichia coli, Coliforms*, *Staphylococcus aureus*, *Enterobacteria*, *Lactic Acid bacteria* and *Bacillus cereus* count were analysed. Total phenolic (TP), beta-carotene (BC) and vitamin C (Vit C) were determined. Collected data were subjected to analysis of variance through the SAS 2010 software. Data on the total bacteria plate count for PY and 'Bophelo' SP biofortified yoghurt [unpeeled raw yoghurt (UPRY), unpeeled boiled yoghurt (UPBOY) and unpeeled baked yoghurt (UPBAY)], showed 3300, 8300, 2210000 and 380000 Cfu/ml, respectively. The lowest count was in PY, whereas the highest was in UPBO 'Bophelo' SP yoghurt.

Results
Compared to standard, UPBOY exhibited high TP (49.23 mg GAE/g dw), followed by UPBAY (36.31 mg GAE/g dw), although not significantly different to each other. In addition, UPRY contributed high BC (23.99 µg/100g), followed by UPBAY (26.03 µg/100g) and UPBOY (28.72 µg/100g), when compared to standard. However, no significant difference between UPBOY and UPBAY fortified yoghurt were observed. In terms of Vit C, PY maintained the highest Vit C (272.95 µg/100g), whereas a significant decrease was observed in all yoghurt samples, compared to standard. The highest decrease was observed in UPRY, UPBOY and the least was in UPBAY by 181.47, 194.87 and 218.63 µg/100g, respectively.

Conclusion
No harmful bacteria were detected. The incorporation of UPBO and UPBA 'Bophelo' SP increased TP and BC of PY.

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Contribution of plant proteins to structure and physical stability of lean meat analogue model systems

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Aim:
Despite increasing popularity, vegetarian emulsified meat analogues often have sub-optimal texture. This study therefore screened plant proteins, the main structure-forming ingredients in these analogues, towards their contribution to structure and physical stability.

Method:
A protein solution system was set-up to compare 6 plant protein concentrates (chickpea, fava bean, mung bean, pea, potato, soy) at 3 concentrations (17.5 wt%, 20.0 wt%, 22.5 wt%). The water holding capacity (WHC) and structure (oscillatory rheology) were determined at 3 stages: unheated (*Solution*), heated (*Hot Gel*) and heated and cooled (*Cold Gel*). Furthermore, the stability (syneresis, freeze-thaw) and texture (peak force) of the final gels were evaluated. Statistical analysis was performed by two-way ANOVA followed by Tukey's post-hoc tests ($p<0.05$; $n=2$).

Results:
At *Solution* soy showed the highest storage modulus (LogG'), a parameter linked to the nature and number of molecular interactions. For all proteins increase in concentration tends to result in higher LogG'. At *Cold Gel* potato at 20.0 wt% and 22.5 wt% showed highest LogG', while other proteins had similar, lower values. Only potato and soy showed a significant concentration effect.
Soy had highest WHC at all stages. Lowest WHC was shown by potato (*Solution*) and mung bean (*Hot Gel* and *Cold Gel*). Except for potato at *Hot Gel*, increasing concentrations led to significantly higher WHC. For all protein systems WHC at *Hot Gel* was higher than at *Solution*. This is attributed to protein gelation and was most pronounced for potato and least pronounced for mung bean.
Significantly higher peak forces were observed with potato and soy. Higher concentrations led to higher peak forces, except for chickpea and pea.
The stability of mung bean, pea and potato (only for freeze-thaw) was lower than other protein sources, with only pea and potato (only for freeze-thaw) showing a significant concentration effect.

Conclusion:
Overall soy and potato showed highest values of structure and physical stability, while mung bean, pea and chickpea showed lower values. Concentration effects were often significant and dependent on protein source.
Follow-up research should consider other ingredients, such as fats, starches and hydrocolloids, and possible synergistic effects on structure and physical stability.

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Mechanistic modeling of the dynamics of phage attack in milk acidification for the cheese-making process

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Aim:
Milk acidification is a key step in the cheese-making process. In the industry, bacteriophages can attack lactic acid bacteria (LAB), which are responsible for the conversion of lactose to lactic acid. In consequence, acidification can be reduced or even stopped, leading to a halt in the production and thus severe economic losses for cheese-makers. The goal of this study is to develop a dynamic mechanistic model to predict the dynamics of phage attack. Cheese-makers can use this model to monitor the cheese-making process based on the detected phage concentration.
Method:
Acidification curves, i.e. pH measurements over time, were generated for 96 different couples of initial LAB concentrations and phage titers. A dynamic mechanistic model was constructed and consisted of 6 ordinary differential equations for the state variables: lactose and lactic acid concentration, susceptible, infected, and dead LAB concentration, and phage titer. The model parameters were estimated by minimizing the squared discrepancies between observed data, on the one hand, and their expected values on the other. The model and its optimization were implemented using python.
Results:
The acidification data showed that normal acidification takes place when the LAB concentration is high and phage titer is low. When the LAB concentration decreases, the acidification is delayed. With high phage titers, acidification does not take place. Phenomena such as increase in pH after some time, or pH drop in high phage titers were observed. The model was able to predict satisfactorily most of the cases. Parameters were estimated with a reasonable confidence interval. Behavior of phages and bacteria were deduced from acidification plots.
Conclusion:
The model succeeded in predicting most of the phenomena taking place in the experiment. Important parameters and behaviors were deduced from simple and low-cost acidification measurements. The model can be expanded to include different phages and bacteria species, and blends of both to mimick a typical cheese-making environment. The model can be used to raise awareness amongst cheese-makers on the importance of cleaning to avoid economic losses and product contamination.

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Nudging as a tool to help students make sustainable and healthy decisions at university canteen

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Aim
Identifying strategies to steer young consumers' eating habits towards healthier and more sustainable eating choices is crucial as today's dietary decisions have an impact on future consumers', planet's health and food systems reshaping.
University students are the target group of this research as they are in a critical phase of their lives.

Method
Four focus group discussions (explorative phase) were conducted in December 2021 with university students from the University of Parma, Italy, to investigate attitudes and opinions on health and sustainability, food purchasing apps, and university canteens. Projective techniques were developed to investigate students' preferences towards logos to identify Healthy and Sustainable (H&S) dishes on a pre-ordering app of the university canteen.
A between-group design approach (experimental study) was implemented in spring 2022 to test the effect of indulgent ("Chef choice") and informative ("Healthy and Sustainable") logos to encourage students to select H&S dishes and to understand whether different types of logos could affect students with different goal orientations.

Results
Food-related and individual factors were identified. Barriers and motives (benefit of not wasting time and food waste reduction) of using a pre-ordering app were also investigated. The most recurrent issue related to a pre-ordering app was the problem of not seeing the dish beforehand, also in line with the importance of food-related factors influencing food choices. To analyze the logos' influence on the purchase intention of students, the average purchase intention score of H&S dishes and NoH&S dishes will be calculated. The ANOVA test will be performed with experimental conditions as an independent variable and purchase intention as the dependent variable. A post hoc test will be performed to explore the differences. In addition, a logit regression will be used to examine the factors influencing participants' intention to purchase. Descriptive statistics will be applied to describe the sample (330 questionnaires).

Conclusion
This research will contribute to promoting canteens being more attractive and innovative considering students' interests in healthy eating, climate change, and technology, and to providing professionals (e.g., canteen managers, foodservices, dietitians, nutritionists, etc.), researchers, policymakers, as well as university staff members with evidence-based recommendations.

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Social Media and Social Amplification of Risk – Consumer Reactions to Food Recall Reporting

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Aim:

This is an exploratory study utilizing user-generated content (UGC) on legacy media outlets' social media risk communications to assess citizen-led social risk amplification during a food scare scenario. To explore the nature of social risk amplification a case food recall is chosen, the Republic of Ireland 2019 recall of bottled water with above normal arsenic levels. The research aims to identify the triggers in legacy media reporting leading to social amplification of risk and the rhetorical tools used by citizen consumers to amplify and/or reduce social risk perceptions.

Method:

This research adopts a qualitative approach and draws on legacy media publications and citizen UGC. Social media UGC is employed to afford contemporaneous insights into emerging consumer attitudes as the food scare/recall evolved. A total of 36 legacy media reports and corresponding consumer reactions totalling 6,400 comments across 21 social media posts on Facebook are analysed to explore the relationship between legacy media communication and citizen UGC. Content analysis is employed to identify manifest and latent content in the emerging discourse.

Results:

Analysis of communication suggests discrepancies between media and citizen discourse. The frequency of representation of various industry stakeholders in legacy media reporting is observed to frame citizen perceptions of responsibility of risk. Where health and wellbeing implications of food scares are unclear to citizen, themes emerging in subsequent citizen discourse are highly heterogenous. A typology of implicit and explicit rhetorical and narrative techniques employed by citizens to contribute to an increase or decrease in risk perceptions is developed. These techniques employ a combination of cognitive and affective strategies.

Conclusion:

Discrepancies between legacy media representations of stakeholder and citizen perceptions highlight areas for development in building consumer trust in food systems. As distinct from previous studies which have considered citizen response to legacy media reporting of food scares on a post-hoc basis, the comparison of media narratives with contemporaneous consumer reaction to media reporting allowed for greater insights into the nature and extent of risk amplification across the food scare reporting phases. Future research should explore citizen consumer reaction to UGC to determine broader societal impact on risk perceptions.

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The Interplay of Food Labels & Dietary Motivation on Product Health Ratings and Purchase Intentions

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Aim:
To examine the effects of two nutrition claims (reduced sugar and protein content), a traffic light nutrition label, and the moderating role of weight control motivation on the appeal and perceived healthfulness of foods.

Method:
The context for this study is the breakfast bar category, where the use of nutrition claims is particularly prevalent. Breakfast bars are considered by some consumers as a health snack or healthy alternative to confectionary products, even though they often contain high amounts of added sugar. We conducted a between-subject factorial experiment, following a 2 × 3 randomised design with a sample of 408 adults living in the UK. This entailed manipulating the nutrition claims (i.e., sugar reduction claim or protein claim or no claim) and traffic light nutrition label presence (i.e., present or absent) to create six experimental versions of a product.

Results:
While the study confirms the existence of a positivity bias towards products that display nutrition claims, it also finds that the effects are malleable. Specifically, the positive effect of the protein claim on product health ratings and purchase intentions was only significant in the absence of a traffic light label displaying moderate (amber) amounts of sugar, and the positive effect of the reduced sugar claim was only significant among participants motivated to control their body weight.

Conclusion:
This study has implications for food marketing and public health policy. To avoid misleading consumers on the overall nutritional quality of a product, food brands should use a traffic light nutrition label on products that contain a protein claim. This is important given that the health halo effect of a protein claim on health ratings and purchase intentions appears to be strongest among participants motivated to control their body weight. With respect to a reduced sugar claim, food brands should avoid using such a claim on reformulated food products has it adds little marketing value when targeted at the average consumer and may mislead health motivated consumers. A 'health by stealth' approach to food reformulation, in which products are gradually reformulated without making the consumer aware, appears to be the optimal strategy.

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Are sustainable and healthy foods also affordable? A multivariate analysis in the Irish market

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Aim:
Evidence shows that Irish diet is rich in unsustainable and unhealthy foods. Moreover, the cost of foods needs to be considered if consumers are expected to shift towards sustainable diets, which are defined as environmental-friendly, affordable and healthy. This study aims to provide practical information for the Irish consumer by identifying nutritious, environmental-friendly, and affordable foods in the market.

Method:
54 commonly consumed foods in Ireland were identified using existing data from the Irish Universities National Adult Nutrition Survey, including also foods such as plant-based dairy alternatives and meat substitutes. Nutrient density was determined using the nutrient-rich foods (NRF) index 9.3. Life cycle assessment (LCA) data from the literature expressed as gCO_2-eq/100g were used to determine the environmental impact of foods. The cost of foods was calculated based on prices from Irish supermarkets. Hierarchical cluster analysis using the Ward's method in XLSTAT was employed to group foods based on price, environmental impact and nutritional composition.

Results:
Hierarchical cluster analysis resulted in the formation of 5 groups. Group A contained most of the plant-based foods, had the lowest environmental impact 99.14 gCO_2-eq/100g, lowest price (0.59 Euros/100g) and medium nutrient density (0.34/100g), while group E contained beef and lamb and had the highest environmental impact 2410.50 gCO_2-eq/100g. The group with lowest nutrient density (-3.67 /100g) was group C that contained fats such as butter and coconut oil. Group D had the highest nutrient density (1.24) and the highest cost (4.57 Euros/100g) and relatively high environmental impact (1310.80 gCO_2-eq/100g). Group B contained a variety of plant and animal foods, had medium nutrient density (0.17) medium cost (1.64 Euros/100g) and medium environmental impact (364.08 gCO_2-eq/100g).

Conclusion:
The study showed that the sustainability of foods in the Irish market varies widely. It is difficult to establish which foods address the three factors investigated, as foods that are environmental-friendly are not necessarily cheap and nutritious. It is recommended to increase consumer awareness through labelling, providing accessible nutritional information, and information on environmental impact of food. Although this study focused on foods from Irish retailers, the method is applicable to other markets as well.

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Characterization of Cronobacter sakazakii isolates from powdered infant formula manufacturing plants by Whole Genome Sequencing

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Aim

Powdered infant formula (PIF) has been recognized as the major transmission vehicle of Cronobacter sakazakii. This opportunistic pathogen responsible for neonatal meningitis, septicemia, and necrotizing enterocolitis in preterm infants, with mortality rate between ranging in 15-80%. The ability of this strain to cause pathogenicity and virulence, biofilm formation, and high resistance to elevated osmotic, low pH, heat, oxidation, and desiccasion have been identified by Whole Genome Sequencing (WGS).

Method

In this study, whole-genome sequencing (WGS) was applied as a tool to characterize 20 *Cronobacter sakazakii* isolates obtained from different powdered infant formula processing facilities in Europe. The prepared genomic libraries were sequenced using MiSeq platform (Illumina) . The draft genomes were assembled and annotated. The presence of antimicrobial resistance-encoding genes and virulence factors were also investigated.

Results

Assemblies and annotations resulted in genome sizes ranging from 4.3 to 4.5 Mb and 3,977 to 4,256 gene-coding sequences with GC contents of 57.0%. The predominant sequence types (ST) were 1 (55%),4 (25%), 40 (5%) and 99 (15%). 180 virulence genes and 97 antimicrobial resistant genes were annotated. The most abundant virulence genes were cstA, dppA, galF, ompA, tufA . These genes encodes adhesion and invasion factors. The most prevalent antimicrobial resistant (AMR) genes were AcrAB-TolC AcrAB-TolC, EF-Tu, EmrAB-TolC, MdtABC-TolC encoding multidrug efflux system components in *C.sakazakii* strain.

Conclusion

In summary, WGS enabled the identification of *C. sakazakii* strains isolated from PIF processing facilities and revealed multiple antibiotic resistance and virulence genes.

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Bread baking modeling: towards the development of new baking strategies

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Aim:
Bakers have become increasingly concerned with the need of optimization tools to help out in innovation and control of raw material fluctuations. Bread baking is one of the most energy demanding processes, close to drying process, and there are generally few innovations in this fiels. This study aims to use multiphysics modeling of baking as a supporting tool for identifying new baking path and strategies to reduced energy consumption process.
Method:
Numerical simulations were conducted using a finite element model that has previously been experimentally validated on French baguettes [1]. This model takes into account CO_2 yeast's production below 40 °C and its desolubilisation from the liquid phase during heating, liquid and water vapor, air. The dough deformation is governed by both gas production and the evolution of the mechanical properties of dough during baking. Gravity and shrinkage due to water loss as well as gas cell opening and evapo-condensation-diffusion are also considered. A sensitivity study on the pressure of the oven atmosphere and on dough formulation helped us to deepen the phenomena involved in the aeration or densification of the crumb. The impact of the temperature of starch gelatinization was especially investigated.
Results:
It was first illustrated how the overall expansion of bread dough and how the local gas fraction were influenced by the temperature of starch gelatinization and its associated impact on viscosity evolution during baking. Lowering of external pressure was identified as a possible way to optimize dough expansion and modify density profiles at lower temperature than that usually involved in conventional baking.
Conclusion:
Although this numerical modeling does not cover the complexity of all the phenomena involved during baking, we think that it helps to come up with possible new baking trajectories and new paths for R&D. Modeling makes it possible to approach phenomena that are difficult or impossible to isolate/disentangle experimentally and at lower economic and environmental costs.

[1] Nicolas V, Vanin F, Grenier D, Lucas T, Doursat C, Flick D. Modeling bread baking with focus on overall deformation and local porosity evolution. *AIChE Journal*. 2016;62(11):3847-3863. doi:10.1002/aic.15301

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Investigation of integral stereoselectivity of lipase on triacylyglycerol of varying fatty acids

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Aim: Development of analytical basement for integral stereoselectivity of lipase on varying fatty acids
We have previously proposed the concept of 'integral stereoselectivity', which is the selectivity of lipase for all positions of acylglycerols, and developed the analytical and computational method to determine the integral stereoselectivity against trioleoylglycerol as a model substrate. However, the substrate for determining integral stereoselectivity needs to be extended, since the selectivity of lipase could vary depending on the fatty acid species.

Methods: Chiral stationary phase HPLC and enzymatic scheme-based kinetic modeling
We established the analytical method for the resolution and quantification of fatty acid, monoacylglycerol isomers, diacylglycerol isomers, and triacylglycerol of different acyl chain lengths (C14:0, C16:0, and C18:0) and numbers of double bond (C18:1, C18:2, and C18:3). The acylglycerols were resolved based on HPLC-ELSD equipped with a single chiral stationary phase column, CHIRALPAK IA. The kinetic modeling for the reaction rate constant for each hydrolysis step was based on Runge-Kutta fourth-order method.

Results: Determination of integral stereoselectivity of model lipases based on the resolution of all acylglycerol isomers and kinetic modeling
With the analytical system, fatty acid, monoacylglycerol isomers, diacylglycerol isomers, and triacylglycerol of each acyl chain were separated with resolution factors of more than 1.5 and relatively short running time. Using the analytical system, the time-courses of triacylglycerol hydrolysis catalyzed by three model lipases from microbial and mammalian sources were obtained and their integral stereoselectivities were determined. The quantitative interpretation of the integral stereoselectivities of the lipases were based on the reaction rate constant for each hydrolysis step determined from kinetic modeling of the time-courses.

Conclusion: Integral stereoselectivity as an index of lipase stereochemistry
This study extended the range of substrates for the determination of integral stereoselectivity, which is an index representing the unique properties of lipases in the triacylglycerol hydrolysis reaction scheme. It would contribute to the application of lipases such as the synthesis of structured lipids with a stereospecific distribution of fatty acids.

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Simulation of Microbial Survival During Fermented Sausages Production to Assess Alternative Formulation

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Aim: Listeriosis is a foodborne disease caused by *Listeria monocytogenes.* Fermented sausages are susceptible to contamination with this pathogen. This product is highly consumed in Europe and they are usually made from comminuted meat and fat, mixed with salt, curing agents, sugar and spices, filled into casings and then fermented and dried to a target pH and water activity (a_w). Food business operators can use predictive microbiology to assure food safety and assess microbial behaviour. Predictive models can be applied throughout the whole food chain.

Methods: The production process of fermented sausages was simulated. The survival of *L. monocytogenes* and lactic acid bacteria (LAB) was studied using mathematical models proposed by Guiufrida et al. (2009) combined with the thermal inactivation model of Geeraerd, Herremans, and Van Impe (2000). Kinetics were modeled by using the secondary model of Gimenez and Dalgaard (2004). The secondary model for inactivation developed by Versyck et al. (1999) was used. Parameters were taken from these articles. D- and z- values were taken from Schoeni, Brunner, and Doyle (1991) and Aryani, Den Besten, and Zwietering (2016). Production scenarios considered were 1) a standard production formulation (salt 2.5%; sodium nitrite 150 ppm; a_w< 0.91; heat inactivation step 53.5°C for 61 min); 2) a reduced salt formulation (2.0, 1.82 and 1.4 %); 3) a reduction of sodium nitrite (100, 70 and 50 ppm); 4) changing the drying endpoint to aw reaches 0.94; 5) changing the heating step (61° C for 40 min,64°C for 20 min).

Results: Sodium Nitrate concentration impacted on the survival of *L. monocytogenes* following thermal treatment. Low a_w did not prevent the survival of *L. monocytogenes* and was a relevant factor in bacterial survival only after the thermal treatment. The salt concentration used was similarly ineffective at reducing survival within the studied range.

Conclusions: This assessment helps estimating and quantifying the main effect the process parameters on the survival of *L. monocytogenes.* This tool can also be used for estimating the time in which the pathogenic population reaches the permitted safety boundaries. With this novel predictive model, safety can be assured and shelf can be estimated.

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Structuring biphasic systems for improved nutritional and textural properties

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Aim: Food products combine a variety of molecular architectures and physical phases leading to the formation of unique structures responsible for specific texture and mouthfeel. The food texture is mainly controlled by the molecular assemblies on a different length scales from the molecular interactions and structural assembly to the bulk network arrangement. These structures can be harnessed to improve food nutritional value by replacing harmful ingredients, such as saturated fat, while maintaining preferable textural attributes and consumer experience. The current research focus on the development, characterization and utilization of structuring methods to form new food systems with unique nutritional and textural attributes.
Method: The combination of oil and water structuring approaches using proteins, polysaccharides, and low molecular weight oil gelators to formulate gel system will be presented while the final gel characteristics will be established using various mechanical, thermal and structural techniques.
Results: The effect of various preparation conditions will be presented with respect to stability and hardness where a significant impact was related to the structuring agent concentration and preparation procedure. Gel structural properties such as droplet size and distribution were examined using confocal microscopy while the gel temperature depended viscoelastic properties were determined using rheology. The effect of emulsifier HLB value on the final gel properties was examined aiming to reveal the role of the interface properties on the final gel functionality. A direct relation between the interface content and bigel behavior was found, suggesting an effective way to rationally design bigels with specific bulk properties. The use of biphasic structuring approach to formulate plant-based products with high protein content and promising textural properties was also examined.
Conclusion: Overall, structuring biphasic system in the form of bigel can enrich the nutritional profile of high saturated fat products aiming to improve the consumer health and wellbeing, while maintaining consumption experience.

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On improving the sustainability tomato processing industry by minimization of water and energy consumption

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Aim:
Tomato processing industry consumes substantial quantities of water and energy (thermal and electrical) which are often linked to each other, given that energy is required to transport, heat, and cool water. Further, water in the form of steam may be used to generate thermal energy. These relationships are known as the water-energy nexus (WEN). In this framework, a WEN assessment is essential to identify the main WEN points where water is linked to electrical and thermal energy, as well as to evaluate the water and energy usage and their distributions through the main processes and equipment.
In this work, the approach used in the frame of the European project AccelWater (Project ID: 958266) to optimize the consumption of water and energy in tomato processing, was described.
Method:
A real scenario of an Italian tomato processing industries was analysed. The tomato company was equipped with two processing lines to convert about 60.000 ton/year of tomato fruit into peeled tomato and tomato sauce with a capacity of about 40 tons/h. For each processing line, the Current Value Stream Map (CVSM) was developed, and a WEN analysis and a Life Cycle Assessment (LCA), was conducted.
Results:
The results showed that about 70% of total fresh water was pumped to flumes to unload, wash, sort, and convey tomatoes as they enter the facility. The remaining part of total fresh water was used for cooling, vacuum pumps, boilers and CIP. Regarding the electrical energy consumption, it was found that about 43% was used within the electrical WEN points, with most of this energy (approximately 80%) being used for pumping operations. On the other hand, it was found that the thermal energy (steam) was unevenly distributed between the thermal units, being intensively consumed in both pasteurization (40%) and evaporation (40%) processes, and to a lesser extent, in peeling (10%) and hot break (10%). Results of this analysis enabled to identify different strategies for water and energy saving based either on conservation measures in closed loop, or on the integration of novel sustainable technologies. Finally, the results of LCA highlighted the improvement in terms of environmental impact of the adopted strategies.
Conclusion:
In conclusion, the approach used to optimize the tomato processing could be adopted to other sectors to improve the sustainability of food industry.

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Lipase-catalyzed synthesis of multi-functional erythorbyl ricinoleate with high emulsifying activity

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Aim: Lipase-catalyzed synthesis of multi-functional ERO with high emulsifying capacity

Erythorbyl fatty acid esters (EFEs) have been suggested as multi-functional emulsifiers with antioxidant and antibacterial activity. To enhance their emulsifying activity, hydroxyl fatty acid was employed for its contribution to emulsion stability by adjusting hydrophilic-lipophilic balance. The primary aim of the study is to produce erythorbyl ricinoleate (ERO), a novel EFE with high emulsifying activity and multi-functionalities including antioxidant and antibacterial activity.

Method: Synthesis and functional characterization of ERO

The lipase-catalyzed esterification of erythorbic acid and ricinoleic acid was conducted in a solvent-free system. The molecular structure was analyzed by LC-ESI/MS and ^{13}C NMR. The interfacial tension at an oil-water interface of ERO was determined using the pendant drop method. The emulsifying properties and stability of EFEs were compared by observing concentration and time-dependent effect on droplet size and polydispersity index, using dynamic light scattering. Antibacterial and antioxidant properties of ERO were evaluated by determining minimum inhibitory concentration (MIC) and radical scavenging activity, respectively.

Results: Multi-functionalities of ERO

The result of LC-ESI/MS and ^{13}C NMR indicated that ERO was produced successfully with regioselectivity. The interfacial tension reduced by ERO was 2.66 ± 0.19 mN/m at 0.75 mM, more effectively than the other EFEs. Among the EFEs, ERO showed the highest emulsion stability with droplet size of 256.37 ± 34.72 nm and polydispersity index of 0.220 ± 0.041. Furthermore, ERO inhibited the growth of Gram-positive foodborne pathogens with MIC ranging from 0.20 to 0.60 mM, and showed antioxidant activity with EC_{50} of 46.93 ± 0.47 and 30.52 ± 0.18 µM in DPPH and ABTS assay, respectively.

Conclusion: ERO as a promising multi-functional food emulsifier

In this study, a novel multi-functional ERO with high emulsifying activity was produced regioselectively via lipase-catalyzed esterification. The interfacial tension reduced by ERO was the lowest among the EFEs. Moreover, ERO showed more effective emulsifying activity than other EFEs. Additionally, ERO exhibited antibacterial activity on Gram-positive pathogens and showed antioxidant activity against DPPH and ABTS radicals. Thus, ERO is expected to provide emulsion stability by controlling both lipid oxidation and microbial contamination in emulsion-based food.

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Microbial cultures to extend the shelf-life of packaged fresh meat: the attitude of Australian consumers

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Aim:
Previous studies by this group have demonstrated the effectiveness of microbial cultures (lactic acid bacteria and coagulase-negative staphylococci) to extend the shelf-life of fresh meat. The purpose of this study was to assess consumer attitudes to packaged fresh meat products with added microbial cultures (PFMMC).
Method:
An anonymous online survey was conducted to investigate Australian consumers' willingness to purchase and consume PFMMC. Gender and age quotas that were reflective of the Australian population were applied.
The survey included respondents':

1) General food shopping and consumption behaviors, including questions about fermented foods and Food Neophobia Scale (FNS) questions.
    - Details about their meat shopping and consumption patterns; satisfaction with the current shelf-life; willingness to buy PFMMC; reasons for willingness to buy decisions; willingness to eat cooked PFMMC.
    - Demographic information.

This study was approved by the RMIT University College Human Ethics Advisory Network.
Results:
There were 803 valid responses collected, and the respondent profile broadly reflected the Australian population.
The overall results were:

- Willingness to buy: more likely (15.3%), no difference (47.8%), depends on other factors (13.6%), and less likely to buy (17.8%). This indicates that at least 63% of Australian consumers would be willing to purchase PFMMC.
- Willingness to eat: definitely yes (11.3%), probably yes (34.6%), may or may not (36.2%), probably not (8.8%), and definitely not (2.2%).

Interestingly, there was no significant relationship between the number of microbial culture-containing foods bought or eaten on the willingness to buy and willingness to eat PFMMC. However, willingness to buy and eat were affected by the respondent's attitude to foods containing microbial cultures. Those that liked microbial culture-containing foods were more likely to buy and eat PFMMC.
Respondents' willingness to buy and/or eat PFMMC were affected by a range of other factors, including age, gender, food neophobia, household members with food allergies or intolerances,

frequency of fresh meat consumption, whether they had uncooked meat spoiled at home, and satisfaction with the current shelf-life of fresh meat.
Conclusion:
These findings can be used by the food industry to develop longer-lasting fresh meat products that will meet consumer expectations and create informed marketing strategies.

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Australians perceptions towards edible insects as a future food

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Aim:

Growing populations, changing dietary preferences and limitations on natural resources have meant that finding an alternative to traditional animal-based protein sources is a priority. Insects have been proposed as a possible solution due to their many benefits including low resource inputs and desirable nutritional profile. Despite a rich history of eating insects throughout parts of the world, many Westernised countries have been reluctant to adopt the practice as a modern-day societal norm. This study aimed to explore Australian consumers' experiences with edible insects, identify barriers to consumption including the role of food neophobia, and explore possible factors that may motivate Australians to consume insects.

Method:

A total of 601 participants (76.2% female, 23.8% male), completed an online survey using a variety of open-ended questions; 5- or 7-point Likert scales and check-all-that-apply questions. Food neophobia status was measured. Participants self-reported usual protein dietary habits, their previous insect-eating experience, willingness-to-try insects or insect-based foods, and potential motivations to increase future consumption to eat insects.

Results:

Results indicated 35.4% of participants had previously consumed insects, with Orthoptera (crickets, grasshoppers) the most consumed order (60.1%). Participants with no previous experience consuming insects cited 'lack of opportunity' as the main reason (57.2%). 'Increased accessibility' (56.6%) and 'increased nutrition knowledge' (56.6%) were identified as major factors that may increase the likelihood of future insect consumption. Participants reporting that they were willing to try insects were most likely to accept 'insect-based flour' (65.6%) and 'chocolate-covered ants' (52.1%). Food neophobia was correlated with a reduced likelihood of previous insect-eating experience ($p<0.001$), as well as a decreased willingness to eat insects in the future ($p<0.001$).

Conclusion:

This study provides a greater understanding of food neophobia status and its role in dietary choices, consumers’ willingness to eat insects and possible motivating factors to increase the likelihood of future insect-eating. By providing increased opportunity, accessibility and education on insect-based food products, a higher proportion of Australians may be willing to eat insects, particularly if presented in indistinguishable forms (i.e., flour). This may lead to a greater acceptance of insects as an alternative, more sustainable protein source than previously anticipated.

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High-pressure-intensified pasteurization of orange juice to inactivate Alicyclobacillus acidoterrestris spores and investigation of quality changes.

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Aim: *Alicyclobacillus acidoterrestris* is a pH stable and temperature resistant spore former, which can cause undesired off-flavors in many fruit juices. Some agencies even want a 0 tolerance of the occurrence of this microorganism in juices. High pressure in combination with elevated temperatures (70-90°C), high-pressure intensified pasteurization (HPIP), could be a feasible approach to "gently" inactivate these spores in comparison to thermal processing alone. The aim of this work was to investigate the intermediate pressure-temperature range between HPP and HPTS on the inactivation of *Alicyclobacillus acidoterrestris* and quality changes in orange juice.

Method: *Alicyclobacillus acidoterrestris* was sporulated according to literature. 10^7 CFU/ml were inoculated in freshly squeezed orange juice and treated at 70,80 and 90 °C for 5-30 minutes under pressure (600 MPa). Based on the inactivation kinetics isokinetic lines were calculated to determine possible process windows. Process windows for a 3 $\log_{10}$ and 5 $\log_{10}$ inactivation were validated via inoculation with 10^6 CFU/ml. After the microbial validation orange juice was treated at the given process windows and chemically analyzed with HPLC (Vit C) and GC-MS (untargeted chemical fingerprint approach). As references untreated, pasteurized (80°C, 20 min) and sterilized (121°C, 15 min) juice was used.

Results: From the calculated isokinetic lines for a 3 and 5 $\log_{10}$ inactivation, temperature time combinations were selected. For 3 $\log_{10}$ the temperature time combinations were between 70-94°C for 5.15-0.90 minutes and for 5 $\log_{10}$ these were between 70-94°C for 9.6-1.67 minutes. In comparison to the thermal treatment (70-90°C) the HPIP was 10 times as faster. The analyses of Vit C via HPLC showed a reduction of Vit C in the HPIP treated samples between 1-5 %, similar to the pasteurized treatment (sterilization ~16%). The results of the GC-MS indicated a better retention of D-Limonene, alpha and beta pinene and a mitigation of process induced compounds like Terpinolene, Hexanal and Furfural by HPIP in comparison to thermal treated samples.

Conclusion: HPIP can be used for successfully inactivate *Alicyclobacillus acidoterrestris* and reduce the degradation of valuable compounds in the juice. The use of HPIP at industrial scale level in existing HPP systems will be possible soon.

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Development of an innovative-novel process approach for reduced oil fried products

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Aim:
Fried products comprise a significant amount in the fast-food industry. Increased consumption of oil in diet and thermal deterioration of oils due to the repeated usage lead to significant health concerns including cardiovascular diseases and obesity. While frying process is a costly operation with additional ventilation maintenance, waste oil is an additional environmental issue. Therefore, the objective of this study was to design a process to use microwave and infrared processing successively for production of low-oil content fried products.
Method:
For the given objectives, previously designed microwave and infrared systems were re-planned using an experimentally validated computational mathematical model. This model was used to determine the required process times, and the suggested novel approach included a conveyor belt microwave (3 min) and infrared (4 min) process to defrost pre-frozen, pre-fried fries and to attain the desired surface crispness and taste. During processing, local and surface temperature changes were measured, and resulting product was compared with deep oil fried product (3 min at 180 °C) with Hedonic sensory, texture profile analysis.
Results:
The suggested novel process with successive microwave and infrared application (Fig. 1) increased the internal temperature of the fries from -18 ºC to 90 °C within 7 min, and the final product was ready for consumption. Hedonic sensory analysis resulted in a higher score compared to the conventional frying in terms of taste and crispiness while the oil content was 15.5% (due to the initial pre-frying) compared to the 27.7% of the conventional fried samples. %. In addition, the suggested approach led to 25% efficiency in the last product mass due to the decreased moisture loss.
Conclusion:
With the suggested novel approach of successive microwave and infrared processing, reduced-oil fried products were prepared with better sensory and textural attributes. With this environmentally friendly process, it is expected to offer healthier products, and designing an industrial scale processing will be feasible.
Acknowledgement:
The authors acknowledge the support of the projects TUBİTAK – Project No: 2190369 and MoESTD – Project No: 451-03-812/2021-14-8).

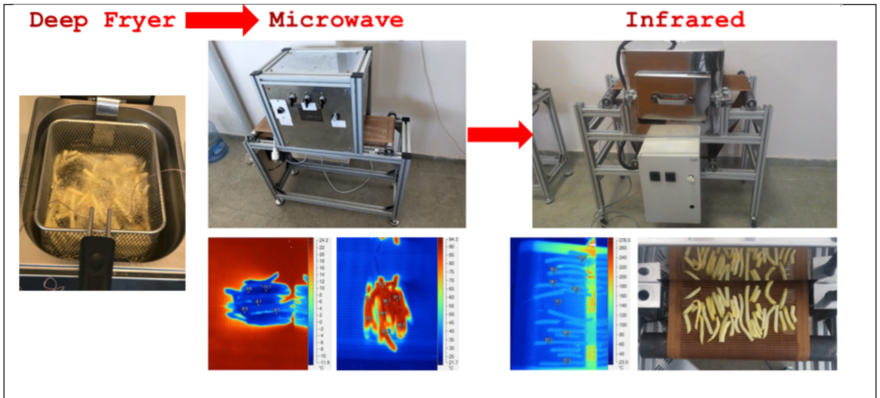

Figure 1. Conventional and innovative methods used in the study

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Influence of the cleaning fluid on changes in the chemical composition of food-based soils

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Aim:

The cleaning of food-based soil in food processing plants prevents hygienic problems, because soil layers form a substrate for microbial growth. In contact with cleaning fluids, soil layers changing their chemical composition and the structure of individual components. Knowledge of these changes can help to explain solubility effects and changes of soil layer strength depending on pH, temperature and contact time. This work focuses on the development of a method to analyse compositional changes of soils in contact with a cleaning fluid. Saving of energy, chemicals and water in cleaning processes will be sustainably supported by these findings.

Method:

A soil powder consisting of whey protein isolate (WPI) was brought into contact with the cleaning fluid by varying pH, temperature and contact time, hereinafter referred to as soil composition change method (SoCoC). To quantify the transfer of soil components (proteins, residual carbohydrates) from the soil powder into the cleaning fluid, the system was separated by filtration. Protein and carbohydrate content in the fractions was determined using the Kjeldahl and the Dubois method, respectively. The specific influence of pH, temperature and contact time on the macromolecular structure of the soil was characterized by size exclusion chromatography (SEC) and differential scanning calorimetry (DSC).

Results:

This research was able to prove the successful establishment of the SoCoC method by means of gravimetric measurements as well as chemical and physical analysis. An influence of pH on solubility of WPI was identified. DSC measurements show that protein structure is denatured by alkali hydrolysis. With increasing pH, coagulations begin, which is reflected in a shift in molecular masses (>200 kDa). In the further course alkali hydrolysis becomes visible with smaller molecular masses (< 200 kDa).

Conclusion:

The results may immediately help to explain the more or less cleaning time of WPI soil layers depending on pH and temperature. In addition, the SoCoC method can be used to investigate the influence of cleaning fluids on soil layers with a complex composition. Optimal pH and temperature can be determined in laboratory tests in order to maximize the solubility of soil and to establish resource-saving cleaning in plants.

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Formulation of Glyceryl stearate-based oleogels as carriers of β-carotene: formation, characterization and in vitro digestion

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Aim:

The study aimed at modulating the microstructure of corn oil oleogels by changing their composition in order to obtain them with desired textural and functional properties. Furthermore, the composition of oleogels was correlated with their digestibility and beta-carotene (βC) bioaccessibility.

Method:

The formation of corn oil oleogels with glyceryl stearate (GS) (20% w/w) and a co-oleogelator, being lecithin (LEC) or hydrogenated lecithin (HLEC) (0 to 2.5% w/w), was evaluated through differential scanning calorimetry (DSC), microscopy, texture analysis and oil binding capacity (OBC). Oleogels were introduced into a static in vitro digestion system and the free fatty acid (FFA) release during the small intestinal phase was monitored with a pH-STAT. Moreover, the βC bioaccessibility was determined spectrophotometrically.

Results:

The addition of LEC decreased the crystallization and melting temperatures, causing the oleogels to become softer. For HLEC-GS-oleogels, the tendency was reversed. LEC crystals were relatively larger and fewer in number than HLEC crystals. The larger crystals resulted in a lower OBC of LEC-GS-oleogels because the surface area to which oil molecules can bind is reduced. In addition, LEC-GS-oleogels released less FFA in the small intestinal phase than GS-oleogels and HLEC-GS-oleogels. The low OBC of the LEC-GS-oleogels can contribute to the leakage of liquid bulk oil from the oleogel structure during digestion, which is then poorly digested by pancreatic lipases due to the large droplet size. Also, intestinal lipases might have a lower preference for LEC compared to HLEC molecules. In those oleogels with a low concentration of co-oleogelator (i.e., 0.5% w/w), the bioaccessibility values for βC differed and were higher in LEC-containing ones than in those with GS and HLEC-GS. Bioaccessibility might be positively affected by LEC's higher hydrophilic-lipophilic balance values. Additionally, LEC molecules that remained intact after lipolysis may be incorporated into micelle formation and increase βC bioaccessibility.

Conclusion:

The information obtained can be used in the design of GS-oleogels with improved textural and functional properties for specific applications.

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Effect of Salt Extraction on Structure and Functionality of Concentrate Pea Protein

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Aim:

Pea protein isolates are increasingly employed as functional ingredients in food products. However, commercial pea protein isolates still show low solubility and varying functional properties. It is hypothesized that better control of the extraction conditions may be a suitable strategy to improve the quality of pea protein ingredients. The objective of this work was to understand the influence of the ionic strength during the extraction conditions on pea protein composition, structure, and functionality.

Method:

The solubility, structure, composition, and colloidal behavior of pea proteins extracted at different ionic strengths (0.0 – 1.2 M NaCl) were studied, using hydration radius analysis, fluorescence, sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE), size exclusion chromatography with multi-angle static light scattering and refractive index (SEC-MALS-RI). The interfacial behavior was studied with drop tensiometer.

Results:

Solubility and size of the protein aggregates significantly varied with ionic strength. Solubility reached a plateau at 0.4 M NaCl. Higher concentrations of salt decreased significantly the size of the protein particles in solution. The fluorescence intensity of the protein solutions increased with ionic strength, suggesting a change in structure with salt extraction, and this may be also due to an increase in the interactions with other components. With increasing ionic strength, a lower protein purity was obtained, and a higher level of phytates and other low molecular weight components were also extracted. SEC-MALS-RI showed a decrease in vicilin and an increase in legumin fraction, with increased NaCl concentration. Further, a soluble aggregate peak increased with NaCl. The same samples, when diluted, showed aggregation pointing at the initial stages of a “micellization” step, which can be used to create more native aggregates. SDS-PAGE profiles indicated that some legumins were lost during dilution, but that this is a reversible process. Drop tensiometer showed that the pea protein extracted with 0.4 M NaCl possessed the lowest interfacial tension and a rigid conformational structure.

Conclusion:

These insights provide important information for a better understanding of how to tailor the colloidal properties and functionality of pea proteins during the isolation process.

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Transcriptomic response of Listeria monocytogenes planktonic and sessile cells to plasma-activated water

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Aim:
Due to the limitations of traditional sanitisers in the food industry, intense research efforts have been focused on the development of more environmentally friendly and effective strategies. Plasma-activated water (PAW) has emerged as a promising alternative for the decontamination of food processing environments. Even though its efficacy for the inactivation of numerous microorganisms, especially in planktonic state, has been widely reported, the precise inactivation mechanism is still unclear.
Method:
In this study, the transcriptomic response of *L. monocytogenes* PAW-treated cells, both on planktonic state and within biofilms, was studied through RNA-seq.
Results:
A total of 399 differentially expressed genes (DEGs) were identified on *L. monocytogenes* planktonic treated cells, 178 of them upregulated and 221 downregulated. However, only 8 DEGs, all of them upregulated, were identified on *L. monocytogenes* biofilm cells due to a lack of statistical significance associated with the high variability observed between biofilm replicas. Some of the most upregulated genes, including the only common DEG in planktonic and biofilm cells, are included in the cobalamin-dependent gene cluster (CDGC), involved on ethanolamine and 1,2-propanediol metabolism. For the planktonic cells, a general remodelling of carbon metabolism, with differential expression of many phosphotransferase systems (PTSs), was observed as well as changes in the expression (either up- and down-regulation) of genes related to virulence and to the general stress response, controlled by the alternative sigma factor SigB. Also, an induction of one of the principal systems involved in *L. monocytogenes* acid stress response, the glutamate decarboxylase (GAD) system, was observed, which was associated to the low pH (2.33±0.01) of the PAW used for the treatment. However, under the tested conditions, no relevant changes in the expression of components of the oxidative stress response were detected.
Conclusion:
Overall, these results contribute to improving the understanding of PAW's mode of action in the inactivation of microorganisms.

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Artificial Intelligence (AI) based optimization of tank cleaning in food production

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Aim:
Cleaning is an important process step in food productions. To avoid contaminations in the process line it is important to reach a safe hygienic state of the setup. To gain a proper high level of food safety demands very high water consumption during the cleaning process, which can reach up to 30% of the whole water household according to a product. There is a huge potential for standardizing cleaning results as well as saving resource and personal costs by using clean in place and sterilize in place setups.
Due to the high natural variability of the food soil, its drying state, the dependence of its adhesion from wall material and the cleaning impact of a specific cleaning system a resourced minimized cleaning imposes high challenges that can only met with self-learning AI approaches. Thus, with a machine learning approach it is possible to predict the optimal cleaning parameters for a beginning cleaning run and to tune the parameters during cleaning to reduce water consumption.

Method:
Cleaning with water jets is performed with different devices, which ranges from static cleaning heads with just several water outlets on the surface to spinning cleaning heads with rotating nozzles which can directly focus coated spots on the surface.
The impact of the jet on the surface and the transversal velocity which affects the water exposure of the coating can be tuned by changing the nozzle speed and the flow rate. These serve in addition to the drying time of the coating as parameter set, in within a machine learning approach such as particle swarm optimization is going to the optimum.

Results:
The result depends on different parameters. Previous work has shown, that there is a possibility of saving 20% to 50 % of resources by using AI based controllers in the process.

Conclusion:
Current cleaning routines were run by one fixed parameter set each. So there is no feedback loop which allows to tune the cleaning parameters. Adding a feedback loop and tune the cleaning parameters during the process can safe power and water consumption in comparison to the state of the art process.

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The Adherence and Significance of Mediterranean Diet as Sustainable Healthy Dietary Pattern

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Aim: The Mediterranean diet (MD) is recognized as the common cultural heritage of Mediterranean communities. However, dietary changes occur in Mediterranean countries due to lifestyle changes. It is important to understand the barriers and challenges that prevent citizens from adhering to long-term MD. The aim of this study is to determine MD adherence and the factors affecting it in family members of 6 Mediterranean countries (Spain, Turkey, Morocco, Italy, Lebanon, and Egypt), within the scope of the EU PRIMA SWITCHtoHEALTHY project.

Method: In this EU project, as a cross-sectional study, comprehensive survey will be applied to at least 200 family members in each country and a total of 1200 family members. The following data will be collected: i) demographic data; ii) adherence to the MD will be assessed using the validated Mediterranean Diet Adherence Screener (MEDAS) in adults and the Mediterranean Diet Quality Index (KIDMED) for children and adolescents; iii) behaviours of family members towards MD will be evaluated by a questionnaire developed by the researchers. It includes questions about the health benefits, diet quality, nutrition literacy, convenience, and environmental impact of MD. In addition, barriers to healthy eating will be questioned. Family relations section includes questions such as family meals eaten together, eating with the television on and phone use during meal time; iv) lifestyle factors will be determined using the validated Mediterranean Lifestyle (MEDLIFE) index. It consists of 32 items divided into three blocks including questions about food consumption, dietary habits and physical activity, rest and social interactions. The statistical analysis will be performed using Statistical Package for the Social Sciences (SPSS) package program.

Results: In this study, which will be concluded in September 2022, we will reveal the MD adherence levels of the participants. MD adherence differences will be assessed by sociodemographic characteristics, dietary habits, lifestyle, barriers to healthy eating, and family relations. Accordingly, we expect to identify a list of barriers to MD adherence.

Conclusion: The results from this research will help to generate and enforcing adherence of the Mediterranean dietary patterns in the Mediterranean countries in order to provide sustainable healthy life-style.

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Towards Autonomous Bioprocess Control: Model-based Reinforcement Learning for the Determination of Control Policies

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Aim:

The aim is to be able to control a bioprocess that is exposed to unstable conditions such as environmental influences or fluctuations in substrate quality. This is investigated in the context of the growth behavior of the cyanobacterium *A. platensis* in a cultivation under the influence of temperature and radiation intensity fluctuations. *A. platensis* has recently been discussed as possible source of various high value food products such as lipids, proteins, or pigments.

Method:

Reinforcement learning (RL) is a computational method to determine control policies that maximize the cumulative outcome of a previously defined reward function. The reward function itself can be any function that depends on the state of the process, the influencing variables, and the actions that are taken to control it. Thus, a reward function can be tailored to satisfy various goals or combinations of goals such as energetic efficiency, economic efficiency, or product maximization. The control policies are defined in terms of preferred control actions for a given process state that is reached at a discrete time step, instead of a static process corridor, and are implemented and learned using artificial neural networks. The algorithms involved in RL are known to require a high number of iterations (process runs) to find a good policy. Running a bioprocess for the required iterations would certainly be very expensive. This difficulty can be addressed by using a process model that was previously trained to approximate the short-term behavior of the process for changing environmental conditions.

Results:

We show that model-based RL can be applied to bioprocesses to optimize a desired output quantity. This is demonstrated both computationally and experimentally with the model process of *A. platensis* growth under the influence of weather conditions that cause fluctuations in the reaction environment of the bioprocess.

Conclusion:

Reinforcement learning is a powerful and versatile tool that can be used to improve the performance of a *A. platensis* cultivation that is exposed to unstable process conditions by autonomously adjusting control actions. This is a promising advance towards the autonomous control of bioprocesses that depend on natural conditions or resources of fluctuating quality.

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Fish processing byproducts: A sustainable source of bioactive peptides

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Aim:

Fish processing side streams including skin, bones and head account for > 60% of processed fish biomass. These side streams contain high amount of bioactive compounds which are either wasted or downgraded into low-value products such as animal and fish feed. However, the consistently growing global demand and the prerequisite for sustainable production have significantly increased the value of bioactive compounds from fish. Here, we focus on antioxidant properties of hydrolyzed proteins and purified peptides from two of the frequently used fish species in Korea as potential candidate for fish-based neutraceuticals.

Method:

Protein hydrolysates were prepared from muscle and processing side streams (frames, fins, head, viscera, skin and scales) of grey mullet (*Chelon labrosus*) and mackerel (*Scomber japonicus*) using enzyme proteases (alcalase, protamex, and neutrase). The protein hydrolysates were purified and characterized through FPLC, RP-HPLC, MALDI-TOF and LC-MS/MS. The antioxidant properties of the prepared protein hydrolysates and purified peptides were further investigated through *in vitro* and *in vivo* assays.

Results:

Enzyme hydrolysis at 50ºC for 60 min hydrolyzed more than 80% of muscle proteins. The highest 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical-scavenging activity of 70% was observed in *C. labrosus* skin hydrolysates using protamex. The highest superoxide dismutase (SOD)-like activity of 90% was observed in *C. labrosus* head protein hydrolysates using protamex. Mackerel protein hydrolysates showed higher superoxide dismutase and catalase protein expressions and regulated lipid peroxidation levels in C57BL/6 mice. Among the isolated peptides, ALSTWTLQLGSTSFSASPM' showed the highest DPPH radical-scavenging activity of 36.34 ± 4.64% and peptide 'LGTLLFIAIPI' showed the highest SOD-like activity of 28.94 ± 4.19%. *S. japonicus* muscle and *C. labrosus* waste side streams showed protein hydrolysates and peptides with significant bioactivities in a short time of less than 120 min.

Conclusion:

The utilization of hydrolyzed proteins and peptides isolated from fish, fish waste, and its by-products could fulfill global demand for cheap dietary supplements especially for underdeveloped and developing countries. The results of this study indicate that, mackerel white meat and grey mullet processing side streams, especially head, could serve as an alternative source of cost-effective proteins and bioactive antioxidant peptides for food and pharmaceutical industries.

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The systemic risk of contamination of recycled packaged food in circular economy

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Aim

New regulations in the EU and France are making the use of recycled materials progressively mandatory. Cross-contamination risks need to be characterized to prevent the systemic contamination of streams and articles by unintended chemicals due to misuse and mishandling. This work analyzes the risk of mass transfer without contact between two plastics, one paper and a plastic, etc. We show that migration modeling used and developed in the EU to demonstrate the compliance of food contact materials can predict and be extended to evaluate the emerging risks during the collection and recycling of materials.

Methodology

Mass transfer from a source thermoplastic material (S) to a recipient one (R: a porous medium or a thermoplastic one) separated by a fluid phase (water or air) were studied both experimentally and from detailed modeling for various sets of molecules (aliphatic and polyaromatic mineral oils, plasticizers and photoinitiators). The reality of the mass transfer was experimentally demonstrated by the depletion of S and the corresponding gain of R. Modeling was used to interpret the effects of the displacement of S-air and S-water equilibrium due to the presence of R.

Results

Mass transfer varying from a few percent to almost full transfer was demonstrated for all substances including non-volatile ones and polyaromatic hydrocarbons (up to 10 rings) known to be almost insoluble in water. The limiting factors are the renewal of the fluid at the surface of R and the distance between R and S. Modeling captured well fluid flow effects and those related to the chemical structure of the studied solutes (vapor saturation pressure, melting point, limit of solubility) and temperature.

Conclusion

Our experiments highlighted the high risk of cross-contamination between materials at all stages from their collection, recycling and reuse into new articles. Water and air cannot be considered good barriers to polyaromatic pollutants. These results would explain the ubiquitous contamination of food by recycled paper and board as well as the contamination of recycled polyethylene terephthalate during mechanical recycling.

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The investigation of sanitizer resistance genes in listeria monocytogenes Isolated from different food processing facilities

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Aim

Sanitizers are widely used for cleaning food processing facilities, but the continued use of sanitizers may cause increasing sanitizers resistance of pathogenic bacteria. At present, a number of genes have been attributed to sanitizer resistance ability of *L. monocytogenes*. This study aimed to detect the presence of sanitizer resistance genes in Irish sourced *L. monocytogenes* strains and to explore the association between the presence of resistance genes on the sanitiser resistance of *L. monocytogenes* experimentally.

Method

The presence of 4 resistance genes (mdrl, qacH, bcrABC, emrE) were determined in 150 *L. monocytogenes* strains collected from Irish food processing facilities. 23 strains contain bcrABC, 42 strains contain qacH, 1 strain contains emrE, and all strains contained mdrl. 47 strains were selected and grouped according to the number and type of resistance genes, and the minimal inhibitory concentrations (MICs) of these isolates against benzalkonium chloride (BAC) were tested.

Results

Compared with other strains, isolates harboring bcrABC and qacH showed higher resistance to BC ($p<0.05$), with MICs of 4-5 mg/L, 1-4 mg/L and 1-4 mg/L for strains with bcrABC, qacH neither gene. Two allelic variants were observed in strains carrying the qacH gene, resulting in low MICs (1 mg/L). Strains harboring both qacH and bcrABC genes did not show higher BAC resistance (MICs 4mg/L). The strains with strain types 5, 9, 31, 121, 132, 204, 836 had higher MICs. In addition, in terms of environmental factors, the mean MIC values of isolates collected from mixed food, seafood, vegetable, dairy, and meat processing facilities were 4 mg/L, 4 mg/L, 3 mg/L, 3 mg/L, and 3 mg/L.

Conclusion

The bcrABC and qach genes in Listeria monocytogenes significantly increase the resistance of strains to BAC. The MICs of the strains in the mixed food and seafood environment is significantly higher than that of the strains in other environments.

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New methodological approaches to study anisotropic structures in foods using rheological and Raman spectroscopic fingerprints

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Aim:
Our food system needs to change to provide more sustainable diets in the future. In this transition, new formulations are being developed with limited knowledge of their impact on structure and texture development during processing and storage. It is imperative not only to learn the details of the structure but being able to follow the change dynamics to ultimately control processing. Objective of this study was to develop a novel strategy to characterize high protein anisotropic structures, with pizza cheese as a model system, using a combination of advanced rheology and microstructural methods.

Method:
Pizza cheese was evaluated at different time scales during the stretching process and followed during storage using rheological and Raman spectroscopic fingerprints. Confocal Laser Scanning Microscopy and Low Field Nuclear Magnetic Resonance provided supporting information on the structures and their hydration state.

Results:
In many process operations, where structures are being developed, the deformation can be large, resulting in a non-linear response from the material. Large amplitude oscillatory shear (LAOS) was utilized in this study to characterize the non-linear mechanical response. Inclusion of contribution from higher harmonics was visualized through Lissajous curves and assigned physical meaning through quantitative analysis. A novel visual analytics software was developed for supporting the interactive analysis of the non-linear dynamics between samples. This new rheological approach was combined with Confocal Raman Microscopy, to provide additional biochemical information by area and line scans. Raman Microscopy successfully identified the hydration of the protein phase, and the data clearly showed the effect of hydration and multicomponent distributions in the samples taken at different timescales.

Conclusion:
This presentation will demonstrate how LAOS rheology, and the new data analysis approach, together with spectroscopy based Raman Microscopy, can contribute to the characterization of complex food matrices. Introduction of the LAOS software provides more insight of the viscoelastic properties of foods during processing, while attention to proper data collection and handling for optimal Raman spectroscopic introduce an increased understanding of the microstructures.

Combined can the two new methodologies be applied to optimize process conditions for the green novel foods of the future.

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A factory layout and associated food hazards in open food processing facilities, a review

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Aim: Food products in open food processing lines are strongly affected by the environment inside and outside the processing factory and may become contaminated with various contaminants. In other words, different food processing environments have different effects on the quality and safety of the final product. This literature review structures the latest development within the hygienic design and the potential sources of food hazards in food processing facilities using open food processing equipment according to proposed hygienic areas.

Method: A systematic literature review was conducted through Scopus, Google Scholar, and Science Direct on published peer-reviewed literature within the last 12 years, using specified search terms related to hygienic design and food production.

Results: To date, considerable scientific research has documented the consequences of insufficient hygienic design and hygiene practices in food processing facilities, leading not only to the reduced shelf life of the product but also to increased risks of foodborne illness, more maintenance and operating costs, and less equipment lifetime. Despite a large number of documents including guidelines, standards, and directives related to hygienic design and safe production, the food industry is still experiencing food safety issues. The major reason behind this is the diversity in the sources of contaminants and the lack of awareness of them within the food processing facility. Based on the reviewed literature, the paper identifies hygienic areas within the food processing facility with similar challenges and describes the potential associated food risks. Appropriate preventive measures and actions against food contamination as found in the reviewed literature are described for each hygienic area.

Conclusion: A clean environment can help to support the quality and hygiene of the final product. This review identifies hygienic areas within food processing facilities for open food processing equipment and gives a comprehensive overview of the associated hygienic risks to facilitate the decisions on hygienic requirements and the development of strategies for producing safe and hygienic food.

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Process Development for Biofilm-Based Production of Nutraceuticals from Microalgae

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Aim:
Microalgae are photoautotrophic microorganisms, i.e., are able to convert light into chemical energy via CO_2 fixation to produce microalgal biomass which is typically rich in primary metabolites such as lipids, carbohydrates, proteins, and peptides. Together with bioactive secondary microalgae metabolites like antiviral extracellular polymeric polysaccharides (EPS), these make microalgae biomass an attractive candidate to develop nutraceutical food products as well as feedstock. Practical application has thus far been hindered by high production cost. Here, processes for biofilm-based Photobioreactors (PBRs) cultivation of microalgal biomass, are investigated, with a special focus on the optimization of process parameters and inoculation procedure for lab scale bioreactors.
Method:
Passive culture media supply in a wicking based flat panel biofilm PBR made from Ultra high Molecular Weight Polyethylene (UHMW-PE) with hydrophilic surface modification was used for the cultivation of *Chlamydomonas asymmetrica*. Inoculation strategies were optimized, including process variation and mechanical surface modification. While destructive methods (biofilm harvest) and nondestructive methods (CO_2 uptake and fluorescence) for biomass accumulation measurement were used. Special consideration was given to determine the tolerance range for evaporation-based nutrient concentration changes in the biofilm as well as the range of process parameters for minimally viable lab scale cultivation.
Results:
Optimized process parameters for the inoculation on the chosen support material were determined, as well as a parameter space for non-growth inhibiting media concentrations and feasible cultivation size with non-destructive off-gas based growth assessment.
Conclusion:
Cultivation of the microalgae *Chlamydomonas asymmetrica* in a biofilm on UHMW-PE is a viable tool for researching process intensification via biofilms usage for the production of nutraceuticals. Low water consumption and relatively simple numbering up of the reactor system suggest that this method could be an attractive production system.

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How does starch affect wheat bread crumb structure during baking and cooling?

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Aim:
In bread making, the wheat gluten matrix is considered to play the main role in dough structure and bread final texture. However, the availability of wheat and its gluten content are expected to decrease, due to climatic changes and the reduction of nitrogen inputs in grain culture. On the other hand, starch is the main component of all cereals and tubers and present a wide diversity of characteristics. One of them is the amylose/amylopectin ratio, which has been shown to affect bread quality. Low-amylose starches, including waxy starches, were related to a higher bread volume at the end of baking followed by a significant shrinkage during cooling. This could be due to a higher resistance of gas cell walls to rupture, reminiscent of gluten behaviour during baking. The aim of this study is to better characterise and understand the sub-mechanisms involved in the retraction of bread made with low-amylose starch.

Method:
Four starches (wheat, waxy wheat, rice, glutinous rice) together with dry gluten were used to partially substitute wheat flour in French bread making process. Magnetic Resonance Imaging was used to monitor non-invasively the gas fraction, globally and locally in the loaf, during baking and cooling.

Results:
Bread made with waxy wheat and glutinous rice starch showed retraction during baking and cooling. Retraction was more intense in the lower part of loaves. This could be explained by the non-opening of pores, preventing air from entering gas cells to compensate the thermal contraction and loss of water vapour and CO_2. Crumb observation under a macroscope revealed that gas cell walls in waxy wheat bread remained mostly intact, but not in glutinous rice bread. Gas cell wall stabilization mechanism might not be the only one involved in retraction. Significant cell wall ruptures were observed under the crust, suggesting that crust may be involved too.

Conclusion:
The results confirmed the increased resilience of waxy starch after gelatinization compared to normal starch. Pore opening during baking could be achieved, at some point, with processes like partial vacuum baking. Henceforth, waxy starch may constitute a solution to gluten loss in future wheat bread making.

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Does carrageenan hinder meat proteolysis? Proteomic analyses of in vitro digestions

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Aim:
Carrageenan (CGN) is an approved food additive whose safety has been under debate. Lately, studies show that CGN adversely affects digestive proteolysis of food proteins in different age groups and alter the bioaccessibility of milk-derived bioactive peptides. This follow-up study aimed to elucidate the effects of commercial CGN preparations on the proteolysis of meat proteins, using cooked beef meatballs as a model food system.
Method:
Commercial □-CGN, □-CGN and □-CGN were characterized in terms of particle size, zeta potential, mineral content, and morphology by scanning electron microscope (SEM). Meatballs (with and without CGN addition) were cooked (10min, boiling water) and characterized for cooking loss and texture profile analysis (TPA). Subsequently, meatballs were fed into a semi-dynamic *in vitro* digestion model and gastro-intestinal effluents were analysed in terms of protein breakdown by SDS-PAGE analyses and LC-MS/MS peptide profiling.
Results:
Analyses of zeta potential, particle size and mineral content of the commercial CGN indicated that all samples maintain a distinct anionic nature under a pH range and concur with regulatory demands. Addition of □– and □ -CGN to the meatballs caused a decrease in the cook-loss compared to the controls, while □-CGN has no significant impact. Further, TPA results show that □– and □-CGN addition have no significant impact on the hardness and chewiness of the meatballs, while □-CGN caused significant decrease in both parameters, compared to the control meatballs. SDS-PAGE analyses of gastro-intestinal effluents refute abrupt effects on proteolysis of the meat proteins. However, in depth peptidomic analyses of bioaccessible peptides shed further insight into these subtle differences.
Conclusion:
Overall, the current evidence improves our understanding of CGN impact on digestive fate of processed meats and refutes any possible marked alterations in digestive proteolysis of meat proteins. The extensive use of CGN in meat and meat alternative products is growing, along with the expected CGN dietary exposure. However, estimated CGN exposure has increased over the years and now surpasses the recommended acceptable daily intake (ADI) in certain age groups, e.g. toddlers and children. Thus, there is a constant need to further investigate CGN digestive fate in real foods.

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Showing the opportunities of fruits by-products valorization through carbon removal technology in Central Wallis (Switzerland)

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Aim: Showing the opportunities of fruits by-products valorization through carbon removal technology in Central Wallis (Switzerland)
The Central Wallis is the most productive fruit region of Switzerland and is exposed to more extreme climate events. As pyrolysis technology brings added value to agrofood value chains through the production of biochar as a soil enhancer, our project aims in understanding the possibilities to implement a sustainable business case for a combined practice of regenerative agriculture and carbon removal technology in the region.
Method: a mix of quantitative and qualitative approach
The project consists in a combined approach: analyzing the availability of fruits' byproducts with data-analysis and understanding the demand for biochar and regenerative agriculture practices by conducting farmer interviews.
Results: the beginning of a promising adventure
In the search for a suitable location for a pilot plant, two companies have already shown interest. The potential to valorize by products is given at a local juice producer, where biomass for pyrolysis is centralized at the site and exhaust heat for drying can be used. The other option is a mobile pyrolysis plant which can serve the different farmers and local fertilizer producer in a flexible way.
The business case consists in valorizing the CO_2 carbon removal certificates, selling the heat for the local fruit juice producer and applying the biochar in organic fruits production to decrease the vulnerability of the farming conditions.
Conclusion:
The spirit of time and momentum is clearly on the side of climate protection and carbon removal technologies. The valorization of fruit by-products by pyrolysis technology offers an excellent opportunity to combine both and builds the bridge for a change in agriculture practices by including biochar and regenerative agriculture. The first rounds of talks, both with potential industry partners and with farmers, showed the great potential and interest. The next step is to plan field trials and intensify the search for a location for a pilot plant.

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Functional compounds extracted from yeast lees

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Aim:
In the oenological industry, fermentation lees are a deposit made up mainly of components of yeast cells removed after alcoholic fermentation. Fermentation lees are considered a winemaking waste but they could be a source of added-value products due to the high interest in yeast derivate products in the oenological industry. This work aimed to extract rich-protein fractions from fermentation lees using enzymatic hydrolysis. Their impact as a fining agent in red wine was evaluated.

Method:
Fermentation lees of two rosé wines Grenache (GFL) and Merlot (MFL) were recovered, frozen at -40 ºC, and lyophilized. Physico-chemical and phenolic characterization were carried out using oenological official methods (OIV). The polysaccharides content (Dubois et al., 1956), mannose/glucose ratio, total protein and protein profile (SDS-Page) were also analysed. Enzymatic hydrolysis was carried out at 37 ºC, and pH 6.0. Clarification ability was measured by Turbiscan technology.

Results:
Fermentation lees were rich in polysaccharide content with 220 ± 20 mg glucose/g lees for GFL and 92 ± 4 g glucose/g lees for MFL as previously found for lees in sparkling wines (Aguilera Curiel, 2016). These polysaccharides were rich in mannose and proportions mannose/glucose of 90:10 according to the mannoproteins released during lees ageing of white wine (Gonçalves et al., 2002). Protein was the second main component with 12.3 ± 1.0 mg BSA/g lees for GFL and 9.4 ± 4.3 mg BSA/g for MFL. SDS-Page identified the deglycosylated protein parts of invertase, an enzyme from the periplasm of *Saccharomyces cerevisiae*, at 62 ± 1 kDa, and proteins from grape (thaumatin-like proteins) at 18.5 kDa. After enzymatic hydrolysis, the electrophoretic profile showed bands at 66 ± 2 kDa, the deglycosylated protein part of invertase, and three new bands at 57 ± 2 kDa, 42 ± 1 kDa, and 32 ± 1 kDa. The smallest one is associated with an N-glycosylated fragment of invertase. The results of fining tests with Turbiscan showed that this product was performant in red wine fining.

Conclusion:
Fermentation lees are a new source for obtaining functional compounds with oenological interest. After enzymatic hydrolysis, rich-protein fractions showed clarification ability in red wines.

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White brined and hard cheeses from Epirus region in Greece: Discovering the terroir secrets

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Aim:
The aim of the study was to determine the core microbiota of different cheeses in relation to their geographical origin within a territorial district.

Method:
A molecular-based system for traceability was applied in samples from kefalograviera, graviera, feta, and goat cheese. DNA was extracted from 57 samples and was tested in paired-end sequencing of the 16S rRNA gene using an Illumina MiSeq. Raw reads were processed using the “Integrated Microbial Next-generation sequencing”.

Results:
A total of 1,341,413 filtered sequence reads were extracted and 52 operational taxonomic units (OTUs) were obtained between all samples. Three distinctive microbial clusters were noted: Cluster A, Cluster B, and Cluster C (P=0.001), corresponding to Epirus (Greece) geographical region. Positive correlation was found between the origin of milk and the cheese type (P<0.001). Different microbial profiles characterized each cluster and the most dominant genera were: Cluster A, Streptococcus (65.05%), Lactobacillus (20.72%), Lactococcus (12.19%), Leuconostoc (0.72%), Enterococcus (0.42%), and Pediococcus (0.41%); Cluster B, Streptococcus (6.56%), Lactobacillus (15.72%), Lactococcus (47.2%), Leuconostoc (8.3%), Enterococcus (4.4%), and Citrobacter (7.91%); Cluster C, Streptococcus (22.68%), Lactobacillus (5.19%), Lactococcus (69.42%), and Enterococcus (1.37%).
In clusters A and C, the OTU network showed that samples were grouped separately in subclusters (Cluster A: 4 subclusters; Cluster C: 3 subclusters). A core microbiota of a few OTUs was shared among the samples. β-Diversity analysis at the subcluster level showed that the samples significantly differed (P<0.001) according to cheese type. *Lentilactobacillus sunkii, Lactiplantibacillus paraplantarum* and *Levilactobacillus brevis* were confirmed as microbial markers for white-brined cheeses (feta, goat cheese) in both clusters, while *Lactobacillus delbrueckii subsp. bulgaricus, Leuconostoc mesenteroides subsp. mesenteroides, Streptococcus equinus,* and *Latilactobacillus curvatus* were identified only in hard cheeses (kefalograviera, graviera).

Conclusion:
This study provided an in-depth description of the microbiota involved in four Epirus cheeses. The results showed a fundamental microbial homogeneity in each cheese type that potentially represents a geographical indication.

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Safety Assessment of Novel Foods from the Biorefinery of Olive, Grape, and Nut By-products

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Aim:
Upcycling for Health (Up4Health) is a H2020-funded project that is developing a sustainable and cost-effective process for the recovery of value-added ingredients from olive, grape and almond by-products for food, nutraceutical, and cosmetic applications. In the context of the European Novel Food Regulation (EU 2015/2283), Up4Health ingredients qualify as novel foods. A critical aspect of obtaining pre-market approval of novel foods is demonstrating their safety in compliance with existing legislation and standards. This research presents the approach for the safety assessment of the ingredients based on regulatory requirements and standards at the European and International level.
Method:
Reviews were conducted of relevant literature, European regulatory documents, scientific opinions by the European Food Safety Authority (EFSA), standards by the International Standards Organization (ISO), European Committee for Standardisation (CEN), CODEX Alimentarius, and toxicological test guidelines by the Organisation for Economic Co-operation and Development (OECD). Reports were compiled to inform the project of the relevant legal requirements and the standards available.
Results:
The review identified the relevant legislations and standards that support the application for pre-market approval of novel foods. These cover nutrition and health claims, labeling requirements, risk assessment and toxicological studies, extraction solvents, contaminant limits, among others. It was found that toxicological evaluation involves hazard characterization combined with a dose-response evaluation. Standard methods to assess the relevant chemical and biological hazards were identified. Biological hazards identified for Up4Health ingredients include *Salmonella, E. coli, Enterococcus, Enterobacteriaceae,* yeasts and molds, aerobic mesophilic count, and microbial toxins such as aflatoxins. Chemical hazards identified include pesticide residues, heavy metals (arsenic, lead, cadmium, mercury) and natural toxins (i.e., allergens). In the dose-response evaluation step, the following *in vitro* methods were identified to assess the safety of the extracts; the Ames and Comet assays for their genotoxicity evaluation, the MTT, Alamar Blue, and Trypan Blue assays for their cytotoxicity studies, and *in silico* models to predict their ADME (absorption, distribution, metabolism, and excretion) properties.
Conclusion:
A safety assessment approach that considers existing regulations and standards is critical to obtaining pre-market approval of the novel ingredients generated in Up4Health.

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Numerical modeling of soluble gas stabilization process as a tool toward full-scale industrialization

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Aim: Increased shelf life reduces food waste and widens distribution outreach in the food value chain, aligning with the sustainability goals. Soluble gas stabilization (SGS) technology as a contributor to this aim is a pre-step process of dissolving carbon dioxide (CO2) into the food product before packaging. This treatment relies on the bacteriostatic effect of CO2. The so-far executed methods in the laboratories for SGS are to fill the headspace of a chamber or sealed bag with 100% of CO2 and saturate the food with CO2. However, this process is time-consuming and therefore inefficient for industrial line processing. An accurate numerical model can pave the way toward more efficient methods, suitable for large-scale industrialization.
Method: A computational fluid dynamics (CFD) model is used to simulate the CO2 gas flow around the food in conjugation with the gas diffusion process to estimate the CO2 dissolution in the product over time. First, the process of CO2 diffusion in salmon inside a chamber with an initial gas concentration in the headspace is simulated using COMSOL Multiphysics. The simulation is validated by previous studies and a simplified analytical solution. Then, to investigate an alternative approach, using continuous gas flow instead of the static gas chamber, a second numerical model is made. Finally, experimental design is suggested to validate the simulations, ensuring the simplified applied assumptions represent the physics of the problem accurately enough.
Results: The simulation of CO2 diffusion in salmon showed good consistency with the experimental results in terms of the dissolved gas in food over time. It opened the door for the investigation of the alternatives to the conventional executed SGS method. Using continuous gas flow as an example significantly increased the dissolved CO2 in the food for the same period as previous experiments. The reason could lie in the gas pressure imposed constantly on the food surface throughout the whole experimental time.
Conclusion: An accurate validated numerical model contributes to develop SGS concept in a cost and time effective manner. It provides the opportunity to examine different design configurations and possibilities, aiming for an optimized design for a full-scale SGS technology.

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Exploring food choice motives of Irish consumers and their potential to drive sustainable consumption

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Aim:
In a recent publication of its sustainable development goals (SDGs), the UN sought to re-emphasis the urgency of a global strategy towards sustainable lifestyles, of which food production and dietary patterns are of paramount importance (SDG 12). However, latest information on Irish diets shows that they are unsustainable. The aim of the present research is to offer insight into the food choice motives of Irish consumers to guide the design of future products to encourage sustainable consumption.

Method:
Qualitative data was collected through 15 semi-structured interviews, conducted online with consumers aged 18-65+ years. Reflexive thematic analysis was used to analyse the data, and the coding process was managed using NVivo software.

Results:
Thematic analysis identified 7 key food choice motives (listed from highest to lowest frequency); 1) Quality; 2) Personal Preference; 3) Health; 4) Cost Factor; 5) Social Issues, 6) Convenience and 7) Sustainable Choices. Quality was shown as the most important motive of those interviewed, which included organoleptic properties such as appearance and freshness, along with labelling information like shelf life and nutritional content. Sensorial factors that were also mentioned in relation to personal preferences, were very important to the respondents. It was highlighted by some that if appearance, taste, and flavour did not deliver, it might impact the repeat purchase of a product. Personal preferences were also influenced by family, especially in families with children. Health was relevant for some of the respondents who follow a specific diet, although in practice most of the respondents were focused on the nutritional quality of their food. Sustainable choices were the least important motive for the respondents, as in some cases sensory appeal, convenience and cost dictate purchase decision.

Conclusion:
The results show that quality, including sensory properties are critical in designing new sustainable foods to meet future challenges. Cost and convenience need to be considered to ensure those with modest incomes can avail of sustainable options. From the findings, it is suggested to educate consumers in making sustainable choices. These choices could be further promoted via labelling in retail settings.

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Dietary guidelines for health and sustainability in Europe: Guidelines vs reality

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Aim:
To determine how national food consumption in European countries compares to FBDG recommendations, and evaluate the greenhouse gas emissions (GHGE) associated with this consumption.

Method:
An extensive review of studies meeting all of the following criteria was completed: data from a European country with FBDG available, and national food consumption data (g/day) and the associated GHGE (gCO2eq/day) was reported. Food consumption data were aggregated into food groups and compared to FBDG recommendations. The GHGE of this national food consumption was also determined.

Results:
National food consumption data and associated GHGE were available for 7 European countries including Ireland, UK, Italy, France, Finland, Sweden, and the Netherlands. Fruit and vegetable consumption was consistently below FBDG recommendations for all countries, as was consumption of legumes. In Ireland, Italy, France, and the Netherlands, dairy consumption was below recommendations. There are no specific recommendations for dairy foods in Finland, Sweden, and the UK. In all 7 countries, consumption of animal-source foods, including red meat, is above the maximum recommendations of approximately 500g/week or 70g/day. Discretionary foods, which should be eaten sparingly, account for 1025-2278g/day of food consumed. Total mean GHGE associated with food consumption across countries ranged from 4541gCO2eq/d to 6534gCO2eq/d. Plant-based food groups contributed lower GHGE to national diets than animal-based foods. In all countries, the "meat, poultry, fish" group was the highest GHGE contributor, ranging from 35-53% of total emissions. The contribution of dairy foods ranged from 8% in Italy to 21% in the Netherlands. Discretionary foods make a substantial contribution to GHGE ranging from 11% in Italy to 33% in Ireland.

Conclusion:
National food consumption is falling short of healthy eating recommendations across Europe. Changes to food consumption are required including increased consumption of plant-based foods, and dairy foods. Alterations to the amount of meat, poultry and fish consumed are also needed. Such changes will influence GHGE, albeit decreasing one food group may be negated by increased intake of other food groups. Discretionary foods, usually high in fat and sugar, account for up to a third of current dietary GHGE, warranting more attention from a health and sustainability perspective.

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Application of innovative technologies for valorization of biomass from house crickets

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Aim: Crickets have been underlined for the valuable composition, containing a high amount of proteins, lipids, antioxidants and chitin. Marketing of frozen dried and powder forms of *Acheta domesticus* have recently been authorized as novel food (Regulation (EU) 2015/2283). The industrial use of their ingredients and the generation of bio-based products require the recovery of fractions with tailored composition. The use of emerging food processing technologies, such as ultrasound (US) and high pressure (HP), as well as the use of green solvents, were explored for valorization of the cricket biomass through sequential extraction steps.

Methods: House cricket flour was mixed with water and treated with ultrasound (25-50% amplitude, 5-10 min) and high pressure (200-500 MPa, 10 min). Afterwards, a hexane/methanol solvent at different volumes (25-50 mL) was added to the mixture, which was agitated for 1 h. Three phases were generated. The hexane-fat fraction (top phase) was isolated and the hexane was recycled with a rotary evaporator, while the fat yield was determined gravimetrically. The aqueous fraction (middle phase) was evaluated for its phenolic content and antioxidant activity. The solid fraction (bottom phase) was subjected to a treatment with a deep eutectic solvent (DES) composed from betaine and urea for a direct separation of proteins and chitin. The isolated proteins were evaluated for their amino acid profile, while the chitin for its properties.

Results: Both HP and US showed no significant effect on increasing the yield of extracted fat that was equal to 12.61±1.91%. Regarding the antioxidant properties of the aqueous phase, US treatment increased the phenolic content by 37% (from 528 to 732 mg GAE/100 g cricket meal), the ferrous iron reducing capacity by 57% and the free radical scavenging capacity by 10%. HP did not affect the antioxidant properties of the aqueous phase. The DES was successful in isolating proteins and chitin, on both untreated and US-treated samples, with similar amino acid profile of the protein-rich fraction (90.32±6.38%) and similar properties of the chitin-rich fraction (77.44±4.41% chitin content).

Conclusions: The proposed sequential processing pathway is appropriate to valorize the cricket biomass with potentially enhanced quality after a US-treatment.

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Development and characterization of active packaging containing TiO2 bio-nano-composite - cinnamon oil for cheese preservation

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Abstract
Aim

Packaging plays a critical role in preventing any physical and chemical damage. By limiting any undesirable chemical or biological changes, packaging also meets the necessity to ensure food safety and quality from manufacture to ultimate consumption. Active packaging is a novel approach to extending the shelf life of food goods while maintaining their quality, safety, and consistency. Active packaging increases the quality and safety of food goods, with a special focus on the use of natural ingredients such as essential oils and natural extracts packaging.

Method:

This study involves the preparation of PLA/PBAT composite blend films incorporated with the nano-carrier TiO_2 (titanium dioxide) and varying concentrations of cinnamon oil by solvent casting method. The films are characterised based on their optical and mechanical properties, chemical composition, thermo-stability, surface hydrophobicity, inhibition of biofilm formation, anti-microbial efficiency against *S. aureus* and *E. coli,* and application study on cheese products.

Results:

The thickness of the films increased with the increase in cinnamon oil concentration along with the water contact angle degree. The greenness of the film was observed to decrease while the yellowness of the film increases as the concentration of cinnamon oil increased. The UV-barrier

properties with the PLA-PBAT-TiO_2-7%Cinn film had increased by 99.42%. The transparency of the film decreased by 5% for PLA-PBAT-TiO_2-7%Cinn with respect to control film. The best anti-bacterial activity was seen in the PLA-PBAT-TiO_2-7%Cinn film against *S. aureus* and *E. coli.* The cheese packed in PLA-PBAT-TiO_2-7%Cinn film has shown the least weight loss and enhanced antibacterial activity against *E. coli* for 12 days of storage.

Conclusion:

The application of cinnamon oil-loaded nano-carriers incorporated in films has a high potential for commercial use and has favourable and positive impacts on the shelf life, quality, and safety of a food product.

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Identification of botanical origin of Greek honeys using UV-vis and FT-NIR spectroscopy

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Aim:
Honey has been characterized as a functional food and has a high commercial value. The botanical origin is an important quality parameter of honey because it largely affects honey's sensorial properties and nutritional value. The establishment of an authentication system for determining the botanical origin of honey samples is very important in order to protect both producers and consumers. The aim of the present study was to differentiate Greek honey samples with regards to their botanical origin, using ultraviolet-visible (UV-vis) and FT-NIR spectroscopy, combined with multivariate statistical analysis.

Method:
A total of 46 thyme, polyfloral and pine honey samples were collected from various areas of Greece. For all samples, UV-vis spectra were acquired using a UV-vis spectrometer (UV-1700 spectrophotometer, Shimadzu Corporation, Japan) in the range of 190 – 900nm, after appropriate dilutions. FT-NIR spectra of the samples were acquired using a Jasco FTIR 6700 spectrophotometer equipped with a PIKE NIR integrating sphere in the region of 10,000 – 4,000 cm^{-1}. Regarding spectra pre-processing, different methods were evaluated, such as smoothing with the Savitzky-Golay algorithm, standard normal variate (SNV) and first and second derivatives. Principal Component Analysis (PCA) and Partial Least Squares Discriminant Analysis (PLS-DA) were used to differentiate and classify the honey samples.

Results:
Several peaks were detected in the UV-vis spectra at wavelengths of 266, 270, 280, 290 and 335 nm. Thus, the region of 240 – 550 nm was selected for further analysis, since no peaks were observed in the rest of the spectrum. Regarding FT-NIR spectra, the full spectrum was used for multivariate statistical analysis, after suitable pre-processing. PCA of both UV-vis and FT-NIR spectra showed a clear separation of different honeys, based on their botanical origin. In addition, PLS-DA with SNV pre-processing provided the best results, with classification rates for the different botanical origins of 91.3 % for UV-vis spectra and 93.56% for FT-NIR spectra.

Conclusion:
Obtaining UV-vis and FT-NIR spectra is simple, rapid and requires a small amount of sample for analysis; therefore, the proposed methodology can be used as an efficient tool to identify the botanical origin of Greek honeys.

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Optical Cleaning Assurance for Reusable PET (re-PET) Food Packaging

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Aim:
The growing environmental and socioeconomic concerns regarding plastic food packaging suggest reuse to replace single-use, particularly considering the UK's aim to eliminate all avoidable plastic waste by 2042. However, packaging reuse systems require suitable cleaning methods and assuring cleanliness to avoid cross-contamination between uses. Currently no rigorous technology exists. This work demonstrates the feasibility of using ultraviolet (UV) fluorescence imaging to detect residual fouling following cleaning processes.
Method:
With respect to Food-to-Go (FTG) plastic packaging polyethylene terephthalate (PET) is commonly used as it is widely recyclable, convenient, and food safe. This research represents simulating various types of fouling (orange juice and cream cheese) on recycled PET (rPET) packs at different dilutions and quantities. A pack form representative of common FTG packaging was utilised for all testing. Successive images of the fouled packs were acquired using a colour camera under UV illumination, and MATLAB-based image processing was performed applying thresholding and segmentation methods. The assessment process was correlated against the industry best practice, adenosine triphosphate (ATP) assay to assess the industrial relevance of the technique.
Results:
The results depict that the lowest concentration of fouling that could be reliably detected was 0.01 % (w/w) and 1% (w/w) for cream cheese and orange juice respectively. ATP assessment tended to misrepresent the cleanliness of a surface depending on different fouling types. Further modifications to the present experimental settings are required to improve the reliability of the optical detection method for the lowest fouling levels.
Conclusion:
The UV detection technique was found to be suitable for the detection of on-pack fouling to a level commensurate with ATP assay, indicating potential suitability for this application. There is substantial industry level shifts required to support a circular economy for plastic food packaging: implementation of reverse logistics, rapid and effective cleaning, and the transition from packaging manufacturers to providers of pack reuse systems. In this work, the technological challenge of cleaning assurance is addressed by investigating the feasibility of UV fluorescence imaging to detect residual fouling following cleaning processes: a technique that could form part of the solution to support the reuse of plastic food packaging.

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Comparative risk assessment study on bisphenol A (BPA) through meat products

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Aim: Meat and meat products provide essential nutrients; however, contamination by chemical hazards, including bisphenol A (BPA) in meat products, is a concern and is continuously monitored. BPA is well-known for its endocrine-disrupting properties, which may cause potential toxicological effects on reproductive, nervous, and immune systems. The dietary pathway, of which meat consumption is the predominant contributor, is the main route of human exposure to BPA. The migration of BPA from plastic packaging has been suspected as a potential contamination source. Therefore, this research aimed to conduct a comparative risk assessment study on BPA through fresh, processed, canned, and non-canned packaged meat products.
Method: A probabilistic risk assessment model was developed for the farm/retail-to-table continuum, using @RISK software to provide a framework and risk estimates for BPA following meat consumption under different meat-consumption choice scenarios. Literature-based data was collated for levels of BPA in various meat products. The European Food Safety Authority (EFSA) and the Irish Universities Nutrition Alliance (IUNA) databases were considered for the consumer survey, including adults, elderly, very elderly, children, and teenagers. The final risk estimates were calculated based on the Hazard Quotient (HQ) method, the fraction of the daily human exposure and Health Based Guidance Values (HBGVs). The EFSA's current HBGVs for BPA is 4 µg kg bw^{-1} d^{-1}, and U.S. Food and Drug Administration (USFDA) suggests 5 µg kg bw^{-1} d^{-1} for similar toxicity endpoints. There is also an ongoing re-evaluation regarding BPA toxicity by EFSA. A sensitivity analysis was performed during the Monte Carlo simulation (100,000 iterations) to capture the variability and uncertainty of the model input parameters.
Results: The simulated HQ was estimated as 6.48E-04 to 1.59E-03, 1.58E-05 to 6.26E-05, 9.23E-05 to 1.60E-04, 2.69E-04 to 4.65E-04, for non-canned, canned, fresh, and processed non-canned meat products, respectively.
Conclusion: Overall analysis suggests a low risk associated with human exposure to BPA through a suite of meat products explored.

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Innovative production of prebiotics from acid whey with a hyperthermophilic β-glucosidase from Thermotoga neapolitana

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Aim:
Greek strained yoghurt has gained a significant share in the global dairy market. Issues related to the difficult management of the large amounts of acid whey discharged in conventional waste treatment facilities have necessitated alternative approaches. Dairy industries have sought acid whey valorization via innovative and economically efficient processes. In this context, prebiotic oligosaccharides can be enzymatically synthesized from acid whey lactose, via hydrolysis and ensuing oligomerization catalyzed by conventional and novel glycosyl hydrolases. Increased thermostability of such hydrolases can be a crucial asset in a combined concentration/oligomerization process.

Method:
The gene encoding a β-glucosidase from the hyperthermophile bacteria *Thermotoga neapolitana* was cloned and the recombinant enzyme (*Tn*bGal1) was heterologously expressed in *Escherichia coli*. The enzyme was biotechnologically characterized, and applied in Greek yoghurt acid whey (lactose concentration of 3.4% w/w). The production of oligosaccharides was monitored over time in relation to lactose concentration and enzyme load, at the optimum reaction conditions. Reaction products were identified via High Performance Anion Exchange Chromatography with Pulsed Amperometric Detection and oligosaccharides yield in relation to initial lactose content was quantified.

Results:
*Tn*bGal1 is a protein of 444 amino acids with a molecular weight of 52 kDa. Enzyme activity and thermostability of *Tn*bGal1 was studied in the temperature and pH range of 50-100°C and 4-8, respectively. Optimum catalysis conditions of *Tn*bGal1 were found at 85°C and pH=5.5, in which enzyme was stable for more than 10 h. Transglycosyllation efficiency of *Tn*bGal1 applied on acid whey was found significant, reaching up to 15,6% in non-concentrated whey, after 8 h of reaction at optimum conditions, using enzyme load of 1 U/mL.

Conclusion:
*Tn*bGal1 is a novel, thermostable glycosyl hydrolase that demonstrated great potential for the oligomerization of acid whey lactose for the production of prebiotic oligosaccharides at severe industrial conditions. Further research towards optimization of lactose oligomerization is essential for efficient production of valuable prebiotics in the framework of circular economy.

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In vitro digestion/fermentation of olive oil by-products debittered with lactobacilli and functionalized with Lactiplantibacillus plantarum

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Aim.
In Europe 6 million t/y of olive oil residues are generated, causing environmental footprint and high costs for their waste management. Olive Pomace is a byproduct rich in fibers, polyphenols, and other bioactives that should be exploited for the formulation of functional foods with an increased polyphenol bioaccessibility, eventually due to the fermentation by colon microbiota. Olive Pomace debittering by lactobacilli is an effective strategy to produce palatable, sustainable food or ingredients, possibly enriched with active strains showing probiotic properties. However, in order to increase the efficacy of that strategy is fundamental to unravel the impact of such bioprocess on the human colon microbiota. The aim of this work is to study how naturally debittered pomace and its interactions with food-dwelling *Lactiplantibacillus (Lbp.) plantarum* strains with probiotic traits may influence colon microbiota after an *in vitro* digestion in MICODE gut model.

Method.
In this work we compared three formulations of defatted olive pomace (D), with and without naturally debittering by lactic acid bacteria (FD) and addition of *Lbp. plantarum* strains with probiotic traits (FDP). Comparison was made after gastro-duodenal digestion (Infogest) and proximal colonic fermentation (MICODE). Throughout multivariate analyses of results from microbiomics (qPCR) and metabolomics (SPME GC-MS), we studied the shifts caused by the samples towards the colon microbiota (core microbiota, beneficial and opportunistic taxa) and its metabolites (health-related and detrimental compounds, and volatilome).

Results.
Considering microbiomics, D induced a slight dysbiosis (*Firmicutes/Bacteroidetes* >2.0), FDP was the best performer fostering beneficial microbes (*B. longum*) and limiting the opportunistic ones (ATOP group), while, for some features, FD was significantly better than FDP (*F. prausnitzii*). Concerning metabolomics, FD and FDP induced SCFAs release similarly and the thrice than D; FDP produced more MCFAs in comparison to FD (hexanoate); fermentations on FD and FDP were able to significantly reduce detrimental VOCs (skatole). Lastly, FDP had the best quantitative prebiotic index; moreover strains with probiotic traits resisted digestion/fermentation.

Conclusion.
Our results pointed out that the olive pomace debittered with lactobacilli and enriched with *Lpb. plantarum* showing probiotic traits was the most promising functional food, regulating the colon microbiota to maintain an eubiosis condition, fostering beneficial microbes and limiting the opportunistic counterpart, releasing, in the meantime, fundamental postbiotics.

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Plant-based protein: the road to sustainability? Says who?

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36th EFFoST International Conference: *Shaping the Production of Sustainable, Healthy Foods for the Future.*

Proposed title: Plant-based protein: the road to sustainability? Says who?

Aim: This paper aims to identify where plant-based foods fit in the concept of a sustainable diet from the perspective of different stakeholders, with recommendations as to how such stakeholders could be involved in a sustainable dietary transition.

Introduction Plant-based foods are often identified as a route to more sustainable diets. Given global patterns of food production, significant changes in diets, underpinned by the development of new foods and ingredients, and other changes within the wider food system, are required to achieve such a transition. In addition to consumers, this has implications for many actors including industry, public health and nutrition experts, policy makers, researchers, non-governmental organisations. This paper explores how plant-based foods, and particularly plant-based proteins, are perceived by various stakeholders, their attitudes towards them, their perceived advantages/constraints/risks/benefits of such foods and perspectives regarding future opportunities.

Method: With a focus on Europe, it draws on a review of the academic literature, and some grey literature relating to market research reports, policy documents and industry strategies. It implements a scoping study approach following the 5-stage process outlined by Arskey and O'Malley (2007).

Results: Alongside a growing market demand, many aspects of plant-based foods have been researched by scientists, explored by policy makers and exploited by industry to date. They are included in discourses that often compare plant-based foods to other foods. Such comparisons can position plant-based foods as substitutes or alternatives to other proteins, with concepts such as "alternative protein", "plant-based protein", and to a lesser extent "novel" protein" being used. Other discourses relating to vegetarianism/veganism often result in comparisons that position such foods as competing with animal-based foods in particular. Hybrid product concepts however position them as complements.

Conclusion: Diverse, frequently complementary, and sometimes contradictory perspectives on the role of plant-based foods across different stakeholder cohorts is evident. While comparisons with other foods may be useful from an environmental and nutritional perspective, positioning plant-based foods without reference to other foods is also important in the context of dietary transitions. This research provides insights into which actors are potential collaborators in addressing different elements of a transition pathway.

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Selection of DNA aptamers for the detection of foodborne toxins

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Aim:
Aptamers are single-stranded nucleic acids with a three-dimensional conformation that confer them affinity and specificity against a target molecule and are generated by a repetitive selection process known as Systematic Evolution of Ligands by Exponential Enrichment (SELEX). In this work, we applied a SELEX methodology using magnetic beads and real-time PCR to select DNA aptamers against staphylococcal enterotoxin A (SEA), the most common toxin in staphylococcus-related food poisoning, for the application on the development of a lateral flow assay (LFA) for the detection of foodborne toxins.

Method:
A SELEX procedure was applied using streptavidin-magnetic beads as immobilization matrix of biotinylated SEA allowing magnetic separation of bound from unbound sequences. In total, ten SELEX rounds were performed using an initial random ssDNA library incubated with ~10^7 SEA-coated beads in binding buffer at room temperature with gentle shaking and increase stringent conditions (i.e., binding time, negative selection, washing buffer). Real-time PCR was used to amplify and monitor the bound pools and generate ssDNA to start a new round. DNA pools obtained in each round were tested by real-time qPCR, and the round with better affinity was sequenced by next-generation sequencing (NGS) to identify potential aptamers to be incorporated in a LFA device.

Results:
The pool of sequences from round 8 showed the highest affinity for SEA. Several potential DNA aptamers were identified, after NGS results analysis, and their dissociation constant (K_D) was assessed by real-time qPCR in the nanomolar range. that are being tested for incorporation into an LFA device. Our group has already optimized LFAs for the detection of other targets, so the application of the best aptamer will allow a rapid detection of samples contaminated with SEA. The aptamers with the highest affinity against SEA were successfully incorporated in LFA that proved to be able to detect the presence of SEA in milk samples.

Conclusion:
The SELEX methodology has provided a set of potential toxin-specific aptamers. This approach can bed adapted to any other protein, including other relevant foodborne contaminants, allowing the rapid identification of aptamers with potential for diagnosis and clinical applications.

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Occurrence of regulated and emerging mycotoxins in raw milk: a Portuguese case-study

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Aim:
Milk is a highly worldwide consumed food, playing an important role in the human diet, especially in vulnerable groups. Raw milk consumption has also been growing, since it has been consider, especially between health-conscious people, as having possible health benefits. Though, these consumption patterns can lead to the exposure of eminent hazards due to presence of food contaminants, such as mycotoxins, which can be carried-over or biotransformed and secreted to milk during animal metabolism. Therefore, this study was focused at performing a characterization of the contamination profiles of regulated and emerging mycotoxins in raw milk.
Method:
One-hundred raw milk samples were collected from the main dairy region of Portugal corresponding to 100 dairy farms, between 2020 and 2021. Sampling was performed directly from bulk milk cooling tanks, in sterile labelled screwed top bottles, in a 1 L-volume, and stored at -20±2ºC, until further analysis. Subsamples (4 mL) were submitted for analysis of regulated and emerging mycotoxins (n=23) by a validated QuEChERS procedure. For identification and quantification purposes, a liquid chromatography coupled to mass spectrometry system (UHPLC-QTRAP-MS/MS) was used.
Results:
Results concerning prevalence data revealed the presence of at least one mycotoxin in 97% of the samples, with high prevalence of emerging mycotoxins. Beauvericin (90%) and enniatin B (77%) presented the highest percentage of positive samples, with fumonisins B1 and B2 being also found in 10 and 31 samples, respectively. No aflatoxins, including aflatoxin M1 (AFM1), were found in the analysed samples. In total, 78% of the samples presented 2 or more mycotoxins. In only three samples, none of the mycotoxins analyzed were detected.
Conclusion:
Mycotoxin occurrence data in milk samples is very scarce, and mainly focused on AFM1. This work is a first insight on a full screening of several regulated and emerging mycotoxins in raw milk samples. The high occurrence of these compounds points out the need to perform further occurrence surveys in this matrix, and continuous monitoring on multi-mycotoxin presence in such samples are crucial to perform accurate risk assessments, as well as to protect consumer health, especially in a food highly consumed by age vulnerable groups.

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A multidimensional heat and mass transfer study of coffee roasting in spouted bed roasters

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Aim:
Coffee's in-cup flavour and aroma are generated by thermally driven chemical reactions during roasting, where coffee's physicochemical transformation is governed by the applied time-temperature roasting profile. Through simulation, comprehension of heat and mass transfer mechanisms that occur within the bean, and the batch of beans, aims to advance the engineering formulation of coffee roasting.
Method:
Here, we build upon two previous works where: (i) a fundamental energy balance was used to develop a zero-dimensional simulation of coffee roasting time-temperature profiles at the batch scale and (ii) particle dynamic studies using Positron Emission Particle Tracking (PEPT) informed the dynamic development of the bean-bed under different process conditions. With these works as the basis, the current study conjugates heat transfer simulations (calibrated using real product and process measurements) and empirical particle dynamic studies to construct a three-dimensional model of a coffee bean within the roaster.
Results:
The three-dimensional model consists of accurate product geometry and properties, with regional heat transfer coefficients - corresponding to the bean-bed and in-flight regions - imposed as realistic boundary conditions, where the zero-dimensional model is implemented at the bean's surface.
Conclusion:
By virtualising the roasting process, modulation of flavour can be achieved through a calculated manipulation of green coffee (raw material) properties, roasting conditions (process parameters) or roast coffee (product) properties - the three pillars that roasting product and process developers rely on.

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Detection of almond traces in processed foods using electrochemical immunoplatforms

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Aim:
Almond is used as ingredient in a wide variety of processed food due to its flavour and beneficial health properties. However, it represents a potential hazard for almond allergic individuals and then, its detection should be included in Allergen Control Plans in food industry. Almond allergy is characterized by its high prevalence and by the low doses that induce severe allergic reactions. Therefore, it is important to develop sensitive and specific analytical techniques to detect its presence in foods. Electrochemical immunosensors have emerged as innovative alternatives for a rapid detection of allergen traces in food. In this study, a novel magnetic beads-based electrochemical biosensor, using, Pru du 6 as the target protein, one of the most abundant and allergenic proteins of almond, was developed to detect almond traces in processed food.

Method:
Pru du 6 was purified from raw almond using chromatographic techniques and inoculated into rabbits to obtain antisera. Specific antibodies were purified by inmunoaffinity using a column with insolubilized Pru du 6 and then conjugated with horseradish peroxidase. The developed bioplatform is based on a sandwich-type immunoassay, using specific capture and detector antibodies and carboxylic acid-modified magnetic microbeads. Amperometric detection was carried out using screen-printed carbon electrodes and the H_2O_2/hydroquinone (HQ) system. The change in the cathodic current is directly proportional to the concentration of Pru du 6.

Results:
The developed bioplatform exhibits good selectivity and sensitivity providing limits of detection and quantification for Pru du 6 of 0.11 and 0.36 ng mL^{-1}, respectively, and a linear concentration range from 0.5 to 50 ng mL^{-1}. The test could detect 0.035 ppm of almond protein. Moreover, it could quantify levels of 0.0002 % almond in incurred samples (raw dough and baked cookies) with good recoveries and acceptable precision.

Conclusion:
This work describes the first electrochemical immunoplatform developed to detect almond traces in processed food using Pru du 6 as the target protein. Evaluation of analytical characteristics showed improved sensitivity compared to ELISA test. Furthermore, the determination can be performed in a short time and using instrumentation compatible with point-of-care applications.

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Findings from a systematic review of behavioural determinants relating to healthy sustainable diets.

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Aim:
Climate change urgency and human health goals have coalesced within our food choices. Food based dietary guidelines provide expert recommendations on what to eat, however adoption is commonly low. Both effective health interventions and sustainable programmes have been shown to rely on behavioural theories for conceptualisation of the problem and construction of the intervention. This systematic review sought to extract food related, adult consumer behavioural findings specifically related to "healthy sustainable diets" to gain insights into the levers of food related behavioural change in this emerging multi-disciplinary research area.
Method:
Potentially relevant behavioural determinants were extracted from studies retrieved from a search of five databases: ProQuest, EBSCO, Scopus, Science Direct and Web of Science, following Page et al's (2021) recommended process of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Data extracted from the retrieved studies were categorised as follows: journal year, lead author discipline, country, definition of healthy sustainable diets, socio-demographics, behavioural theory and construct(s), method and measurement, and behavioural related findings.
Results:
Healthy sustainable food behaviours investigated in the research included meat consumption reduction, increased consumption of plant-based foods, local, seasonal and organic fruit and vegetable consumption, acceptance of alternative-to-animal-protein, pulse consumption acceptance, seafood consumption, and discretionary food consumption reduction. Across the studies, consumer segmentations were proposed, food choice motives were investigated, and barriers identified. Application of established theoretical behavioural concepts was mixed across the studies and in some studies missing. In total 16 behavioural theories (including revisions and extensions) were used to underpin the research, with the behavioural constructs most investigated being beliefs, attitudes, affect and values.
Conclusion:
Facilitating adoption of sustainable and healthy diets will require context specific and culturally appropriate solutions. These solutions should be explored using robust behavioural frameworks to evaluate consumer's current beliefs, values, attitudes, and affect. Gaining behavioural insights into how consumers will adopt expert dietary recommendations can inform effective policy, dissemination and intervention design.

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Driving towards net-zero carbon under climate change: Modelling energy use for dairy manufacturing and distribution

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Aim: Energy-derived carbon emissions from dairy manufacturing and distribution are significant. If energy mitigation actions are not taken, climate change is likely to raise emissions due to the increased differential between ambient temperature and the cold chain. Achieving net-zero carbon is a global priority and the dairy industry must develop a robust emission-reduction strategy. The aim of this study is to develop an energy consumption modelling tool that can aid decision-making towards a net-zero carbon dairy sector.
Method: The developed model evaluates the energy consumption for manufacturing and distribution of skimmed milk and cream. It integrates chemical engineering process design and empirical modelling to simulate energy consumption for each individual supply chain component, sequence-by-sequence. Climate change has been considered by modelling the impact of ambient temperature on the cooling load of the cooling facilities. Four different manufacturing and distribution scenarios were simulated. The scenarios resulted from the combination of two different distribution infrastructures, centralised and decentralised, and two different types of fuel for the manufacturing plant's heating needs, natural gas and oil. Ambient temperature climate projections for the UK by 2050 were used, to simulate the impact of climate change on energy use. Furthermore, UK emission targets for electricity and transportation were used, to simulate the scenarios up to the year 2050.
Results: In the simulated scenarios, the embodied energy ranged between 0.70 - 1.76 MJ/L for milk and between 0.35 - 0.53 MJ/ 330 mL for cream. The scenario of decentralised manufacturing with natural gas as a fuel for heating needs is not only the least carbon emitting scenario of all, but also led to the greatest emission reductions (approximately 40%) by 2050. Modelling climate change impact led to a considerable increase in energy consumption in all scenarios simulated.
Conclusion: The results highlight that current conventional manufacturing and distribution practices are not sufficient to meet the net-zero target by 2050. However, the model can assist the dairy industry towards that aim by analysing the efficiency of various net-zero carbon practices as they become available. Such modelling tools can substantially contribute to industrial and environmental sustainability.

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Increasing the fermentable dietary fibre content of bread by addition of accessible cellulose

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Aim: Dietary fibre has gained increasing interest from consumers and food companies since several beneficial health effects are attributed to a sufficient intake of fibre. However, the daily recommended intake of fibre is not reached in most countries. Many attempts to increase the fibre content in everyday food products, such as bread, have already been made. However, the consumer acceptance of these fibre enrichments is still relatively low. In searching for alternative dietary fibre additives, cellulose is a suitable, sustainable, and economically feasible substrate. Cellulose is barely fermented in the colon, however, limiting its physiological benefits. To counteract this, we developed an innovative modification protocol using mechanical disruption and acid hydrolysis. This protocol decreases cellulose crystallinity and degree of polymerization, enhancing its enzyme accessibility and fermentability. The goal of the research presented here was to compare the effect of the incorporation of microcrystalline cellulose (MCC) and its fermentable counterpart on the breadmaking process and to understand the molecular drivers for these effects.
Method: Breads with incorporation of different types of fibre were evaluated on their end-product quality. Furthermore, physicochemical characterization of the fiber additives, fundamental dough rheology and dough consistency tests allowed us to document the mechanisms leading to the observed differences in quality loss.
Results: The addition of 20% unmodified MCC or commercial fibre additive (inulin) resulted in a decrease in loaf volume of 36% and 47%, respectively. Low field H-NMR analysis showed that the high water-retention capacity of the MCC aggregates caused suboptimal hydration of the gluten network during mixing, resulting in a lack of proper dough development. The proposed MCC modification protocol changed the shape and hydration properties of the aggregates. As a result, the incorporation of fermentable cellulose in bread dough had only minor effects on the hydration of gluten and starch. With 20% fermentable cellulose addition, the loaf volume reduction could be limited to only 15%.
Conclusion: By an extensive investigation of doughs with different fibre incorporations, fundamental insights for fibre enrichment in bread without quality losses are provided. Furthermore, this study underpins the potential of fermentable cellulose as a multifunctional dietary fibre additive.

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A model for consumer exposure to norovirus from oysters, based on ISO 15216-1:2017 detection.

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Aim:
The aim of this study is to develop an exposure assessment model for norovirus in oysters which is directly relevant to the practical questions of EU regulation. In the EU and the US, bacterial detection criteria are used to assess and manage microbial risk in shellfish. This regulatory framework is effective in managing the risk of wastewater bacteria but does not correlate well with viruses from the same source. Although a standard detection method for norovirus in oyster exists (ISO 15216-1:2017), no quantitative microbial risk assessment (QMRA) has been published that links production area concentration with consumer exposure. This study is the first step towards this goal, and better shellfish virus risk management.
Method:
This study shows the successful development of a two-dimensional Monte Carlo exposure assessment model. It takes as input an ISO 15216-1:2017 pooled detection result and produces as output an estimate of per-serving consumer exposure. Consumption is modeled using individual oysters as the unit, rather than total flesh weight. The variation in copies per oyster is modeled using a Poisson-lognormal distribution.
Results:
The results show the boundaries for potential exposure following a given ISO detection result. The variability and uncertainty of the final output distribution are driven by three key inputs: test concentration, test measurement uncertainty, and the number of oysters consumed in a serving. Other inputs, like the size of the oysters themselves, or the variance between them, are not nearly as significant to the outcome. For a relatively low pooled concentration of 200 gc/g, the model predicts that individual oysters will contain 60-400 copies each, before uncertainty is included. A serving size of six oysters would yield a total exposure range of 180-1400 gc, or 70-3100gc with uncertainty included.
Conclusion:
The model shown here estimates exposure for any given site concentration, allows for measurement and sampling uncertainty, and is built on robust experimental data. However, some care must be taken in interpreting levels of genome copies, as many will be non-infectious. These results are directly relevant to potential shellfish safety regulatory thresholds being considered in the EU.

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Consumer perception of plant-based cheese and yoghurt alternatives: Estonian consumers' perspective

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Aim: Plant-based alternatives to dairy milk are becoming more popular. The present study explored this product category to evaluate consumer perception of commercial plant-based yoghurt and sandwich cheese analogues as well as developed prototypes with improved nutritional value. The aim was to understand the sensory and quality attributes that drive Estonian consumers´ preferences and purchase decisions.

Method: The study used a qualitative approach with focus group (n=18) discussions and quantitative consumer study (n=100) for 4 types of fermented yoghurt alternatives (commercial oat-based product, prototype oat-based product enriched with fibres, commercial soy-based product, and prototype fava bean-based product); and 3 types of sandwich cheese alternatives (commercial starch-based product, commercial starch-based product with 1.6% of plant protein, and prototype starch-based product with 7% plant protein). The consumers were grouped according to dietary habits as vegans-vegetarians and omnivores-flexitarians.

Results: Consumers are looking for a more diverse selection in the product category based on the plant source. There is somewhat a preference for higher protein content in the product, but consumers are not necessarily looking for plant-based products that resemble their animal-based counterparts. However, good taste is the main driver for purchasing. Based on the consumer study, no significant differences between the demographic groups on the pleasantness of the products were seen. Fava-bean-based yoghurt was the least favourable of the yoghurt alternatives because of its distinctive and intensive taste. The commercial starch-based cheese alternative without protein was rated as the most likeable of the tasted cheese alternatives (mostly by odour and taste, but also appearance and texture).

Conclusion: The results provide insight into the improvement of sensory and quality attributes of plant-based cheese and yoghurt alternatives for Estonian consumers.

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Improving the quality of ready-to-eat Atlantic salmon fillets using soluble gas stabilization (SGS) technology

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Aim:
The aim of the present study was to investigate the effect of pre-dissolved carbon dioxide (CO_2) on the quality and microbiological composition of vacuum-packed pre-rigor Atlantic salmon (*Salmo salar* L.) fillet portions during cold storage.

Methods:
Pre-rigor salmon fillet portions (n = 96) were divided into two groups, pre-treated in either 100% CO_2 (SGS) or air (Control). After 18.5 h at 4 °C, the samples were re-packaged in vacuum, given two groups (SGS-VP and VP). The storage trial was conducted by splitting each group into two sub-groups stored at 4 and 8 °C, respectively. Microbiological and chemical analysis (n = 3) was carried out at frequent intervals for all groups. The total aerobic and psychrotrophic bacteria counts were quantified using Iron agar and Long and Hammer agar, respectively. The composition of the microbiota was determined by microbial community analysis sequencing of the variable regions V3–V4 of the 16S rRNA gene. The degradation of ATP-related compounds and biogenic amine formation were analyzed using high-performance liquid chromatography.

Results:
For the SGS-VP samples stored at 4 ℃, a significant lag phase was achieved for aerobic (15.5 ± 4.8 days) and psychrotolerant (14.7 ± 3.9 days) bacteria, which was longer than the control group. Microbial community analysis revealed that the *Photobacterium* genus was dominant in all groups. Compared to other samples, the SGS-VP samples stored at 4 ℃ have acceptable K-value until day 10 and a slower formation of biogenic amines.

Conclusion:
The results demonstrated that SGS-technology combined with vacuum packing could effectively prolong the lag phase of the salmon microbiota and thereby potentially improve the quality and shelf-life of pre-rigor salmon fillets stored at
4 ℃. Thus, SGS is a promising technology that ensures high-quality ready-to-eat salmon products. Compared to modified atmosphere packaging, this technology effectively lowers the packing material needed and the product transportation cost by reducing the package size, which benefits the environment.

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ROTARY DRUM HEAT PUMP DRYING AS ALTERNATIVE TO MALT PROCESSING

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Aim

Although drying is widely used for food preservation, this process demands high amount of time and energy. Heat pump drying (HPD) is an emerging technology aimed to save energy and reduce the process costs while preserving quality attributes of products. Therefore, the aim of this work was to investigate the rotary drum HPD applied to malt production, evaluating the energy consumption during the process.

Method

Malt was produced using two-row spring barley (YM organic barley). Barley was stepped for 8 h immersed in water, followed by 15 h of rest and then 3 h immersed at 20°C. Germination was carried out for 72 h at 16°C with water being sprinkled to maintain the moisture. The HPD was performed in an in-house designed equipment based on a clothes dryer running at 60 rpm and charged with 2 kg of green malt. Temperature and relative humidity sensors were placed in different locations of the system to monitor drying. Energy meters were used to quantify the consumption during the processes. After different drying times, the process was interrupted, and the malt moisture was determined by gravimetric method in an oven with air circulation at 105 °C for 24 hours.

Results

In HPD, the remotion of water from the sample into the drum can be considered an adiabatic process, because the variation in enthalpy of the air passing through the drum was close to zero during the process. During HPD, the drying temperature increased from 20 to 80°C. The HPD process takes 174 min to reduce the moisture of malt from 0.8664 to 0.1108 g/g(db), which is almost 4 times faster than the traditional convective process. For the HPD process, the specific moisture extraction ratio (SMER) was 0.3681 kgH_2O/kWh, the specific energy consumption (SEC) was 9.78 MJ/kgH_20 and the moisture extraction ratio (MER) was 1.09 kWh/kg of wet sample, which is in accordance with other results reported in literature.

Conclusion

The rotary drum HPD proved being suitable process to be applied in drying of barley malt. It was possible to obtain a dried product with low processing times and energy consumption.

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Cooking Methods Affect Quality of 3D-Printed Vegan Burger Patties Containing Chia Mucilage-based Emulsion Gels

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Aim:
There is rising global interest and demand for plant based meat analogs as alternatives to meat products. 3D printing offers great opportunities for developing customized meat analogs such as vegan burger patties. Before consumption, a post-processing, such as cooking, is generally required to improve functionality and safety of 3D printed products. A premium 3D printed vegan burger patty (VBP) formulation was developed by optimizing the addition of chia mucilage-based emulsion gel (CMEG). This study evaluated the effects of baking, grilling, or air-frying on physical, chemical, and microstructural characteristics of this premium 3D printed vegan burger patty.
Method:
Ingredients to manufacture VBP were lentil flour, pea protein, yeast, spices, pepper, garlic, onion, olive oil, and water. The optimum values for 3D shaped product in terms of targeted dimensions, cooking loss, and hardness resulting from one of our previous studies were CMEG concentration=1.82%, print speed=23.1mm/sec, and fill density=97.6%. 3D printed VBP were prepared, and cooked either by electric oven, air fryer or a commercial grill. Proximate composition, pH, aw, CIE L*, a* and b* values, hardness, cooking loss, microstructure and sensory characteristics were determined in all final products.
Results:
Grilling rendered the highest moisture content and pH, and the lowest protein, fat, and ash contents, as well as the a_w value ($p<0.05$) followed by air frying and baking. Baked VBP had higher L* and b* values over those cooked by air frying and grilling. Low L* values ($p<0.05$) when these two last methods were used, indicates darkening took place after cooking. Hardness values of air fried and baked VBP were lower than those grilled likely due to the collapse of the porous structure affected by the high temperature applied on the surface. In terms of sensory attributes, all samples received acceptable scores. Grilled VBP had the lowest appearance scores, and the highest flavor and odor over the baked and air-fried products ($p<0.05$).
Conclusion:
Different cooking methods of newly developed 3D printed VGP containing CMEG result in significantly different final products. Therefore it is essential to select the right processing technique to attain the desirable properties of a given product.

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Using Near Infrared Spectroscopy (NIRs) to Help Consumer's Food Choices

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In sustainable food systems, innovations using new technology are needed to facilitate the food preferences of consumers. NIRs technology is a spectroscopic method used in the analysis of organic compounds of foods, determination of imitation and irritation in foods, determination of protein, fat, dry matter, and compositional properties. It is very important to integrate this technology, which is widely used in the food industry, into the field so that consumers can make their product choices more easily and reliably. From this point of view, it is aimed to develop an artificial intelligence model that can decide on behalf of consumers whether the food products they want to buy in online shopping applications and/or local markets, by using NIR technology, are suitable for their own tastes and liking.
In this context, White cheese was determined as the study group due to its widespread use. Spectra of the compositional properties of 15 different feta cheese samples selected from local food markets in Turkey were taken using NIRs technology. Then, sensory analysis of all cheeses was made with randomly selected consumers (n=100) and the cheeses were evaluated on the parameters of taste, smell, elasticity, hardness, color, and overall liking. At the same time, fat, dry matter, acidity, protein determinations, texture, and color analysis of cheeses were made. With all the data obtained, a data set was created using the SPSS data analysis system and determined the relation between data. In addition, a significant correlation of NIR spectra and sensory analysis data was performed with data analysis systems (Principle Component Analysis, MatLab).
With the chemometric study, white cheeses could be grouped according to their spectral, compositional, and sensory properties. In this way, the consumer, who introduces the taste criteria to the developed artificial intelligence model by tasting once, will be able to understand whether the product fits his taste by reading the QR code on the product, which contains the product characteristics data, during his shopping. This developed forecasting model has the potential to serve for the product development of the food industry in the future and to help consumers make informed choices.

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Transformative change towards more sustainable and healthy diets for all-An outline of the SusHealth project

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Aim: To promote the consumption of sustainable and healthy food
SusHealth is a new interdisciplinary project funded through UKRI's 'Transforming UK food systems' programme. *SusHealth* aims to establish a blueprint of a system that incentivises the consumption of sustainable and healthy food. *SusHealth* will demonstrate to stakeholders how the use of a co-designed, combined measure of environmental impact and nutritive value (the *SusHealth* Index) of foods can be used to influence the future direction of our food system.
Method: A coproduced and interdisciplinary research approach based on stakeholder driven innovations
The objectives of *SusHealth* will be achieved through: a) Co-developing an actionable *SusHealth* index and scoring system with stakeholders to combine the environmental and nutritional value of foods; b) *SusHealth* communication tools will be applied to transforming index scores into changes in food production and consumption practices. This will be conducted through interventions in Northern Ireland, and at a UK scale through national surveys; c) Sustainability and Health Cost Offsets to the pricing of food choices on menus; and d) the provision of a *SusHealth* toolkit will be validated using a "living lab" approach.
Results: Interventions for more healthy, sustainable and affordable food
SusHealth's key outputs will be: a) stakeholder guidelines for using the *SusHealth* index and related communication tools; b) an understanding of how consumer preferences can be influenced for healthier and more sustainable food choices using the communication tools and the *SusHealth* assessment on real settings (e.g., restaurants, digital and physical retailers). This will be tested across the UK to understand the behaviour of different socio-economic groups; c) interventions focused on food affordability e.g economic assessments of direct policy interventions that would make healthy sustainable food more affordable.
Conclusion: Achieving an innovative solution for influencing consumer food choices and preferences
SusHealth will co-create a systemic strategy and innovative solution for influencing food choices and consumption, so that they better align with both sustainability targets and nutritional guidelines. Research examaining consumer preferences (through living lab experiments) will feed back down the entire food chain, influencing the processes and raw materials used, towards more sustainable and health-inducing foods and diets.

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Mapping water use in food manufacture: trends and reduction opportunities

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AIM: The food industry, a major water consumer, is facing significant environmental challenges (i.e., depletion of freshwater resources due to climate change) that are building up pressure on food security – as the global population is growing, both food and water demand for food production are expected to increase too. In this context, this work identifies water consumption hot spots in food manufacture processes, which will help to allocate resources more effectively and create a more sustainable food chain.

METHODS: Water data usage for products and processes was collected from literature sources, and clustered by product and processing technique. Before analysis, data was transformed into standard units when needed/possible and sorted chronologically to account for changes in technologies/structural changes across the sector.

RESULTS:
Data shows that the meat and dairy sectors are the most water intensive ones – water is systematically used to rinse and clean surfaces, pipework and vessels and thus guarantee hygienic standards and cleaning requirements; however, most cleaning-in-place (CIP) protocols are based on very conservative and outdated protocols, which could be significantly optimised. Similarly, literature reveals scope for further improvement of sterilisation and pasteurisation policies used in packed foods (pouches, cans, jars) - alternative preservation techniques, like microwaves or pulsed-electric-field (PEF) are being slowly introduced in the sector, so heat could be generated without using water/steam.

Water is also added and mixed in the formulation of a number of food products as main component, although in most cases is then removed either by evaporation or sublimation, through drying or freeze-drying processes. Therefore, processing of dough-based products such as bread, cookies, pastries or cakes, as well as processing of powder foods and ingredients, like instant coffee, instant soups or powdered spices constitutes a major source of water consumption, too.

Finally, this study has crossed data related to process water usage per location with geographical areas of water scarcity, revealing those areas/countries more compromised by climate changes and draught.

CONCLUSIONS

The outcomes of this work constitute valuable information for the sector and policy makers that can help to re-evaluate current environmental and manufacturing strategies, increasing sustainability and security of food chains.

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A first approach to the modelling of Cleaning-In-Place processes using Machine Learning methods

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Aim:
Most food processing plants are fitted with Cleaning-in-place (CIP) systems that use sprays/jets to clean vessels. The efficiency of these sprays/jets to clean a target surface depends on a combination of processing parameters such as deposit thickness, nozzle diameter and sprays/jet flow rates. This work explores the suitability of using Machine Learning techniques to model such jet cleaning processes and predict their corresponding cleaning curves.

Method:
A series of jet cleaning experiments of a viscoplastic deposit were designed to study the effect of (i) jet flow rate (ii) nozzle diameter and (iii) deposit thickness on cleaned areas (cm^2) over time (up to 60 seconds). This resulted into 18 cleaning conditions, providing 1620 measurements. Three different Machine Learning methods, i.e., Artificial Neural Networks (ANN), Support Vector regression (SVR) and Gaussian Process Regression (GPR), were used to model this CIP process and predict the effect of the processing parameters on the corresponding cleaning curves (e.g cleaned areas over time). From the original set, 1215 data (75% of the total) were used for training the models. The remaining 405 data (25% of the total) was used for testing.

Results:
Each model was evaluated using the Root Mean Square Error (RMSE) and the adjusted coefficient of determination (R^2_{adj}) as performance measures. Results showed that all three models were able to predict the test data - this is, cleaned areas at the observed times from the test data set - with accuracy (R^2_{adj} >0.98; 0.86<RMSE<1.5). However, when the models were used to predict cleaned areas corresponding to different times than those observed – this is, unseen data – only the ANN model provided an acceptable prediction (R^2_{adj} >0.98) of the cleaned areas values and cleaning curve trends, while the SVR and GPR models show very poor predictive capabilities (R^2_{adj} <0.5).

Conclusion:
Overall, this work presents a first approach to the use of Machine Learning techniques to model jet impinging CIP processes. Results revealed potential in using ANN models as the core of digital/virtual tools that help designing and monitoring hygienic processing conditions in the food industry, while further work is still needed to develop accurate SVR or GPR models.

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Evaluation of sensor performance for smart home applications to analyze bakery products

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Evaluation of sensor performance for smart home applications to analyze bakery products
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Aim:
Based on data from the European Commission, 88 million tons of food are wasted each year across Europe, 53% of which is generated by private households. Smart home applications have the potential to help the population save food waste by monitoring the quality of available food within households. However, due to the complexity of food, this is a challenging task.

Method:
In our study, we therefore systematically compare different sensors that could be installed in smart home applications, using bakery products as an example. A commercially available bread box has been equipped with a variety of different sensors. With these, we collect data on the ageing of different bakery products. The sensors record the parameters mass, relative humidity, temperature, color, electromagnetic waves outside visible light and volatile aroma components. For the detection of the latter, quartz crystal microbalance- and carbon nanotube-based chemosensors are used. With the aid of the sensors, we record signals for characterizing the different bakery products on the one hand and data on the ageing of each bakery product on the other. We evaluate the data with machine learning algorithms to subsequently classify unknown bakery products according to type and age.

Results:
The different sensors show varying potential to classify the bakery products by type and age. The loss of mass and the change in relative humidity over the storage period do not prove to be sensitive enough. While the same is true for electromagnetic waves in the visible light range, evaluations in other wavelength ranges are more promising. Chemosensors currently perform best. With the aid of advanced mathematical methods, it is possible to reliably separate both types of bakery products and the associated age.

Conclusion:
In this ongoing project, we are constantly optimizing the selection of sensors to be used. The aim is to identify sensors that are also interesting for smart home applications from a cost perspective. Therefore, we are currently investigating the use of cost-efficient sensors based on metal oxides and chitosan. The results of the investigation will then be applied to other smart home applications with food relevance.

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Lactic acid bacteria fermentation of chickpeas flour for gluten-free breadmaking: sensory and physico-chemical modifications

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Aim: In the bakery sector, gluten-free food products are traditionally characterized by poorer physical, sensory and nutritional quality if compared to traditional, gluten-containing products. The aim of the study was to use lactic acid bacteria (LAB) fermentation of chickpeas flour as a strategy to improve gluten-free breads' quality.
Method: Four wild LAB strains belonging to the UPPC (University of Parma Culture Collection) were employed: *Lactobacillus delbrueckii* 1932, *Leuconostoc* 4454, *Lactiplantibacillus plantarum* 4199 and *Lactobacillus casei* 4339. Each strain was inoculated (2% w/w) in chickpeas dough (60% moisture w/w) and incubated for 20h. During fermentation, the evolution of doughs was monitored *in-continuo* by rhelogical and impedometric analyses. Before and after fermentation, the doughs were tested in terms of microstructure, water holding capacity (WHC), microbial counts, and antioxidant capacity. Fermented and non-fermented (control) chickpeas doughs were then employed in mixture (25g/100g of total flour) with a commercial gluten free mix to produce gluten free breads. Breads were then characterized in terms of physical, microbial, and sensory characteristics.
Results: The 20h-fermentation of chickpeas flour determined a strong modification of rheological characteristics. Both the rheological and impedometric data were fitted using Gompertz equation. *Lactobacillus delbrueckii* 1932 was the LAB strain with the fastest capacity of modifying the dough rheology, while *Lactiplantibacillus plantarum* 4419 demonstrated the maximum rheological change at the end of fermentation. These rheological modifications may be related to the ability of the strains to produce exopolysaccharides , as observed by fluorescence microscopy. LAB fermentation also improved the WHC and the antioxidant capacity of the samples. The rheological change in dough determined a strong modification in bread structure/characteristics: the specific volume increased, crumb pore size and texture were modified and the sensory properties were found to be different as compared to the control. In particular, fermented breads showed a reduced legumes flavour and taste, a softer consistency and a brighter color compared to the control.
Conclusion: LAB fermentation demonstrated to strongly affect the physical, structural characteristics of chickpeas doughs and to be a valuable, innovative tool to shape the sensory characteristics and to improve the physical and structural properties of gluten-free breads.

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Quality evaluation of processed meats using rapid and/or non-invasive sensors and machine learning algorithms

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Title
Quality evaluation of processed meats using rapid and/or non-invasive sensors and machine learning algorithms

Aim
1) Assessing the feasibility of using several rapid and/or non-invasive sensors for quality evaluation of processed meat products using beef burgers as a model system.
   - Utilising machine learning algorithms to Develop models by which various quality attributes of beef burgers can be estimated.

Methods
- Beef burgers were prepared with different fat ratios and/or mincing degrees.
- Several sensors were used to scan the samples including colour vision, hyperspectral imaging, spectroscopic, ultrasonic, and dielectric.
- Samples were either scanned in the defrosted (i.e. thawed), or fresh status.
- Commercial samples were also scanned.
- Machine learning models were applied to classify samples based on their fat ratio and/ or mincing degree.

Results
- Preliminary results indicate that there is a feasibility for using optical sensors to classify samples based on the fat ratio and/or mincing degree.
- Ultrasonic system was found to be better used for frozen burgers.
- Dielectric system was found to be sued as a rapid method to differentiate between samples based on fat ratios.

Conclusion
- Optical sensors can be effectively used for rapid quality evaluation for processed meat products.
- Optical sensors have the possibility for developing online systems for rapid quality evaluation of processed meat products.
- Sensor fusain was found to boost the performance of classification and/or regression models.

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Soy juice fermentation for yogurt production: how a relevant starter selection can improve it ?

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Aim
In order to reduce the environmental and health concerns related to food, an alternative diet is recommended, containing 50% of plant-based protein instead of a mostly animal-based protein. In this context, soy juice, which is protein rich, is a relevant alternative to animal milk. However, soy “beany” and “green” off-flavors limit the consumption of such products. Fermentation by lactic acid bacteria (LAB) is a sustainable and an inexpensive process, which applied to soy juice, it can help to improve the organoleptic properties of fermented soy products. Our aim was i) to select strain of LAB able to ferment a soy juice in a satisfying way and ii) to decipher its metabolism during fermentation.

Method
About 250 strains of LAB were screened for their ability to ferment a soy juice based on their acidification properties, their ability to ferment the sugars of soy juice (sucrose, stachyose and raffinose). The fermented soy juices were evaluated for their organoleptic properties (off-notes, aroma compounds). The metabolism of the strain Lactobacillus delbrueckii CIRMBIA865 (*Ld*865) was investigated. A soy juice fermentation with *Ld*865 was performed and the metabolism was deciphered in kinetics, using different approaches, including sugars (HPLC) and volatile compounds (GC-MS) analysis.

Results
Our findings showed that the ability of LAB to ferment soy juice is species- and strain-dependent. Some strains can improve organoleptic properties of fermented soy juices, and the study highlights the diversity of metabolic profiles of LAB in soy juice fermentation. Ld865 presented an atypical fermentative profile. Despite the acidification and gelation that occurred correctly, *Ld*865 population did not increase, and *Ld*865 cells were unusually long at the end of fermentation, suggesting stressfull conditions encountered during growth of Ld865 in soy juice. The analyses of the residual sugars at the end of fermentation showed that sucrose was the only sugar used by *Ld*865.

Conclusion
Specific LAB can improve plant-based product fermentation, with increased organoleptic properties and reduction of the off-notes. A relevant selection of strain for fermentation is thus necessary, and the improvement of the organoleptic properties of the products could help to promote plant-based proteins in our diet.

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How do phenolic compounds affect bioactive peptide formation from casein digestion in vitro?

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How do phenolic compounds affect bioactive peptide formation from casein digestion in vitro?

Aim: Bioactive peptides, capable of exerting bioactive properties on human health, are derived mostly from milk protein casein. They are recently getting more attention in healthy diets as they possess a series of health-promoting features, such as antioxidant, antimicrobial, ACE-inhibitory and opioid properties. Formation of these peptides might be affected by the protein-phenol interaction. Protein-phenolic compound interactions take place in foods resulting in the formation of both soluble and insoluble complexes. These interactions are important as they co-exist in a wide variety of foods, however, they also take place in the gastrointestinal tract after food ingestion. This study aimed to clarify how bioactive peptide formation is affected by the co-ingestion of casein and phenolic compounds in vitro.

Methods: Casein (300 mg) and phenolic compounds such as chlorogenic acid, catechin, green tea extract and black tea extract (15 mg), singularly or in combination of casein plus each phenolic compound, were digested *in vitro* according to INFOGEST procedure. In the samples collected through the gastric and intestinal phases of the digestion, the total antioxidant capacity (TAC), degree of hydrolysis and peptide formation were assessed.

Results: Soluble TAC of intestinal digesta obtained from casein-phenol combination was 1.5 to 4 times higher than the controls (casein or phenolic compound alone). This was due to higher release of antioxidant peptides in the presence of phenolic compounds, as assessed by the peptide analysis. Similarly, some AGE-inhibitory and DPP-IV inhibitory peptides were also induced in the presence of phenolic compounds together with casein. On the other hand, TAC values in the intestinal insoluble part of casein-phenol digests were higher than the starting material, thus indicating that such interactions may be functional to transport phenols to the colon. Degree of hydrolysis analysis confirmed no significant change in the digestibility of casein.

Conclusion: The results of this study confirmed the formation of protein-phenol interaction in the digestive tract and showed that casein may be carrier of phenols to the colon, without affecting protein degree of hydrolysis. Formation of bioactive peptides of casein, mostly antioxidant peptides, was stimulated in the presence of phenolic compounds.

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Chemometric models for rice sourdough fermentations based on fluorescence spectroscopy

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Aim
Online monitoring is, with respect to the ongoing digitalization of food processes, of increasing relevance. Due to biogenic fluorophores 2D-fluorescence spectroscopy makes it possible to monitor the fermentation process of sourdoughs. Fluorophores are influenced by pH, viscosity and temperature. Using chemometric models it is possible to predicted the courses of further fermentations. pH and total titratable acid (TTA) are the main monitoring values for sourdough fermentations. In addition, the concentrations of present sugars, acids, glycerine and ethanol are determined using HPLC. The aim of the study was to predict the course of the offline measurements during sourdough fermentations at different temperatures using fluorescence spectra.
Method
Twelve sourdough fermentations were performed at 26 °C, 28°C and 30 °C for the model development. During the fermentation process fluorescence spectra were recorded every 90 s. pH, TTA were measured in defined time intervals, maltose, glucose, fructose, lactic acid, glycerine, acedic acid and ethanol were determined by HPLC. The spectra were evaluated either as raw spectra or pre-processed with Standard Normal Variate Transformation (SNV) or a High-Pass-Filter (HP). Using the Regression Learner (Matlab 2021) three regression models, linear, support vector machines, gaussian process regression were trained with or without a previous performed principal component analysis (PCA).
The quality of the models for the courses of the offline measurements were rated by the R^2, RMSE and percental error ERP (RMSE related to the measurement range) of a five-fold cross validation implemented in Matlab. A 13th fermentation at 29 °C was performed to validate the models.
Results
Best results were obtained for the courses of the pH and TTA. For the linear models of the TTA the same calibration and validation ERP of 7.1 % could be achieved. The best models were the GPR models with R^2 of 1 and an ERP of 0.03 % for the validation without pre-processing even for ethanol whereas the other models resulted in ERPs around 30 %.
Conclusions
The authors will demonstrate that fluorescence spectroscopy fulfil the needs for the online-monitoring of sourdough fermentations. Advantages and disadvantages of the methods will be explained within this contribution.

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A prospective study of antibiotic resistance in the food chain

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Aim: Antibiotic resistance is one of the biggest health threats around the word. The food chain is the most relevant route of resistance transmissions due to the extensive use of antibiotics in food-producing animals. In addition, food microbiota can be reservoir of resistance genes that might be ultimately transferred to foodborne pathogens. Fermented meat products are characterized by a high diverse microbiome while stressing factors associated with processing and food conditions could foster antimicrobial resistance. The objective of this work was to investigate antibiotic resistance profiles of the microbiota of Spanish fermented meat products.

Methods: A stratified sampling was carried out at retail for the most consumed fermented meat products in Andalucia (Spain). Relevant microbial groups were isolated from the selected products using culture-dependent methods and tested for antibiotic susceptibility using the disc diffusion method according to CLSI guidelines.

Results: Among all microbial isolates, more than 59% showed resistance to any of the antibiotics tested and 30% to more than three different classes, being considered multi-resistant. The microbial groups showing most resistances to first-line antibiotics were Coliforms and Enterobacteriaceae*,* 35% isolates being resistant to ampicillin, followed by *Pseudomonas* spp., with 50% resistant to ceftazidime. In turn, *Pseudomonas* spp. and Enterobacteriaceae were susceptible to gentamicin. Lactic acid bacteria showed low resistance to first-line antibiotics with less than 10% isolates, although high resistance to second-line antibiotics as vancomycin and ciprofloxacin with more than 60% of isolates. Finally, 50% *Staphylococcus coagulase* positive isolates were resistant to first-line antibiotics for *S. aureus* (i.e., penicillin, cefoxitin and clindamycin).

Conclusion: This study provides an insight into the current profiles of antibiotic resistant bacteria in fermented meat products in Andalucia (Spain). Results confirm that the current situation of fermented meat products does not present a severe problem of antibiotic resistant bacteria to first-line antibiotics. However, it is important to develop suitable control measures to prevent an increase of antibiotics resistances through the food chain and dissemination to humans and environment.

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Coagulase Negative Staphylococci: a Potential Reservoir of Antibiotic Resistant Genes in the Pork Meat Chain

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Aim:
Antimicrobial resistance is considered a global problem that threatens the health of humans and animals. Its rapid emergence is endangering the efficacy of antibiotics against bacterial infections. The overuse and misuse of antibiotics in farm animals have increased selective pressure on commensal microorganisms, such as coagulase-negative staphylococcus (CNS). These microorganisms can then be a potential reservoir of antibiotic resistance genes for pathogenic bacteria present in the food chain. Because of this, it is essential to study the prevalence of antibiotic resistance in this group. As such, the objective of this work was to identify CNS isolated in a Portuguese pork meat chain, characterizing their antimicrobial resistance.

Method:
The experimental work was performed on 281 coagulase-negative staphylococci isolates, isolated from samples of swine, slaughterhouse environment, workers, pork cut pieces and consumers. These isolates were clustered utilizing PCR fingerprinting and identified by multiplex PCR. After identification, the antibiotic sensibility was tested (n=104) using the disc diffusion method, according to the EUCAST (2021) and CLSI (2018) standards. In addition, ETESTs (Biomérieux, France) and broth microdilution methods were also used to assess resistance.

Results:
It was possible to identify 94 *S. equorum* (33.7%), 90 *S. carnosus* (32.3%), 28 *S. saprophyticus* (10%), nine *S. epidermidis* (3.2%), eight *S. warneri* (2.9%), one *S. aureus* (0.4%), one *S. xylosus* (0.4%), and one *S. capitis* (0.4%). Antibiotic resistance was assessed with high resistant rates being observed, with 91% of isolates resistant to at least one antibiotic. Susceptible isolates were only found for *S. carnosus* (5%) and *S. equorum* (27%). Multiresistance was also found in all species except for *S. warneri* and *S.capitis*, most with origin in the swine and on final consumers. The profile of antibiotic multiresistance of *S. equorum* isolates from these two sources was different.

Conclusion:
It was not evident the transmission of CNS bacterial strains between meat and consumer families. Nevertheless, resistance transmission between meat and worker was identified. Overall, the high presence of antibiotic resistance on CNS from the pork meat chain confirms the emergence of antibiotic resistance linked to the food chain.

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AI4Food: Bringing Artificial Intelligence and Mobile Device Sensors to Health Diets

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Aim: today's health is directly related to eating habits and it is proved that a poor diet leads severe consequences: epidemiological data indicate that these habits were responsible for more than 11 million deaths in 2017 alone. In the last decades, many efforts have been carried out in the topic of digital health, but most approaches remain general, inconvenient, and time-consuming. Personalized nutrition is thus expected to be one of the greatest revolutions ever achieved by health systems. In this study we will present the AI4Food project, which aims to break the limits of current personalized nutrition through the combination of mobile device sensors and state-of-the-art Artificial Intelligence (AI) methods. In particular, we will pay especial attention to one of the tasks of the AI4Food project, assessment of a person's diet through the smartphone pictures taken by the person of the food ingested daily.

Method: we present the first programmable environment able to generate synthetic databases from different eating habits profiles, including those associated with healthy and unhealthy eating according to the guidelines from national and international organizations. Due to the lack of diet databases based on the images of what people eat daily, we have also created a large-scale food image database. This new database comprises food images of the 6 popular levels of the nutritional pyramid.

Results: we have evaluated the health quality of the person's diet from food images using AI techniques. First, we have achieved interesting results in the detection of different food groups and food products from these images. Then, we have identified different nutritional patterns to determine the health quality of the person's diet.

Conclusion: AI4Food is an interdisciplinary project that brings together experts in the fields of molecular biology, nutritionist, and AI. One the main aims is to integrate all this information and develop a new generation of digital tools to help in decision-making for nutritional decisions. In this work we have implemented the first programmable environment able to generate synthetic databases to date. We have also assessed the health quality of the individual's diet from food images.

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Consumer perception and willingness to try new food products produced by new food technologies

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Aim: The increased demand for healthier and sustainable foods is a major driver for the development of a wide variety of processing technologies, such as ohmic heating, high-pressure processing and edible coating. These technologies have the advantage of better preserving the original quality of food products. Therefore, understanding consumers' needs and possible barriers to acceptance of these technologies helps to better assess the commercial viability of new food products resulting from their application. The aim of this research is to evaluate Portuguese consumers' attitudes towards new food technologies and understand their willingness to try new food products produced with such technologies.
Methods: 704 consumers were interviewed at their homes and selected using random route techniques. The questionnaire presents seven groups of questions with the following dimensions: i) Sensory Appeal and Food Convenience subscales from the Food Choice Questionnaire, ii) Domain-Specific Innovativeness, iii) Concerns about price/cost of food, iv) Food and Nutrition Knowledge, v) Food Neophobia Scale, vi) Food Technology Neophobia Scale, and vii) Suspicion regarding novel foods. To evaluate their willingness to try products resulting from the application of new food processing technologies, different product concepts were created using Conjoint analysis. The product concepts were based on the following characteristics: food technology, product preservation, benefits associated with the application of food technology and price of the food product.
Results: Four clusters showed that certain consumer segments ("Wealthy and relaxed" and "Adopters") were more likely to buy food from new technologies. The segments of consumers ("Rejectors" and "Conservative"), with low academic degrees, low monthly income, and over 50 years, reveal high levels of food neophobia and food technology neophobia. There is a generally low level of adoption of innovation among Portuguese consumers, associated with higher levels of neophobia in relation to new food technologies. Food neophobia tends to be low, although there is a higher level of suspicion regarding novel foods.
Conclusions: Care must be taken when communicating the benefits to consumers of new technologies, to assure concise messages regarding their positive impact on food characteristics, and trusted information, in order to avoid new product rejection.

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Contactless characterization of potato drying by using air-coupled ultrasound

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Aim:
The food industry is requesting novel technologies for non-invasive food control in the context of Industry 4.0 and the Smart processing purposes. Thus, the recent development of highly energy air-coupled ultrasound transducers allows the characterization of different food products as a non-invasive and real-time. Therefore, the aim of this study was to determine the feasibility of the air-coupled ultrasound technique to monitoring the drying of potato slices as a rapid, non-destructive and non-invasive technique.
Method:
Potato slices (5 mm thickness) were dried in a convection oven at 60ºC at different times (0, 15, 90, 180, 300 and 420 min). At each drying time, ultrasonic measurements were carried out using through-transmission mode (250 kHz) and, subsequently, the viscoelastic properties of the samples were evaluated by the stress-relaxation test. Finally, the moisture content and density were determined. The ultrasonic velocity (m/s) and the variation of the transmission coefficient with frequency (ΔTC_f, dB/MHz) were obtained after the ultrasonic signal analysis.
Results:
During the potato moisture reduction, the ultrasonic velocity and the ΔTC_f increased significantly ($p<0.05$) from 509 m/s (fresh sample) to 673 m/s (420 min dried) and from -205 dB/MHz (fresh sample) to -55 dB/MHz (420 min dried), respectively. Therefore, a reduction of the potato slices attenuation was computed by the ΔTC_f. Finally, the Elastic Young`s modulus were satisfactorily related with the ultrasonic velocity (R^2= 0.93) and the ΔTC_f (R^2= 0.82). While the density was linearly related with the ΔTC_f (R^2= 0.91).
Conclusion:
The viability of the air-coupled ultrasound to characterize the viscoelastic properties of potato slices during drying has been showed in this study. The ultrasonic parameters studied showed a direct relationship with moisture loss and textural properties that allowed potato snacks to be classified at different drying times. Therefore, this study presented a potential application of air-coupled ultrasound technique that could translate as an improvement in potato dried snack production, as well as being considered an additional step forward in green technology.

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Dynamic sensory, emotional and rheological characterization of a functional vanilla ice cream

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Aim: Sensory perception of a food product is considered dynamic, changing across the consumption process. Also, food-evoked emotions and rheology constitute relevant information for predicting overall liking, aiding industry players to improve their products. This work aimed to evaluate the dynamic sensory, emotional and rheological profiles of vanilla ice creams with incorporated phytosterols (Phytosterol) and with no added bioactive compounds (Control), using dynamic sensory analysis techniques, such as Temporal Check-All-That-Apply (TCATA). TCATA allows for a multi-attribute simultaneous analysis during a given time, using sensory or emotional parameters.
Method: A TCATA with emotions (TCATA-E) ballot was designed, in which consumers were asked to select all the applicable attributes for 30 seconds. Afterwards, consumers were asked to rate their overall liking using a 9-point hedonic scale. A trained panel evaluated the same samples of vanilla ice cream, using two different TCATA ballots (texture and flavour attributes). Rotational rheometry essays were performed at 25ºC.
Results: Results showed that Phytosterol was significantly more liked than Control, having evoked significantly more *pleased*, *satisfied,* and *happy* emotions over time, presenting a very positive sensory trajectory, concentrating on attributes such as *pleased*. However, near the end of the trial, the evoked trajectory led to *unsatisfied*, depicting a possible unpleasant aftertaste. The trained judges identified more positive texture and flavour attributes for Phytosterol, such as *creamy* or *melting* textures or *milky* flavour, during the whole duration of the trials when compared to Control, for which the citation rate was higher for negative attributes, such as *hard/firm* texture or *intense* flavour. Also, Phytosterol presented very positive sensory trajectories, although almost overlapping with those obtained for Control. Rheology showed a pseudoplastic behaviour in all samples, with an increase in viscosity for Phytosterol, reflected by the flow and consistency indices.
Conclusion: The incorporation of phytosterols in the vanilla ice cream resulted in a sensory improvement and an emotionally well-connected product, giving space to introduce more functional foods in the market. The increase in viscosity was well perceived by the tasters, due to the increase in the citation of *creamy* or *melting* attributes during the whole duration of the trials.

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Protein concentrates from edible insect Tenebrio molitor – development of extraction methods and techno-functional characterization

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Protein concentrates from edible insect *Tenebrio molitor* – development of extraction methods and techno-functional characterization

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Aim:

The goals of this work were to develop extraction techniques to obtain protein concentrates from larvae of *Tenebrio molitor*, with high protein purity as well as good techno-functional characteristics.

Methods:

Two different protein extraction methods were developed, based on isoelectric point precipitation or membrane ultrafiltration. For both methods, dried *T. molitor* larvae were defatted with the Soxhlet method, with ethanol as a solvent. The defatted fraction was then homogenized in a NaOH solution with the homogenate being recovered and centrifuged. The supernatant and the pellet fractions were recovered. For the isoelectric point precipitation method, the recovered supernatant pH was modified to 4.55 and the precipitate was centrifuged at 5 000 rpm for 30 minutes, at 4ºC. The pellet fraction was freeze-dried (IP). For the membrane ultrafiltration, the supernatant was filtrated with a 50 kDa membrane with the retained (> 50 kDa) and filtered (< 50 kDa) being recovered and freeze-dried. The fractions were characterized regarding the protein recovery related to the defatted sample, protein content, protein profile (SDS-PAGE and FPLC) and techno-functional properties (colour, foaming properties, water/oil absorption capacities and emulsifying properties).

Results:

Both the IP and the > 50 kDa fraction had protein contents above 80%, while the <50 kDa fraction only had a protein content of 44% (± 1.6). Despite their high protein content, the IP and >50 kDa only attained a protein recovery rate slightly above 30%. Concerning the protein profiles, the >50 kDa fraction had a very similar profile to the supernatant, while the IP fraction was composed by protein with higher molecular weight. The >50 kDa fraction had a higher *L** (lightness) and *b** (yellowness) colour than the IP fraction or the defatted or oven-dried samples. Additionally, the insect protein concentrates presented better techno-functional properties than the dried or defatted sample and the >50 kDa fraction had better properties than commercial protein concentrates (whey protein or pea protein).

Conclusion:

The protein extraction method based on ultrafiltration led to a protein concentrate with high purity and acceptable techno-functional properties and can function as an alternative to the more common method based on isoelectric point precipitation.

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Chitin and chitosan extraction from edible insects: characterization and comparison between different species and by-products

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Aim
The main goals of this work were to extract chitin and synthesize chitosan from two different edible insect species - *Tenebrio molitor* larvae (TM) and *Acheta domesticus* (AD), as well as from by-products from *A. domesticus* processing (wings and legs – AD_WL).
Methods
Prior to chitin extraction, all sources were dried, ground and defatted. Chitin extraction consisted of a demineralization step (acid treatment) followed by deproteinization (alkaline treatment). The obtained chitin was dried and decolourized with sequential treatments with $KMnO_4$ and $C_2H_2O_4$. The decolourized chitin was dried and submitted to treatment with a strong alkaline solution in order to synthesize chitosan. The yield of the extractions was calculated and the obtained samples were characterized for colour (CIE-*LAB* system), molecular weight (viscosimetric method), surface morphology (SEM), functional groups characterization (ATR-FTIR, FT-Raman) and crystallographic structure (XRD). Furthermore, the antioxidant activity of chitosan was assessed.
Results
The highest chitin extraction yield was observed for AD_WL (14.98 ± 0.16%) followed by TM (9.01 ± 0.10%) and AD (8.70 ± 0.36%). For chitosan, the yields relative to the chitin were very similar (*ca.* 73%) for all sources. Regarding colour, all the samples had a very similar whiteness index and the discolouration step increased its value from *ca.* 37 to *ca.* 68. Insect samples presented the characteristic peaks of the α-chitin form, while also showing similarities to the commercial samples in XRD, ATR-FTIR and FT-Raman. Surface morphology showed some differences between samples with insect chitin and chitosan presenting pores which were not present in commercial samples. Concerning the molecular weight of the synthesized chitosan, the lowest value was obtained for AD_WL (309 kDa) which was lower than the MW of commercial shrimp chitosan (324 kDa). Neither the insect nor the commercial chitosan demonstrated DPPH inhibition, while for the β-carotene assay the insects' chitosan demonstrated lower antioxidant activity than commercial chitosan.
Conclusion
It was possible to extract chitin and synthesize chitosan from different edible insect species. The wings and legs of *A. domesticus* are promising since they presented the highest yield and similar behaviours to commercial products and can increase the economic value of edible insect rearing.

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Simulating a part of the industrial chain in vR

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Aim:
The scope of this project was to digitalise a section of the industrial chain by replicating a set of analytical tests in a virtual environment. This was done in conjunction with MEVGAL which is a Greek dairy products company.

Method:
In order to tackle this challenge, we went through the industrial processes to determine the best application of virtual reality (vR). After some consideration, the qualitative lab was chosen as it could include interaction with objects and would have concrete application for the company. Following this the environment and the tests performed were carefully observed and were translated into a virtual representation of the laboratory and apparatus. The next challenge was to add the ability to interact with the environment and objects using the vR controllers. Functionality was added to the essential apparatus as well as the hand controllers which allowed for the option of grabbing and moving apparatus. Finally, we included instructions for the several tests with the potential to gamify the system.
Results:
The program was successfully uploaded onto the Oculus vR headset. This allowed the user to move within the environment as well as giving the ability to interact with objects and move them around. Further improvement could see the program having improves physics for liquid objects as well as perhaps gamifying the system to include a scoring system.
Conclusion:
A program was successfully developed which translated a section of the industrial chain to vR. This program could find concrete application in the training of personnel granting the benefit of reducing any waste of consumables. Also it could serve the company by informing the public and staff about the process carried out behind the scenes.

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Eat the box too… insects biomass growth and plastic biodegradation

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Eat the box too… insects biomass growth and plastic biodegradation
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Aim

The aim of this work was to study the biodegradation of polystyrene (PS) by mealworms (*Tenebrio molitor*) larvae. The effect of different diets on their growth and well-being was assessed. Different *Omics* approaches, namely *Metabolomics*, *Microbiomics and Lipidomics*, were applied in both biomass and frass, to highlight the biochemical activities underpinning plastic biodegradation, and the formation or accumulation of potential harmful degradation products (styrene monomer, styrene oligomers) in the biomass or in larva's frass.

Method

Three different diets, consisting of PS, rolled barley and water were tested, whilst the degree of depolymerization was assessed with ^{1}H NMR in combination with thermogravimetric analysis (TGA). For the metabolomics, a gas chromatography-quadruple time-of-fight mass spectrometry (GC-QTOF-MS) methodology was applied, after silyl derivatization of the polar (methanol/H_2O) and organic extract ($CHCl_3$) of the biomass and frass. For microbiomics, next-generation sequencing (NGS) based on 16S rDNA and 18S rRNA was performed to explore the larval gut microbiome effects on the microbial communities. For cellular activity, lipidomics based on ultra-high-performance liquid chromatography QTOF-MS methodologies were applied for the polar (methanol/H_2O) and the organic fraction ($CHCl_3$) of the biomass and frass together with ion-chromatography, and protein alterations with the DUMAS method.

Results

PS was degraded with rates ranging from 16% to 23% within 15 days, while larva's biomass decreased due to PS consumption. The larva fed with ad libitum barley:PS (20:1 w/w) and H_2O had the highest growth rate. Metabolomics studies revealed no contaminating substances in the gut intestine tissue, nor styrene or PS oligomers, whilst several bioactive compounds (fatty acids, amides) and traces of alkanes, mostly with small carbon chains, were present. The microbiome data indicated three bacteria, namely *Erwinia olea, Lactococcus lactis* and *Lactococcus garviae*, to be more abundant. A lower level of excreted nitrogen, and various apoptosis biomarkers suggested the presence of oxidative stress conditions. Under the current conditions about 25 % depolymerization was reached within 15 days. The inclusion of H2O together with additional barley bran proved to facilitate he higher degradation rates and the better well-being of the insects' larva.

Conclusion

Tenebrio molitor could safely metabolize PS, but this caused an increase in stress for the insects. The study revealed that mealworm larvae can grow in the presence of expanded polystyrene, with no oligomeric residues. The work demonstrates the potential of insects gut microbiota research to develop new composting strategies for plastic food contact materials.

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Comparing the techno-functional properties of plant-based proteins obtained by dry fractionation and wet extraction

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Aim:
Demand and investments for alternative proteins are constantly increasing, but most of them are produced by the “wet extraction” technology which requires water and chemicals such as acids, bases, salts, and enzymes. Dry fractionation (DF) is a green and sustainable process to obtain protein concentrate that involves solely physical processes i.e., milling and air-classification by cyclonic separation. DF proteins (DFP) are challenging to use, since they have lower protein content than the wet-extracted proteins (WEP) and different functionality. Therefore, in the perspective of promoting their utilization in the food industry it is crucial to assess the techno-functional properties in comparison with the most diffused WEP.
Method:
The dataset covers the well-known proteins used in the food industry. It consisted of 5 DFP i.e., pea, chickpea, mung bean, lentil and faba bean (provided by Innovaprot – Gravina in Puglia, Italy) and 5 WEP i.e., soy, pea, oat, chickpea, and wheat gluten (purchased by European suppliers). The water and oil absorption capacities (WAC, OAC), the water absorption and water solubility indices (WAI, WSI), the foaming activity and foam stability at 10 and 20 minutes (FA, FS10, FS20) were determined.
Results:
DFP and WEP showed similar OAC (0.97 vs 1.25 g oil/g protein), but WAC was significantly lower in DFP (0.75 vs 3.34 g water/g protein). Owing to their native state, DFP have the tendency to remain soluble in water rather than staying insoluble and form a dough. This also positively affects the solubility and foaming properties. DFP were indeed characterized by a high WSI.
WEP showed a FA highly variable, ranging from 20 to 200%, whereas DFP showed a FA always higher than 100%. Moreover, the DFP foam was noticeably persistent over time with a mean FS20 of 86%, significantly higher than what observed in WEP, in which the FS20 was only 51%.
Conclusion:
The results suggests that DFP have better performances than WEP for some food applications. Owing to the high solubility, DFP could be used for plant-based beverages, whereas the foaming properties make DFP useful for bakery products and egg replacers, where the incorporation of air is required.

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Processing-dependent nature of plant-protein polyphenol interactions: Are the interactions responsible for protein protection of polyphenols?

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Aim: Polyphenol stability is important for both their sensorial and health-promoting properties. A large body of literature has focused on non-covalent protein-polyphenols binding, occurring via hydrophobic and hydrogen interactions. Many have also suggested that such binding is responsible for the often observed protection against degradation of polyphenols in the presence of proteins. Yet, a comprehensive understanding of the structural features contributing/decreasing the interactions, especially at slightly acidic conditions common to polyphenol-rich products, is not fully known. The knowledge gap is further increased when common processing conditions are considered, known to affect protein structure, and therefore the extent of binding.
Method: We quantified both the relative binding as a function of structure in multi-model systems (strawberry polyphenol extract and canola protein concentrate) and the binding constant in a purified single component model (Cyaninidin-3-O-glucoside) using ultracentrifugal filtration and fluorescence spectroscopy. Stability during accelerated shelf-life studies at pH 3 was monitored after extraction from bound complexes by LC-MS. Thermal and high-pressure processing (HPP) conditions resembling low- and high pasteurization were employed. In-vitro total antioxidant capacity (TAC) was quantified using FRAP and ORAC methods.
Results: Both relative binding and binding constants were polyphenol structure and processing dependent. More hydrophobic polyphenols (like Quercetin-3-O-glucuronide) presented higher binding than the more soluble anthocyanins. HPP presented increased surface hydrophobicity and a slight, yet significant, increase in the binding. On the other hand, the first-order degradation constant was not correlated with the extent of binding. The increased stability of polyphenols during shelf-life in the presence of proteins was not correlated with increased TAC. In a signle-component model using Cyaninidin-3-O-glucoside, a high TAC of the Cyaninidin-3-O-glucoside degradation products was quantified, likely explaining, at least partially, the lack of correlation between the protein-induced stabilization and the lacking increased stability of TAC.
Conclusion: The results present the structure-dependent nature of polyphenol non-covalent interaction under acidic conditions. While the non-covalent binding occurs at different affinities for all detected polyphenols, the extent of binding is not correlated with enhanced stabilization. Furthermore, enhanced stability in the presence of proteins is not correlated with increased TAC during shelf-life, likely due to the antioxidant properties of the degradation products.

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A consumer exploration of the awareness, understanding and perception of plant-based meat alternatives (PBMA)

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Aim: In the UK/Ireland, the plant-based meat analogue (PBMA) market is rapidly expanding, across a wide consumer base. Despite this there is poor understanding of consumers perception of products. Therefore, this project aimed to gain an understanding of consumers motivations to avoid meat; awareness/preference of PBMA products/brands; understanding of the ingredients that make these products; and subsequent perceptions of PBMA in relation to ultra-processing and clean label trends.
Method: A voluntary, online survey was used to gain primary data from consumers of PBMA. The survey was advertised using social media and gained 109 eligible responses, the majority (73.4%) resided in Northern Ireland, with representation from Republic of Ireland also evident (5.5%). Obtained data was assessed demographically, thematically and statistically.
Results: Evidence of PBMA consumption was noted across all major dietary groups. Those who avoided meat were motivated by animal welfare concerns, environmental concerns, and health. Burgers, sausages, mince, and chicken were highlighted as popular PBMA products whilst consumption of seafood and steak PBMA was lower. Quorn, Linda McCartney and Beyond Meat were identified as familiar brands and familiarity was also shown towards fast-food PBMA, particularly the McPlant burger by McDonalds. Highest engagement with products was by vegans and ages of 25-44years. Although consumers were aware of the major protein sources used to create these products, their awareness of additives and their functions in PBMA was poorer. Additionally, most consumers were unfamiliar with the terms ‘clean label’ (64.2%) and ‘ultra-processing’ (59.6%), with low numbers considering these factors before PBMA purchase. Those with education in a food related degree were significantly ($p>0.05$) more likely to have knowledge of both terms.
Conclusion: There is evidence of purchase/consumption of a wide range of PBMA products and fast food options across the population, being driven particularly by younger consumers with environmental concerns. Enhancing education of ingredients used to create these products, and terms such as ‘clean label’ and ‘ultraprocessing’ is recommended, particularly to avoid purchasing decisions being overshadowed by a percieved ‘health halo’. Results may have been limited due to the sample group demographics, however, this study is considered as a strong pilot to aid further and expanded investigation(s) in this area.

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How microstructure, mechanical properties and macrostructure breakdown affect gastric digestion of whey protein gels

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Aim:
Gastric digestibility of protein-rich foods is influenced by multiple factors, including macroscopic and microscopic food structure, mechanical properties and structure breakdown during mastication. Our current understanding of the impact of each of these factors independent of the others on gastric digestibility is limited, since these factors are often correlated. This work aimed to clarify the contribution of microstructure, mechanical properties and macrostructure breakdown on *in vitro* gastric digestibility of whey protein gels.

Method:

Whey protein isolate was mixed with different types of polysaccharides at various concentrations to obtain gels with distinct microstructures (homogeneous, coarse stranded, protein continuous and bi-continuous) and mechanical properties. Heat-set and acid-induced cold-set gels were prepared. Structural breakdown during mastication was mimicked by cutting gel cylinders (total surface area: 1879 mm^2) into smaller cubes (total surface area: 3150-6450 mm^2). Static *in vitro* gastric digestion was performed using the INFOGEST 2.0 protocol with minor modifications. The concentration of free amino groups in simulated gastric fluid (SGF) were quantified using the OPA assay.

Results:
For heat-set gels, increasing the surface area (simulated mastication) led to a 20-68% higher concentration of free amino groups in SGF and 29-108% faster release rates of free amino groups. For gels with similar mechanical properties but different microstructures, coarse stranded gels showed the highest digestion rate (1.92 $mmol\cdot L^{-1}/h$ for cubes, 1.49 $mmol\cdot L^{-1}/h$ for cylinder) followed by homogeneous, protein continuous and bi-continuous gels regardless of the macrostructural breakdown degree (total surface area). For acid-induced cold-set gels, protein continuous gels showed 1.6-2.3x faster digestion rates than homogeneous gels with similar mechanical properties. Digestion rate decreased with increasing Young's modulus regardless of gel microstructure. Nonetheless, protein continuous gels showed faster digestion rates (1.62 $mmol\cdot L^{-1}/h$) than homogeneous gels (1.25 $mmol\cdot L^{-1}/h$), although the former had a 1.7x higher Young's modulus.

Conclusion:
Macroscopic structural breakdown caused by simulated mastication contributes more to *in vitro* gastric digestibility of whey protein gels than microstructure. Microstructure of whey protein gels had stronger effects on *in vitro* gastric digestibility than mechanical properties. Further studies

should focus on the interplay between structure breakdown during mastication and food microstructure to better understand protein digestibility.

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Neuroscience tools to predict more appealing forms for senior population

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Aim:
Today, people worldwide are living longer. WHO data predict that by 2050, people aged 60 years and older will double than now. The elderly population appears among consumers with some relevance, since many suffer alterations of taste and smell or physical disorders, what may lead to a reduced food intake and malnutrition. This leads to involuntary weight loss that contributes to progressive deterioration of health and reduced physical and cognitive functions. In this sense, there is need to conceive products tailored to seniors, nutritious attractive foods with easy-to-eat textures. On this regard, neuroscience tools can help to understand consumer perceptions of food through the measurement and integration of physiological, behavioural, and cognitive data.
Method:
In this work, 50 participants (54% women) from the senior population (55-75 years) evaluated 2 food products with the same sensory characteristics in terms of taste, texture, and flavour, but with different appearance. Liking degree and emotional response were scored using a 9-pt hedonic scale and EsSense25 in combination with GSR and facial coding (FaceReader 8.0). Subjects were asked to observe, smell, touch, and consume each sample with no time restrictions, but for the sick of this abstract only data obtained during the observation task was considered. Statistical analyses by gender included ANOVA and PCA as well as Cochran's Q test and CA (p<0.05).
Results:
Even though both samples elicited an equivalent liking perception, products evoked a different emotional response measured at a cognitive, physiological, and behavioural level. Interestingly, men and women experienced different emotion while observing both samples. The multivariate analysis allowed us to examine the sample configurations per gender and to establish associations between variables.
Conclusion:
The shape of a food product influences the food-evoked emotion of seniors at both conscious and unconscious level. This knowledge could be of interest when designing food products for this group of population with the ultimate purpose to engage consumers and to maximise the enjoyment of the food experience through more appealing food forms.

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Conscious and unconscious emotional perception of senior consumers towards dysphagia liquids

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Aim:
Dysphagia, or swallowing impairment, is a prevalent difficulty among aging adults and it has negative consequences for quality of life. The necessity to design food products that not only meet the requirements of consumers with swallowing impairment, but also their expectations becomes a reality. Far from the traditional evaluation of the hedonic response elicited by foods, the evaluation of food-evoked emotions is thought to contribute the understanding of food preferences and food choices. Therefore, the main aim of this study was to determine if texture-modified liquids induced different conscious and unconscious emotional responses in seniors.
Method:
Liquid products designed to have the same sensory characteristics in terms of taste, flavour, and appearance, but textures that varied from slightly thick to extremely thick (levels 1, 3 and 4 of IDDSI) were evaluated with 50 seniors (54% women; 55-75 years). Subjects were asked to observe, smell, touch, and consume each sample with no time restrictions and to rate liking (9-pt hedonic scale). During the session, facial expressions were coded with FaceReader 8.0 and the skin conductance response (SCR) was monitored with Shimmer3 GSR+. ANOVA, Tukey's test as well as a PCA was conducted to examine the emotional responses induced by the three sample and their evolution during the time of evaluation.
Results:
Texture-modified liquids induced an equivalent liking response in seniors, but a significantly different emotional response. The observation, olfaction, manipulation, and consumption of three liquids that only vary in texture induced different emotional responses at a conscious and unconscious level. Interestingly, the food-evoked emotions measured during the study were also gender-dependent, being the thinnest liquid more positively associated with men, while the thickest liquid more positively related to women.
Conclusion:
Food liquids designed to only vary in texture induce different conscious and unconscious emotional response in senior population long time before touching the product, even during their observation and olfaction. The identification of food textures that elicit more positive emotional responses could be of interest when designing food products for this group of population with the ultimate purpose to engage consumers and to maximise the enjoyment of the food experience.

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Tracing radiolabeled pesticides to investigate their fate during food processing

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Aim:
Analysing the fate and metabolism of ingredients or environmental and technical contaminations in complex matrices, such as food, is a major challenge in food technology. Modern food processing aims to combine more and novel ingredients and to apply combinations of physical processing factors. Pesticide residues are of major public concern, this study focuses on the fate of pesticides during food processing.
Method:
By using radioactively labelled compounds their remains, e.g. metabolites and fragments are identified and monitored along processing chains. Thereby it is possible to reveal potential hazardous compounds that have not yet been identified with common techniques and to optimize food processing strategies to yield safer food.
Results:
First results of this project indicate that current guidelines to elucidate the fate of pesticides (e.g. OECD 507) do by far not represent all chemical reactions in food processing. Additional degradation products were observed e.g. of the imidazole fungicide Prochloraz when heated in the presence of rapeseed oil. Heating radiolabelled [imidazolyl-2-14C]-Prochloraz at temperatures up to 240 °C in closed vessels for 45 minutes leads to an extensive degree of degradation of the active substance by more than 70 %. Using radio-UPLC methods coupled with high-resolution mass spectrometry, in total eleven degradation products were found. Several of the degradation products cannot be formed by simple bond breakage but were shown to be formed by chemical reactions of the active substance with matrix components (e.g. fatty acid moieties).
Conclusion:
These observations demonstrate the limitations of the OECD guideline in which such complex matrix reactions cannot be discovered. These first results show that further investigations on the fate of chemicals in food processing have to be conducted and that realistic food processing steps need to be considered for pesticide regulation. Thereby it is possible to further elucidate and finally assess potential hazards caused by unknown process metabolites.

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Evaluation of meat industry's environmental impact via LCA: Current state and future/alternative perspectives for sustainability

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Introduction

Meat processing industry includes high energy and water consumption, while results in the production of large amounts of solid wastes and wastewater. Therefore, methods for the effective treatment of wastes in order to recycle water within the industry and to valorize the solid wastes for the production of value added products and energy have been established. The primary aim of this work was to evaluate the total environmental impact of a typical meat industry (base case) and of an industry (scenario case) equipped with appropriate processes (anaerobic digestion, composting and membrane bioreactors) that sufficiently valorizes wastes from the production via conducting Life Cycle Analysis (LCA). LCA is an effective framework for assessing the environmental impacts of product systems and decisions. The objective of this LCA study was to identify the hotspots of the industry and to compare the environmental footprint between the scenario and the base case.

Materials and Methods

The whole processing chain within the meat industry along with the solid wastes and wastewater treatment was studied, and data for both cases were thoroughly collected. LCA was performed with Gabi ts (v8.7.0, 8007) database and the selected impact assessment method was ReCiPe 2016 (H), with 1 m^3 of produced wastewater selected as the functional unit.

Results

From the LCA study of the base case, a significant environmental footprint was found that has to be significantly improved. Specifically, the indicators regarding the climate change and the freshwater consumption were 80 kg CO_2 eq./m^3 produced wastewater and 0.508 m^3/m^3 produced wastewater, respectively. Moreover, fossil depletion and human toxicity (non- cancer) rose up to 27 kg oil eq./m^3 produced wastewater and 1.56 kg 1,4-DB eq/ m^3 produced wastewater. Comparing the results obtained in the scenario and the base case, it was found that in all the studied indicators an improvement of the situation was recorded, which in some cases reached up to 40%.

Conclusions

The proposed scenario for the valorization of solid wastes and water recycling within the meat industry resulted in an improvement in the environmental footprint of the meat industry, which is a necessary step towards environmental sustainability.

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Impact of organic apple puree processing on consumer's perceived value and purchase intentions

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Aim:

The demand for natural, healthy products and, at the same time, for processed organic products has increased in the last decade in most countries of the world. In France, for example, sales of organic products have jumped by 19% for savoury products and 16% for sweet products in 2020. The consumption of processed organic products is growing and concentrates the largest increases. At the same time, the number of processors has increased by 12%. While the legislation (Regulation (EC) n° 889/2008) imposes clear rules concerning the composition of organic foods, the majority of processing processes are authorised excluding ionising treatments. Previous research conducted over several decades has contributed to the emergence of new alternative processing methods (highly technological) to better meet consumer demands for naturalness, quality and safety. However, these processes and technologies raise questions, both among researchers and consumers, the latter tending to be sceptical about these methods. Food science studies have for example studied the biochemical impact of pulsed electric fields, ohmic heating, or high hydrostatic pressures, but stakeholders are aware of a significant lack of research on consumer perception of processes in this sector. It is now essential that legislation evolves to take consumers' opinion into account.

Method:

In this paper, we investigate the role of more or less innovative, more or less known processes to the general public, on consumers' perceptions and behavioural intentions towards organic products. An experiment will be conducted in july 2022 on a sample of 270 French consumers in order to measure the impact of preservation processes (conventional heating, ohmic heating and high pressure) on the perceived value, attitudes and purchase intention of apple puree. Our experimental approach enables to test moderating effects as well, such as technophobia, attitude towards naturalness, confidence in organic food, and socio-economic variables (e.g. age, gender, jobs). The objective of the present research is to understand the underlying process of consumers' intentions in order to list clear recommendations to professionals in the organic processing industry.

Result:

Our results will be available in August 2022.

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Development of 3D microstructure in fried starch-water mixtures for property estimation

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Aim:
Deep frying involves complex multiphysical phenomena that induce physicochemical and structural changes that affect the final oil uptake. During the immersion stage steam conversion of water present inside the food matrix causes a change in vapour pressure, leading to subsequent expansion and deformation of the internal porous structure, in which oil can penetrate. A model of the frying process involving heat and mass transfer and deformation helps to understand and optimize the process. To properly parameterize such model, a multiscale approach is proposed where material parameters calculated from the microscale porous structure are used as input for the macroscale process model.
Method:
Potato starch samples with varying hydration levels (30% - 60%) were fried in perforated teflon tubes for frying times ranging from 15s to 120s. X-ray µCT was used to characterize microstructure of the fried potato starch to measure the 3D porous microstructure at different time intervals. The different phases (starch, air, and oil) were segmented and changes in oil content, porosity and physical dimensions were quantified. In a first step to establish the structure-parameter relationships, pore-space images were used to build a pore-network model to evaluate absolute permeability using Darcy's law in fully saturated porous media.
Results:
A clear progression of change in structure morphology with respect to frying time was observed among the tested sample groups, with noticeable changes between low and high moisture content samples. In low moisture samples the granular structure was preserved with uniform oil distribution whereas in high moisture samples oil was limited to outer regions of the structure. Overall, oil content and porosity increased as a function of frying time with low moisture samples showing higher initial uptake in contrast with steady increasing trend in higher hydration samples. The correlation between absolute permeability and open porosity was influenced by heterogenous structure morphology of the samples.
Conclusion:
In this work, X-ray µCT enabled non-invasive analysis of fried starch, characterization of microstructure and enhanced understanding of spatial oil distribution while establishing a corelation between starch matrix porosity and absolute permeability.

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Milk consumption among schoolchildren in Ireland

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Aim:
Adequate calcium intake in childhood is essential in optimising peak bone mass and milk and dairy products are an important source of calcium in the diets of Irish children. It is recommended that children aged 5 to 8 years consume three servings of dairy products daily and those aged 9 to 18 consume five servings. However, children's milk consumption has decreased over the past ten years in Ireland and in other developed countries. The aim of this analysis is to understand the milk consumption practices of and attitudes towards milk among Irish schoolchildren and their parents.
Method:
This is a cross-sectional analysis of baseline questionnaires completed by a cohort of Irish primary school children and their parents as part of an evaluation of the EU School Fruit, Vegetables and Milk Scheme in Ireland. Parents and children in 1st, 3rd and 5th class, attending participating schools, were invited to complete an online questionnaire. The questionnaire collected data on children's and parents' milk consumption, children's and parents' attitudes towards milk and availability of milk. A descriptive analysis was conducted.
Results:
Responses were received from 616 parent-child dyads. Children were aged between 5 and 12 years and 56% were female. Ninety-one percent of parents were mothers and 51% of parents had achieved university-level education or higher. Fifty-three percent of children were daily consumers of cow's milk and 2% consumed non-dairy milk alternatives daily. Forty-five percent of parents were daily consumers of cow's milk and 7% consumed non-dairy milk alternatives daily. Seventy-one percent of children and 60% percent of parents liked the taste of cow's milk. Sixty-seven percent of parents served milk to children daily with meals and snacks and 72% agreed that it is important for their child to drink cow's milk.
Conclusion:
The results presented highlight the low milk consumption of a cohort of schoolchildren in Ireland and describe practices and attitudes related to milk consumption. Further analysis is necessary to examine the influence of such factors on children's milk consumption in this cohort. This will contribute towards an understanding of potential intervention targets to increase children's milk consumption.

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Real Time Anomaly Detection in Cold Chain Transportation using IoT Technology

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Aim:
There are approximately 88 million tonnes of food waste generated annually in the EU alone. Food spoilage during distribution accounts for some of this waste. To minimise this spoilage, it is of utmost importance to maintain the cold chain during the transportation of perishable foods such as meats, fruits, and vegetables. However, these products are often unfortunately wasted in large quantities when unpredictable failures occur in the refrigeration units of transport vehicles. This work proposes a real time IoT anomaly detection system to detect equipment failures and provide decision support options to warehouse staff and delivery drivers, thus reducing potential food wastage.
Method:
We developed a bespoke internet of things (IoT) solution for real time product monitoring and alerting during cold chain transportation, based on the Digital Matter Eagle cellular data logger and two temperature / humidity probes. A visual dashboard was developed to allow logistics staff to perform monitoring, and business defined temperature thresholds were used to develop a text and email decision support system. This system would notify relevant staff members if anomalies were detected in either the freeze or chill zones of delivery trucks transporting perishable foods to end users. The alerts would enable staff to take corrective action such as redirecting the produce.
Results:
The IoT anomaly detection system was deployed with Musgrave Marketplace, Irelands largest grocery distributor. Five delivery vans operating in the greater Belfast area were fitted with the IoT system, which monitored both the frozen and fresh produce refrigeration areas of each van. Early results show that the system is robust and avoids sending false alerts due to the trip detection algorithm which was developed. This algorithm uses GPS and accelerometer data to ensure that alerts are only sent when vans are performing deliveries and an issue is detected.
Conclusion:
We have developed an IoT solution which monitors in real time the temperature of cold chain delivery vehicles transporting perishable items. The end-to-end solution provides decision support options if anomalies are detected, helping staff redirect the delivery to a closer drop-off point and thus reducing the spoilage and waste of food.

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Inverse graphics: from X-ray to 3D pork shoulder models

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Inverse graphics: from X-ray to 3D pork shoulder models

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Aim:
Deboning of meat is a labor-intensive process that is still performed manually. There is an interest in advanced automation of the processing chain to replace or assist the deboning operations. Thereto, inline inspection systems are explored that can analyse the bone structure of pork shoulders. A computed tomography (CT) system would be suitable as the X-rays can penetrate the large volumes of meat resulting in high contrast reconstructed 3D images of the meat and bone. Based on these 3D models a pork shoulder can be produced and fed to the automation system. However, CT systems have a few disadvantages like its size and cost. However, using prior knowledge of the pork shoulder shape, a 3D image can be rendered from few projection images only. Such X-ray imaging system could be made much more simple and cheap, and would be easier to integrate in existing processing lines.
Method:
In this research specifically trained neural networks are explored to predict the 3D bone structure from a limited number of 2D radiographs. CT measurements of more than 90 pork shoulders of different pork weight classes were performed. Using this dataset, reference 3D models of the outer shape and the bone were created. Shape models are developed to characterize the shape variance of pork shoulders to synthetically create more training data for the neural network.
Results:
A 2D Unet was trained to predict 60 projections uniformly distributed between 0 and 360 degrees around the pork shoulder. These 60 projections where predicted based on one measured X-ray radiograph. 10 % of the 90 pork shoulders where used to validate the model. The predicted X-ray radiographs achieved an mean absolute error (MAE) of 0.04 and the reconstructed volume achieved an intersection over union score (IOU) of 0.67 on the validation set.
Conclusion:
The use of a 2D Unet to predict missing radiographs from a single X-ray image allowed to reconstruct the 3D volume of pork shoulders. In further research the robustness of the model will be tested using a real data measured with an X-ray line scanner.

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Ultrasonic Sensor Measurements and Machine Learning to Monitor Baked Product Quality

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Aim: The aim of the work is the integration of ultrasonic sensor measurements and machine learning (ML) to monitor the quality of baked products.

Method: A contact ultrasound system was used and combined with ML regression and classification methods. Regression models were developed to determine critical quality parameters such as moisture content whereas classification models were developed to determine the overall texture and quality such as fresh and stale digestive biscuits. While the fresh biscuits' moisture content was approximately 1-5% by mass, the stale biscuits had a high moisture content of over 5%. In order to change moisture content, the climate chamber was used with settings of 65% RH and 70°C for 100 samples. The textural quality of biscuits was probed using measurements including speed of sound (SOS) and received ultrasonic signal amplitude and energy. SOS through the biscuits was calculated by measuring the height of a biscuit and time-of-flight of an ultrasonic wave propagating through the biscuit. The amplitude of the signal and the energy were calculated from the received waveform. SVM, ANN and Decision Trees algorithms were chosen to model the measurements performed on the biscuit results.

Results: The correct classification rate, R-squared and RMSE values represent the results of the classification and regression models. The highest classification accuracy to predict textural quality was 99.6% using ANN model with amplitude, energy and SOS as features. However, SVM and Decision Trees models also achieved high classification accuracy of 98.2% and 99%, respectively, using only SOS and energy features. The highest R-squared value to predict moisture content was 0.999 and obtained from ANN model with amplitude, SOS, energy features. However, the second highest R-squared value and the lowest RMSE value were 0.998, 0.081 for an ANN utilising SOS and energy features.

Conclusion: The combination of ultrasonic measurements and ML models are a promising quality inspection tool for the food production sector. The results of applied ML models show that smart sensors systems and digital technologies have the capability to monitor the key properties of food products. As the digital revolution continues, intelligent sensors will play an important role in the sector.

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Metamorphasis of Crab Shell into Butterfly Wings: Advanced Patterned Films from Food Waste

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Aim:
Patterned thin-films (PTFs) play a crucial role to a host of critical technologies across a broad range of industries. Contemporary PTFs rely on unsustainable and relatively ineffective petrochemical polymers. These generate pollution; come from dwindling, finite resources; and are suboptimal for making the structures needed for certain advanced applications. Similar structures are produced during food production, through a process known as *phase separation,* though on a larger scale (> 100 μm). This is done to enhance the sensory appeal of food items, while improving their nutritional value. Utilizing similar techniques to the food industry, and biopolymers from food waste streams (chitosan and bovine serum albumin [BSA]), this work produced quasi-ordered sub-micron structures. The application of these structures ranges from anti-reflective/hydrophobic coatings to enhancing food properties, while adding value to both food waste and their byproducts.
Method:
Low molecular weight chitosan (50-190 KDa, 75 % deacetylation) and BSA was blended 90 % formic acid. Films were cast using a spin coater. Phase separated structures characteristics were controlled by ambient humidity, deposition speed, and solution parameters. Metals structures were grown in the chitosan phase through metal inclusion using EtOH as a green solvent. The biopolymer template was removed via calcination. Patterns were transferred to the Si substrate using $NH_4F/dH_2O/HNO_3$ as an etchant. Characterization was performed using AFM, XPS, FT-IR and Raman.
Results:
The biopolymer template morphology was readily modified by controlling ambient humidity and deposition speed, suitable for anti-reflective applications (approx. 200 nm diameter) and food texturing. Casting parameters determined whether the phases grew via Ostwald ripening or coalescence. Metal binding to the biopolymer template was largely controlled by HSAB theory and the Hofmeister effect. Undesired effects such as incorrect binding and metal cracking were controlled by processing conditions.
Conclusion:
Waste stream biopolymers offer a superior, green alternative to synthetic polymers for structure generation. This work elucidates the fundamentals of biopolymer interactions, producing the smallest patterns to date (> 200 nm). Producing advanced technologies such as PTFs from waste biopolymers, significantly adds value to waste produced by the food industry, while shifting production towards a more circular economy.

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Electro-heating technologies for innovation in industrial applications for process safety and efficiency

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Aim and methods:

The recent food safety issues emerged with the low water activity (<0.85) food products (peanut butter, chocolate, tahini, powders, dried fruits and vegetables, etc.) indicated the requirement of innovative approaches in processing. Even though the low moisture foods are accounted to be less susceptible to the microbial growth, the pathogen microorganism, with their low numbers, might still survive through the shelf-life and cause significant safety concerns due to their lower infectious numbers. *Salmonella* has been specifically linked in a numerous number of outbreaks. A proper thermal processing is expected to provide a significant reduction in the number of the pathogenic microorganisms, conventional thermal processing approaches have certain disadvantages for process efficiency due to the lower thermal conductivity and higher viscosity of tahini while electro-heating technologies (microwave - MW, radio frequency - RH, ohmic heating and infrared) are promising to reduce safety risks while still maintaining the quality with sustainable and efficient processing.

Approaches and Results:

In this presentation, the effectiveness of these electro-heating approaches for process effectiveness for pasteurization of the low water activity products is demonstrated. The examples for process innovative include industrial scale (experimentally validated) computational models. These models highlight the scale-up issues for industrial scale sustainable processing with required process design.

Following this, sustainable processing, optimization approaches and quality-based studies for the electro-heating technologies will be presented, and they are expected to demonstrate a novel approach to the industrial applications.

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New process for improved sensory properties of marine powders based on cod filleting residues

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Aim:
The Norwegian whitefish industry generated 315 200 tons of residual materials (heads, backbones, viscera, and skin) in 2021. Only 56% were utilized, mainly caused by low degree of valorisation onboard factory trawlers. Currently applied onboard process technology gives a product with a strong fishy and rancid flavour generally unsuited as a food ingredient. This study aimed to develop an improved process for the manufacture of a palatable and highly nutritional fish protein powder from cod heads and backbones implementable onboard factory trawlers.
Method:
Milled heads and backbones from cod (*Gadus morhua*) were washed from one to four times by either saltwater of freshwater, followed by mechanical dewatering (sieving vs. pressing), steam cooking, drying, and milling. Changes in chemical composition, colour, and sensory properties as an effect of the various washing methods were evaluated.
Results:
Consecutive water washing steps showed decreasing red colour of separated water, reflecting that residual blood were primarily removed in the first and second processing step. However, only negligible effect on colour of the obtained powders were observed. Each washing step gave a small loss of protein with increased ash level on dry matter basis in powders. Volatile nitrogen compounds (i.e., trimethylamine and ammonia), known to negatively affect sensory properties, decreased significantly (2-3-fold) after the first step. Trimethylamine, with levels of 66 and 54 mg N/100g in backbones and heads, respectively, could not be detected in the end products. Saltwater versus freshwater gave significant difference in salt content. Only minor effects of dewatering method were observed on chemical composition. Some differences could be attributed to the composition of the raw material (head or backbone).
Conclusion:
A fish protein powder with better sensory properties can be obtained by inclusion of a washing step prior to steam cooking and drying. The new processing technology gives a highly nutritional food grade protein powder and can easily be implemented onboard trawlers and replace current fishmeal technology. The process may contribute to improved valorisation and sustainability of the whitefish industry.

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Sensory properties of whitefish protein solubles – can it be broth?

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Aim:
The whitefish industry in Norway generate large amounts of side streams after fileting or heading&gutting operations. Of 315.000 tons in 2021, as much as 138.000 tons (44%) was discarded. This is mainly caused by processing onboard the fishing vessels without bringing the residual material ashore. Storage space is a limiting factor and onboard processing of the residuals is considered the most promising exploitation route. Several modern fishing vessels have fishmeal plants onboard, however, only the solid phase (press cake and decanter solids) is dried to fishmeal. The water-phase (protein solubles) is discarded and pumped overboard. The solubles have high nutritional value, including essential amino acids, minerals, and vitamins, with potential for human consumption. However, knowledge on how different whitefish species and side stream fraction influence the sensory properties of the solubles is imperative for potential food applications.
Method:
Fillet, head-backbone-skin (HBS), and viscera fractions from filleting of cod, saithe, haddock, and golden redfish were heat treated and separated into presscake and stickwater, followed by membrane filtration to the latter to obtain a fat-free solubles fraction. The sensory properties of the stickwater solubles were assessed based on generic descriptive analysis by a trained sensory panel.
Results:
All products had high flavour intensity. Only small differences between fish species on sensory attributes were found, however products based on redfish were perceived as significantly more fishy and rancid tasting. The solubles based on filets and HBS were comparable for most sensory properties assessed, whereas the intensity scores for the viscera-products were higher for properties considered unpalatable, such as bitter and astringent. Further, solubles based on HBS were perceived as the saltiest, explained by the high proportion of bones in this raw material.
Conclusion:
The high flavour intensities of the solubles indicate potential use as broth and/or flavour enhancer. HBS and fillet solubles were nutritionally comparable and palatable. The global broth sector is expected to increase in the coming years, and this could potentially pave the way for increased utilization and value creation for solubles manufactured from whitefish residuals.

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Digital Tools for Knowledge Transfer in MW/RF Heating of Foods

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Aim:
Aim of this topic is to discuss practical examples of digital tools which can be employed in knowledge transfer in the field of food products heating by means of electromagnetic fields, in radio-frequency and microwave range.

Method:
Stand alone apps have been prepared with applicative examples of radio-frequqnecy and microwave heating of foods.
Particularly, apps were built by using Cosmol Multiphysics, as software for solding the complex partial-differential equations system which describe the relevant physical phenomena happening is such processes, and Comsol Complier to compile the mathematical models, the solution, and the data post-processing in a unique virtual environment.

Results:
Results show how powerful these tools are in terms of operability, possibility to extract and analyse data, with particular emphasis to so called “what-if” scenarios, that consists in simulate what will be the behaviour of the system under observation if some input or initial/boundary conditions will change.

Conclusion:
Digital tools represent an unbeatable way to train personnel and to tyransfer knowledge, especially in the area of processes which are characterized by a complex interdependence of phenomena like in the case of radio-frequency and microwave heating of foods

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Modeling and design of Ohmic heating chambers: a computational approach

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Aim:
Ohmic heating (OH) represents an interesting 3D heating technology base on the use of electric current passing through food. During an OH-treatment a difference of potential is stablished between two electrodes that enclose the food to be processed, which generates an electric current: the current passes through the food matrix based on its electric impedance and while colliding with the molecules of the food heat will be generated. This means energy is directly dissipated in the food matrix, instead of undergoing a heat transfer process through a liquid-liquid, solid-liquid, gas-liquid, gas-solid interphase or radiationAlthough the technology has been investigated in several studiesit still requires a design optimization to reduce the formation of the formation of cold spots. Distribution of cold spots depends on several parameters, like chamber geometry, process parameters, electrodes distribution, and of course on the electrical properties of food itself, which can be portrayed as a complex matrix of heterogenous phases and multiple biochemical and microbial interactions.

Method:
In order to gain an insight into the complexity of food-electric field interactions, e mechanistic model was implemented inside a CFD code to analyse mutual effects of the aforementioned variables. The effects of the electric field are reproduced together with a full 3D Navier-Stokes model, including natural convection effects in liquid food and in food containing particulates. The density and viscosity of the fluid domain are considered to be temperature dependent. Several electrodes distributions will be investigated, as well as the effect of equivalent-DC models adopted to simulate AC power source generators lifting the heavy computational requirements for high frequency systems.

Results and conclusion:
Results showed that chamber optimization plays an important role in reducing thermal non-homogeneity, in both the shape and electrodes distribution. Some details will be provided also in terms of possible effects of different wave shapes of power generators on heating effects.

Posters

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The effect of an active coating on mold growth and aflatoxin production in pistachio

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Aim:

The present study investigated the development of an active edible coating based on carboxymethyl cellulose modified (CMC) with octenyl succinic anhydride (OSA) containing *Bacillus subtilis* against the growth of *Aspergillus flavus* and inhibition of aflatoxin production in pistachio kernel.

Method:

Initially the chemical structure of carboxymethyl cellulose was modified by octenyl succinic anhydride. The bacterial cells with a specific concentration (10^8 CFU/ml) were then incorporated into the coating solution.

Results:

Minimum inhibitory concentration (MIC) evaluations against *A.flavus* on pistachio kernel approved the inhibitory effects of the modified coating solution containing *B. subtilis*. The growth evaluation of A. flavus on pistachio kernels within 90 days showed that at the samples coated with the modified active coating containing live cells of B. subtilis with completely inhibited the growth and sporulation of *A. flavu*s as well as aflatoxin production. The results of B. subtilis survival test in coating solutions showed that the microbial population of this bacterium could better retain its viability at 4°C better than 25°C.

Conclusion:

The results of this study showed that structural modification of the coating based on CMS could significantly improve the inhibitory effect of the coating against *A.flavus* growth and aflatoxin production. These findings could be exploited to improve quality and safety of pistachio kernels in industry level

Keywords:

Carboxymethyl cellulose modified coating, Bacillus subtilis, Aspergillus flavus, Aflatoxin

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Gas Hydrate Formation in a Stirred Tank Reactor

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Aim:
CO_2 gas hydrates can be observed in aqueous systems at elevated pressure and temperature above 273 K. They offer prospect to increased energy efficiency and to gentle concentration of liquid food extracts. The aim of the current contribution was to study the formation of CO_2 gas hydrates in a batch autoclave system for pure water and reconstituted pure soluble coffee on theoretical and practical basis.
Method:
To ensure proper understanding of the gas dissolution and hydrate formation process, a dimensional analysis was performed on a set of 30 physico-chemical parameters to obtain a dimensionality reduction to 26 dimensionless numbers. Aside from a set of trivial dimensionless numbers (such as geometrical ratios), Reynolds, Péclet, Prandtl, Sherwood, Schmidt and Henry numbers were considered as of particular interest.
Results:
The flow in the current batch autoclave system was shown to be turbulent. The CO_2 gas dissolution kinetics was governed by convective mass transport. At near-equilibrium state of the considered closed system, the molar concentration in the gas phase was of same order of magnitude as in the liquid phase. The molar concentration in the liquid phase was sufficient for gas hydrate formation from a spatio-stochiometric point of view.
These insights were then used to perform gas hydrate formation experiments in pure water and in reconstituted soluble coffee. Observations revealed a formation of gas hydrates in both systems (coffee and water) at similar thermo-fluiddynamic conditions (pressure 30-40 bar, temperature 274-278 K). Spontaneous formation of gas hydrates was observed in more than 90 % of the experiments. In experiments carried out in a different configuration (small-sized batch reactor) but at conditions represented by similar dimensionless numbers, same spontaneous formation of gas hydrates was observed.
Conclusion:
It was concluded that gas hydrate formation can be triggered in different types of batch reactors and fluid systems, if similar predominant thermo-fluiddynamic conditions are applied. This raises the idea that gas hydrates can possibly also be formed in a continuous system, if the dimensionality requirements are met, which offers prospect for industrialization.

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Combination of proteins to improve the chemical score in vegan food

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Aim:
Vegan food is becoming more and more important, and it is impossible to imagine our tables without it. Proteins play a major role in this, but it is usually only a source with less protein content in the food than in a comparable animal based. Here our goal was to achieve a high chemical score with various plant and fungal proteins in the right combination.
Method:
The basis of the calculation are the amino acid compositions of the individual protein sources, which were taken from the literature. In addition, the best combination of proteins was tried out and presented in the vegan application. Texture profile analysis and a human sensory analysis was performed of this system and compared to a system using pea protein isolate. To validate the system, an amino acid composition of the final mixture was performed and calculated again.
Results:
It was shown that the literary values fit very well with commercially available proteins on the market. A combination of potato, pea, mushroom, and yeast protein is the best solution so far. In addition, the mixture is allergen-free. Through combinatorics, values like beef could be achieved. Here, the limiting amino acid is methionine. In the application a better techno functionality could be shown by the combinatorial effects, which can be seen in the values of the texture profile analysis. There was no deviation in taste, but slight color changes, which can be compensated by food colorants.
Conclusion:
A higher chemical score in vegan foods is a next step to ensure better care for the consumer. In addition, some hydrocolloids can be dispensed with in this way, since a better techno-functional property, such as hardness or elasticity, is available. In this way, the VAN HEES Group could offer solutions to the manufacturers of vegan products, which are of high interest, allergen free, plant based, and have a unique selling point. Moreover, by simply reformulating the formulation, these goals can be achieved and thus marketing can be done.

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Development of a new dehydrated black olive product

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Aim: Consumers are increasingly demanding dehydrated food products, particularly dehydrated table olives. This type of table olives is traditionally elaborated from ripened black olives that are dehydrated using salt (NaCl). However, this is a season dependent product that must be processed in a few months. The objective of this work was to develop a new dehydrated olive product based on black ripe olives also known as California-style black olives that are available throughout the whole year.

Method: Big size olives (160 fruit/kg) of the Hojiblanca cultivar preserved for several months under acidic conditions were processed as black ripe olives (alkali treatment, washings and iron fixation solution) and, subsequently dehydrated at 80ºC using infrared radiation. The physicochemical and organoleptic characteristics of these olives were modified in order to mimic those of the traditional dry-salted olives.

Results: It was found that hot alkali (40º C) at higher concentration than normal strength (3.5-5%, w/v) was necessary to decrease the firmness of the olives from around 100 N/fruit to 40 N/fruit. This hot alkali gave rise to a very high solubilization of the tripterpenic acids from the olive skin, and it allowed a higher dehydration rate of the olives, $k=1.4 \times 10^5$ and 3.7×10^5 (s^{-1}) for the control and hot alkali treatments respectively. Moreover, olives must loss around 40% of their initial weight according to tasters´ recommendations, and the salt content in the olive juice can range between 10-15% in order to comply with 8-10% minimum salt established in international table olive standards. Finally, it was also demonstrated that the iron concentration used during the fixation stage can be reduced from 1 g/L to 0.5 g/L without any negative effect on the color of the dehydrated olives.

Conclusion: A new dehydrated black olive product has been developed from black ripe olives with similar characteristics to the traditional dry-salted black olives.

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Ensuring product stability, quality, and safety while introducing novel sustainable packaging solutions

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Ensuring product stability, quality, and safety while introducing novel sustainable packaging solutions
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Key words: Material-science, food powders, recyclable packaging, product stability

Aim: Ensuring product stability, quality, and safety while introducing novel sustainable packaging solutions
The rapidly evolving consumer trends and rising awareness about the ecological impact of their products makes it vital for packaging, food and ingredient manufacturers to be capable of quickly adapting processes to meet the consumer demands. The most striking and discussed topic is most likely the concern about the use of non-recyclable packaging materials and their impact on the environment including waste in the oceans and sustainable use of resources. However, manifold attempts to remove or replace undesired ingredients or packaging materials, one often faces hurdles linked to product stability, quality, and safety, particularly in products with a large overall surface area such as food powder.
Method:
To overcome this drawback material-science driven approaches are required tackling all aspects of the value chain – modifying product recipes, processes, storage & distribution, and packaging materials.
Different approaches targeting recipe or process optimisations and adaptations of the storage and distribution will be highlighted aiming at improving the physical stability of the powders towards temperature and humidity changes. Such multi-functional challenges can only be addressed by material-science based investigations of the underlying degradation mechanisms and approaches aiming at optimising the functional behaviour of food powders while meeting the consumer demands going to more sustainable food production.
Results:
Both changes in the powder structure (e.g. particle size and its distribution) and recipe (amount of sensitive ingredients) allow to increase the physical and chemical stability in food powders. However, to optimse the increase in shelf life specific solutions need to be found for each individual product. With such solutions shelf-life increases by a couple of months can be achieved in sustainable packaging low barrier properties.
Conclusion:
Nevertheless, to widely sell products in sustainable packaging further effort is needed to extend the range of products that can be sold in sustainable packaging or in bulk and improve the barrier

properties of such packaging. Moreover other aspects such as targeted shelf-life might need to be reconsidered.

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Fungal and Aflatoxin Progression in Nixtamalized Maize Using Activated Charcoal

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Fungal and Aflatoxin Progression in Nixtamalized Maize Using Activated Charcoal

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ABSTRACT

Aflatoxin causes non acceptability of farm produce such as grains at global markets. The aim of this study was to investigate the fungal and aflatoxin load of fermented maize treated with Activated charcoal. Twenty samples (n=20) of dry maize moisture level was adjusted from 12% safe moisture level to 17%, incubated at 28ºC and assessed for fungi and aflatoxin levels using standard microbiological procedures and High Performance Liquid Chromatography (HPLC) respectively. The result was statistical analysed by one way ANOVA using SPSS version 18.0. Five fungi isolates were isolated from the maize and identified as *Aspergillus flavus* (23%), *Rhodotorulla* spp (3%), *Alternaria* spp (16%), *Saccharomyces cerevisiae* (43%) and *Fusarium oxysporum* (15%). Aflatoxin quantification at the end of the experiment revealed samples fermented with 0.5% Activated Charcoal had no detectable aflatoxin (100% efficiency) and samples fermented without Activated charcoal had minimal aflatoxin (60%). The study revealed Nixtamalization has a higher efficiency in the control of aflatoxin in fermented maize even though fermentation ordinarily controls aflatoxin without the use of activated charcoal but it is variety dependent. To ensure food safety, nixtamalization should be incorporated into maize fermentation processes which could also help in the management of aflatoxicosis.

Keywords: Activated charcoal, Aflatoxins, High-performance liquid chromatography, Microbiological-procedure, Nixtamalization

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Batch Baking of Pound Cake using Ohmic Heating for 3D Printing Applications

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Aim:
Additive manufacturing (AM) or 3D printing technology offers new limits to the food industry due to its large scope of application. AM provides multiple advantages such as customized food designs, innovative textured foods, and a reduced ecological footprint by the use of fewer raw materials and less energy. However, in the usual approach to cook/solidify the structure of the printed product, a post-processing step such as drying, baking or frying is often applied. In most cases, the printed products do not retain their structure/shape after this step mainly due to material composition. This study aims at developing a continuous heating system using Ohmic heating (OH) as baking the medium while printing simultaneously, focusing on honeycomb cereal matrices (cake-type).
Method:
Batch baking process using OH was firstly considered to evaluate the relevance of OH for pound cake baking. Different OH process parameters (rate of heating, power input and holding time) were tested and their effect on the physico-chemical properties of batter (specific volume, porosity, starch gelatinization) and cakes (texture, porosity, degree of starch gelatinization) were analyzed in comparison to conventional heating (CH). Alongside, the effect of leavening acid type with different levels of baking powder on batter and cake properties were investigated in the two heating modes.
Results:
Extended holding times (15min and 20min) at 100°C of OH increased crumb firmness accompanied with the appearance of an internal brown band. However, as rate of heating increased from 1.6°C/min to 6.4°C/min with 5min and 10min holding times respectively, crumb firmness was reduced and reached values comparable to that of CH cakes. Cake specific volume and porosity also increased with increasing rate of heating but with reduced holding time. Both OH and CH had different rates of gelatinization from the external to the internal regions of the final cake product.
Conclusion:
Overall, OH reduced baking time for a fully expanded pound cake by more than half, hence, giving insight to the high potential of this technology as an efficient heating system for 3D printing of cereal matrices and other suitable food products.

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Nanostructured cellulose particles for O/W Pickering emulsions stabilization

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Abstract

Emulsions are thermodynamically unstable systems, which require emulsifiers and/or stabilizers to achieve long-term stability. The majority of the emulsions used in the industry are currently stabilized by synthetic or animal-based emulsifiers. Therefore, alternative solutions, offering higher biocompatibility, ecological acceptability, renewability, and low toxicity are desirable. In this respect, this research aimed at exploiting nano-structured cellulose particles, of plant and bacterial origin, as an efficient stabilizing agent in Pickering emulsions, thanks to their unique nanostructure, high aspect ratio, and amphiphilicity. Plant cellulose was extracted by TEMPO-mediated oxidation treatment from Celeste Star - TCF 85, while bacterial cellulose was recovered as the SCOBY pellicle, a by-product in the kombucha tea fermentation process. Nanocellulose particles (NCs) were obtained by ultrasound (US) and high-pressure homogenization (HPH) treatment applied to plant and bacterial cellulose, respectively. NCs physicochemical characteristics (microstructure, interfacial tension, ζ-potential, and particle dimensions) were determined prior to emulsion fabrication. Emulsions stability (emulsifying activity and emulsion stability indexes) and physical properties (microstructure, particle size distribution, ζ-potential, rheological behavior) of oil-in-water (O/W) Pickering emulsions with low content (5% wt) of peanut oil using different NCs as emulsifier dispersed in the continuous aqueous phase have been evaluated. The cellulose origin and the treatment used to obtain NCs significantly affected the emulsification properties of NCs. All types of NCs enabled the formation of a thick interfacial layer around the oil droplets, offering a mechanical barrier against coalescence, and phase separation due to steric hindrance and electrostatic repulsions. Moreover, NCs-stabilized Pickering emulsions formed 3D interconnected networks in the continuous phase, which entrapped the oil droplets and therefore increased the resulting emulsion viscosity. In conclusion, this work shows the potential of NCs derived from natural sources as natural emulsifying and stabilizing ingredients promoting the development of new food-grade products or favoring the replacement of undesired ingredients in existing ones for cleaner labels.

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Valorization of whey protein fraction by High Pressure Processing

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Aim:

Cheese whey, traditionally processed as a by-product, it is considered a source of valuable whey proteins (WPs) with multiple applications in food industry. However, the main WPs, b-Lactoglobulin (b-Lg), have been associated with infant allergies, making crucial the development of new technological approaches for their removal.

Avoiding any high temperature condition is desirable for conserving the native state of the proteins. So, High pressure processing (HPP) has been proposed as a mild technology to selectively reduce the b-Lg concentration in cheese whey while not affecting other WPs like a-Lactalbumin (a-La).

Besides, whey is mainly compounded by water, what makes its concentration a convenient step for energy and time saving and for increasing its chemical and physical stability.

In this study is HPP will be performed to obtain an a-La enriched fraction from bovine whey.

Method:

The objective of this work was to assess the effects of different HPP conditions (pressure 145-600 MPa; treatment duration 7-433 s; temperature, 7-35ºC; and different pH) on the WPs of bovine whey. Characterization of the resulting product after processing was performed (RP-HPLC a-La yield, a-La purification degree, gel electrophoresis, hydrophobicity surface and total free thiol groups quantification).

Results:

HPP affected WPs in agreement with what reported previously in the literature. b-Lg was significantly reduced after the treatment in comparison with a-La. Pressure and treatment duration had a significant effect on the characteristics of the final product, being possible to obtain a a-La fraction, increasing the ratio a-La/b-Lg after HPP treatment.

Conclusions:

High pressure processing (HPP) proved to be an efficient strategy for b-Lg reduction from bovine whey, allowing the development of new protein-based potential products. However, further experiments for scaling the process at industrial level and using whey from other animal sources would be interesting.

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Antioxidant profile and redox status of fresh-cut Eruca sativa treated with plasma activated water (PAW)

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Aim: investigate the effect of PAW, generated by high-power atmospheric pressure corona discharge plasma source, on some antioxidant properties of rocket salad. Specifically, we explored (i) the antioxidant activity measured with an in vitro multimodal approach; (ii) the quali-quantitative content of bioactive compounds by standard HPLC-MS/MS technique and (iii) the role exerted by polyphenolic extracts on cell viability and oxidative status in Caco2 cells.

Methods: PAW was obtained using distilled water by a corona discharge plasma source. Immediately after PAW generation, rocket samples were dipped in PAW for 2, 5, 10 and 20 min at room temperature. For each treatment 20 g of samples were dipped in 400 mL of PAW (product:liquid ratio of 1:20 (w:v)), and kept under agitation. Antioxidant activity was tested by 2,2'-azinobis(3-ethylbenzothiazoline-6-sulfonic acid (ABTS), 2,2-diphenyl-1-picrylhydrazyl (DPPH), and ferric reducing antioxidant power (FRAP) methods. The total polyphenol content was quantified by the Folin-Ciocalteu phenol reagent. Caco2 cells were used to test cell viability, reactive oxygen species (ROS) and reactive nitrogen species (NOS) determination.

Results: PAW caused a slight reduction in the radical scavenging activity of the amphiphilic fraction over time but induced a positive effect on both total phenolic and glucosinolate content. Interestingly, PAW polyphenol extract did not induce a cytotoxic effect, and caused a lower imbalance in redox status compared to untreated sample.

Conclusion: According to the obtained results, the use of PAW technology induced an immediate slight increase of the radical scavenging activity analysed in the amphiphilic fraction in comparison to the untreated sample and the hypochlorite solution, the latter used as industrial reference process. On the other hand, PAW determined a higher value of the reducing power prolonging the treatment time. Our results revealed a significant greater content in glucosinolates in the sample dipped in PAW for 20 min in comparison to the untreated ones. Interestingly, the data obtained in human cultured colonocytes showed that polyphenol extract obtained from rocket leaves after exposure to PAW, did not induce a significant change in cell viability in comparison to the extract obtained from the untreated sample, which induced a cytotoxic effect at the highest concentration tested.

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Sustainable meat alternatives: Probing interactions of potato protein and fungal hyphae composites

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Aim:
Microbial proteins, also known as single cell proteins, offer high quality protein for human consumption at relatively low cost to the environment. Underpinning the drive for alternative proteins are increasing ethical and sustainability concerns around traditional animal proteins, especially meat and dairy proteins. Consumers want meat alternatives with texture and taste characteristics similar to animal muscle. Filamentous fungi in combination with added plant proteins provide high quality protein with similar structure and texture performance as meat fibres. This study aimed at understanding the microstructure of fungal hyphae and its interactions with added potato proteins in a fungal protein-hyphae composite.
Method:
To elucidate these interactions, the effects of pH, mono and divalent cations were measured on hyphae pastes with and without added potato protein via small deformation rheology. The composite microstructure was also studied using confocal laser scanning microscopy (CLSM), cryo-scanning electron microscopy (cryo-SEM) coupled with energy-dispersive X-ray (EDX) and atomic force microscopy (AFM).
Results:
The results demonstrate the complex nature of the hyphae paste, made up of *β*-glucans, sulphur-rich proteins and chitin fibres. A clear dependency of storage modulus (G’) on pH, ionic strength and divalent cation was observed. For example, at a shear strain of 0.1 % and frequency of 0.1 Hz, G’ of 20% solid paste at pH 6.0 with and without potato protein were 6.7 and 6.4 kPa, respectively. Addition of 100 mM NaCl, increased G’ to 10.3 and 9.0 kPa, respectively. The microscopy suggests that the proteins coat the hyphae and dominates the composite behaviour.
Conclusion:
Across all measured pH, addition of NaCl and $CaCl_2$ increased G’, hinting that electrostatic interactions between the fungal hyphae and the protein governs overall microstructure and textural development.

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Green bioremediation of casein powder production waste by autotrophic microalgae growth

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Aim:
Casein production generates waste streams that are rich in high levels of nitrogen and phosphate. This makes this type of waste very difficult to treat using conventional techniques with a high amount of cost and investment needed. In this research, we investigated a novel green method, based on the application of consortium of microalgae cells, for simultaneous valuable biomass production and uptake of waste nutrients i.e. nitrogen and phosphate in the wastewater of casein powder factory comprising of protein and lactose free whey and creamery wastewater.
Method:
The effect of autotrophic microalgae cultivation on the protein, nitrate, ammonium, and phosphate concentration of the main waste stream of the casein factory was studied. Changes in cell growth pattern were also investigated by light microscopy and flowcytometry. *Chlorella vulgaris, Tetradesmus obloquus, Nonnochlropsis ocenica* and a mixture of these three microorganisms were analyzed.
Results:
The results showed that the use of a consortium of three microalgae cultures exhibited the most efficient nutrient removal approach. Protein concentration was increased at the first week of cultivation while nitrate concentration was decreased. This observation indicated that microalgae could hydrolyze the protein present in the waste streams. *Tetradesmus obloquus* showed the highest hydrolytic activity. At the same time, the concentration of phosphate was decreased sharply. At the initial stages, the biomass production was mainly due to cell division while at the final stages, the cells tend to grow in their size. Both flowcytometry and microscopic analysis confirmed that the largest population number was observed for *Chlorella* followed by *Tetradesmus*. Since microalgae could utilize the atmospheric CO_2 as their carbon source, the wastewater streams used in this study with high levels of nitrogen and phosphate favored the growth of microalgae.
Conclusion:
Therefore, it can be concluded the application of microalgae cells for nutrient recovery from acid casein wastewater is a promising method for wastewater treatment. The obtained biomass can be further separated for other applications such as feed or high value food.

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3D-Printing of probiotic enriched cookies made from confectionary's waste

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Introduction

The problem of food waste and the growing interest in customized nutrition resulted in the emergence of new technologies in sustainable food production such as 3 D food printing. 3D printing could potentially re-use food waste and produce more complex food products with lower costs. The aim of this study was to investigate the possibility of exploiting 3 D food printing to re-use confectionary's waste to custom design cookies containing probiotic bacteria (*Lactobacillus plantarum*).

Materials and methods

An initial printable cookie formulation based on confectionary's waste was provided. In order to increase the viability of probiotic cells in the printable cookie formulation during printing and baking, cell microencapsulation was performed. Concentrations of 4% sodium alginate and 3% calcium chloride solutions were used as optimal concentrations for microencapsulation of Lactobacillus plantarum. Then, 1 gram of the prepared microcapsules was mixed with 10.5 g of powdered confectionary's waste and 9 grams of water and a printable dough was eventually prepared. The viability of cells after 3 D printing and baking at 150 ° C and 180 ° C for 10 minutes was investigated. All the results were compared with the blank sample (Printable dough containing free probiotic cells.

Results and discussion

The initial number of bacteria inoculated into sodium alginate solution was almost 10^{15} CFU/gr and the cell number after microencapsulation using extrusion methods drop to 0.33×10^{13} CFU/gr (microencapsulation efficiency: 89.41%). The number of microencapsulated probiotic cells after 3 D printing drop from 5×10^{12} CFU/gr to 2×10^{12} equivalent to 96.86% survival rate. In the dough containing free cells this survival percentage was considerably lower (77.6%). The cell viability after baking at 150 ° C declined in 5×10^{7} and 3×10^{4} in doughs containing microencapsulated and free cells, respectively. However, no viable cells were detected after baking dough samples at 180 ° C.

Conclusion

The results of this study conformed the possibility of using 3 D food printing to convert close to out of date confectionaries to healthy probioticated cookies by printing the raw dough on-demand close to the point of final consumption alleviating the need for for secondary packaging.

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Plant-based burgers with gelled emulsions as fat source: Composition, lipid profile and sensory properties

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Plant-based burgers are getting rapidly popular worldwide mainly due to their convenience and to the increasing concerns about the impact of animal food consumption on human health, climate change and animal welfare. Nutritionally, they should be designed keeping the most valuable nutritious compounds found in meat (high protein content with a well-balanced amino acid profile) and avoiding the unhealthy ones (saturated fats and cholesterol) to reach advantage for human health purposes. In this sense, the use of gelled emulsions (GE) from vegetable oils as fat source seems to be a good strategy to provide them mechanical and visual properties similar to solid fat.
Aim: To assess the effect of using gelled emulsions (with chia and hemp oil) as fat source in plant-based burgers on their nutritional characteristics, lipid profile and sensory properties
Method: Plant based-burgers were formulated using texturized soya (as protein source), pea fiber (as dietary fiber source), freshly beet juice (as blood analogue), chia-GE or hemp-GE (as fat source), and spices. Proximate analysis (AOAC methods), lipid profile (gas chromatography) and sensory properties (hedonic scale of 7 points) were determined. ANOVA was applied ($P<0.05$) for data statistical analysis.
Results: Both plant-based burgers (PBC and PBH formulated with chia-GE and hemp-GE, respectively) resulted a good source of protein (19%) and dietary fiber (10%) with a low fat content (2.5%), without differences between both formula. In addition, unsaturated fatty acids (UFA) were predominant (88%) in both samples, being the main fraction the polyunsaturated fatty acids (PUFA, 57%). Regarding lipid profile, in both samples the main fatty acids were linoleic (C18:2, *w*6) and linolenic fatty acids (C18:3, *w*3) but in different proportions: in PBC the majority FA was C18:3 (41%) while in PBH was the C18:2 (41%). Both burgers were positively scored (without differences between them) during sensorial analysis regarding color, texture, general aspect and flavor and also showed a good general acceptability (>5)
Conclusion: The use of GE with chia and hemp oil as fat source in the development of plant-based burgers is a good strategy to obtain burgers with a good nutritional composition, sensory acceptance and a healthy lipid profile.

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Ultra-high-pressure homogenization (UHPH) in the preparation of spray-dried functional emulsion: application in dairy-based products

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Aim

Combining functional compounds like omega-3 rich oils and buttermilk (BM) in spray-dried emulsions (SDE) is a suitable technique for incorporating these ingredients as alternative dairy fats and enhancing their functional properties. In comparison to conventional homogenization (CH) of liquid emulsions, ultra-high-pressure homogenization (UHPH) remarkably improves emulsion stability. In the food industry, spray drying is the most widely used method to fabricate SDE due to its low cost, availability, and diversity. The addition of them to dairy products can help to acquire functional foods that are commonly consumed by consumers, like yogurt. The aim of this study was to evaluate the main characteristics of yogurts with SDE incorporated at different concentrations to develop a functional dairy product which is frequently consumed.

Method

Feed emulsions were produced by CH and UHPH at 30 MPa and 100-200 MPa, respectively. Emulsions were formulated with a 10% oil mixture of chia seed (*Salvia hispanica* L.) and sunflower (*Helianthus annuus* L.) oils in 1:1 ratio, commercial BM was added at 7% (w/w) as emulsifying agent and maltodextrin (30% w/w) as carrier material of SDE. Yogurts were produced according to the following formulation: 3% skimmed milk powder (SMP), 2% starter and 4 or 6% SDE. The particle size, physical stability, and rheological characterizations of the feed emulsions were evaluated. The encapsulation efficiency (EE), oxidation stability, and water solubility for SDE were analized, and rheological, textural, water holding capacity (WHC), and sensory properties of the yogurts were investigated.

Results and conclusion

Results showed that the UHPH improved stability of feed emulsion by reducing considerably the individual particle size of oil droplets and colloidal particles such as aggregates which significantly increased the EE of SDE. The 7% BM UHPH-treated SDE indicated the best primary oxidation stability during storage, while the 4% BM-UHPH-treated SDE had better secondary oxidative stability. On the other hand, quality characteristics of yogurts in terms of WHC, texture and sensory perception were improved in UHPH-SDE yogurts compared to CH. However no significant differences were observed in the percentage of UHPH-SDE added (4 or 6%), which means that the highest concentration of UHPH-SDE would be used for fortifying yogurts with omeg-3 oil.

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Biodegradable Active Bio-nanocomposite Film for the Enhanced Shelf life of Tomatoes

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The increased environmental pollution has led to finding sustainable solutions for non-renewable plastic-based food packaging materials. Thus, the use of biomaterial-based packaging material has become an immense trend. This work aims at developing an antimicrobial biodegradable chitosan-alginate bio-nano composite film with TiO_2 nanoparticle (NPs) for food packaging applications. The film was developed by a solution casting method. The chemical, mechanical, thermal, barrier, antimicrobial, and biodegradable properties of the packaging films were evaluated. Packaging studies were performed for 15 days for cherry tomatoes. The designed packaging material had enhanced the mechanical properties with a significantly ($p < 0.05$) higher tensile strength of 15.76 folds and 2 fold higher elongation at break. The UV barrier properties increased by 88.6%, while the film transparency decreased by 87.23%. Molecular interaction of N-H covalent bonds was observed between alginate and chitosan together with TiO_2 NPs. The developed bio-nano composite film showed antimicrobial activity against foodborne pathogens *E. coli*, *S. aureus*, *S. typhi*, and *L. monocytogene* with a log reduction of 7.08, 7.28, 6.04 & 6.02 log CFU/ml respectively at 24 hours incubation period. The film was completely biodegraded and a weight loss of 89.06% was observed in bio-nanocomposite film during the 3 months. Shelf-life estimation of cherry tomato using developed packaging films showed an increase in the shelf-life up to 8 days with stable pH, total soluble solids, and weight with no bacterial growth when packaged with prepared film. Owing to their improved mechanical, UV barrier, antibacterial, and biodegradability, the prepared active bio-nano composite packaging films could be considered a potential candidate for fruit packaging.

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Diacylglycerols as structuring agents in different oil systems

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Aim:
Oleogels, semi-solid gels made of vegetable oil and structuring agent, were proposed as healthier alternatives to conventional fats due to their high unsaturated fatty acid content, providing an improved nutritional profile while maintaining similar physical and sensory attributes as fats. The current research aims to further improve the functionality and nutritional values of oleogels by implementing water to the system. More specifically, this study explores the use of diacylglycerol (DAG) as oil structuring agent and as stabilizer of water-in-oleogel systems.
Method:
The oil structuring ability of saturated DAGs and their surface-active performance was examined using various DAG concentrations (10-20%) and water contents (10-50%). The samples' mechanical properties such as the gel strength and viscoelastic behavior were investigated using a texture analyzer and rheometer. The thermal properties, such as the gelation, melting, and crystallization temperatures were investigated by rheological methods and differential scanning calorimetry. Different techniques such as X-ray diffraction, transmission electron microscopy, light and confocal microscopy were used to study the gels' nano- to micro-scale structure.
Results:
DAGs formed stable oleogels with a minimum concentration of 10% and stable emulsion gels with a maximum water content of 30%. DAG-based emulsion gels with 30% water showed a significantly higher gel strength compared with oleogels with the same DAG concentration. Interestingly, oleogels demonstrated behavior similar to ideally elastic materials characterized by a zero slope in a frequency sweep test, while emulsion gels exhibited viscoelastic behavior characterized by frequency-dependent behavior with a slightly positive slope. Both oleogels and the corresponding emulsion gels exhibited typical sol-gel transitions characterized by a cross-over between the storage and loss modulus and thermo-reversible behavior. DAG crystallization in oil revealed the formation of large spherulite crystals, whereas water addition and homogenization reduced the crystal size. Moreover, aggregated crystals were found around the interface, implying on the involvement of DAG crystals in the interfacial stabilization of the two-phasic system.
Conclusion:
In conclusion, saturated DAGs can be used as oil structuring agent as well as surface active agent in emulsion gel systems. Such ability can be exploited while developing new food products based on biphasic systems like margarine and mayonnaise.

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Bioplastic material based on ethyl-cellulose

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Bioplastic material based on ethyl-cellulose

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Aim

Conventional plastics are composed of petroleum-based polymers which are durable and very slow to degrade; hence, lead to resource depletion, massive waste accumulation and extensive carbon dioxide emission to the atmosphere. The growing awareness of these deleterious effects lead to increased interest in developing new sustainable bioplastics. The current research aims to exploit ethyl-cellulose (EC), a polymer derived from renewable sources, to formulate a bioplastic material and examine its performance.

Method

EC-based films were fabricated using a lab-scale micro-extruder and a compression molding device. Films based on neat polymer at various molecular weights and with the addition of various plasticizers were prepared. The resulted films' thermal, mechanical, chemical, barrier, surface wetting, and biodegradability properties were examined.

Results

EC was successfully processed using hot melt extrusion leading to the formation of transparent films. According to the thermal analysis, the extrusion process itself caused a significant decrease to both T_g and T_m with respect to the raw powder, and a further decrease was observed after plasticizer addition. The first observation can be related to molecular weight decrease resulted from the thermal processing as confirmed by gel permeation chromatography tests. The successful incorporation of the plasticizer molecules in the polymer matrix was also confirmed by the clear shift from an elastic behavior for the neat polymer to both elastic and plastic regions for the plasticized films. In addition, all tested plasticizers enhanced the film tensile strength, while also increasing its flexibility which was expressed by higher percent of elongation at break. Surprisingly, the water contact angle measurements revealed a hydrophilic nature characterized by contact angle in the range of 58-82º, which was supported by the water vapor permeation tests (76-110).

Conclusion

The findings in the current study emphasize the feasibility of forming EC-based films with tunable properties based on plasticizer type using thermal processing for diverse applications. Such findings provide the first step towards the development of new bioplastics from bio-based sources.

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Sodium Alginate, Nanoclay And Curcumin Based Food Packaging Material For Intelligent Food Packaging Applications

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Key Words: Intelligent Packaging, Nanoclay, Sodium alginate, Curcumin

Abstract:

Bionanocomposite food packaging contains materials of biological origin which display high-performance activity when compared to biopolymers and are eco-friendly alternatives to conventional packaging materials. Intelligent packaging monitors the condition of the food or environment surrounding the food and communicates changes to the consumer. This study aimed to develop a bionanocomposite intelligent packaging material by utilising sodium alginate, nanoclay and curcumin. Sodium alginate (2 W/V% SA) film incorporated with 0.3 W/V% curcumin (Cur), glycerol, and nanoclay (NC) in various concentrations (0, 0.5, 1 and 2 W/V %) was prepared using the solvent casting method. The influences of nanoclay and curcumin on the optical, mechanical, physical, chemical, thermal, and pH sensing properties were studied. Results showed that the films were of high colouration and low transparency with a $\Delta E^*> 4$ as compared to the control film. Among all the developed films, the SA_Cur_2%NC film was the thickest (0.072 ± 0.00mm) and showed the most effective UV barrier property. It has been observed that with the increasing NC concentrations, transparency of the films decreased while there was an enhancement in the UV barrier property. SA_Cur_1%NC had the highest mechanical properties with high tensile strength (14.68 ± 1.06 MPa), elongation at break (3.31 ± 0.62%) and Young's modulus (0.93 ± 0.02MPa). When compared with the control film (SA_Cur_0%W/V NC) the tensile strength increased more than two folds. It has been observed that curcumin at 0.3 W/V% was an effective pH changing indicator which changes from orange to red in alkaline conditions. The developed film had an effective UV barrier property together with the enhanced mechanical properties and pH sensing ability and therefore can be used as smart packaging material. Further research is in the progress to incorporate the antimicrobial agent of the natural origin in the packaging film to bring antibacterial properties to the film.

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Development of a functional snack for gut-brain axis health

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Aim:
Aging and age-related neurodegeneration are among the most urgent challenges in modern society because of the progressive increase in the number of elderly people all over the world. Aging and neurodegenerative disorders' pathogenesis are strongly dependent on the gut-brain axis. Preservation of a healthy gut microbiota is a key condition for longevity and it can be favoured and preserved by a diet rich in probiotics and prebiotics. Snacking has become a megatrend in food. Snacks are an opportunity for improving dietary habits of consumers while fulfilling consumers' request for a combination of health and indulgence in food. This study aimed to develop an innovative functional snack to promote healthy aging, with positive action on gut-brain axis health, with focus on the delivery of probiotics and prebiotics.

Method:
Functional snack has been developed by identification of multiple ingredients that have been used in a variety of recipes and processed to obtain multiple prototypes. Prototypes have undergone recipe and processing optimization to identify the best product based on physico-chemical (texture, water activity, color), nutritional (macronutrients' content, *in vitro* starch digestibility, probiotic viability), sensory (acceptance of consumers' panel) attributes and verification of production feasibility in commercial facilities.

Results:
The innovative functional snack has been designed and it consists in a chocolate coated biscuit containing: a main phase (cookie with prebiotic-rich ingredients), a probiotic carrier (chocolate coating), and one probiotic formulation (bifidobacteria and lactic acid bacteria with documented positive effect on gut-brain axis health). The main phase (cookie) has been formulated including legume flours and specialty fibres, to be rich in fibre, slowly digestible carbohydrates, and unsaturated fats, low in sugar and fat contents, but also to be feasible for production in a commercial facility. The functional snack was found to be highly acceptable by consumers for all attributes.

Conclusion:
An innovative functional ready-to-eat snack for supporting healthy aging was developed and its efficacy in prevention/delay of metabolic and cognitive impairments must be verified *in viv*

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Crystallization behavior of emulsified triglycerides and their stability as a function of emulsion-stabilizing excipients

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Crystallization behavior of emulsified triglycerides and their stability as a function of emulsion-stabilizing excipients

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Aim:

Many food and cosmetic products consist of fats like triglycerides emulsified in a continuous phase. They must often remain stable for several months to years without losing their product functionality. For production, the fat phase is heated above the melting point and emulsified in the aqueous phase. The product is then cooled to crystallize the fat phase. Finally, the products are preserved by UHT treatment or spray drying. Storage and transport expose the product to temperature fluctuations around and above the melting point of the dispersed phase. This favors aggregation and (partial) coalescence processes of the fat particles. Consumers perceive these texture changes by a creaming of the fat phase and, in particularly pronounced cases, as a grainy structure on the tongue. These instability phenomena are, among other things, the result of phase transitions of the dispersed fat phase. The targeted adjustment of crystallinity is therefore of central importance for the production of products with long-term stability. Important parameters for this are the size of the fat particles, the temperature profile during cooling and storage, and the molecular structure of the fat and the emulsifiers.

This contribution focuses on the influence of emulsifying excipients on the crystallization behavior of emulsified triglycerides and their stability during temperature variations around and above the melting point of the triglycerides.

Method:

We follow droplet crystallization and particle morphology and stability using a specially developed thermo-optical method on a cryo-polarization microscope [1]. The thermo-optical method allows to distinguish between liquid droplets and crystalline particles.

Results:

The crystallinity and particle morphology were determined at any time during the cooling and heating process. The droplet crystallization processes and their stability against coalescence differed greatly depending on the applied temperature time combination during the cooling process and on the applied emulsion-stabilizing agents.

Conclusions:

We were able to correlate the microscopically observed crystallization processes on droplet with the coalescence and aggregation stability of corresponding formulations. This makes it possible to provide manufacturers with recommendations for their processes and product design in order to obtain stable products in the long term. This minimizes the waste of raw materials, which in turn can save immense production costs.

Reference

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Elaboration of dried olive leaves for the preparation of healthy infusions

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Aim: Nowadays, consumers are demanding many different types of commercial herbal infusions, as well as beverages based on these products. However, the production of dried olive leaves marketed for infusion purposes is insignificant, despite their high content in bioactive compounds as polyphenols, in particular the oleuropein. The aim of this work was to study the dehydration of olives leaves at different temperatures, and its influence on the polyphenol composition after the heat treatment.
Method: Olive leaves of Hojiblanca cultivar were harvested and then dehydrated at 40, 50, 60, 70, and 80 ºC using a system with a forced convection oven and an infrared drying equipment. Leaves were dried on the same day of harvesting and after one day storage at room temperature. Dried leaf polyphenols content was characterized by HPLC before and after the heat treatment.
Results: The olive leaf drying process has been modeled applying the Page equation with n=2. The olive leaf lost around 50% of moisture during the dehydration process, displaying that the higher the drying temperature, the shorter the dehydration time. In addition, drying by infrared system occurred in less time than using only convection drying air.
Also, it was observed that the phenolic content was affected by the drying treatment. The use of temperatures of 50 and 60 ºC produced a greater decrease in oleuropein concentration than temperatures of 40 or 80 ºC, regardless of the system used. However, the loss of oleuropein was lower when the leaves remained 24 hours at room temperature before drying.
Conclusion: An optimization of the olive leaf drying process has been achieved to maintain the highest concentration of oleuropein in order to obtain infusions rich in this compound considered healthy for the consumers.

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Effect of olive leaf grinding on the content of biocompounds and color in their infusions

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Aim: A large spectrum of beneficial health properties *in vitro* and *in vivo* has been attributed to olive leaves and their extracts, which has been related to their bioactive compounds, particularly oleuropein, the main active phenolic constituent in olive leaves, which can constitute up to 6-9% of the dry leaf matter. The concentration of phenolic compounds in olive leaves has a great variability depending on several factors including cultivars, harvesting time, drying process, etc. The degree of crushing of the leaves could be also a factor to consider for a better diffusion of bioactive compounds from the leaves to the water phase of the infusions.
Method: Manzanilla olive leaves were harvested and then dried using an infrared drying equipment at 80 ºC for 40 minutes. After drying, leaves were grounded using an ultracentrifugal mill. Crushed leaves were sifted through different sieves (5, 3.15, 2, 1, and 0.5 mm of diameter) to obtain different degrees of grinding. Afterward, 1.7 grams of leaf were mixed with 240 mL of boiling water for 5 minutes with occasional stirring. The oleuropein concentration in the infusions was measured by HPLC and the color (CIELAB) was determined by spectrophotometry.
Results: The degree of grinding of the leaf directly influenced the amount of oleuropein diffused into the aqueous phase of the infusion. The diffusion of oleuropein was greater with lower degree of grinding. The maximum diffusion, about 10% of the initial concentration in the dry leaf, was reached with the lowest grinding degree of 0.5 mm. In the same way, a linear correlation was observed between the degree of grinding and the color reached by the infusions. As the degree of grinding was lower, the parameter L^* decreased, and the parameters a^* and b^* increased.
Conclusion: The degree of grinding is a very determining factor in the design of the production of commercial olive leaves for the preparation of infusions, especially to optimize the concentration of bioactive compounds that make it healthy for the consumers.

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Application of flowcytometry to characterize Tetradesmus obloquus and Nonnochlropsis ocenica growth on casein whey permeate

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Aim:
Microalgae are novel green solutions able to grow on different food processing waste, such as whey, without the need of carbon source while they capture atmospheric CO_2 and convert it to a high value biomass and omega-3 oil. It is critical to monitor the growth and lipid accumulation of microalgae during their cultivation. Flowcytometry has been proved to be a reliable and fast method for comprehensive analysis of microalgae cells. During the production of aid casein followed by diafiltration, a large volume of clean and clear whey permeate is generated which is rich in minerals and can be a good medium for omega-3 production.

Method:
Tetradesmus obloquus (TO) and *Nonnochlropsis ocenica* (NO) were cultivated on diafiltered lactose free acid casein waste after pH adjustment. The microalgae cells were also cultivated on standard BBM-3N and f/2 medium, respectively. Cell growth pattern was analyzed based on cell autofluorescence using a flowcytometer. Fat accumulation was also monitored during the growth stage. The data were correlated to cell biomass analysis and microscopic cell analysis.
Results:
The autofluorescence of cells could be detected clearly at the emission wavelength of 450 nm induced by a near ultraviolet laser as the light source which is related to chloroplasts photosynthesis and natural pigments present in the cells. Populations of microalgae cells were distinguished in this setting. TO cells exhibited the largest cell sizes while NO cells showed the smallest sizes. Each microalgae population was comprised of two or three sub-populations differing in both size and autofluorescence intensity. The subpopulations exhibited different growth stages of microalgae. This configuration allowed detailed evaluation of subpopulations in terms of their size and number, and then distinguish the proper harvesting time of microalgae cells. Application of different stains including BODIPY and DAPI allowed further investigations of the cell structure. BODIPY stained the fat and by measuring the light intensity at 525 nm exited with a blue laser, it was shown that both NO and TO cells accumulated fat specially in the late stages of cultivation. NO cells stored more fat, however, the medium seemed to be stressful for the cells as aggregates could be detected. The aggregated cells exhibited larger light intensity values for BOBIPY showing higher amounts of fat accumulation.
Conclusion:
It can be concluded that NO and TO cells are able to grow in whey permeate and produce valuable biomass. Flowcytometry can be used as a versatile and robust technique to monitor the growth of microalgae. Intense autofluorescence of the cells allowed successful measurement of cell populations and staining with DAPI and BODIPY could be used for the identification of fat and DNA content.

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The removal of cholesterol content from milk and the production of low-cholesterol dairy products

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Aim:

The intake of dairy products is associated with an increased risk of cardiovascular diseases (CVD) due to its high content of saturated fatty acids and cholesterol. As CVD are the leading cause of mortality, especially in the developed world, the production of low-cholesterol content products would be one of the critical steps in CVD prevention. Thus, this study deals with the development of low cholesterol foods (milk, cream, butter, soft cheese, cottage cheese) and the determination of their final cholesterol content and organoleptic profiles, such as color and textural characteristics.

Method:

The removal of cholesterol content from milk and cream was made by the application of β-cyclodextrin (β-CD), as this method is selective enough and does not influence considerably final nutritional or organoleptic properties of treated dairy products. The cholesterol content was determined by HPLC with UV-DAD detection. The color properties were measured with the UV-VIS spectrophotometer equipped by a specific color sphere accessory, and the textural parameters were evaluated using a TA-XT texture analyzer with Peltier temperature control unit.

Results:

High effectivity of cholesterol removal was achieved for milk (97.3 %), cream (95.6%), butter (95.6%), cottage cheese (97.9%) as well as soft cheese (97.7%). However, the measure of cholesterol removal was influenced by the concentration of β-CD or processing conditions, such as mixing and centrifugation speed or settling time. The color differences (ΔE) between the low-cholesterol products and the original ones varied only from 0.25 to 1.13, so they would not be perceptible to consumers by visual observation. The texture characteristics of the products (firmness, consistency, softness) were not affected by cholesterol removal, as well.

Conclusion:

β-cyclodextrin can effectively remove cholesterol from milk matrix, while the nutritional, textural, or color properties of the products are not considerably affected. Moreover, the application itself is easy, effective, low cost, and realizable on current technological production lines. Therefore, it can be concluded that the proposed procedure is sufficient for development of new assortment of low cholesterol dairy products with considerable health benefits toward the incidence of CVD

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The effect of saturated and monounsaturated fatty acids on the thermo-oxidative stability of stigmasterol-modified acylglycerols

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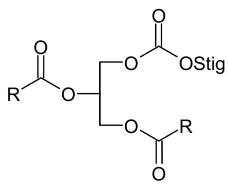
The potential of phytosterols, also referred to as plant sterols, to reduce blood cholesterol has been known for decades. They are known for preventing dementia in elderly patients, but also show anticancer properties against breast cancer, colon cancer, and cervical cancer. Phytosterols, like other unsaturated lipids, are prone to free radical and non-radical mediated autoxidation where their oxidation products, called oxyphytosterols (SOP), are formed. They play an important physiological and pathological role in humans. The unsaturation level of fatty acid moieties influences the thermo-oxidative stability of stigmasteryl esters.
Aim: Monostigmasterol-modified acylglycerols in which one fatty acid parts are replaced by stigmasterol residues were synthesised and their thermo-oxidative stability was analysed.
Method: Monostigmasterol-modified acylglycerols were synthesised according to Huang & Szoka (2008). The chemical structures of the obtained compounds are presented in Figure 1. Obtained compounds were heated at 60°C and 180°C for 8 hours. The remains of fatty acids and stigmasterol, the content of stigmasterol oxidation products, volatile compounds and polymers were determined by chromatographic methods. The cytotoxicity was assessed using small intestinal FHs 74 Int, colon mucosal CCD 841CoN and liver epithelial THLE-2 cells obtained from ATCC, Manassas, VA, USA.
Results: The degradation of novel structured 1-stigmasterol-2,3-palmitoyl-sn-glycerol (mSt-diPA) heated at 60°C for 8h was 12%, but at 180°C it was 70%, whereas the decrease of the 1-stigmasterol-2,3-oleoyl-sn-glycerol (mSt-diOA) content was not detected. Heating of mSt-diPA at 60 and 180°C caused respectively 53 and 47% degradation of palmitic acid part, while the degradation of oleic acid was 13% and 45%. When mSt-diPA was heated at 60°C phytosterol was not degraded, but increasing the temperature to 180°C caused 72% decrease of stigmasterol content. Degradation of stigmasterol in mST-diOA was lower and amounted to 21% and 49%, respectively. Total content of stigmasterol oxidation products was the highest after heating of mSt-diPA at 180°C (6.4 mg/g), followed by the mSt-diOA heated at 180°C (3.4 mg/g), and 60°C (2.4 mg/g) and mSt-diPA at 60°C (0.2mg/g).
Conclusions: Two new structured lipids in the form of monostigmasterol-modified acylglycerols were synthesised and their thermo-oxidative stability was determined. After heating at 60 and 180°C, mSt-diOA was more stable then mSt-diPA.



R = $C_{15}H_{31}$ (16:0)
R = $C_{17}H_{33}$ (18:1)

Fig. 1. Chemical structure of synthesised stigmasterol-modified acylglycerols.

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Environmental impacts of innovative sustainable agri-food value chains: rights, duties, potentialities of Life Cycle Assessment

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Aim:
Life Cycle Assessment (LCA) is often used to claim sustainability in food innovation projects. Sometimes, its abilities is overestimated by stakeholders when define their expectations leading to deceptions and possible mistakes. Sometimes, its capacities are underestimated and LCA is not part of the innovation process but only used for a posteriori validation. This is emphasized by the increasing diversity of innovations (e.g. technological/organisational) and the expansion of LCA in response to this diversity (e.g. organisational/territorial LCA). Facing with the diversity of innovations in Fairchain EU project, we aim to analyse what should reasonably be expected from LCA for each of the 5 case studies (CS) of agrifood value chains.
Method:
By crossing initial expectations of CS stakeholders with potentialities of LCA and first results, we expect to answer the following questions: (1) is LCA suitable to help meeting the claimed sustainability objectives, (2) is it suitable to assess the consequences of their realisation and (3) how LCA should be supplemented or adapted to fulfil these objectives. By doing this on various CS, we define recommendations of usage of LCA by food innovators giving them information on what they can expect – or not – from LCA, in what conditions (e.g. supplemented with other methods).
Results:
Based on Fairchain CS, we discuss LCA capacities and requirements to meet the expectations of stakeholders and the role they should play into LCA process and data providing. It comes to recommendations such as, for example, (i) defining adequately the goal and scope of the study in order to produce fair comparisons between current situations, generally optimized, and future situations, non-optimized during development of the innovation and (ii) complementing LCA by other methods when insufficient to evaluate all the environmental impacts, and furthermore the sustainability.
Conclusion:
LCA is a powerful method with multiple possibilities when being involved in research and innovation of food projects. However, initial expectations and choices can lead to impaired usages (missing opportunities, asking wrong questions, not giving answers, giving wrong answers, greenwashing). Based on innovation CS, this work aims to well involve LCA and stakeholders during a project.

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An exposure assessment of Diarrhetic Shellfish Poisoning arising from consuming Irish produced mussels

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Aim: Diarrhetic shellfish poisoning (DSP) is a food-borne disease, majorly arising from the consumption of contaminated mussels. Marine biotoxins, okadaic acid (OA), and dinophysistoxins (DTXs) produced by *Dinophysis spp*. are the main toxins responsible for DSP in humans. Clinical symptoms normally arise 30 minutes to several hours after consumption with gastrointestinal disorders, including nausea, abdominal pain, vomiting, and diarrhea. To prevent outbreaks, the EU has regulated that mussels should not contain DSP toxin levels of no more than 160 mcg OA equivalent /kg shellfish meat. This study aims to develop an exposure assessment of contaminated mussels to investigate if current regulatory limits can provide enough protection to Irish seafood consumers. Method: Regarding each single eating event, the number of consumed mussels were calculated from the portion size distribution, and the total toxin level ingested was the summation of DSP levels in each individual mussel. Mussel consumption data were collected from a recent survey targeting seafood consumers in Ireland to estimate the portion size distribution, and an average toxin concentration was estimated from monthly survey data collected by the Irish Marine Institute. Considering the significant variation of DSP concentration in mussels harvested from different times of the year, an assessment was conducted for each month separately. Monte Carlo simulation using @Risk with 50000 literations gave an estimate of the likely toxin intake in a single eating event. Outputs (the 99th percentile intake) were compared to published acute reference dose (ARfD) for DSP to assess the safety of ingestion in different months of the year. Results: Results showed the effectiveness of the regulation intervention in reducing the exposure level of DSP toxins, but specific attention needs to be addressed for harvesting mussels from July to September as the exposure assessment indicated a small probability that ingestion of DSP toxins may exceed safe limits.

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Acid-induced pea protein emulsion gels: Rheology and microstructure

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Aim: Protein gels that contain fat/oil are known as emulsion gels, which are the matrix of many foods, such as cheese, yogurt, and processed meats. These gelled protein systems can be prepared by heat treatment or by adding coagulants e.g., glucono-δ-lactone (GDL), which are called "heat-induced gels" and "cold-set gels", respectively. To date, investigations of heat-induced emulsion gels have been widely performed using dairy proteins. By contrast, only a few studies focused on the cold-set emulsion gels that are formed by plant-based proteins, and most of them used soy protein. Pea (Pisum sativum L.) protein has shown great potential as a sustainable alternative to animal proteins and soy protein because of its high nutritional value and low allergenicity. Fat/oil plays an important role in the rheological properties and textural properties of emulsion gels. Oil droplets incorporated in these gels can be categorized as active or inactive filler particles, depending on their type, content, and interaction with the surrounding protein matrix. Therefore, this study investigates the rheological properties and microstructures of GDL-induced pea protein isolate (PPI) gels, of which rapeseed oil has been incorporated at different ratios.
Method: PPI (provided by International Flavors & Fragrances Inc.) dispersion was prepared at room temperature, followed by storage overnight at 4°C to ensure full hydration. One batch of this dispersion was first heated at 95 °C for 30 min and then emulsified with rapeseed oil at different concentrations. Another batch of the dispersion was first emulsified with oil and then heated at 95 °C for 30 min. Subsequently, these emulsions were mixed with GDL and incubated at room temperature for acid-induced gelation. The gelation process and formed emulsion gels were characterized thoroughly.
Results: Differences in the fat-holding capacity, water-holding capacity, and microstructural properties were observed among various emulsion gels. Small and large amplitude oscillatory shear (SAOS and LAOS) tests showed that the amount of rapeseed oil changes the rheological properties of emulsion gels in both the linear and non-linear viscoelastic regimes.
Conclusion: The rheological properties of acid-induced pea protein emulsion gels can be tailored by incorporating different amounts of rapeseed oil.

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Designing and Developing Health Promoting and Sustainable Meat-based Comminuted Products.

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Aim:
There is a growing interest in both flexitarian and reducetarian diets, resulting in an increase in the development of comminuted products containing both meat and algal ingredients. The present study aims to develop and evaluate protein alternatives to replace a percentage of meat in a patty product. Initially the focus is on optimising sensory properties. Successful development of health promoting, and sustainable comminuted products will address the goals of both the UN SDGs and Kepak Group.
Method:
A proteomic database was created for quantification and characterisations of a range of algae. The following important components were considered in this study: energy value, nutrient (protein, fats, carbohydrates, saturated fatty acids, fibre, sodium), and amino acid profiles. Algal protein alternatives were ranked based on the quantity of each component per 100g against the RDA guidelines issued by FSAI. Five different types of algae were considered, three different percentages of each replaced a portion of beef in a patty. These combinations evaluated against a control Kepak beef patty (n=6) were conducted using a 5-point hedonic scale, fifteen semi-trained panellists were instructed to rank the sample in order of preference based on the sensory attributes of colour, texture, juiciness, flavour, aroma, and overall acceptability.
Results:
Principal Component Analysis (PCA), ANOVA and Tukey's Test were used to analyse the sensory test results. All analysis were at a significant level ($p \leq 0.05$). The results from the Tukey's test showed only three of the six algae combinations were significant for likeability of all sensory attributes analysed. The texture and juiciness attributes showed significant differences of increased hardness and dryness when comparing different algae combinations with different emulsions: kappa carrageenan or gelatine.
Conclusion:
The addition of all algal samples had a negative effect on the sensory attributes of colour and aroma. Consumer acceptability of an algal meat-based patty shows the potential of using a sustainably produced algal protein alternative to replace a percentage of the beef in a meat-based product. Future optimisation of food texture and flavour is necessary along with nutritional and chemical testing to support the health benefits of incorporating algae into a meat-based product.

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Desirability-based optimization of bakery products containing pea, hemp and insect flours using mixture design methodology

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Aim: The growing food industry is driving forward the protein market and the need for alternative protein food sources and their derived ingredients as a response to climate change, increasing population, and changing diets. Particularly, in the bakery sector, the animal proteins historically used for formulating are from dairy and egg origin. This study describes the optimization of an egg- and dairy-free sponge cake using pea, hemp and insect flours. Method: Simplex lattice design was used to formulate 15 sponge cakes combining pea (PP), hemp (HP) and insect (IP) flours (ranging from 0-15% of dough composition). Moisture and protein content, baking loss, specific volume, texture profile and incremental cost of the 15 samples, plus the control with 0% added protein, were analysed. The desirability function was used to obtain a multi-response optimization of the samples with maximum protein, maximum specific volume and minimum incremental cost. Then, five samples with the highest desirability (0.43-0.36) were analysed by a trained and robust sensory panel. The intensity of the attributes was compared to the qualitative descriptive analysis (QDA) of a standard sponge cake formulated with eggs and milk. Results: Statistically significant differences were found among samples. Results showed that the effect of PP, HP and IP on the 10 responses could be modelled with linear regressions from R^2 from 96.80 to 99.96%. Ternary diagrams showed the effect of the combination of the three proteins in each response. It was possible to improve the specific volume, texture and cost of the reformulated sponge cakes using a combination of alternative protein ingredients. In particular, the combination of 3.75% pea, 3.75 % hemp and 7.5 % insect proteins showed a QDA without significant differences from the control with animal-derived proteins. Conclusion: The results of this study indicated that it is possible to improve the specific volume, texture and cost of substituting egg and dairy ingredients in sponge cakes, by combining pea, hemp and insect flours.

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Antimicrobial compounds-assisted thermal treatment in low moisture food matrices and the corresponding bacterial resistance mechanism

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Aim:
The study investigated the effect of heat treatment with food-grade antimicrobial compounds against *Salmonella*. Typhimurium in various low moisture food (LMF) components at different water activity (a_w) and bacterial resistance mechanism at physiological and transcriptional levels.

Methods:
Trans-cinnamaldehyde (CA) and eugenol (EG) were selected from a screening study to assist thermal treatment against *S*. Typhimurium adapted to different a_w in whey protein (WP), corn starch (CS) or peanut oil (PO). Bacterial metabolic activity was analyzed by monitoring fluorescence produced from bacterial metabolite of resazurin. The fluidity and fatty acid compositions of bacterial membrane were measured with the fluorescence polarization value of 1,6-diphenyl-1,3,5-hexatriene (DPH) and gas chromatography, respectively. Expression of nine stress-related genes on *S*. Typhimurium adapted to low-a_w conditions in different matrices with or without the CA-assisted heat treatment was analyzed with RT-qPCR.
Results:
Although addition of CA or EG significantly accelerated thermal inactivation of *S.* Typhimurium in food components at 0.9 a_w, similar effect was not observed in bacteria adapted to 0.4 a_w in any of those matrices. Matrix compositions also affected bacterial thermal resistance at 0.9 a_w (WP > PO > CS). The CA/ EG-assisted heat treatment reduced bacterial metabolic activity with varied efficiency, where enhancement effect from CA or EG was attenuated in WP. Bacterial membrane fatty acid profiles were changed in desiccation-adapted cells, which lowered their membrane fluidity and might contribute to resistance against the CA/ EG-assisted heat treatments at a low a_w. During bacterial adaptation to low-a_w environments or the combined heat treatment, the upregulation of *rpoH* and *dnaK* and the downregulation of *ompC* was detected. Their expression profiles were consistent to the previously observed a_w or matrix-dependent effect on bacterial resistance and are likely contributors to bacterial resistance mechanisms. The changes to the expression of *rpoE*, *otsB*, *proV*, *fadA*, *fabA* and *ibpA* were likely not a direct contributor.
Conclusion:
Results in this study have demonstrated the potential of using food-grade antimicrobial compounds to complement thermal treatment in LMF during processes that start with a relatively high a_w. The a_w and matrix-dependent bacterial resistance was likely contributed by both physiological and genetic response.

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Effects of thermal stabilization and enzyme-assisted hydrolysis on cocoa fruit pulp for food applications

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Aim: Cocoa pulp is a by-product of the cocoa supply chain. Prior to cocoa bean fermentation, cocoa pulp can be partially separated using mechanical de-pulpers and then be used as a food ingredient. Its high viscosity complicates its processing, while its high moisture and sugar content incite its spoilage. Therefore, the addition of different enzymes to reduce the pulp's viscosity was studied. To obtain shelf-life stable cocoa pulp, pasteurization and ultra-high treatment (UHT) were tested, and the effects on the aroma profile, color and storage stability were investigated.

Method: Using a D-optimal design, interactions of temperature, enzyme concentration and enzyme combinations on the viscosity, particle size distribution and color of cocoa pulp were investigated with focus on the endo-polygalacturonase, cellulase and hemicellulase activities. Furthermore, pasteurization was carried out at 80° C for 20 min and UHT at 135° C for 30 s. Color and microbial load were measured during storage at 4°C and 23° C for 24 weeks. The aroma profiles of fresh and thermally treated pulps were evaluated by trained panelists.

Results: A mathematical model was obtained for the enzyme-assisted hydrolysis of cocoa pulp. When combining 300 U endo-polygalacturonase and 300 U hemicellulase activity at 40° C, a reduction of 70% in viscosity and 30% in $d_{v,05}$ were determined. Synergistic effects of polygalacturonase with the other enzymes were shown. Both treatments inactivated microorganisms effectively, with UHT showing over 99% efficacy. During storage, no significant microbial growth was detected. However, browning of the pulp was observed, especially when stored at 23 °C. Thermal treatment significantly changed the aroma profile of cocoa pulp. Especially a banana-like impression was less intense after preservation. Compared to fresh and UHT-treated pulp, pasteurized pulp was described as less pungent. UHT-treated pulp scored highest in the attribute tropical fruit-like.

Conclusion: The model helps to predict optimal processing parameters for the enzyme-assisted hydrolysis of cocoa pulp, which might ease large scale processing. The suitability of pasteurization and UHT as preservation technologies was demonstrated, whereby cold storage is recommended to maintain the color. Thermal treatments of cocoa pulp lead to distinctive aroma profiles, enabling a wide-range of applications.

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Discovery of taste modulating peptides in soy sauce using the Sensoproteomics approach

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Aim:
Food products, for example, reduced in fat, sugar, or salt, are well-known to induce nonacceptable flavor changes in the products and has, thus, created flavor challenges for the food industry. To meet consumers´ demand for healthy but tasty foods, novel ingredient discovery is essential to overcome such flavor challenges. Various drying, fermentation, cooking and roasting procedures have been developed and the alluring flavour of these dishes prepared do attract consumers on a global scale. One of the most common Asian fermented foods, soy sauce, is highly appreciated all over the world for its savoury taste and thus, the aim of the project was to elucidate its taste profile on a molecular level and to identify new natural taste modulators.

Method:
Targeted quantitation of literature-known compounds and taste re-engineering experiments were applied to identify the key tastants in soy sauce. Furthermore, the Sensoproteomics approach, a combination of human sensory experiments and proteomics techniques, was followed for the elucidation of new taste-modulating peptides in soy sauce.

Results:
Using the Sensoproteomics approach, 14 umami-, kokumi- and salt-enhacing peptides were identified in soy sauce with taste modulating thresholds between 42 and 420 µmol/L. Targeted quantitation as well as taste recombination experiments enabled the identification of the key tastants in soy sauce. Quantitative profiling by means of UHPLC-MS/MS in different (non)-fermented foods revealed very low concentrations or the absence in non-fermented foods, whereas the peptides could be detected in high concentrations in the fermented food samples.

Conclusion:
The Sensoproteomics approach highlighted the significant impact of taste-enhancing peptides to the taste impression of soy sauce. Furthermore, quantitative profiling by means of UHPLC-MS/MS in different (non)-fermented foods emphasized the importance of fermentation in regards to taste formation. On the basis of this knowledge, microorganisms with specific digestion patterns may be used to tailor the taste profile and especially the salt taste sensation of soy sauces.

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Alternative legume proteins in the biorefinery process

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Alternative legume proteins in the biorefinery process

Aim:

Value-added valorization of fodder galega (*Galega orientalis*), green pea (*Pisum sativum*) and faba bean (*Vicia faba*) plants was carried out in a biorefinery concept to recover protein. The functional properties of the proteins were determined, chemical composition identified, and anti-inflammatory properties measured.

Method

The liquid protein fraction was pressed from the green parts immediately after harvetsing, using a twin screw press. The functionality of the proteins was analysed based on the nitrogen solubility (NSI) index, emulsion and foaming properties. Various chromatographic methods were applied to characterize and quantify selected secondary metabolites in the raw materials and the liquids. Potential anti-inflammatory properties were studied using human THP-1 promonocyte model to see effects on cell signaling and activation.

Results

The NSI of the plants was highest for *Galega officinalis* (69%), followed by *Pisum sativum* (66%), and the least solubility was shown by *Vicia faba* (52%). *Pisum sativum* formed the most foam, and this foam had also a superior stability when compared to others. *Galega officinalis* had the highest emulsion capacity, but *Vicia faba* had the most stable emulsion. The *Vicia faba* liquid was the most efficient in inhibiting THP-1 cell activation (IC50 26 mg/L, S.D. ±12) being about 30 times more effective than fodder *Galega officinalis* and *Pisum sativum*. Chemical analyses indicated that all samples contained free tryptophan, saponins, phenolic acid conjugates and flavonoids, and *Galega officinalis* in addition smirnovine alkaloids.

Conclusion

Protein recovery succeeded from different legume biomasses using a twin screw press. The proteins had good functional properties which allows them to qualify as food ingredients should safety issues be taken into account. The whole *Pisum sativum* plant, their pods & greens, and unmatured seeds of *Vicia faba* seeds can already be used as food. Depending on the variety, matured *Vicia faba* beans should be fermented and/or soaked and cooked before human consumption. These plants also showed an efficient inhibition of THP-1 cell activation. Beside the proteins, different phenolics, saponins, flavonols and other compounds were identified in the liquid stream.

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Influence of heat treatment intensity on acrylamide formation in oxidized black olives

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Aim:

Table olives are one of the most economically important fermented vegetables in Spain, the oxidized black olives being almost half of the national production. This product must be sterilized to ensure microbiological stability, which is currently run at 121º C to reach 15 F_0 of accumulated sterility. This thermal process causes the formation of a genotoxic substance called acrylamide. It is known that there is a direct relationship between the heat treatment and the acrylamide content in olives. The objective of this work was to generate knowledge on the relationship between the intensity of the heat treatment (F_0) at different temperatures and the acrylamide formation in black olives.

Method:

Two batches of olives of the Hojiblanca cultivar were elaborated as black ripe olives at industrial level. Then, they were pitted, washed and packed in A-314 glass jars with a standard cover brine. Several heat treatments were carried out (F_0: 10, 15, 20 and 30 units) at different temperatures (119, 121, 123 and 125ºC). One month after sterilization, the jars were opened and the acrylamide content along with the standard quality parameters (texture and color) were measured.

Results:

The highest acrylamide concentration was obtained at the lower temperature tested (119ºC) regardless of the accumulated sterility value reached. Also, lower acrylamide concentration was obtained at 10 units of F_0 with respect to the 15, 20 and 30 units of accumulated sterility, this decrease being of the order of 40, 10, 20 and 35 % at 119, 121, 123 and 125ºC respectively. On the other hand, texture was degraded at higher temperature and accumulated sterility values, ranging from 2.2 to 1.3 kN/100 g pitted fruit. The color obtained was independent of the heat treatment assayed.

Conclusion:

The concentration of acrylamide detected in oxidized black olives was dependent on the heat treatment used, being lower at high temperature (125ºC) and low accumulated sterility (10 F_0).

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The use of a digital environment during official food safety inspection

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Aim:

Although digital technologies offer many possibilities to improve consistency and transparency in food control, their use has not been studied yet. This research aimed at assessing the use of a digital environment during inspections in retail establishments by municipal control authorities in the Province of Barcelona (Spain). We consider a digital environment the context where digital tools and devices are used to record, analyse and transmit information.

Method:

A structured electronic questionnaire was elaborated and sent to inspectors, chief inspectors and control managers from different municipalities. The questionnaire inquired into the reasons for using a digital environment during inspections, its development and implementation process, the inspection processes carried out through such an environment and the results obtained. Additionally, for those respondents not using a digital environment, the questionnaire asked about the reasons for not using it.

Results:

The questionnaire yielded 70 responses coming from 42 municipalities. Based on the responses, 39% of the respondents from 14 municipalities confirmed that a digital environment was used during inspections. 100% of those respondents indicated that the main reason for using a digital environment was to standardise the procedures to collect information during inspections. The majority of respondents (80%) answered that internal and external personnel participated in the development and implementation process. The respondents equally indicated that 1) generation of

digital inspection reports based on template documents and 2) digitally delivering inspection reports to food business operators when inspectors are still at the food premises were the processes most (88%) carried out through a digital environment. Standardisation of the procedures to collect information during inspections was the highest result indicated (89%). Of all respondents, 61% from 28 municipalities confirmed that no digital environment was used during inspections and the most common reason for not using it was because of technological constraints (56%).

Conclusion:

A digital environment is already being used to support inspections, though the majority of municipalities face technological barriers for its implementation. The main benefit of using such an environment during controls is increased consistency of inspections through standardisation of the information's collection procedures, which is aligned with the main reason for using this environment.

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Evaluation of different factors affecting the antifungal activity of chitosan

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Aim:
The aim of this study was to evaluate the effect of different factors as: molecular weight, concentration, and type of fungi on antifungal activity of chitosan. The antifungal activity of high molecular weight (HMW) and medium molecular weight (MMW) chitosan solutions with different concentrations was evaluated by *in vitro* antimicrobial tests on four spoilage fungi, with high incidence in fruits spoilage: *Penicillium expansum*, *Fusarium oxysporum*, *Aspergillus flavus* and *Botrytis cinerea*.
Method:
In order to test *in vitro* antimicrobial effect of the chitosan solutions on the selected spoilage fungi, four solutions with different concentrations of chitosan were obtained by solubilizing them in acetic acid and ascorbic acid. The solutions of MMW and HMW chitosan (concentration 0.5%, 1% and 2%) were obtained by solubilizing chitosan in aqueous solution of acetic acid 1% and ascorbic acid 2%. The evaluation of the antimicrobial activity of the chitosan solutions on the four fungi strains was determined by measuring the inhibition halo, following monitoring of fungal growth for 7 days of incubation at 25°C. Four doses (40 µl, 60 µl, 80 µl and 100 µl) of each chitosan solution was tested.
Results:
The results of the study highlighted that significant antifungal activity was obtained in the case of *P. expansum* and *F. Oxysporum* strains using the medium molecular weight chitosan solution with 2% chitosan solubilized in 1% acetic acid, and the high molecular weight chitosan solution with 1% chitosan solubilized in 2% ascorbic acid. In the case of *B cinerea* strain, the only chitosan solutions that presented antimicrobial activity were high molecular weight chitosan solution with 1% chitosan solubilized in 1% acetic acid or 2% ascorbic acid solutions. No antimicrobial activity was recorded for the *Aspergillus flavus* strain.
Conclusion:
The results of the study showed that the antifungal activity of chitosan solutions depends on the type of chitosan used (medium or high molecular weight), the type of acid used for dissolution (acetic acid or ascorbic acid) and also depends on the target microorganism.

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Identification of volatile spoilage indicators for pork packaged under modified atmospheres

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Aim:

Modified atmospheres have been widely implemented in the domain of meat packaging to prolong shelf life. However, pork is still highly susceptible to microbial activity. Over storage time, specific spoilage organisms can use nutrients rapidly and generate volatile organic compounds (VOCs) characterized by unpleasant odors. The aim of this study is to identify VOCs that contribute to pork spoilage in modified atmosphere packaging.

Method:

In this study, fresh pork was packaged under different gas mixtures (%O_2/CO_2/N_2): air, 70/30/0, 0/30/70. Meat quality during the 4 °C storage was characterized by classic microbiological analysis, sensory evaluation and real-time mass spectrometry (selected-ion flow-tube mass spectrometry, SIFT-MS). The obtained datasets were subsequently analyzed by using multivariate statistics for the identification of potential spoilage indicators.

Results:

While air packaging favored the growth of *Pseudomonas* spp., the decreased level of oxygen (0/30/70) and/or the addition of CO_2 (70/30/0) inhibited the growth of aerobic pseudomonads and supported the growth of lactic acid bacteria over other species. Statistical analysis results revealed a positive correlation between the spoilage volatilome, bacterial growth and the increased percentage of sensory rejection. Acetoin was one of the most significant spoilage markers under aerobic conditions, whereas ethanol, 3-methylbutanal and sulfur compounds can indicate the progress of anaerobic spoilage.

Conclusion:

This study has provided deep insights into the volatolomic profiles during meat spoilage under different packaging conditions. Monitoring the levels of these spoilage-related compounds can be promising for predicting quality deterioration in the early or intermediate storage stages. Thus, the results can be expected to be useful when aiming at developing novel methods for safeguarding food and reducing spoilage wastage in the supply chain.

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Use of sensors and models for the prediction of meat colour

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Aim:
Preventing the waste of meat in grocery stores is an important part of improving the sustainability of the animal-based food system. Uncontrolled colour change due to oxidation is wasteful because it causes consumers to reject products. Hence, predicting the evolution of meat colour, which may allow for the prevention of wasteful situations, would benefit societal health and the environment.

Method:
Images of the surface of a case-study product, beef ribeye steak boneless samples with a low level of initial bacterial contamination, stored in modified atmosphere packaging trays at different temperatures and oxygen contents were captured. The colour change in diluted meat juice obtained after freezing and thawing of muscles was also measured. Along with imaging, an oxidation-reduction potential (ORP) sensor capable of penetrating to measure into meat was designed and validated in liquids.
From the imaging data, a phenomenological model under Gompertz law was developed to predict the variation of the redness in ribeye steaks during storage. This model describes the evolution as a function of two parameters, lag time and maximum rate of change, stemming from environmental conditions.
The measured variation of redness was finally compared to the variation predicted by a reaction-diffusion model solving the system of chemical reactions involved in the oxidation of meat myoglobin.

Results:
In juice, the redness variation correlates with the variation of ORP.
In meat, cutting direction and ageing time had a significantly lower influence on colour kinetics than environmental conditions.
Results from the reaction-diffusion model could be used to estimate the variation of redness. This mechanistic approach predicted similar storage durations for acceptable colour, although deviating for higher and lower redness levels, which are of no interest for meat acceptance. High oxygen causes a few days of delay in the redness change in simulations, as observed in practice.

Conclusion:
The prediction of oxidation-induced browning of meat is possible, and desirable for the food industry, from in silico models. This can open the way for sustainable food products or packaging designs where ORP sensors and models can provide complementary inputs, to link with consumer acceptance thresholds.

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Preventing the waste of animal-source foods by predicting the kinetics of oxidation reactions.

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Aim:
Preventing the waste of foods, notably of animal origin, improves the sustainability of food systems. Predicting the kinetics of the reactions responsible for food oxidation can help to determine how food formulation, processing, or packaging limit their unwanted colour changes, or their undesirable odours, and therefore their rejection by consumer and subsequent waste.

Method:
An advanced Reaction-Diffusion model has been developed and then applied to predict the variation of the myoglobin chemical state. The chemical scheme includes reactions of three groups which relate to: (1) the compounds directly related to oxygen, mitochondrial respiration and production of hydrogen peroxide by glycolysis; (2) the Fenton reaction; and (3) the water-soluble antioxidants. Sensitivity analysis was performed to simplify the initial reaction scheme. Results calculated with this simplified scheme were compared against the spatial distributions of oxymyoglobin, metmyoglobin, and deoxymyoglobin measured in beef meat cuts stored at 20°C in air-permeable packaging.

Results:
Global agreement between the measured and calculated distributions was found when adequate rate constant values were input into the Reaction-Diffusion model. The calculated results led to an analysis of the relative influence of mechanisms involved in the variations of the myoglobin chemical state in beef meat, and then to a discussion on the performances and limits of the approach, and of its application to the oxidation of other animal-based foods.

Conclusion:
An advanced Reaction-Diffusion model and numerical procedures were developed to predict the various kinetics related to the variation in the chemical state of myoglobin, using numerous reactions with rate constants of different magnitudes. Sensitivity analysis proved that the initial reaction scheme was equivalent to a simpler scheme. The results calculated with this scheme were in agreement with the spatial distributions of the different forms of myoglobin measured by Saenz et al. (2008) in a meat cut stored at 20°C. This paves the way for the formulation and design of more sustainable animal-source foods.

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THE EFFECT OF TEMPERATURE DISRUPTION DURING TRANSPORT ON THE MICROBIOLOGICAL QUALITY OF ATLANTIC COD SAMPLES

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Aim:
Chilled seafood is an integral part of healthy, sustainable diet. They, however, easily subject to microbial spoilage processes and present a food safety risk. When transported, fresh fishery products must be maintained at a temperature approaching that of melting ice (Regulation (EC) No 853/2004). This study assesses the effect of elevated transport temperatures on the outcome of microbiological analyses of Atlantic cod (*Gadus Morhua*) fillets.

Methods:
Atlantic air-packed cod fillets, vacuum packed, and packed in modified atmosphere were prepared for the experiment. Model experiments simulated temperature increases during transport of the samples to temperatures of 3, 5, 8, 11, 14, 17, 20, and 25 °C. Temperature exposure times were 1, 2, 3, 3.5, and 4 h. Microbiological analyses were performed immediately after the exposure to elevated temperature (0 h), 3 h, and 24 h after the return to the adequate temperature. The following microbiological parameters were determined for the analytical samples: total number of microorganisms (ISO EN 4833-1/2013), number of psychrotrophic microorganisms (ISO 17410/2020), number of *Escherichia coli* (ISO 16649-2/2003) and presence of *Salmonella* spp. (ISO EN 6579-1/2020).

Results:
The study statistically evaluate the effect of three factors on the numbers and abundance of microorganisms in samples of all three package types, namely the effect of (1) higher temperature, (2) the duration of cold chain disruption, and (3) the examination time after the disruption of sample cooling. The results will be used to develop mathematical models describing the effect of temperature and the duration of exposure to elevated temperature on the microbial profile of chilled fish. These models can serve for establishing the maximum acceptable cold chain disruption duration.

Conclusion:
The presented study helps standardize the methodology of collection and transport of chilled food samples for microbiological testing and to reduce the number of samples not accepted for processing by laboratories due to improper transport. Finally, the results are useful for supervisory authorities and producers of chilled fish.

Acknowledgment

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Variability of modified atmosphere in packed chicken meat and its changes during shelf life

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Aim:
Modified atmosphere packaging of fresh meat has remained one of the best methods for increasing shelf life and allowing retail distribution of cost-effective products with consistent quality. According to the EU Directive No. 1169/2011, the manufacturers have no obligation to declare the accurate composition of the used gas mixture, the information "packaged in a protective atmosphere" on the packaging is sufficient. Moreover, it is impossible to do regular checks verifying the gas composition, although the correct composition of gases within the protective atmosphere is crucial for the preservation of the packaged product. Hence, this work aims to monitor the composition of protective gases in packaged chicken meat and to observe the potential changes in the representation of individual gases over the storage period.
Methods:
Representative samples of chicken meat (with skin/skinless) packaged in the modified atmosphere were purchased from the retail 4-5 days before the expiration date. Samples were intentionally selected in a way encompassing various producers with goods available in retail in the Czech Republic. The analysis of gas composition in the protective atmosphere was performed using the CheckMate3 device (O.K. Servis BioPro, s.r.o., Prague, Czech Republic), calibrated for measurements of oxygen and carbon dioxide in the internal packaging atmosphere. The remaining gas (share missing to 100%) was considered nitrogen as this is the third gas typically used for protective atmosphere in packaged food.
Results:
This study compares the composition of the gas mixture in packaged chicken meat supplied to the market by various manufacturers and evaluates the changes in the gas composition of samples from the same batch during storage. Namely, the skin-containing and skinless chicken meat are compared and changes in the gas composition as the use-by date approaches are evaluated.
Conclusion:
The study shows the types of modified atmospheres used by different producers of packaged chicken meat. The development of the composition of the modified atmosphere during storage, i.e. the effect of the time remaining until the use-by date on gas composition, is an important conclusion of the study.
This work was supported by the NAZV project No. QK21020245.

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In Silico modelling of the salmon salting process to reduce saline effluent

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Aim:
Industrial production processes for smoked salmon and trout creates large amount of saline wastewater. Optimizing the salting stage in relation to initial product variability could help achieving a better homogeneity of fish salting, optimize the salt content and reduce the environmental impact of the effluents.

Method:
Initial physico-chemical properties of salmon and trout filets of various origins, farmed and wild, were characterized.
Unilateral and bilateral dry salting were performed and environmental conditions, notably temperature, were modified according to industrial timings and recorded. Proton and sodium MRI captures were performed at multiple time point after salting. Complementary, salt contents and water activity were measured at different localisations and time though destructive analytical measurements.
Heat and mass transfer models were compared to the data, in terms of behaviour tendencies and global or local quantitative predictions.

Results:
Multiple existing literature models could be compared to measured sodium maps, thus leading to recommendations on model use. Abacus accounting for the initial product's most influent sources of variability could be obtained from modelling.

Conclusion:
Technological strategies derived from in silico modelling considering initial product variability may allow for improvements in the homogeneity of salt in smoked fishes filets and reduction of waste. Resolution of sodium MRI remains a limitation for the analysis of diffusion. Further improvements in the accounting of fat, myoseptum and skin may improve performance of models.

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Monitoring of temperature changes affected by different types of cod fillet packaging

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Aim:
Cod (*Gadus Morhua*) is a nutritionally important non-oily fish with beneficial effects on human health. It is a sustainable food, although this currently depends on the region of fishing. Cods from regions certified by Marine Stewardship Council (MSC) constitute a relatively large share of cods imported into Europe as these regions meet the criteria for effective and sustainable fishery. Fish meat is generally prone to rapid spoilage, which can endanger consumers' health. If the cold chain is disrupted during the transport of the fish, the safety of the fish meat can be significantly compromised. This work aims to determine the time required for elevating the cod fillet temperature to the ambient temperature if cold chain is disrupted and, subsequently, the time required to re-cool.

Methods:
Fresh skinless fillets of Atlantic cod (*Gadus Morhua*) were packaged in three ways: simple (in air), vacuum and protective atmosphere packaging. The packaged fillets were first chilled and then placed in a thermostat at an elevated temperature (temperatures of 8, 11, 14, 17, 20 and 25 °C were tested) for 4 hours. The temperature in the core of the fillet was monitored using a needle temperature probe.

Results:
Obtained temperature curves showed a gradual temperature rise in the core of the fillet. At the higher temperatures tested, the time required to reach the ambient temperature was as long as 3 or 4 hours. The rate of the temperature increase in the core of the fillet and the subsequent cooling was significantly influenced by the packaging method. Vacuum-packaged fillets, where the wrapping film tightly surrounded the fillet, reached the ambient temperature significantly faster than fillets packaged in simple packaging or in a protective atmosphere where air or a mixture of gases were present inside the packaging around the fillet.

Conclusion:
The method of fillet packaging significantly influences the time needed for the core to reach the ambient temperature. Vacuum-packaged fillets reached the ambient temperature significantly faster than those packaged in simple packaging or a protective atmosphere.

Acknowledgment:

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Quality of farmed Atlantic Halibut chilled in refrigerated seawater versus on ice

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Aim:
The aim of the study was to assess the quality and shelf life of farmed Atlantic halibut (*Hippoglossus hippoglossus* L.) stored in super chilled refrigerated seawater (RSW) versus traditional storage on ice.
Method:
On 2nd of November 2021, 21 farmed halibut were obtained from a farming locality at the west coast of Norway. These were super chilled by placing them in a vessel with 3.5% brine and brine ice. The fish was chilled for 24 hours, until the temperature reached -1.2 / -1.4 °C. The fish were then divided into two groups; the fish in one group (SI) were packaged in boxes with ice and the other group (S) was packaged in boxes without ice. The boxes with fish were placed in a cold room at 4 °C for 24 hours. Ten halibut from the same locality that were slaughtered at a commercial slaughterhouse on the same day, gutted and stored in boxes on ice, served as controls (C). All fish were then placed in a cold room at 0 °C for further storage. Five fish from each of the three groups were used for microbiological analyses including a microbiological shelf-life study according to Nordic Committee on Food Analysis (NCFA) protocol no. 180, and the remaining 5 fish from each group used for quality index method (QIM) analysis.
Results:
The microbiological shelf-life was extended by 5-6 days in groups SI and I compared to C. For the quality parameters, group C was the one with the highest values, and thus the lowest sensory quality. SI and I had the same score on most quality parameters, but SI had significantly better sensory score on gill smell and gill colour.
Conclusion:
The results indicate that RSW-storage may minimize the need for ice and extend the shelf-life of Atlantic halibut. The novel storage technology offers significant savings in energy and water compared to traditional storage on ice.

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Novel Protein Phase: Plant protein coacervation

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Aim:
The ultra-purified protein isolates and concentrates have reduced functionality due to protein denaturation during the exhaustive extraction process. On the contrary, legume flour is mildly treated and contains protein in its native-functional state. Here, we present a study on the self-assembly of proteins in legume flours. We study the influence of pH, protein composition, and concentration on coacervates. Furthermore, we compare the resemblance and discrepancies of coacervates across various plant protein sources.

Method:
The reduced solubility of plant proteins, compared to animal proteins, accelerates the spontaneous phase separation process. A novel-protein-rich phase occurs spontaneously using the intrinsic property of plant proteins. Coacervates are naturally occurring spherical viscous, immiscible, equilibrium state achieved by charge neutralization. In nature, coacervates are found in several places, such as animal cells, plant cells, and insects. To ascertain the spherical nature of these protein-rich domains, a signature of coacervates, we use confocal microscopy and particle size distribution.

Results:
Increasing soluble protein concentration accelerates the process of phase separation and boosts the coacervate yield. Coacervates developed closer to the proteins' isoelectric point have the largest diameter and high protein yield.

Conclusions:
In the current study, we characterize protein fractions that prefer to be in the coacervate phase and fractions that prefer to be in a continuous phase. Additionally, we determine the optimum pH range for manufacturing coacervates with large sizes and elevated protein yield.

This work is part of the project 'Clean label solutions for plant-based foods' co-financed by the Top Consortium for Knowledge and Innovation Agri & Food by the Dutch Ministry of Economic Affairs under contract number LWV20.68.

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Sustainability on bread: Fibre-rich currant pomace in fat-based spreads

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Aim:
Increasing the nutritional value of “unhealthy foods” compared to naturally wholesome foods is desirable to expand the target audience. Currant pomace is an underestimated by-product of juice production, rich in dietary fibre and polyphenols. Several studies have shown its high potential as an ingredient in cereal-based foods. For application in fat-based systems, characteristics such as physical stability and particle size become demanding. In this study, formulations of sweet spreads with seedless currant pomace (SCP) were designed to gain knowledge on processing conditions and product characteristics.

Method:
SPC was dispersed in fat and milled in a planetary ball mill. Spreads were finalized by adding icing sugar, lecithin, and vanillin. Formulations varied in pomace content, pomace variety, and solid fat content. The spreads were analysed with respect to particle size distribution, oil separation, and texture. Viscosity at 25 °C and 50 °C was derived from flow curves and structural changes were assessed by applying small amplitude oscillatory analysis. Measurements were repeated after storage to identify changes in physical stability. Flash profiling was used as sensory tool to discriminate formulations.

Results:
Laser diffraction spectroscopy showed that 90% of particles in spreads with blackcurrant pomace were below 25 µm, thus below the common sensory noticeable threshold of 30 µm. Overall, spreads with SCP showed dominant elastic behaviour and by increasing the pomace content, viscosity and stiffness were increased. However, when the solid fat content was reduced, these parameters decreased and were shifted to the reference. Rheological properties and particle size of a formulation with 16 g/100 g blackcurrant pomace and a low solid fat content matched best with a commercial spread. Compared to the pomace-free reference, SPC showed stabilizing effects, as oil separation was reduced and consistency increase during storage was prevented. Principal component analysis of the sensory results showed perceived differences in fruitiness, sweetness, greasiness, and viscosity.

Conclusion:
Currant pomace was successfully comminuted to be applied in sweet spreads, where the stabilizing effects as well as its nutritional value can be exploited. By varying the solid fat content, viscosity and stiffness can be adapted to suit commercially spread products or even waffle fillings.

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Impact of adding wheat arabinoxylan to gluten-starch dough on its rheological properties

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(Aim) The consumption of dietary fibre is associated with many health benefits. While wheat (*Triticum aestivum* L.) in principle is an important source of dietary fibre in our daily diet, most wheat-based food products consumed today are made from white flour that is low in fibre. To provide a basis for increasing the average dietary fibre consumption and fill the so-called "fibre gap", a multidisciplinary research consortium, with the project titled FIBRAXFUN, is building a knowledge base for developing and using novel white wheat flours which are rich in arabinoxylan (AX) dietary fibre. The work presented here aimed to study the impact of water-extractable (WE-)AX on gluten-starch dough rheology. (Method) First, large-scale WE-AX isolation from 20 kg of commercial wheat flour was executed. The WE-AX isolate was subsequently analysed for its AX content and arabinose to xylose ratio using gas chromatography, and its molecular size distribution using size exclusion chromatography. In a second part, the impact of WE-AX addition on the rheology of gluten-starch doughs was investigated using a rheometer with extensional viscosity fixture setup. (Results) Inclusion of WE-AX isolates in gluten-starch dough recipes clearly increased the transient extensional viscosity both at small and large deformations. The former is mainly dominated by short-range interactions (starch-starch and starch-gluten), and very sensitive to the water content, while the latter is mostly determined by longer-range interactions (gluten-gluten) and less sensitive to water content. Since WE-AX imparts viscosity and binds water, the increase at small strains is very likely caused by a decreased water availability for starch and gluten. However, the increase at large deformations cannot solely be attributed to water availability and thus needs to be further investigated. To what extent these changes in dough rheology relate to the bread making performance will be the area of future research. (Conclusion) The insights of this work provide a framework for developing high-quality fibre-enriched breads.

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A Bicelle Nanocarrier for Improving Transmucosal Delivery of Non-water-soluble Compounds

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Aim:
Curcumin, one of the most frequently used spices, has drawn attention as a functional food compound by the virtue of its anti-inflammatory, antioxidant, and antitumor promoting activity. However, its feasibility has been limited due to its low water-solubility and stability. A disc-shaped lipids assembly, bicelle, has a bilayered structure at the core section and its hydrophobic rim area is stabilized by short-chain lipids so that it is suitable for entrapping the non-water-soluble biomolecules into its bilayer membrane and protecting them from physical or chemical degradation. In this study, high-throughput preparation method for the curcumin-loaded bicelles was suggested and the physicochemical properties of them was investigated.

Method:
The curcumin-loaded bicelles, micelles and liposomes were prepared via the microfluidic method or thin-film hydration method. The stability of the curcumins was evaluated by measuring the residual contents at each predetermined condition and the membrane properties were spectroscopically investigated by employing two fluorescent dyes: Laurdan and DPH. The transmucosal property of each lipid carrier was assessed using an artificial mucous membrane, and the antioxidant activity was evaluated via ABTS assay.

Results:
The microfluidic method enabled the monodispersed and rigid bicelles to be prepared. The stability of curcumins against the pH and temperature elevation was enhanced when they were incorporated to the bicelle in comparison to the micelle or free form, indicating that the bilayer membrane was largely protective structure, which was rationalized by the membrane property difference between them. Moreover, the muco-penetrating property of bicelles was confirmed whereas the liposomes were stuck within the mucous layer. With the presence of hyaluronic acids, the permeability was enhanced so that the HA film containing bicelles was presented to expand the bioavailability of the curcumins. Finally, the curcumin-loaded bicelles showed remarkable antioxidant activity in the FBS and PBS mixture solution, analogous to the physiological condition.

Conclusion:
The bilayered structure allowed the bicelle to have high entrapment efficiency and protective ability and it showed mucopenetrating property due to its small size and disc-like shape. In other words, it takes advantage of both micelle and liposome.

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Simplified heat transfer modelling for temperature prediction in an insulated box equipped with PCM

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Aim:
Insulated boxes equipped with Phase Change Material (PCM) are suitable for food transport due to their simplicity and low cost. However, the box configuration (box design, mass of PCM, and its melting point) is still based on the user's experience. Thus, it is difficult to apply to other box configurations and other transport conditions (different products and different ambient temperatures). A simplified heat transfer model taking account of heat transfer and airflow was developed to predict the product temperature under different conditions with a short computation time. This model could be used for box design, so that product temperature does not exceed the recommended value along a logistic chain.

Method:
Experimentation: A 40-L insulated box (500 mm x 310 mm x 300 mm internal dimension) was equipped with water-based PCM (melting point ~ 0°C) at a lateral wall. Sixteen packs of test product (Tylose, dimension of a pack 200 mm x 100 mm x 50 mm, initial temperature 4°C) were placed on support to allow airflow underneath the product (support height 55-mm). T-type thermocouples were put to measure the temperature of PCM, air, internal box wall, and product surface and core.
Model development: The simplified heat transfer model consisted of differential equations derived from heat balance. This model considers conduction, natural convection, radiation, and PCM melting. It was solved by the Euler method using Python. The model was validated with experiments under steady state condition. The effect of box configuration (height/width and wall insulation) and ambient temperature were numerically investigated.

Results:
The simplified heat transfer model showed the impact of the box's height/width, wall thermal conductivity, and ambient temperature on air/ product temperature distribution and PCM melting rate. It could predict the duration during which product temperature remained below a recommended value.

Conclusion:
The simplified thermal model gives a good agreement with experimental air and product temperatures. It can be used for box design e.g. box insulation and to predict the mass of PCM required for food product transport under different logistic scenarios.

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Impact of growth conditions on protein content and profile of the cultured macroalga, Palmaria palmata

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Aim:
The aim of this study was to enhance the nutritional value (protein content) of the edible red seaweed *Palmaria palmata*
Method:
P. palmata biomass was collected from open sea longlines located off the southwest coast of Ireland. This biomass was cultured under the following conditions: (i) sterilised seawater (control) (ii) sterilised seawater with the algal culture medium, (f/2) (iii) sterilised seawater with f/2 and urea (0.05 g/L) and (iv) sterilised seawater with f/2 and 0.1 g/L urea (n=3). The samples were cultured for 18 days at 11 ± 1°C, 100 μmol m^{-2} s^{-1} irradiance, under agitation with aeration with a 16:8h light:dark photoperiod. Following culture, the biomass was collected, freeze-dried and milled (< 3 mm). The nitrogen profile, protein profile and colour were determined using Kjeldahl nitrogen analysis, SDS-PAGE and CIELAB colorimetry analysis.
Results:
The total nitrogen content of *P. palmata* increased by 125, 139, 137% compared to the original sample with f/2 alone or with f/2 in combination with 0.05 and 0.1 g/L urea, respectively. The control sample had a 36% reduction in nitrogen compared to the original sample. The SDS-PAGE profiles indicated the presence of prominent protein bands at molecular masses of 55, 14.2 and 6.5 kDa corresponding to the phycobiliproteins and ribulose bisphosphate carboxylase. The intensity of the bands depended on the culture treatment received being stronger for the samples grown with f/2 and urea. The colour characteristics (L, a, b) were impacted with treatment, e.g., lightness reduced, positive a values (redness) were obtained for f/2 cultured samples whereas negative values (greenness) were obtained for the control sample. The colour difference (ΔE) increased from 6.78±1.59 to 29.54±1.27 in the f/2 with 0.1 g/L urea cultured sample. Pearson's correlation analysis showed a significant positive correlation ($r = 0.945$, $p = 0.016$) between total nitrogen and ΔE.
Conclusion:
It was possible to increase the nutritional value (protein content) of *P. palmata* by culturing either with a nitrogen source (f/2 culture medium and urea). This study provides useful information on how to enhance the protein content of cultured *P. palmata* as a potential alternative source of high-quality protein ingredients.

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Anti-inflammatory activity of peptides derived from sustainable food proteins

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Aim

Peptides exhibit numerous bioactivities making them useful as ingredients in functional foods. Biopeptides are gaining attention for preventing and treating inflammation, with a special focus on those obtained from novel sustainable sources.

This work was devoted to review the structure-function relationship of anti-inflammatory peptides reported in the literature, identifying the most bioactive peptide sequences from natural sources. Based on this research, two dried meals from sustainable sources, mealworm (*Tenebrio molitor*) and lupin, were chosen to produce protein hydrolysates, investigating the influence of both enzyme and degree of hydrolysis on their *in vitro* anti-inflammatory activity.

Method

The initial search for antiinflammatory was limited for studies published between 2015 and 2022. The selected peptides were categorized by their length, charge, isoelectric point, hydrophobicity and *in silico* degradation during gastrointestinal digestion (ExPASy PeptideCutter tool). The amino acid sequences displaying the highest levels of anti-inflammatory potency were identified in natural protein sources registered in the PDB database. This research allowed selecting the natural substrates and enzymes for the hydrolysis. A set of hydrolysates was produced from mealworm and lupin meal, employing food grade proteases at degrees of hydrolysis ranging from 5 to 20%. The anti-inflammatory activity of these hydrolysates was studied by determining their ability to inhibit *in vitro* enzymes involved in the inflammatory process such as phospholipase A2, cyclooxygenase 2 and *lipoxygenase*.

Results

Anti-inflammatory activity of peptides might be related to the presence of hydrophobic and positively charged amino acids. Moreover, smaller peptides have less susceptibility to be digested by gastrointestinal proteases, maintaining their *in vitro* bioactivity. Some of the most active amino acid sequences identified *in silico* were found encrypted in proteins from novel sustainable sources such as *Tenebrio molitor*. The combination of subtilisin and trypsin led to the highest degree of hydrolysis, releasing shorter peptides displaying anti-inflammatory activity. The outcome of this work will allow to optimize the enzymatic treatment (enzyme, operating conditions and extent of the reaction) to produce anti-inflammatory peptides.

Conclusion

This work confirms the potential of protein hydrolysates from sustainable sources as ingredients in nutraceutical formulas to prevent chronic inflammatory diseases and reduce risk factors.

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ACE inhibitory peptides from sustainable protein sources

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Aim

Plant protein sources are gaining attention to produce bioactive peptides able to take part into the formulation of nutraceuticals. This work investigates the in vitro ACE inhibitory capacity of protein hydrolysates of plant and microalgae sources, proposing a membrane ultrafiltration procedure to recover bioactive fractions.

Method

Vegetable meals from chickpea, lupin, lentil, sunflower, olive seeds, rapeseed, with protein content from 20-28% w/w, were chosen to produce enzymatic hydrolysates with potential ACE inhibition. The enzymatic reaction was carried out at 50ºC and pH 8, controlled by an automatic titration method. A combination 1:1 of Alcalase and PTN (Novozymes) was employed as enzyme mixture to obtain protein hydrolysates at 20% degree of hydrolysis. The freeze-dried hydrolysates were tested for their in vitro ACE inhibitory activity by means of a multiplate spectrophotometer. Besides the plant-derived proteins, other sustainable protein sources such as algae biomass were chosen to investigate their potential to produce ACE inhibitory peptides. Those hydrolysates displaying the highest inhibitory activity, as well as resistance against in vitro gastrointestinal digestion, were fractionated by size exclusion chromatography (SEC), evaluating the in vitro activity of the fractions obtained. These results were reproduced at semi-industrial scale employing ceramic ultrafiltration membranes with molecular weight cut offs (MWCO) ranging from 8 kDa, 5 kDa, 3 kDa and 1 kDa. The peptide fractions recovered were tested for their in vitro ACE inhibition.

Results

Some of the protein hydrolysates investigated, such as lupin, olive seed and rapeseed meals presented high levels of ACE inhibition, with IC50 values around 1.8 – 2.1 mg/mL. According to the molecular weight profiles, some of these hydrolysates presented 18% short peptides below 500 Da, responsible for the ACE inhibition. These results were confirmed by the SEC fractionation, where the peptide fractions below 1 kDa displayed improved ACE inhibition. A stepwise fractionation process, comprising a final ceramic membrane of 1 kDa MWCO was able to recover a final permeate with improved ACE inhibition.

Conclusion

This work confirms the potential of protein hydrolysates from sustainable plant and microbial sources to take part in the formulation in nutraceutical formulas to prevent ACE inhibition.

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Statistical models describing the effect of protein addition on the physicochemical properties of fortified soup

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Aim:
Protein-fortified soups (PFS) could be used to improve protein intake of older adults, a growing consumer group with special nutritional needs. However, addition of protein may affect the physicochemical properties of the final product. This study aimed to investigate how the addition of a dairy protein (Milk Protein Concentrate (MPC)) and a plant-based protein (Pea Protein Isolate (PPI)), or their combination affects the physicochemical properties (firmness, consistency, pH and colour) of tomato soup, a food commonly consumed by older adults.
Method:
Tomato soup powder was mixed with two protein powders (PPI and MPC) or their combinations, and 9 formulations were generated that could bear the nutrition claim "high in protein" (Regulation EU No 1924/2006). The mixtures were diluted with pure water and cooked at 80° C for 10 min. Colour (L*, a*, b*), pH, consistency (g.sec) and firmness (g) were determined at 60ºC (recommended serving temperature). We investigated 4943 different linear models (i.e. combinations of PPI and MPC) for each physicochemical property, and we selected the model that achieves minimum predictive error on a k-fold cross-validation setup (ordinary least squares, Matlab version R2018a). The statistical properties of the optimal models were computed by Statsmodels (version 0.12.0, Python 3.8).
Results:
Regression analysis showed that the selected models could describe sufficiently colour parameters L*(R^2=0.972, p~0.000), a*(R^2=0.834, p~0.000), b*(R^2=0.795, p~0.000)), pH (R^2=0.979, p~0.000) and firmness (R^2=0.614, p~0.001) of PFS (p-value: maximum among all model parameters). These were all significantly affected by the type and amount of protein. However, best performing model developed for consistency could not describe sufficiently the effect of protein type possibly because of the complexity of the PPI and MPC interactions.
Conclusion:
The developed models could predict with high accuracy the effect of PPI and MPC on the pH, colour and firmness of soup and could serve well the purpose of PFS design and optimization. Further investigation of the interaction between the two proteins could describe their effect on consistency. Instrumental analysis is suggested to be combined with data on sensory acceptability by older people who are the target population of this product.

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In vitro digestion effect on DPP-IV inhibitory activity of protein hydrolysates obtained from plant by-products

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Aim:
Diabetes mellitus (DM) is a chronic metabolic disorder marked by persistent hyperglycaemia, resulting in high morbidity and mortality. DM is linked to both genetic and environmental factors, where nutrition plays an important role. In recent years, the rising prevalence of DM and the adverse side effects of its conventional drugs have pushed for new, safer, alternative treatments. Thus, bioactive peptides capable of regulating the glycaemic index (e.g. by inhibiting DPP-IV enzyme) have gained interest. Special attention is paid to obtain bioactive peptides from sustainable proteins and food by-products.
Therefore, this work studied the DPP-IV inhibitory activity of plant protein hydrolysates obtained from lupin, chickpea, lentil, sunflower, olive, rapeseed, pea, and potato. Moreover, the effect of *in vitro* digestion on the DPP-IV inhibitory activity of the hydrolysates was investigated.
Method:
An array of plant-based by-products (lupine, chickpea, lentil, sunflower, olive, rapeseed, pea, and potato) were hydrolysed with Alcalase and PTN until a 20% degree of hydrolysis. The antiglycaemic capacity of the hydrolysates was measured by determining their in vitro DPP-IV inhibitory activity. Then, the INFOGEST *in vitro* digestion method was used to analyse the effect that digestion may have on the stability of the peptides present in the hydrolysates. Finally, a comparison was made of the DPP-IV inhibitory activities obtained for these hydrolysates before and after digestion.
Results:
The DPP-IV inhibitory assays showed IC_{50} values ranging from 0.338± 0.010 mg/mL (olive seed meal) to 1.331± 0.087 mg/mL (potato protein isolate). The determination of the DPP-IV inhibitory activity of the digested hydrolysates will be discussed.
Conclusion:
Protein hydrolysates obtained from protein rich plant by-products present promising antiglycaemic activity as indicated by their DPP-IV inhibitory activity. The ingestion of the bioactive hydrolysates and subsequent digestion may affect their stability. Thus, this research work provides insights for the production of DPP-IV inhibitory protein hydrolysates from plant by-products with potential use in the formulation of functional food.

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Antimicrobial activities of selected lactic acid bacteria in egg products

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Abstract EFFoST May 2022

Aim:
To protect food from spoilage microorganisms and human pathogens, fermentation has been used for centuries. The best known fermentation with lactic acid bacteria (LAB) for biopreservation of food are sour dough, cheese and yoghurt. Because of this, LAB are well researched and there is much in the literature about their bioconservative properties. Fermentation with LAB as a pretreatment to remove carbohydrates from eggs prior to spray-drying is widely used in the egg industry.
Lactobacilli are already widely used for the biological protection of food, but so far not for special egg products. In this study, the influence of a special egg matrix on the antimicrobial potential of selected lactobacilli will be investigated.

Method:
This study shows the comparison of the antimicrobial potential of two *Lactobacillus* strains and one *Streptococcus thermophilus* strain using a modified agar diffusion test. The LAB are incubated anaerobically in the medium or matrix at 42 °C for 24 hours. Antimicrobial properties are tested against three test organisms.
After fermentation, the medium is solidified with agar and poured into petri dishes. The surface of the media is inoculated with the test organisms and incubated for 96 hours. The growth of the test organisms on the plates is observed and recorded photographically. Agar plates without LAB and agar plates with lowered pH were used as controls.

Results:
In the literature, the antimicrobial properties are usually studied without considering the matrix effects in complex food matrices. From this study, it can be seen that the matrix egg has no effect on the antimicrobial properties of the LAB studied. Fermentation of the egg product with LAB dropped the pH. The drop in pH during fermentation plays a significant role in the antimicrobial properties of LAB. In conclusion, this study has shown that the potential of preservation of special egg products by fermentation with LAB is possible as the egg matrix has no interfering effect on the biopreservative potential of LAB.

Conclusion:
Fermentation of egg products with lactic acid bacteria opens up new possibilities for preservation and refinement of egg products. In particular, side streams of the egg product industry can be used for value-added products. In addition, high-quality protein sources are created for vegetarians or

lactose-intolerant people for whom a conventional protein source based on nuts is unsuitable due to allergies.

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Impacts of ionic calcium fiber supplementation on preserving bone health in C57/BL6 mice.

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Aim:
Calcium is essential for muscle contraction, nerve impulse transmission, cellular activity, and skeletal structure. Dietary calcium is ionized in the stomach (Ca^{2+}) and absorbed by transcellular and paracellular transport in the small intestine. However, the pH changes in the stomach (1.5-2.5) to the intestinal environment (5.5-6.5) can reduce the ionized calcium concentration. Ionic calcium can help in the prevention of the process of osseous decalcification. This study aimed to evaluate the physicochemical properties and toxic effects of ionic calcium-fibre supplement (ICa^{+}) and its impact on bone health preservation in mice C57/BL6 fed a calcium-deficient diet.
Method:
The ionic calcium fibre powders were produced using a mixture of chitosan, fructans, gum arabic, calcium phosphate and vitamin D (400 UI) in a spray-dryer (DL410, Yamato Scientific America Inc., Santa Clara, CA, USA). Physicochemical properties include FTIR, apparent calcium solubility estimated by the calcium ratio obtained by ionization chromatography and atomic absorption. Twenty-five 7-weeks-old C57/BL6 mice were fed calcium-free diet (CFD) or CFD plus $CaCO_3$ (1.33 mg Ca) or CFD plus *ICa^{+}* (1.33-6.66 mg Ca) for six weeks. After that, bone mass and microstructure parameters were assessed. Histological staining was performed to determine calcium deposits.
Results:
FTIR showed that the intensity of typical absorption bands of carbohydrates decreased from 2000-1100 cm^{-1}, which probably resulted from the electrostatic interactions between functional groups of the carbohydrates. The *ICa^{+}* (100%) exhibited an apparent calcium solubility higher than $CaCO_3$ (12.3%), confirming that the complex carbohydrate enhanced the solubility of the calcium ions. The model of bone decalcification of young mice caused by a calcium-free diet was successfully established after six weeks of supplementations. The animal showed a ratio of BV/TV similar in calcium carbonate mice and ionic calcium-fiber supplement and was less in the control group calcium deprived. Histomorphometry analysis showed that the *ICa^{+}* treated group displayed a high trabeculae number compared to the trabecular space. Also, the ratio of BV/TV was increased compared with all treatments.
Conclusion:
These results show that ionized calcium supplements can be safely employed to promote the absorption and retention of osseous calcium.

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"Impact of pulsed electric fields as pre-treatment of fermentation process during yogurt production"

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Aim:

Yogurt is a dairy product obtained by milk fermentation with lactic acid bacteria (LAB) of *Lactobacillus* and *Streptococcus* genera. Usually, a fermentation process takes around six hours, representing high energy costs (1,607.8W/h). The reduction of this time represents a challenge for scientists and technologists looking toward alternative treatments to optimize fermentation processing without affecting the final product. Pulsed electric fields (PEF) is a non-thermal technology based on the application of electricity, at different intensity levels (0.1- 40kV/cm) during short times (µs) to food placed between two electrodes. Electroporation is its primary mechanism of action that induces irreversible or reversible permeabilization of cell membranes, depending on the field intensity. Low-intensity treatments cause cell stress and could be used as a potential alternative to accelerate LAB metabolism. Hence, this research aimed to apply low-intensity PEF in *Streptococcus thermophilus,* and *Lactobacillus bulgaricus* culture inoculated in whole milk and evaluate its impact on yogurt fermentation time.

Method:

Twenty PEF treatments (1-3kV/cm; 50 pulses of 4-8µs; 50-150 Hz) were applied to 125ml of inoculated milk before the fermentation stage. Each process was performed in an EPULSUS®-LPM1A-10-System. Samples were treated in a parallel treatment chamber with stainless steel electrodes. The pH and degrees Brix were monitored every hour during six hours of fermentation using a potentiometer (pH 510 OAKTON) and refractometer (HANNA HI 96813), respectively.

Results:

The fermentation time of conventional yogurt production lasted 4.25h when pH reached 4.5. PEF application at different processing parameters to the inoculated milk reduced the fermentation time (4.22-3.43h), being PEF at 3 kV/cm (50 pulses, 8µs,150Hz) was the optimal treatment, reducing fermentation time by 42min when compared to control. It might be possible that during PEF processing, reversible electroporation occurred in the LAB membrane, allowing them to absorb more nutrients from milk and thus accelerating their metabolism, increasing the production of lactic acid in a shorter time.

Conclusion:

PEF processing at a low field intensity (1-3kV/cm), pulse width between 4-8μs, and 50-150Hz applied as pre-treatment of the fermentation stage represents a potential alternative to reduce fermentation time in yogurt production, obtaining a product with fresh-like characteristics.

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Effect of N-glycosylation on catalytic properties of recombinant lipase from Cordyceps militaris

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Aim: Elucidation of the effect of yeast-derived *N*-glycosylation on lipase
Lipase (triacylglycerol acylhydrolase, EC 3.1.1.3) is a lipolytic enzyme that is crucial in enzymatic lipid modification. In general, the massive production of lipase from eukaryotic sources is carried out by recombinant expression in yeast such as *Pichia pastoris*. However, due to the extensive mannose-type *N*-glycosylation, the changes in *N*-glycan moiety may modify the catalytic features of the native lipase. In this study, we aimed to investigate the effect of yeast-derived *N*-glycosylation on lipase activity using recombinant lipase from *Cordyceps militaris* (rCML) as a model lipase.

Methods: Colorimetric lipolytic assay and analysis of conformational changes
Pichia pastoris X-33 was chosen as an extracellular expression system and the *N*-glycosylation profile was evaluated by peptide and glyco-mapping. Deglycosylated rCML (drCML) was obtained by treating Endo H_f without denaturant for 24 h. A colorimetric assay using *p*-nitrophenyl alkanoates with various chain length (C4:0 – C18:0) were applied to evaluate the kinetic parameters of rCML and drCML. Intrinsic fluorescence spectroscopy (ITF) and circular dichroism analysis were used to demonstrate the conformational changes.

Results: Chain length-dependent variation in kinetic parameters
Compared to drCML, rCML exhibited more than a 2-fold increase in maximal velocity (V_{max}) towards *p*-nitrophenyl esters with chain length below C14:0 compared to drCML; whereas the difference in V_{max} decreased as the chain length exceed C14:0. Compared to V_{max}, apparent dissociation (K_m) was not significantly affected by *N*-deglycosylation. The ITF analysis revealed that the conformational change of rCML was more dramatic in different pH compared to that of drCML. Unlike drCML, antiparallel β-sheet was not observed in rCML. Instead, the unordered segment of rCML was 11.2% higher than that of drCML at pH 8.0.

Conclusion: Enhanced catalytic activity of rCML induced by *N*-glycosylation
In conclusion, the yeast-derived *N*-glycosylation enhanced the V_{max} and pre-exponential factor of rCML by increasing the conformational dynamics of the enzyme. The findings indicate that *N*-glycosylation on lipase could have a positive impact on lipase activity despite the presence of bulky *N*-glycans and increased surface hydrophilicity.

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Bread losses and surplus in French bakeries: what place for repurposing as food?

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Aim: About 30% of food is estimated to be wasted all along the food chain. Regulation is evolving, with emphasis on prevention of losses through to the recovery as molecules or energy. The present study focused on bread surplus at the production and distribution steps; it addressed from small (bakeries which produce and distribute at the same place) to large scales (industries, retailers). According to The French Agency for eco-transition, 20 to 60% of bread surplus were incinerated or landfilled in 2016, the highest score at the artisanal scale. However, this former study was based on few survey answers and we decided to perform our own survey at local scale.

Method: 20 bakers located in Rennes Métropole, a French local authority with 450,000 inhabitants, were interviewed about their bread surplus, the quantity, the existing pathways for collection and valorisation of old bread, and the associated levers. Findings were compared to the scientific literature on the processes to specifically transform bread surplus or waste.

Results: Results showed that prevention was a top priority for bakers, valorisation pathways were in place and used in combination to absorb all bread surplus. The most frequent pathways were donation to charities (encouraged by the French regulation) and animal feed, as livestock breeding is very present around this metropole. Bakeries sometimes collaborated with start-ups that upcycle this resource into foodstuffs (beer, biscuit, pastry, snacks…), and these collaborations were analysed. Interviews also revealed that these entrepreneurs were facing several challenges (modified functionality compared to the original wheat flour, variability of this novel matter, microbiological quality). Surprisingly there are few scientific studies to support such food developments, which also contrasts with the large number of papers dedicated to biotechnology to produce molecules or energy from bread waste (ten times more).

Conclusion: The repurposing of surplus bread into new foods is low in the region studied. There are emerging initiatives in this direction that could be better supported by revisiting our traditional food processes and safety practices in this context of new ingredients, and this is also part of what should emerge from the research area for the future.

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Development of a method for measuring the electrical conductivity of cake batter

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Development of a method for measuring the electrical conductivity of cake batter
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Objectives:
Ohmic heating (OH) involves the circulation of an electric current through a product, which will heat up by Joule effect. OH is viewed as an energy efficient process that can reduce cooking times and yields to a more homogeneous heating. Thus OH could be very useful for additive manufacturing in the food industry where baking and printing must be simultaneous in some cases. To develop such a continuous heating system, focusing on honeycomb cereal matrices (cake-type), the electrical conductivity (EC) of the products has to be perfectly known. The objective of this work is to develop a method for determining the EC of the cake batter as a function of temperature in the heating conditions (voltage, frequency of the current…).
Methodology and results:
The method proposed in this study consists in simulating the heating of xanthan solutions (0.4, 0.65 and 1% g/g) in a conductivity cell for several voltages. The cell consists of a polyacetal tube and two electrodes between which the product is placed. The 2D axisymmetric model takes into account the natural convection phenomena in the heat equation. The Navier-Stokes equations were therefore used for the flow and the equations governing the electric field were also solved. The numerical results of the temperature at two locations were compared with the experimental results, which allowed, knowing the electrical conductivity of the solutions, to determine the calibration parameters of the cell. The efficiency of the cell, corresponding to the conversion efficiency of electrical energy into heat was determined to be 78% for electrical conductivities values expected for the cake batter. This value was validated by experiments carried out with potassium chloride solutions (KCl). The ohmic cell was then used to determine the EC of the cake batter and the influence of the starch gelatinization from a temperature of about 70°C was highlighted.
Conclusion:
The characterisation of the conductivity cell takes into account the influence of temperature gradients during heating. The method developed, based on the comparison between numerical and experimental results, thus makes it possible to estimate the electrical conductivity of products whose temperature increases during the measurement.

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Characterization of an oven dedicated to Lebanese bread baking

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Characterization of an oven dedicated to Lebanese bread baking
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Objectives:
Lebanese bread, commonly known as pita bread, is a round, flat, two-layer bread formed when a flattened piece of dough separates into two distinct layers during baking. The baking process of Lebanese bread is characterized by very short baking times, less than 10 s, and high oven temperatures ranging between 600 and 700 °C. Only tunnel ovens with direct flame burners are suitable. Recent results have shown that only 18% of the energy consumed is used for bread baking. On the other hand, from an economic point of view, energy costs represent about 45% of the total cost of bread production. The fight against global warming and the current crisis in Lebanon make this study essential to improve the energy efficiency of such baking process.
Methodology:
The objective of this work is to characterize the heat transfer within Lebanese bread throughout baking process. An instrumented oven (with a grid of 9 thermocouples) is first developed. The full-scale chamber is made of refractory thermal bricks and heating is provided by a single direct flame diesel-fired burner with a nominal thermal power of 130 kW. A special fluxmeter is also installed to measure the heat flux at three different positions and angles inside the baking chamber. This device allows to quantify heat flux potentially received by the bread that changes from a flat shape to a spherical one during the baking process. The experimental results are coupled with numerical simulations to allow a complete characterization of the oven.
Results:
Experimental results show a clear heterogeneity in the temperature profile inside the oven (from 600°C to 900°C). The conductive heat flux from the conveyor varies between 6.5 and 7.5 kW/m^2. The radiative and convective flux vary between 8 and 30 kW/m^2 depending on the orientation and position inside the baking chamber. Numerical simulations, performed using Ansys software suite including the combustion modelling, agree well with the experimental results (difference less than 10% on temperatures). This shows that the developed numerical model can be used as a predictive and optimization tool.

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Up-cycling and valorisation of European plaice by-products originating from Norway

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Aim:
A comprehensive study on European plaice (*Pleuronectes Platessa*) discovered that by-products account for more than 50% of the fish's weight. This highlights the importance of developing methods to up-cycle side streams to utilise the total available biomass. This study aimed to recover value-added products from different by-products originating from European plaice. Furthermore, the study intended to optimise the recovery, characterise and identify the extent of the beneficial properties.
Method:
Four different by-product fractions (head, viscera, skin, backbone) were considered for this study. Analysis of proximate, amino, and fatty acid profiles was performed on the raw material before further processing. To extract components from the four by-product fractions, enzymatic hydrolysis was conducted, and three phases were obtained: protein and oil phase and solid residues.
The aqueous phase containing soluble proteins was separated and freeze-dried. A part of the protein hydrolysates was separated by ultra-membrane filtration to generate fractions with different molecular weight distributions. The protein fraction and the fractions containing different molecular sizes were studied by analysing the molecular weight distribution, total and free amino acid profile, degree of hydrolysis, and bioactivity. The oil phase was characterized by analysing the fatty acid profile. The solid residue was analysed for its proximate composition and hydroxyproline content to calculate collagen recovery.
Results:
All four by-product fractions showed great nutritional value with high-value protein containing up to 17% in skin and viscera. Furthermore, enzymatic hydrolysis as an extraction method was found to be highly efficient. The protein hydrolysates were identified as the main fractions with the most potential for valorisation. Peptides could be separated according to molecular weight, and beneficial properties such as bioactivity were discovered. The main findings of valorisation through hydrolysis, focusing on peptides and collagen recovery, will be presented at the conference.
Conclusion:
Residues of European plaice pose a great opportunity for up-cycling into valuable products. Particularly collagen and peptides' excellent bioavailability, nutritional and functional properties suggest promising utilisation in various applications, from incorporation into food to nutraceutical products. Further work should focus on bioeconomical aspects related to the processing of side streams and how to optimize these.

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UNDERSTANDING THE EFFECTS OF PHENOLIC-STARCH INTERACTIONS ON PHENOLIC ACIDS INHIBITORY PROPERTIES OF ALPHA-AMYLASE

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Aim:
As an essential source of carbohydrates, starches are consumed all around the world, while phenolic acids are utilised in our diet for their antioxidant properties, lowering post prandial glycaemic index and helping in preventing the onset of type II diabetes. For these benefits, it is essential for phenolic acid to be present in an unbound form in the small intestine. However, recent studies have demonstrated that in the presence of starches, phenolic acids may be able to bind with them. Thus, this study aims to understand how interaction between phenolic acids and starches affect the inhibitory properties of phenolic acids with digestive enzymes.

Method:
In this study, the interaction between phenolics and starches were measured by hydrolysis of starch in terms of its viscosity using a RVA (Rapid Visco Analyser). Phenolic acids such as Gallic acid (GA), Ethyl gallate (EGA) were introduced either during cooking or after cooking of starches. Once cooked, the digestion assay was performed with the addition of digestive enzymes at 37C. To understand how the molecular structure of starch could influence its interaction with phenolics, starch samples were sourced from potato, rice, wheat and maize.

Results:
The results showed that the addition of GA/EGA during the cooking process appears to slow down the drop in viscosity as opposed to when GA/EGA were absent. The addition of GA alongside digestive enzyme following cooking showed the least drop in viscosity. The largest difference in the digestive viscosity was observed in potato starch.

Significance:
The inhibition of digestive enzyme relies on phenolic acids being available in its free form. However, the binding of phenolics with starches would decrease the amount of free phenolics, which would lead to a decrease in the inhibition of digestive enzymes. On the other hand, phenolic-starch complexation has shown to increase the total resistant starch content, this would in turn help lower post prandial glycaemic index. Thus, understanding phenolic-starch complexation would give us a better insight on how these mechanisms occur on a molecular level and affect each other's functionalities.

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The influence of high-pressure processing (HPP) on rheology and colour of strawberry nectar

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AIM
The application of non-thermal processing technologies has increased in recent years due to their impact on food quality and lower energy demands compared with thermal treatments (TT). Moreover, the presence of endogenous enzymes as well anthocyanins, have been shown to change after high-pressure processing (HPP) and TT, and these aspects can alter the physical stability of strawberry products. Furthermore, the rheology of juices and nectar affects not only their sensorial properties but also their physical stability. However, limited research has been completed to date regarding the influence of HPP on rheology.
METHOD
The effects of HPP at 600 MPa for 8 minutes and TT (75 °C 15 seconds) on strawberry nectar colour and viscosity were investigated in this study. Such treatments were selected to ensure a 5-log reduction in acid-resistant food pathogens. Nectar was formulated with 40% puree and the necessary sucrose and citric acid to achieve 12 °Brix and 3.5 pH. As a control, an untreated sample was used. Shear stress versus shear rate was studied at 25°C using an Anton Paar viscometer. To estimate the colour changes, the total colour difference (ΔE) and CIE Lab parameters were used. Colour measurements were performed on a Minolta colourimeter. Total microbial count and yeasts and moulds were counted for all samples to ensure the inactivation of microbial activity.
RESULTS
No significant ΔE were identified between the samples. The viscosity of the heat-treated samples did not differ significantly from the control. However, the viscosity of the HPP samples was noticeably higher than that of the control; at 100 s-1, the 600 MPa 8 min sample had a value of 75.35 ± 0.89 while the control sample had a value of 38.36 ± 0.77. The n index indicates that the flow behaviour of HPP samples is more non-Newtonian after treatment. Changes in viscosity may be due to starch swelling properties of polysaccharides, protein structure and the activity of endogenous enzymes.
CONCLUSION
This work suggests that HPP treatments of 600 MPa for 8 minutes may influence the viscosity of strawberries while maintaining colour. This result will not only affect sensorial perception but also the downstream processing conditions during the manufacturing process.

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Impact of convective drying temperature on the rheological properties of avocado seed flour

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Aim: Avocado (*Persea americana*) seeds, a by-product of avocado processing industries, represent 12 to 21% of the fruits and are known to provide health-promoting properties. Therefore, it can be explored as a flour for the bakery industry, reducing waste by following a circular economy approach. The objective of this work was to evaluate the effect of drying temperature on the rheology of the avocado seed flour as rheological parameters give an indication of the structure of the flour sample.
Method: Peeled seeds, cut into 2 mm thick slices, were convectively dried at 40°C, 50°C and 60°C under air velocities of 1.5 m/s. Storage and loss moduli, phase angle and viscosity of the flour dried at different temperatures were measured using a Bohlin rheometer using freshly prepared gels of flour with 6% concentration. For dynamic viscoelastic measurement, the linear viscoelastic range was determined with strain sweep (0.01–10%). A dynamic frequency sweep was then conducted by applying a constant strain of 0.1%, which was within the linear region, over a frequency range of 0.01–10 Hz along with power law model parameters. Temperature ramps were then conducted for each different dried temperature sample.
Results: The frequency range analysed had an impact on the viscoelastic properties, which is a characteristic of weak gel-like structures having the elastic modulus (G') consistently higher than the viscous modulus(G") for each of the three drying temperatures. The moduli for 40°C sample were highest, suggesting lower volume and higher crumb hardness due to the larger granule size of the flour in bread-making. Also, at 5 Hz frequency, the tan δ values for flour were between 0.19 - 0.23, again indicating an elastic behaviour predominancy. From the power law parameters, n' is always higher than the n", meaning the frequency spectra of the sample correspond to the plateau (rubbery) region. The impact of temperature ramps on storage and loss moduli was most predominant in 40°C samples.
Conclusion: Rheological analysis showed that a drying temperature of 60°C was more suitable for bread making as it has higher specific volume and texture properties due to small elastic and viscous moduli.

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Synthesis and characterization of erythorbyl fatty acid esters and their derivatives

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Aim: Development of erythorbyl fatty acid esters and derivatives as multifunctional food additives
We have previously developed erythorbyl laurate (C12:0) and erythorbyl myristate (EM, C14:0) with interfacial, antibacterial, and antioxidative activities. In this study, we modified the hydrophobic moiety (C10:0 – C18:0) of erythorbyl fatty acid esters (EFEs) to characterize them as multifunctional food additives, and attempted to introduce cationic biomolecules into EFEs to enhance antibacterial activity.

Methods: Synthesis of EFE derivatives and investigation of interfacial, antibacterial, and antioxidative properties of EFEs and derivatives
We enzymatically synthesized a homologous series of EFEs (C10:0 – C18:0) and their cationic derivatives. We observed the interfacial property of EFEs by measuring interfacial tension between the oil-water interface and calculating theoretical values of their log P and HLB. Regarding antibacterial properties, we determined the MIC and MBC of EFEs against several foodborne pathogens, and examined the antimicrobial spectrum of cationic derivatives. Finally, lipid peroxidation inhibitory activity in the oil-in-water emulsion was assessed by ferric thiocyanate assay, and radical scavenging activity (DPPH and ABTS) assay was performed to investigate the antioxidative activities of EFEs.

Results: Significant influence of hydrophobic moiety on multifunctionalities of EFEs and broad antibacterial spectrum of their cationic derivatives
All EFEs lowered interfacial tension of the oil-water interface, suggesting their applicability as food emulsifiers. Lipid peroxidation inhibitory activities of EFEs in the emulsion system increased with increasing acyl chain length, while erythorbyl stearate (C18:0) exhibited similar activity with erythorbyl palmitate (EP). Likewise, increasing antibacterial activity against Gram-positive bacteria was observed with elongation of chain length (C10:0 – C14:0), but a cut-off in the activity occurred with further acyl chain elongation. Synthesized cationic derivatives of EFEs showed a broader antibacterial spectrum than their original counterparts.

Conclusion: EFEs and cationic derivatives as potential multifunctional emulsifiers
This study indicates that the hydrophobic moiety alteration influenced the multifunctionalities of EFEs. The highest antibacterial activity against Gram-positive bacteria was observed with EM, while

EP showed the highest antioxidative activity in the emulsion system. Also, the cationic derivatives of EFEs exhibited enhanced antibacterial activity against Gram-negative bacteria. Our results can provide a basis for the development of multifunctional emulsifiers.

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Tailoring an extruded plant-based cereal product for seniors and studying its in vitro digestibility

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Aim:
Increasing life expectancies in the western world mandate the design of foods tailored to the preferences, acceptance and nutritional needs of seniors. The EAT4AGE consortium seeks to meet the growing demand for age-tailored foods by rational design of food solutions that are nutritionally dense and palatable. One of the explored avenues is to produce new shelf stable solutions based on an innovative plant-based cereal product.
Method:
First, co-extrusion (105-120oC) of a plant-based cereal with a sweet oil-based filling (sesame, coconut, and olive leaf extract) has been optimized for production conditions and the shell formulation to comprise of a flour mixture (Teff, chickpea, corn and rice) with Maca powder and Olive leaf extract as functional supplements. Proximate analyses and TPA analyses have been applied to various prototypes. Subsequently, prototypes were studied for the oro-gastrointestinal breakdown using a semi dynamic in vitro digestion model of the elderly gut (>65 years). Gastric and intestinal effluents are monitored by SDS-PAGE, LC-MS/MS proteomics and DIAAS determinations. Oral bolus of the products collected from healthy volunteers will also be characterized size and flow behaviour characteristics.
Results:
After optimization process, three formulae were produced: reference version without functional ingredients (Ref+ref), Maca-added product (Ref+maca) and product with Maca and Olive leaf extract (Maca+oleu) and contain 14±0.03%, 13.1±0.2%, 13.61±0.01% protein, respectively. One-bite compression TPA test shows addition of Maca powder and Olive leaf extract reduced product hardness values (16.0±0.9 N, 8.4±0.3 N for Maca+ref and Maca+oleu respectively) than the reference version (20±3 N). Proteomic analyses highlight the differential digestive fate of the various prototypes but establish the expected high digestibility of the products in the gut of seniors.
Conclusion:
In summary, the current study presents new knowledge about the impact of co-extrusion and formulation on the oral processing and digestive proteolysis of an innovative cereal product designed to benefit older adults.

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Impact of pulsed electric fields (PEF) on the peeling ability of tomatoes and kiwis

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Aim:
Peeling is a fundamental unit operation of fruit and vegetable processing. Peeling is performed by traditional methods as well as by novel methods such as blanching, steaming, lye peeling, infrared or ultrasound application and ohmic heating. However, the peeling methods can be further improved to minimize peeling losses and to improve the final product quality. In this study, the effects of the pulsed electric fields (PEF) technology was applied on tomatoes and kiwis in order to investigate the effects on their peelability.
Method:
The PEF treatments were performed using a batch system (Cellcrack 1, DIL, Germany). Monopolar shape pulses (pulse width of 200 µs and frequency of 2 Hz) were applied. An electric field strength of 1.0 kV/cm was used and the number of pulses was between 25 and 200 for tomatoes and between 50 and 500 for kiwis. The resulting total energy input was in the range of 0.6 and 5.0 kJ/kg for tomatoes and 1.3 and 12.6 kJ/kg for kiwis. The performances of the PEF treatments were compared with two traditional peeling techniques: blanching (98 ° C, 60 s) and lye peeling (2% NaOH, 98 ° C, 60 s). The peelability performances were assessed by manual peeling, mechanical peeling, mechanical properties of pericarp, skin resistance to mechanical stress, weight losses, colour, total carotenoids content and sugars content.
Results:
The PEF treatment on whole red tomatoes (1.0 kV/cm, 5.0 kJ/kg) and whole kiwis (1.0 kV/cm, 12.6 kJ/kg) led up to 70% decrease in force needed for mechanical peel removal compared to the untreated plant materials. Compared to lye peeling and blanching, the performance of the PEF treatment resulted in comparable or better peelability and in a significant reduction of pericarp softening and weight losses. However, the softening and the weight losses tent to increase by increasing the number of pulses for both the investigated matrices.
Conclusion:
This study proved that PEF can be a promising non-thermal technology to achieve a better peeling of fully ripe tomatoes and kiwis. Further studies are required to understand the mechanism behind the improved peelability and to evaluate the potential in industrial scale.

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Computational Approach for Radio Frequency Pasteurization Process of Peanut Butter with an Improved Temperature Uniformity

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Aim:

Recent *Salmonella* outbreaks in peanut butter have raised food safety concerns with respect to this product, and conventional thermal processing has certain disadvantages for pasteurization due to its lower thermal conductivity (low moisture high oil content product) with rather high viscosity. Radio frequency (RF) heating is a promising technology to reduce the safety risks with efficient thermal processing while still maintaining the quality. However, non-uniform temperature distribution observed during this process is a major challenge for developing an effective process.

Method:

Therefore, a mathematical model was developed using Comsol Multiphysics (v6.0) to define the process and experimentally validated in a staggered through field electrode RF system (27.12 MHz, 10 kW). High viscosity peanut butter was processed in a cylindrical polypropylene container (310 g) by RF at 9 cm electrode gap and 2250 V charged electrode potential. Local temperature measurements were recorded using fiber optic probes while surface temperature distribution was obtained with an infrared camera.

Results:

Fig. 1 showed the model results compared with the experimental data. Following the model validation, process efficiency improvement studies were carried out by turning over the container periodically during the process. This approach increased the average temperature from 55.8 to 66.5°C on top surface while there was an improved temperature uniformity thorough the product volume (Fig. 2) with maintained quality in terms of color and oil content. Then, various computational studies were carried out for an effective design of an industrial scale continuous process.

Conclusion:

The results of this study confirmed the potential of RF heating for thermal processing of low moisture foods with high viscosity.

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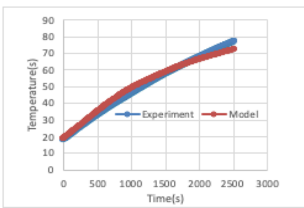

Fig. 1 Comparison of modeling results with experimental data

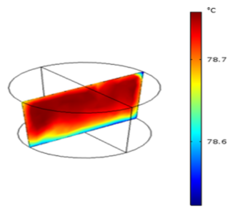

Fig. 2 Computational temperature distribution within the peanut butter sample at the end of the process

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Microwave Processing of Tahini Pasteurization: Computational Study for Industrial System Design

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Aim:
Low water activity food products (<0.85) have been subjected to significant outbreaks. Among these, *Salmonella* species are specifically observed, and one of the recent outbreaks affecting North America and part of Europe was linked to tahini (and halva) where the contamination possibly occurred during the earlier stages of process. Conventional thermal processing approaches have certain disadvantages for process efficiency due to the lower thermal conductivity and higher viscosity of tahini while microwave (MW) processing is promising to reduce safety risks while still maintaining the quality.
Method:
To demonstrate the MW processing effectiveness, first a mathematical model was developed (using Comsol V6.0) to determine the temperature change of tahini and experimentally validated. All thermal and physical properties of tahini were determined (dielectric properties and viscosity experimentally, and other thermophysical properties with respect to the composition). Then, microbial decontamination studies for *Salmonella enterica* ssp. *enterica* serovar Enteritidis (*Salmonella* Enteritidis; ATCC 13076) were carried out with 150 g tahini. MW processing times (150, 200, 270 and 300 s to reach 55-60, 65-70, 80-85 and 90-95 °C, respectively) at 1000 W power were determined using the developed model. Color and peroxide values (for a measure of oil oxidation) were evaluated, and industrial scale MW system design studies were presented.
Results:
MW processing over 270 s was determined for a decontamination level of more than 5 log cycle reduction without significant changes on quality parameters of color and peroxide value. Industrial scale design studies focused on continuous flow MW systems (with temperature uniformity of the tahini samples) to obtain over 80 °C temperature at the outlet with respect to the results of the microbial decontamination studies. The proposed – designed system was designed and presented to process 250 kg/h tahini sample with a significant temperature uniformity and microbial decontamination.
Conclusions:
MW processing for tahini samples was demonstrated as an efficient pasteurization process, and an industrial scale system design for continuous flow processing to obtain a temperature uniformity with a significant decontamination level of *Salomonella* was presented.
Acknowledgement:
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Development of β-sitosterol and γ-oryzanol oleogel-based emulsions for enhancement of oral bioavailability of hydrophobic molecules

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Aim:
Oral administration is the most preferred route for drug and bioactive delivery, though it raises great challenges due to the involvement of the gastro-intestine system and limited bioavailability. To this end, oleogel-based particles offer a very promising strategy overcoming this challenge due to the protective and hydrophobic environment. Thus, this study aims to improve the oral bioavailability of hydrophobic molecules by developing oleogel-based emulsion formulations.
Method:
A hot emulsification process followed by cooling was used to prepare gelled oil-based emulsions in the presence of β-sitosterol + γ-oryzanol mixture (PS) as an oleogelator. The inner microstructure of PS oleogel is made by the formation of a three-dimensional fiber network, in which both canola oil and dispersed hydrophobic molecules can be entrapped. The effect of PS concentrations was investigated (5%, 10% and 15% w/w of the total lipid phase). All the samples were assessed for their stability and their behavior under simulated gastro-intestinal conditions and changes in their particle size, zeta potential and morphology were evaluated. Furthermore, in vitro lipid hydrolysis, in vitro model hydrophobic molecule release, and in vivo oral bioavailability were studied.
Results:
The size of the oleogel particles significantly decreased with the increase in PS concentration. Samples prepared with PS showed a higher physical stability over a period of 90-d compared to unstructured emulsion. Gastro-intestinal digestion revealed that in unstructured emulsions there is a higher probability for particle coalescence with increased size compared to oleogel-based emulsions. The extent of lipid digestion was correlated to the particle size and the oleogel-network mechanical strength. All digested samples presented large negatively ζ-potential values. Moreover, the results also showed the formation of smaller mixed micelles during the lipolysis process when the particles were prepared using higher PS concentration implying on the ability to control micelle size during digestion.
Conclusion:
Overall, the results demonstrated that combination of solid and liquid lipid components offers mechanical protection, on one hand, and micellization of the hydrophobic molecule during digestion, on the other hand. Therefore, the obtained oleogel-based emulsion has the potential to be utilized as effective encapsulation systems for hydrophobic molecules.

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Complete mechanical characterization of meat samples using shear wave elasgography: preliminary results

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Aim:

Consumers define tenderness of meat as its most important organoleptic characteristic and find variability and lack of consistency as two of the main problems in meat industry [1]. Assessing the tenderness with in-line, non-destructive technique could provide a useful tool for this industry. Shear wave velocity (SWV) and attenuation (SWA) are related to the mechanical properties of soft solids. To properly obtain mechanical properties, SWA should be corrected by diffraction effects induced by the shear wave source. To our knowledge, diffraction correction in transverse isotropic media (TIT) such as some meat cuts has not been reported. In this work we address this correction to provide full mechanical characterization of meat using SWV and SWA.

Method:

Experiments were conducted in a meat sample (“peceto” type). A 7 MHz probe was used to generate and track shear waves. The pushing sequence consisted of four pushing points at 4 different depths. Then, the shear wave was tracked using plane wave insonification at 5 kHz framerate. Measurements were carried out with the probe parallel (//) and perpendicular (⊥) to the fibers’ orientation. To quantify diffraction effects, a simulation of the experiment was conducted under the assumption of a purely elastic TIT were SWA can be attributed completely to diffraction effects. The radiation force field was computed using FieldII [2] and used as a shear wave source to calculate the displacement field using a Green’s function algorithm [3]. Finally, experimental SWA values were corrected using simulation by subtracting attenuation obtained through simulation (caused by diffraction) to the experimental values.

Results:

For the meat samples SWV at 100 Hz along both axes were $SWV_{//}$ = 4.5 ±0.7 m/s and $SWV_{\perp}$ = 3.2 ±0.3m/s. SWA coefficients before correction at the same frequency were $\alpha_{//}$ = 89±14 Np/m, $\alpha_{\perp}$= 135±20 Np/m, which after correction became $\alpha_{//}$ = 68±14 Np/m, $\alpha_{\perp}$= 112±20 Np/m. These results are in good agreement with [4].

Conclusion:

The methodology presented allowed diffraction correction in TIT, which avoids overestimation of the SWA. Future work will address the possibility of using this methodology to characterize different meat cuts. Sports medicine and other food industry applications are also envisaged.

Funding: ANII - FMV_1_2019_1_155527 – Espacio Interdisciplinario UdelaR

[1] Geesink et. Al 2000 [2] Jensen JASA 1991 [3] Chatelin PMB 2015 [4] Catheline JASA 2004

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The effect of polyphenol supplementation and high-pressure homogenization on yogurt alternative fermentation and polyphenol bioavailability

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Aim:
Supplementation of polyphenol-rich matrixes to yogurt is a convenient way to deliver the health-promoting properties related to polyphenols. Yet such supplementation can affect the techno-functional properties of the yogurt alternatives and their bioavailability. It was suggested that polyphenols can interact with proteins to form complexes. This wotk aimed to study the impact of fermentation and high-pressure homogenization (HPH) on the bioavailability of polyphenols and their interaction with proteins, as well as the impact on the chemical and rheological properties of protein matrix during yogurt fermentation. This study is focused on a model system using plant proteins and polyphenols extracted from grape (*Vitis labrusca* L.) seed extract (GSE).
Method:
We characterized the influence of the incorporation of polyphenols from grape seed extract and HPH treatment prior to inoculation with the lactic acid bacteria (LAB) *Lactobacillus bulgaricus* and *Streptococcus thermophiles* on the techno-functional properties of the proteins in the gelation together with the bioavailability of the polyphenol compounds during the fermentation time. The effect of both HPH and GSE on protein solubility, structure, and surface hydrophobicity was studied. In addition to antioxidant capacity measurements and total polyphenols content measurements, quantification of free phenolic compounds was performed using a high-performance liquid chromatography-mass spectrometer (HPLC-MS) during the yogurt fermentation. Gel physical properties as affected by HPH and GSE addition were also examined.
Results:
LAB improved the bioavailability of polyphenolic compounds from GSE by inducing changes and formation of metabolites with better bioavailability and higher biological activity than their origin molecule. The total polyphenols and antioxidant capacity values increased after fermentation; this may be related to LAB fermentation metabolites and the changes in the GSE polyphenol profile after the fermentation. Homogenization of proteins increased the surface hydrophobicity, enhancing the interaction with GSE polyphenols. The rheological measurements demonstrated that all samples reflected characteristics of a weak gel. However, G’ and water holding capacity values of GSE-supplemented yogurt alternatives were lower compared to the control (without the addition of GSE).
Conclusion:
This study showed that producing a GSE-enriched yogurt alternative is feasible, and GSE can be used as a functional food ingredient in yogurt alternative production.

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Active antioxidant gelatin films composed by coffee parchment lignin nanoparticles

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Aim:
Due to growing concerns about sustainability, practices related to the reduction of the use of non-renewable resources and the recovery of agri-food waste are increasing. The coffee industry generates huge amounts of waste with added value. This research focuses on the conversation of coffee parchment, a by-product of green coffee beans production, into lignin nanoparticles (LNP) for their use as components of gelatin films with improved physicochemical properties and antioxidant activity.
Method:
Lignin was extracted using natural deep euthectic solvents composed of acetic acid or lactic acid with choline chloride. Afterwards, lignin nanoparticles (LNP) were prepared by an anti-solvent method, and characterized according to their yield, morphology, size, z-potential, and stability. For comparative purposes, a commercial kraft-lignin was also employed. Gelatin film-forming solutions and films incorporating LNP from coffee parchment or commercial lignin (1-3 g/100 g gelatin) were produced and characterized according to their rheological, mechanical, barrier (water vapour, light) and/or antioxidant properties.
Results:
Lignin obtained from coffee parchment using acetic acid and choline chloride (≈50% yield) showed the best functionality for nanoparticle production, considering yield, morphology, size, Z-potential and stability. All these properties were similar to those obtained for nanoparticles prepared with commercial lignin. The presence of LNP did not affect the viscoelastic properties of the gelatin film-forming solutions. On the contrary, the LNP-gelatin films showed better mechanical properties (maximum tensile strength and modulus of elasticity), barrier to water and UV light, and antioxidant capacity than the control prepared using only gelatin, with only minor changes in other properties such as transparency or extensibility. Little differences were found between the films produced using LNP from coffee parchment lignin and that commercially available.
Conclusion:
Coffee parchment is a good source of lignin which can be converted into LNP by a simple method. Once incorporated into gelatin films, LNP provide UV light barrier and antioxidant properties to this food coating or packaging materials without impairing other physico-chemical properties. Therefore, the results support the feasibility of coffee parchment for producing active food coating or packaging.

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Effect of novel deep eutectic solvent extraction on structure-functional properties of fava bean protein isolates

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Aim: The effects of deep eutectic solvent (DES)-based protein extraction on some structural and functional properties of fava bean protein isolates (DESE-FBPI) were determined in comparison to conventional salt (SSE- FBPI), alkaline (ALKE-FBPI) extraction and commercial soy protein isolates (CS-PI).

Method: The choline chloride- glycerol-based DES system developed in our group was used to extract protein from fava bean. Conventional protein extractions and functional properties evaluation were performed using previously established methods. Gel electrophoresis (SDS- PAGE) amino acid (AA) and Fourier transformed infrared spectroscopy (FTIR) analysis were carried out to determination of structural changes.

Results Protein content of fava bean flour, DESE-FBPI, ALKE- FBPI, SSE-FBPI, and CS-PI was 30.68±0.12, 92.33±2.28, 92.50±1.36, 92.12±1.21, and 86.97±2.58% respectively. The greatest solubility was observed for all protein isolates at higher acidity and alkaline conditions, and the lowest at pH 4.0-5.0. Solubility of extracted protein isolates was increased in the order of SSE-FBPI>DESE-FBPI>ALKE-FBPI>CS-PI. Gel electrophoresis showed significant similarities in molecular patterns except in alkaline extraction, where some of the lower molecular weight protein (10kDa) disappeared. Based on the AA composition, DESE- FBPI exhibited higher AA content compared to all other protein isolates. FTIR data indicated that DES extraction and SC-PI increased α-helix content; 21.37% and 30.8%, respectively, compared to other isolation methods. Both ALKE-FBPI and SC-PI showed intermolecular β sheets as protein aggregates, 7.61% and 8.53%, respectively. The differences in the extraction methods reflected better forming capacity in DESE-FBPI (132.50± 1.66%) at pH 3 with 0.5% (w/v) protein concentration compared to other protein counterparts. At a protein concentration of 0.2% (w/v), emulsion formed by DESE-FBPI had a higher Emulsification index at both pH 3 (33.5±0.23) and pH 9 (40.83±0.89). Based on the least gel concentration, CS-PI produced firm gel at a protein concentration of 15% (w/v) (pH -7) while DESE-FBPI produced at 20%.

Conclusion: It can be concluded that functional properties of protein isolates are dependent on the type of extraction technique in which structural confirmation, pH and protein concentration had a better influence on DESE- FBPI. Therefore, our findings support that DESE- FBPI has potential in new food applications.

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Pressure Effect on Microwave Heating and Development of Innovative Sterilization Process for Canning

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Aim:
Canning as a conventional thermal process has been applied for over 200 years with retort sterilization while microwave sterilization is used mostly for ready-to-heat meals, and continuous flow tubular processing is another approach to replace to innovate conventional aseptic processing. With the development of poly-propylene-based thinner wall semi rigid containers, MW processing might be used for innovation in the conventional canning, but the effect of pressure on the microwave heating should be known for this purpose. Therefore, the objective of this study was to determine the effect of pressure (2 bar) on temperature increase of the food products and develop computational models to present a MW sterilization process.
Methods:
77% moisture Tylose material was used in the experiments, and the MW heating experiments were carried out in a custom-built cylindrical cavity system (operated at 2450 MHz with adjustable power, 1-6 kW at both atmospheric and 2 bar pressure). The comparison of these experiments were used to determine the pressure effects on the MW heating, and a mathematical model was developed (and experimentally validated) to determine the temperature change. Following this, end-over-end (EoE) rotational processing was combined with the MW heating at 915 MHz to both benefit of the electromagnetic field variation and increased penetration depth for temperature uniformity.
Results:
The experimental results demonstrated the non-significant effect of the pressurized process on the temperature increase and indicated the use of the developed (and validated model) for a further sterilization process. The computational model, for this objective, was modified for an industrial scale MW system including EoE rotational mechanism and using a poly-propylene container. The results indicated the significant temperature uniformity effect of 915 MHz frequency with the applied rotation with a significant process efficiency.
Conclusion:
MW sterilization process was presented for efficiency and novelty for innovation of the conventional canning process. It was rather important to use the available poly-propylene-based containers for electromagnetic transparency as thinner and robust containers. The results of this study were to present an industrial process to compare the results for process efficiency in terms of process time and product quality.

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Effect of artisanal or industrial fermentation process on the sensory qualities of traditional French bread.

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Aim:
This study aimed to evaluate the importance of the duration and temperature of the fermentation process involved in French bread making process on the formation of aromas and Maillard reaction products (MRPs), playing a role on the sensory properties of breads.

Methods:

Yeast bread (YB) and sourdough bread (SB) were prepared according to traditional French bread making process after artisanal and industrial fermentation. Volatile compounds were semi-quantified by GC-MS, acrylamide assay was performed by LC-MS/MS and water-soluble melanoidins were analysed by a HPLC system coupled to a fluorescence detector. Descriptive sensory analysis was carried out by a panel of ten well-trained panelists.

Results:

In the crumb, the aromas coming from leavening agents' metabolisms were influenced by the type of fermentation studied i.e. aromas from fermentation were much more concentrated in artisanal breads, in particular alcohols from yeasts alcoholic fermentation in the YB, and acids produced by Lactobacilli in the SB. In the crust, Strecker aldehydes and heterocyclic compounds, which play a role in improving the sensory quality of breads, were more present in both the artisanal YB and SB. Conversely, industrial fermentation led to higher melanoidin amounts as well as acrylamide.

The descriptive sensory analysis highlighted the higher aromatic intensity and a more pronounced acidity in artisanal SB, comforting the previous results.

Conclusion:

Both type of fermentation had a significant impact on sensory properties of breads, through fermentation mechanisms and MR pathways. Some products of fermentation and MRPs associated with the typical and pleasant taste of bread were found in higher amounts in both the artisanal breads, and these results were confirmed by the panellists.

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The Effect of Mondora myristica Extract on the Oxidative Stability of Cashew Nut Spread

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Aim: To study the Effect of *Mondora myristica* Extract on the Oxidative Stability of Cashew Nut Spread
Introduction: Lately, the growing concern is not only how to feed the expanding population, but also how to provide nutritious and healthy diets that are not only chemical free but sustainable. Cashew nut is an execellent nut with about 21% protein, 28%carbohydrate, 46%fats and oil and 2.5%Total Ash. Spreads are generally prepared from foods from animal origin which are usually expensive and equally not sustainable in terms of demands and supply. *Mondora myristica* extracts have properties which are bactericidal and antibacterial attributed to the presence of compounds like phytosterols, phenols, tocophherols and flavonoids which protects fat from oxidation (Owen et al., 2017). The deliberate campaign for healthier foods to accommodate the changing lifestyles and health awareness of modern consumers who eats by "the label" has led to search for alternatives to chemical additives used as preservatives from plants with anti-oxidative properties that can extend the shelf-life of food.
Method: Cashew nuts paste was mixed with *Mondora myristica* extracts ((El-Mahmood, 2009) in ratios 95:5, 90:10, 85;15, 80:20 and 100% cashew nut paste as control. Physico-chemical and microbial analysis were carried out over a period of five weeks.
Results: The results showed scanty growth for yeast and mould especially in samples with increased blends of *Mondora* myristica extracts. A count of 2-16cfu/g which is less than recommended 100cfu/g in a spread was observed after five weeks of storage. The Physico-chemical analysis results revealed that the pH, acid , peroxide and iodine values of the 100% cashew nut paste was higher than the sample blended with *Mondora myristica* extracts and these values decreased as the substitution of *Mondora myristica* increased.
Conclusion: The addition of *Mondora myristica* extract into cashew nut paste enhanced the shelf-stability of the spreads; the extract was able to retard the growth of yeast and mould and a relative low pH, acid, peroxide and iodine value which are indicators of good keeping quality was observed. Addition of up to 20% *Mondora myristica* extract is recommended to prevent oxidative rancidity in cashew nut spread.

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The quality of frozen-thawed salmon fillets as affected by sub-chilling prior to freezing

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Aim:
The present study aimed to enhance the quality of thawed Atlantic salmon by implementing sub-chilling prior to freezing.

Methods:
Eighty salmon (4-5 kg) were electrically stunned and bled commercially before being divided into two equal-sized groups. The first group (*ice*) was packaged on ice in eight expanded polystyrene boxes, whereas the second group (*RSW*) was immersed in a premade refrigerated seawater (RSW)-cooling system. The RSW-setup was created using a 7% NaCl brine and ice, creating an environment of ~-1.0°C. After chilling, the fish was hand-filleted and vacuum-packed (99% vacuum) before the fillets were randomized (20 fillets per group) into a factorial design following the fixed factors "chilling condition" (*ice* versus *RSW*) and "storage condition" (*fresh*, *one-*, and *four-months frozen*, respectively). The "storage condition" *fresh* was used as a control. The control groups (*ice-fresh* and *RSW-fresh*) were, after packaging, directly placed in the cold room (0.6±0.5°C) and evaluated through a 16-day storage experiment. The fillets to be frozen (*ice* and *RSW*, *one-* and *four-months* frozen, respectively) were flash-frozen (30 minutes) with dry ice (-78.5°C) before being stored in a freezer (-28.5±1.4°C). After frozen storage (*one- and four-months*), fillets were thawed in a water-bath (4°C) for 4 hours before being transferred to a cold room (0.6±0.5°C), conducting the same storage experiment as the *ice-fresh* and *RSW-fresh* controls. The salmon fillet quality throughout the storage experiments (*fresh* and after *one- and four-months* of frozen storage) was evaluated by following the fillet drip loss, texture, and colour, as well as protein denaturation, adenosine triphosphate degradation, and microbial parameters on day 1, 5, 12, and 16 post packaging/thawing.

Results:
Sub-chilled fish (*RSW* groups) had a higher drip loss than those ice-chilled, with lower aerobic plate counts and higher concentrations of inosine monophosphate. Moreover, frozen fish showed a higher drip loss than the fresh controls, lower total viable psychotropic counts, surface-breaking force, firmness, chroma, and higher hue. All groups showed a decrease in quality through storage.

Conclusion:
It is concluded that sub-chilling prior to freezing improved the overall quality of fresh and frozen-thawed salmon fillets, whereas no effect of frozen storage time was observed.

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Acid-based stabilisation of carrot pomace by instant organic acid addition and fermentation

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Aim:

Carrot pomace, a by-product obtained after carrot juicing, is currently used as animal feed. However, carrot pomace still contains valuable components such as carotenoids, vitamins and dietary fibres (e.g. pectins) which could be used for human applications. Indeed, pectin is one of the valuable components with interesting functional properties for gelling, stabilising, thickening and emulsifying applications. As carrot pomace also contains high amounts of water (85g/100g fresh pomace) and fermentable sugars (5g/100g fresh pomace), deterioration by microorganisms and/or endogenous enzymes can occur rapidly after carrot juice processing, which results in microbial spoilage and pectin degradation, as well as it may lead to the production of toxic compounds. Therefore, stabilisation of the matrix is necessary. Freezing or drying requires large amounts of space and energy, in contrast to acid-based stabilisation methods such as acid addition or lactic acid fermentation. During storage, it is expected that resulting pH decreases can stabilise the matrix.

Method:

Carrot pomace was treated by different w/w% additions of acetic acid (AA). Additionally, after screening 10 lactic acid bacteria (LAB), three were selected based on their growth potential, to be added to carrot pomace. Results were compared with natural fermentation (NF), i.e. without addition of any starter culture. During incubation, several parameters such as pH and the number of LAB, yeast and moulds (Y&M) were assessed, as well as, several (fermentation) metabolites (organic acids, sugars, ethanol). Additionally, after 8 weeks of incubation, pectin in the stabilised pomace was characterised by measuring the galacturonic acid and neutral sugar content.

Results:

The results indicate that AA addition can instantly inhibit growth of Y&M at both 21 and 30 °C as opposed to NF. Careful selection of the LAB could also result in minimal growth of Y&M during incubation at 21 °C and no observed growth of Y&M during incubation at 30°C. Stability of the carrot pomace could also be linked to fermentation metabolites after LAB addition during incubation.

Conclusion:

Addition of 3 w/w% AA or specific LAB during incubation of carrot pomace can lead to full inhibition of Y&M growth at 30 °C, even when stored during 12 weeks.

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Protein-enriched breads as an alternative dietary source of sustainable protein: Sensory properties and consumer acceptability.

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Aim:

Pulse flours offer a sustainable protein source, for innovation of protein-enriched foods. The current study sought to investigate the sensory profile of wheat breads following the addition of high-protein pea flours.

Method:

Wheat flour was substituted with raw- and toasted-pea flour (30% w/w) in a white bread formulation. The sensory properties of the enriched bread were determined through physical analysis: loaf dimensions, crumb structure, texture, staling; volatile analysis: HS-SPME GC-MS; and rapid descriptive sensory methods: Flash Profiling (FP) and Check-All-That-Apply (CATA).

Results:

Breads reformulated with toasted-pea flour had comparable specific volume and density to the wheat flour control. Bread staling was not affected by the inclusion of pea flours. Protein content of bread containing pea flour ranged from 10.1-10.8%, compared to the control bread (8.27%, $p<0.001$). Aroma profiling revealed significant differences in the total concentration of volatile compounds following the addition of pea flour. Breads formulated with raw-pea flour were characterised by higher concentrations of aldehydes and ketones compared with the control. These are typically characterised by “green” and “beany” aromas. Breads formulated with toasted-pea flour were characterised by significantly higher concentrations of pyrazines, resulting from Maillard reactions, which are associated with roasted and nutty aromas. Trained panellists (8) generated 79 semantically different attributes to discriminate between the different wheat-pea flour breads and the control. Attributes were grouped under appearance, texture, aroma, flavour, taste and aftertaste. The CATA questionnaire indicated that texture attributes of the breads were significantly affected by the addition of both raw- and toasted-pea flour. Aerated, soft, fresh and springy were the attributes that had the highest association with consumer liking, while dry, hard and stale properties significantly reduced liking scores. However, changes in volatile profile were not detected by consumers and did not impact the liking scores, indicating that volatile differences were likely below their odour thresholds and could not be perceived.

Conclusion:

Results from this study suggest that toasting may have applications in flavour improvement of pulses for use in New Product Development. Panellists confirmed that appearance and texture attributes contributed significantly to consumer acceptability, highlighting an opportunity to increase consumer acceptance by improving crumb structure and texture.

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Stabilisation of potato trimmings for protein extraction by lactic acid fermentation

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Aim:
Potato trimmings, generated during the cutting stage of potatoes to French fries, are seen as by-products as they do not fulfil size and/or colour requirements. Currently, they are mainly used as animal feed. However, potato trimmings contain approximately 4g true protein/100g trimmings (dry matter based), with interesting nutritional and functional properties, that when extracted can be used for human applications.
As potato trimmings also contain high amounts of water (70g/100g fresh trimmings), they are easily spoiled by microorganisms or by the action of endogenous enzymes. This will result in protein losses and unwanted compound formation. Less energy- and space stabilisation methods, such as acid-based ones, of which lactic acid fermentation is an example, could replace classical stabilisation methods.
Method:
After screening six lactic acid bacteria (LAB), potato trimmings were treated by the addition of three amylolytic LAB, capable of producing extracellular amylase, to degrade starch into fermentable sugars. Fermentation was followed up by determination of the number of LAB, yeast and moulds (Y&M) and pH during incubation at 30 °C. Additionally, different (fermentation) compounds such as organic acids, sugars, ethanol, as well as protein content, were quantified and compared to results obtained during natural fermentation (NF). Visualisation of both the potato trimmings' structure and potato proteins was performed by cryo-SEM and Confocal Scanning Laser Microscopy to have an indication of the impact of the fermentation process on cell wall degradation.
Results:
Careful selection of the added amylolytic LAB during fermentation at 30°C led to no outgrowth of Y&M during 8 weeks of fermentation and resulted in 10 % less decrease in true protein content compared to NF. Microbial parameters could also be linked to fermentation metabolites and the observed stability. Structural analysis was able to visualise increased starch degradation by the addition of amylolytic LAB and potato proteins were clearly observed.
Conclusion:
Lactic acid fermentation of potato trimmings led to better preservation of the protein content with limited growth of Y&M versus natural fermentation.

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Impact of culinary practices on microconstituents' bioaccessibility : the example of a model tomato sauce

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Aim: Eating fruits and vegetables is recognized to have health benefit such as protection against cardiovascular diseases, certain cancers or vision… These effects can be partly attributed to microconstituents of fruits and vegetables. However, concentrations in the raw food product are not necessarily good predictors of bioavailability. Indeed, the food matrix, with all its complexity, the food preparation (including culinary practices), and structural factors of microconstituents (as Z-isomers) matter. Therefore, it is important to know how sauce composition and/or thermal process can influence the fate of microconstituents and their bioaccessibility. This will be illustrated here with carotenoids, capsaicinoids, polyphenols and Amadori compounds, in a model tomato sauce.
Method: Tomato sauces containing varying proportions of olive oil, onion and sweet pepper were cooked by conventional or microwave heating; bioaccessibilities of microconstituents were evaluated by *in vitro* digestion.
Result: Increased lycopene diffusion and bioaccessibility were correlated to increased Z-isomerization during heating of tomato-based sauces. Addition of EVOO (extra virgin olive oil) had the highest positive effect, followed by onion. Unblanched onion favored Z-isomerization of lycopene, probably by a radical mechanism involving degradation products of diallyl disulfide (DADS), formed by alliinase-catalyzed breakdown of non-volatile precursors in onion. Compared to conventional heating, microwave heating also promoted Z-isomerization of lycopene and total lycopene diffusion, especially the combinations of high power and short time. Polyphenols and their bioaccessibility were generally stable during processing. Amadori compounds, generated from free amino acids and sugars, were present in low concentrations in the tomato-onion-EVOO sauces but greatly increased by addition of dried pepper, as were capsaicinoids, during thermal processing and with no effect on Z-isomerization of lycopene. Amadori compounds, whose bioaccessibility was characterized for the first time, showed both a very variable bioaccessibility, *N*α-(1-Deoxy-D-fructos-1-yl)-L-Arginine being the most bioaccessible, but also degradation notably during the gastric phase of in vitro digestion.
Conclusion: Z-isomerization of lycopene, a key step for bioaccessibility of lycopene in tomato sauce, was induced by the presence of unblanched onion and oil during cooking, but not by addition of pepper. These results highlight the relevance of taking into account all ingredients to understand health impact of fruit and vegetables.

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Encapsulation of anthocyanins in alginate beads using electrostatic extrusion: process optimization and storage stability

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Aim:
The objectives of this study were to: 1) optimize the encapsulation efficiency (EE) and particle size of alginate beads containing purple corn anthocyanins and 2) to obtain capsules with desired stability for their potential application in intelligent food packaging and functional food products.
Method:
Purple corn extract was incorporated into alginate beads by ionic gelation via the electrostatic extrusion technique and response surface methodology (RSM) was used to predict optimal parameters, including alginate concentration, extrusion voltage, and extract concentration. A Box-Behnken design was employed to determine the highest encapsulation efficiency and minimum particle size. In the next step, the models were validated by the actual experiment. Purple corn anthocyanins-loaded alginate beads were then produced according to the obtained optimal parameters, and the effect of storage temperature and time on the stability of the capsules was studied during one month of storage.

Results:
Alginate concentration and extrusion voltage significantly influenced ($p < 0.05$) mean particle size and EE based on total phenolic content (EE_{TPC}), whereas EE based on cyanidin-3-glucoside (EE_{C3G}) was mainly affected by extract concentration. The maximum encapsulation efficiency and minimum particle size were found to achieve at 1% (w/v%) alginate, 20% (w/w) extract, and a voltage of 5kV based on mathematical optimization. At optimal points, the actual encapsulation efficiency was 70.2% and 91.5%, based on TPC and cyanidin-3-glucoside, respectively with the mean particle size of 1293.6 µm. Validation studies were carried out by comparing the predicted and experimental results. The error between actual and predicted data, in turn, was reported to be 6.5%, 2.3%, and 5.1% for EE_{TPC}, EE_{C3G}, and mean particle size. Stability studies revealed the anthocyanins retention of 82.23% for encapsulated samples, while this value for the plain extract was 23.5% at the end of the storage period. Furthermore, anthocyanins retention was improved by 33.7%, 30.5%, and 31.3% at room temperature, 8 °C, and 4 °C, respectively.

Conclusion:
The RSM method successfully determined the optimal production conditions for purple corn anthocyanin-loaded alginate beads with desired stability paving the way for the potential use of these beads in the intelligent packaging systems and food or pharmaceutical products.

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Seasonal and geographical variations in size and gonad quality of sea urchins harvested in Mid-Norway

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Aim:

The aim of the present study was to investigate seasonal variations in biometrical, physicochemical, and microbiological parameters of sea urchins (*Echinus esculentus*) harvested at different locations in Mid-Norway.

Method:

Sea urchins were harvested during autumn, winter, and spring. Given that the quality of sea urchins can be affected by the surrounding environment, two different locations were selected. The first location was in Trondheimsfjorden, close to areas with intense agricultural and human activity. The second one, was located at the coastline in open water. The biometrical parameters of sea urchins were measured. Samples from the gonads were collected to determine the proximate composition, pH, psychrotrophic plate counts (PC), *Pseudomonas* spp. and *Enterobacteriaceae*. In the present study, the results from autumn and winter harvest are only included. Results from the spring sampling will be included at the conference.

Results:

The size of sea urchins and the gonad index were significantly affected by season and location. No significant correlation was found between size and gonad index. Moreover, the proximate composition was not affected by the location. The winter sea urchins had higher water and ash content in either of the locations than in autumn ones, while a non-specific pattern was found for the lipid content. Although no seasonal variations were found in total amount of proteins, a negative correlation was found between the water and protein content. The pH of gonads was significantly higher during winter. The location did not affect the PC counts, but they were significantly lower in winter harvested sea urchins. No *Pseudomonas* spp. and *Enterobacteriaceae* were detected.

Conclusion:

The preliminary results, based on two seasons, indicate that the harvesting season mainly affects the gonad's quality. This study's outcome contributes to a better understanding of the nutritional value and the microbial quality of sea urchins originating from different locations in Norway. However, further research is needed to determine the possible utilization of sea urchins as a food in the Norwegian market or exported to Europe.

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Comparison of the frictional properties of plant and dairy proteins

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The food industry has a long-standing interest in increasing the protein content of food products. In recent times, plant proteins have increased in popularity due to the rise in veganism and awareness of sustainability issues. However, increasing protein concentration often generates an undesirable mouthfeel, which is even more prominent for plant proteins[1,2]. Although the molecular mechanisms behind such adverse sensorial perception remain poorly understood, electrostatic interaction between the protein and saliva during oral processing are often hypothesized to be the cause of such adverse perception[3]. Therefore, the aim of this study was to compare *in vitro* mouthfeel properties of alternative cereal and legume proteins (wheat, pea and soy) with dairy proteins (whey protein isolate and sodium caseinate) at higher concentrations (5-20 wt%) using soft tribology and quartz crystal microbalance with dissipation monitoring (QCM-D). Methods: soft tribology was performed using glass-polydimethylsiloxane (PDMS) contact surfaces to analyse the lubrication behaviour of proteins at 37 °C in the absence and presence of model saliva (protein: saliva ratio: 4:1 w/w). QCM-D was carried out using PDMS as a substrate coated with mucin to reproduce orally relevant surfaces. Preliminary results reveal effects of protein concentration and saliva-protein ratio on the lubrication performance. Solubility of plant proteins was also a key factor affecting the lubricity and adsorption behaviour. Future studies involving sensory tests are key to understand whether such in vitro tools are correlated with mouthfeel perception using plant proteins.

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COMPARATIVE ANALYSIS ON ORGANIC AND INORGANIC VEGETABLES: A SCIENTIFIC APPROACH ON CONSUMERS' PERCEPTION

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Aim: To determine the heavy metal contaminations and pesticide residues of organic and inorganic fluted pumpkin leaves (*Telfairia occidentalis*) from two farms as factors that could determine consumers preference in choosing organic or inorganic vegetables for consumption.

Introduction: Consumers have different perceptions on the consumption of organic and inorganic vegetables, especially in terms of how safe they are due to growing health awareness about food safety. This study decided to investigate the safety of organic and inorganic fluted pumpkin leaves collected from two different popular farms located at Ikorodu, Lagos State for consumers to be able to have informed choices of what they eat and how safe they are.

Method: The heavy metal and pesticide residue analysis of organic and inorganic fluted pumpkin leaves (*Telfairia occidentalis*) from two farms were evaluated. The vegetables were analyzed for presence of heavy metals (Iron, Lead, Cadmium and Zinc) on Atomic-Absorption-Spectrophotometer while pesticide residues were determined on a Gas Chromatography-Mass Spectroscopy utilizing 4-chloro-2-methylphenol, Endrin, 2,4 dichlorophenoxy, Paraquat dichloride, Lindane, gamma-Lindane, Aldrin, Malathion, Heptachlor Epoxide, Dieldrin, p,p'-DDT, Endosulfan I, Cis-Nonachlor, p,p'-DDE, Pirimiphos methyl, Endosulfan sulfate, Endrin aldehyde and Methoxychlor.
Results: The result of the heavy metals analysis of the vegetables shows low heavy metals contamination, as lead, cadmium, iron and zinc were within safe level of (0.001 – 0.890 mg/L) as described by FAO/WHO, 2010 as the accepted limit (0.10 mg/L for cadmium and 0.3 mg/L for lead) meaning both vegetables samples from the sampling locations are safe for consumption. The result of the pesticide residues shows that the organic vegetables had a very low (0.00 Mg/Kg and 0.009 Mg/Kg) and were within WHO limit for pesticide residue (0.02 mg/kg lower limit and 0.7 mg/kg upper limit). This implies that the organic fluted pumpkin leaves are safe while the inorganic samples had more residues (0.017 Mg/Kg and 0.032 Mg/Kg) but still with a safe limit.
Conclusion: The study concluded that organic and inorganic fluted pumpkin vegetables examined were safe for consumption but consumers still preferred the organic vegetables because of the lower heavy metal contamination and pestidue residues compared with the inorganic samples analysed.

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NUTRITIONAL PROFILE AND SENSORY QUALITY OF SNACK BARS FROM OAT, SESAME SEED AND COCONUT FLOURS

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Aim: To develop and assess the quality characteristics of a snack bar using a combination of oat flour, sesame seed flour and coconut flour.

Introduction

The lifestyle of the modern day consumer is gradually evolving with more interest being shown towards food composition, i.e. the consumer desires to know what exactly is being consumed per time. These convenience foods and snacks are expected to provide functional health benefits to the consumer. The consumption of oat (*Avena sativa*) in human diets is increasing because of the health benefits associated with dietary fibers such as functional protein, lipid and starch components and phytochemicals present in oat grain (*Gupta et al. 2010)*. Sesame seed (*Sesamum indium*) contains protein with a balanced amino acid composition, dietary fibre and important bioactive compounds with antioxidant activity and health-promoting effects, such as lignans, mainly sesaminol triglucoside, sesamolinol diglucoside and sesaminol diglucoside (Melo *et al*., 2021). Snack bars are solid foods and can be developed using raw materials that provide adequate calories, protein, fat, and other nutrients and micro nutrients which are necessary for growth and development.

Method:

The oat flour, sesame seed flour and coconut flours were blended in the following ratio using D-optimal design for three dependent variables: 80:15:5, 70:20:10, 75:15:10, 80:10:10, 75:20:5 for sample BCM, OSP, KPR, OPG and GSN respectively and the snack bars were produced from the blends. The nutritional profile (proximate and micronutrient composition) and sensory analysis were determined.

Results:

The nutritional profile of the snack bars revealed that sample OPG (80% oat:10% sesame:10% coconut flours) had the highest values for crude ash, fat, fibre, protein, carbohydrate, and calorific value with considerable contents ofiron and calcium. Consumer acceptability of the snack bars revealed that that sample BCM (80% oat flour:15% sesame seed flour:5% coconut flour) was rated the best in terms of colour, taste, aroma, mouth feel, texture and overall acceptability with a mean score of 7.10.

Conclusion: Acceptable snack bars with high protein and fibre content can be successfully produced from oat flour, sesame seed flour and coconut flour up to 10% substitution of both sesame seed and coconut flours.

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DEVELOPMENT AND CHARACTERIZATION OF IMITATION YOGHURT FROM BLENDS OF PIGEON PEA AND ALMOND SEED MILKS.

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Aim: To determine the effects of substitution on the proximate composition, physiochemical and sensory properties of imitation yoghurt from blends of almond milk and pigeon pea milk.
Introduction: Poor nutrition, as a result of poor eating habits which include under- or over-eating, not having enough of the healthy foods needed daily, or consuming too many types of food and drink, is one of the leading causes of global health problems. Milk from seeds and nuts could serve as an alternative to animal milk in the production of yoghurt. Pigeon peas (*Cajanus cajan*) are rich in protein and also contain bioactive compounds which play a vital role in modulating the gut micribiota hence, can reduce inflammation (Talahari and Shapakkar, 2018). Almond (*Prunus amygdalu var. dulcis*) is a good source of vitamins, minerals, dietary fiber, mono- and polyunsaturated fats which have cholesterol reducing properties (Alozie and Udofia, 2015). Advocacy for dietary diversification, as a practical and sustainable way to encourage the use of nutritious and readily available food crops, can solve health challenges of the populace, while improving global food and nutritional security.

Method: Imitation yoghurt was produced from blends of pigeon pea milk, and almond seed milk in the following ratio: 90:10, 80:20, 70:30, 60:40 and 50:50 with 100% pigeon pea imitation yoghurt serving as the control. The effects of the substitution on the proximate composition, and physiochemical of the samples were investigated. Sensory analysis was also conducted on the imitation yoghurt.

Results: The proximate analysis showed that sample XYZ (60% Pigeon pea milk:40% Almond seed milk) had the highest contents of protein, crude ash, crude fat, crude fiber and carbohydrate contents. The physiochemical tests revealed that as the level of inclusion of almond seed milk increased, the total titratable acid and pH reduced, while the total solids, brix content and viscosity increased. Sensory analysis showed that sample XYZ (60% Pigeon pea milk:40% Almond seed milk) was the acceptable.

Conclusion: The study has revealed that acceptable and nutritious imitation yoghurt can be obtained from pigeon pea milk and almond seed milk up to 40% substitution level of almond milk.

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Effects of abiotic factors on the callus induction of Ecklonia cava for sustainable food production

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Effects of abiotic factors on the callus induction of *Ecklonia cava* for sustainable food production

Abstract

Aim: The brown macroalgae *Ecklonia cava* is widely used as food and therapeutics in Korea. Its industrial use requires stock sustainability and food safety. Tissue culture by callus induction can be an alternative for macroalgae production under controlled conditions. We performed *E. cava* callus induction under several abiotic conditions to find its optimal conditions.

Method: Fresh *E. cava* explants obtained from Korean waters were axenically treated by a series of betadine and Triton-100 treatments with an antibiotic mixture. Two types of explants, stipe and meristem were implanted on four different solid media (1.5% agar), PESI, ASP2, ESAW, and VS for 30 days. After optimization, PESI media was then used to treat different lighting periods (0 and 12 hours), agar concentration (1.2 and 1.5%), and incubation temperature (12 and 18 °C).

Results: The stipe induced callus higher on VS media (50.63%), followed by PESI (35.63%), ASP2 (6.88%), and ESAW (5.63%), while the meristem induced callus higher on PESI media (34.17%) than VS (10.00%) and ESAW (4.17). Meristems on ASP2 media did not induce callus, but disintegrated. Both the stipe and meristem induced higher callus formation in the dark condition (40.53 and 35.9%, respectively) compared to 12 h light exposure (19.1 and 2.8%, respectively). Stipe and meristem explants induced callus 32.2 – 44.5% at 1.5% agar concentration, while at 1.2% agar concentration the callus induced only 0 – 18.3%. Callus induced by meristems implanted at an incubation temperature of 12 °C (31.65%) was higher than that at 18 °C (13.05%). In the stipe section, the callus was induced at 12 °C (51.9%), which differed only slightly from that at 18 °C (48.55%).

Conclusion: Based on these results, *E. cava* callus induction became more optimal on agar media (1.5%) PESI incubated under no-light conditions and at 12°C. These results can be taken into consideration when optimizing suspension culture in an industrial scale for sustainable food production.

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Food loss and waste case study: Economical and environmental impact on apple supply chain

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Aim:

The last decade has seen an exponential increase in studies of food loss and waste (FLW) as FAO estimates that one third of food produced is either lost or wasted. FLW causes are many and vary according to product nature and local conditions. Analysis of potential macroeconomic impacts of FLW through a Computable General Equilibrium Model (CGE) is recommended by FAO as a complement to economic evaluation of reducing FLW at value chain level. In Uruguay, a FLW study on an apple supply chain was recently carried out. The aim of this work was to identify critical loss points (CLP), analyze FLW root causes and develop a list of specific directions to their reduction. Potential macroeconomic impacts of apple loss reduction were also evaluated.

Method:

The case study methodology recommended by FAO was used for micro level analysis. A meso level analysis was also performed through a dynamic CGE calibrated for Uruguay with two scenarios: “Manna from Heaven” (S1) with no costs associated to FLW reduction, and a scenario where FLW reduction resulted from improved production efficiency due to higher costs in hired labor force, which allowed better fruit classification (S2). Simulated scenarios were compared to “Business as usual” (BAU) scenario.

Results:

The CLP in apple supply chain were storage and packaging. Results indicated that apple losses reached 18% (weighted average), of which 80% were caused by "damage due to impact" and "presence of physiological disorders”. Root causes resided mainly in failures at harvest selection stage and poor crop control and process management.

In CGE simulations, an annual Horticultural GDP growth of 1.31 % and 1.29% was observed for S1 y S2 respectively. Horticultural domestic sales showed an average annual expansion of 0.707% for S1 and 0.691% for S2. This mild expansion observed is related to higher price of fruit due to augmented costs in harvesting process.

Conclusion:

Micro level analysis was effective in highlighting opportunities and specific actions to reduce FLW. CGE simulations provide a disaggregated picture of socio-economic and environmental impacts triggered by the selected actions for FLW reduction.

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Evaluation of impact of emulsion matrix on survival of Salmonella during simulated gastric digestion

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Aim:
While *Salmonella enterica subsp. enterica* serovar Typhimurium's resistance to acid, osmotic stresses, and pathogenicity have been investigated over the years, there is necessity to systematically study how food matrices impact *Salmonella*'s survivability in digestive tract. The purpose of this study was to investigate the potential effect of emulsion structure on *Salmonella* survivability during gastric digestion.
Method:
Water-in-oil (W-O) emulsion and oil-in-water (O-W) emulsion were prepared with peanut oil and water with 10% dispersed phase and stabilized with 2% (w/v) soy lecithin for W-O emulsion or 3% (w/v) sunflower lecithin for O-W emulsion. Samples were inoculated with *Salmonella* in oil or water phase and equilibrated at room temperature (21 ± 2 °C) overnight. The samples were challenged with simulated gastric fluid (SGF) (pH 2, 3g/L pepsin) facilitated with stomacher mixing at 37 °C, and samples were taken periodically, serial diluted and plated on tryptic soy agar (TSA) to measure bacterial inactivation.
Results:
With *Salmonella* in dispersed phase (water) of the W-O emulsion, 2.4±0.41 log CFU/ml reduction was achieved after 120 minute of SGF exposure. In contrast, a significantly ($P<0.05$) higher 5.08±0.44 log CFU/ml reduction was achieved when it was inoculated in dispersed phase (oil) of the O-W emulsion. Similar trend persisted when *Salmonella* was inoculated in the continuous phases, in that higher reduction was observed in O-W emulsion than W-O emulsion ($P<0.05$), indicating that protection offered by W-O emulsion to *Salmonella* inactivation was independent of its phase of inoculation.
Conclusion:
W-O emulsion offers better protection to *Salmonella* against inactivation than O-W emulsion during simulated gastric digestion indicating food matrix can affect *Salmonella* survivability during digestion.

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Development and evaluation of an instrumental test to emulate the IDDSI testing method

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Aim:
Appropriate food textures are important for people with chewing and swallowing difficulties. The International Dysphagia Diet Standardisation Initiative (IDDSI) was established to develop best practice guidelines and to help ensure consistency between care organisations. The purpose of this project was to develop an instrumental method to simulate the IDDSI fork test procedure and to compare the results of instrumental and manual for testings.
Method:
A test rig was developed that is capable of holding a variety of cutlery items (primarily forks; also spoons). This was used to evaluate a range of commercially available food products over a range of operating conditions to determine suitable operating conditions.
The instrumental and the manual fork tests procedures were used to assess meat products with the intention of selecting a formulation to comply with the IDDSI level 6 (soft and bite-sized) requirements. A constrained mixture design approach was used, with variables of meat, carboxy methyl cellulose (CMC) and tapioca starch (TS). In addition to the instrumental and manual fork tests, a variety of other product attributes were determined.
Results:
Instrumental and manual testing: results showed that instrumental fork test obtained correlated well with the manual IDDSI test. The results obtained from various texture analyser operating conditions suggested that positive area of the resulting force-time curve can be used as a useful predictor to explain the differences in fork, food, test speed, resting time and the sample position.
Desirability: using the the results of manual IDDSI fork test as a guide, the formulation optimiation process was based on a combination of: texture attribues (hardness, cohesiveness, adhesiveness, fork travel, force-time curve area) and quality attributes (cooking yield, colour [a^*], diameter reduction).
Formulation: using this approach and considering all above criteria, the optimum formulation was meat (88.587%), CMC (0.895%) and TS (0.018%). This formulation gave a 0.867 desirability score, which is above the level regarded as acceptable (0.67).
Conclusion:
The mixture design approach was effective at optimizing inclusion of hydrocolloids in beef patty formulation, with a view to obtain texture modified beef products compliant with a level 6 diet.

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Bioactive Fucoxanthin from Edible Marine Algae: An Update on Biofunctional Evidence for Healthy Diet

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Bioactive Fucoxanthin from Edible Marine Algae: An Update on Biofunctional Evidence for Healthy Diet
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Aim:
Fucoxanthin is a natural and edible antioxidant pigment of marine algae. The plethora of scientific evidence supports the potential benefits of the dietary use of fucoxanthin to promote human health and disease management. Therefore, the authors review the current scientific literature on fucoxanthin, which focuses on biofunctional properties with molecular mechanisms to highlight the importance of its dieary inclusion as a food supplement.
Method:
The studies to be reviewed were identified, screened and finally systematically included using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) method. Scientific articles on fucoxanthin published between January 2017 and February 2022 were included in the search.
Results:
Fucoxanthin remains the most popular option for anticancer and antitumor activities, followed by protection against inflammatory, oxidative stress, nervous system, obesity, liver, diabetic, kidney, cardiac, skin, respiratory and microbial diseases, in a variety of model systems. Despite a lot of biofunctional evidence from *in vitro* and *in vivo* findings, fucoxanthin is still unsatisfactory in clinical research, as only one clinical study for the treatment of obesity has been reported in the last five years. In addition, the pharmacokinetics, safety, toxicity, functional stability and clinical perspective of fucoxanthin are essentially addressed. Nonetheless, fucoxanthin and its derivatives have been shown to be safe, non-toxic, and readily available after dietary intake.
Conclusion:
This review will provide biofunctional insights into fucoxanthin that underlie the diverse molecular mechanisms underlying the health benefits upon consumption. However, it requires more activity-

oriented translational research in humans before it can be introduced as a healthy dietary component of multiple disease management.

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EGG WHITE AMYLOID FIBRILLATION IN THE PRESENCE OF SUGARS AND ITS POTENTENCIAL FOR PROTEIN FUCNTIONALITY

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Hen egg white proteins (EWPs) are a common structural ingredient in food products containing sugar (*e.g.* meringues and cakes). While EWPs have excellent techno-functional properties (*e.g.* gelling capacity), designing EWP structures in the presence of other food ingredients (*e.g.* sugars) with specific techno-functionality might be advantageous for food product design. Amyloid fibrils are highly ordered protein structures composed of β-sheets with the potential of delivering specific techno-functional properties in proteins. While amyloid-like fibrils (ALFs) from EWPs were already prepared at food relevant processing conditions (*e.g*. 85 °C, 24 h, pH 7.0), the impact of sugar addition on EWP fibrillation during heating and the gelling properties of the resultant ALFs are unknown. Aim: Against this background, the aims of this research are (i) to study the impact of sugar addition (*i.e.* glucose, fructose and sucrose) on EWP fibrillation during heating and (ii) to evaluate the gelling properties of the resultant ALFs. Methods: EWP solutions [0.5% (w/v), pH 7.0] containing glucose, fructose [0.2% - 20% (w/v)] or sucrose [0.2% - 38% (w/v)] were heated (85 °C, 24 h) while shaking (70 rpm). After incubation, cooling and centrifugation (9 600 g, 10 min, 20 °C), the resultant soluble fractions were evaluated for their level of β-sheets with thioflavin T (ThT) fluorescence and for their protein morphology with transmission electron microscopy. Results: While heating EWP in the presence of 10% (w/v) glucose or sucrose concentrations resulted in similar ThT levels (*ca.* 50%) as those after heating EWP in water, larger worm-like ALFs networks were observed in heated EWP in the presence of those sugar levels than in water. In contrast, 10% (w/v) fructose levels resulted in low ThT levels (*ca*. 1%) and the formation of mainly amorphous aggregates. Small-amplitude oscillatory measurements were performed to evaluate the rheological properties of gels obtained by similar heating of EWP dispersions [6.0% (w/v)] in the presence of 10% (w/v) glucose or sucrose. Preliminary results indicated that the presence of worm-like ALFs in those gels contributed to an increase gel hardness. Conclusion: These results suggest the addition of 10% (w/v) glucose or sucrose enhanced EWP fibrillation during heating and that the resultant ALFs have specific gelling properties.

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Can flavor-imparting (bio)chemical reactions in vegetables be steered by targeted processing steps?

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Aim:
The emerging interest in a healthy diet, in which vegetables play a central role, has arisen in the last decades. Nevertheless, the aversion to consuming vegetables is still existing which can sometimes be ascribed to their unpleasant flavor attributes as a consequence of the presence of flavor-imparting volatile compounds. These compounds can witness the occurrence of (bio)chemical reactions, comprising both enzymatic and non-enzymatic reactions. Enzymatic reactions occur when an active enzyme can interact with its substrate, both often present in different compartments in the cell. Hence, tissue disruption may be necessary to enable interaction. Non-enzymatic reactions encompass for instance thermal degradation of substrates and enzymatic reaction products. Intrinsic (bio)chemical reactions can be influenced by processing, usually including pretreatment, preservation, storage and regeneration steps. In this context, the question arises whether flavor-imparting (bio)chemical reactions can be deliberately steered by targeted processing steps. Therefore, in current research, it was aimed to understand the effect of different selected pretreatments on the ensuing (flavor-imparting) volatile profile of leek and Brussels sprouts and to link this profile to the possible (bio)chemical reactions that could have taken place during treatment.
Method:
Selection of the (sequence of) pretreatment steps aimed at either minimizing (by heating to inactivate enzymes) or inducing (by several tissue disruptive treatments) enzymatic reactivities. The latter aimed both full and partial tissue disruption, empowered by a mix or a pulsed electric field (PEF) treatment step (at low electric field strengths), respectively. Also a control (i.e. non-treated material) was taken into account. After selected pretreatments, volatile profiles were analyzed using a headspace solid-phase microextraction gas chromatography mass spectrometry approach.
Results:
It was observed that different pretreatments led to markedly different volatile profiles, characterized by different (abundances of) flavor-imparting compounds. The volatile compounds could be related to several (bio)chemical reactions which occurred during the different pretreatment steps.
Conclusion:
Based on the outcomes of this study, it can be concluded that targeted (pre)processing allows to steer (bio)chemical reactions towards specific flavor-imparting compounds in vegetable products.

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The use of G. geotrichum to increase the amount of bioactive ingredients in fried cheese.

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Aim:
In western Poland, fried cottage cheese is a very popular product. The production of this cheese and its maturation is related to the presence of a specific microflora. One of the microorganisms which has beed found in the fried cottage cheese is identified as the mold *Galactomyces geotrichum*. The aim of this study was to optimize the *G. geotrichum* culture medium, which would enable the biosynthesis of polyunsaturated fatty acids (PUFA), essential in the human diet. The results of these studies were used for the preparation of fried cottage cheese with *G. geotrichum* and components which influenced the production of PUFA.
Method:
In order to optimize the culture medium, medium components that can affect PUFA production were selected and an experimental design was designed using the Design Expert program. After conducting a series of laboratory scale cultures and analyzing the fatty acids by gas chromatography, it was assessed which components influenced the production of PUFA. The fried cheese was also analyzed as a result of the above tests, both in terms of PUFA as well as other bioactive ingredients. HPLC determined the content of vitamin B_2 and ergosterol.
Results:
The best medium for PUFA biosynthesis by *G. geotrichum* is 10 g/L rapeseed oil, 5 g/L yeast extract, 0.05 g/L K_2HPO_4, 0.17 g/L $MgSO_4$, 0.015 g/L $MnSO_4$, 0.015 g/L $ZnSO_4$, 0.05 g/L $FeSO_4$, and 10 mg/L vitamin B_{12}. In the fried cottage cheese prepared with the addition of *G. geotrichum*, the highest amount of PUFA was found after 3 days of cheese ripening. The presence of vitamin B_2 and ergosterol has also been demonstrated.
Conclusion:
It is possible to use the natural microflora found in fried cottage cheese to increase the amount of bioactive ingredients in the cheese.

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Stability of bioactive crocins during loading into solid lipid nanoparticles and production of protein gels

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Aim: Bioactive substances from saffron (*Crocus sativus*), such as crocetin esters (crocins), have various positive health effects. However, due to their pH and temperature sensitivity, they may be degraded during food processing and/or human digestion. The aim of this project is to increase the stability of crocins during processing by loading them in solid lipid nanoparticles (SLN) as a carrier system. The impact of heat treatment and gelation by pH adjustment on the stability of crocin stabilized in SLN in the presence and absence of β-lactoglobulin (BLG) was investigated.
Method: SLN were prepared by melt emulsification of tristearin and stabilized by lecithin and sucrose palmitate, before crocins were added. Additionally, BLG or Tween 20 was used as a third emulsifier. Crocin-loaded SLN stabilized by BLG (CroBS) or Tween 20 (CroTS) were subjected to heat treatment (90 °C, 30 min) in the presence or absence of excess BLG, followed by pH reduction to induce protein gelation. The amounts of total crocins and free crocins not associated to SLN were determined by HPLC before and after processing. The crocins were identified to evaluate degradation and isomerization.
Results: Crocins could be embedded in both CroTS and CroBS with about 78% and 51% of the total extractable crocin content, respectively. The addition of BLG led to a crocin release of 15% from CroBS and 7% from CroTS. Upon heating, crocins were degraded and isomerization occurred. Crocins stabilized within CroTS were degraded to a lesser extent compared to CroBS, both, in the absence and presence of excess BLG. However, heat treatment in the presence of BLG resulted in significantly decreased amounts of free crocins in both cases. This was probably due to the binding of crocins in BLG aggregates which were formed during the heat denaturation.
Conclusion: SLN are suitable for stabilising crocins during gel preparation, although Tween20-stabilised systems are more effective. This study will help to understand heat-induced changes in the loading capacity of SLN and in the stability of the loaded substances. This knowledge is important when SLN are to be used as carriers in complex food systems.

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Driving Future Food Systems Through Norway-Japan Innovative Research & Training Network

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Aim:
Framed by UN SDGs, iFOODnet will develop world-class research and education in Norway upon long-term Noway-Japan (inter)national partnership with 2 Japanese universities of agriculture & marine science on four cross-disciplinary/sectoral innovation pillars (CIP) paving the way towards next-generation sustainable, resource-efficient, zero-waste food systems.
Method:
In iFOODnet Nofima, Norwegian food science and aquaculture research institute teams up with Norwegian University of Technology & Scienceto build long-term, international collaboration with Tokyo University of Marine Science & Technology and Tokyo University of Agriculture in Japan.
To reinforce strategic Japan-Norway collaboration iFOODnet is anchored on 4 CIPs.
[CIP#1] Bioprospection of Novel Biomolecules & Microbiome Sequencing;
[CIP#2] Innovative Food Processing and Functionality;
[CIP#3] Biomaterials and Smart Packaging;
[CIP#4] Food Waste Biorefinery.
Through these CIPs iFOODnet's International Training Research & Innovation Programme will feature research-driven student mobility, annual Training School and dissemination training events for early-stage researchers in partner countries. The project runs complementary to TUMSAT's international joint research program with Nofima funded by Japan Society for the Promotion of Science.
Results:
To initiate collaboration amongs project partners a series of CIP workshops have been arranged to foster multidisciplinary knowledge sharing and to identify potential "matches" for research collaboration and research-driven student mobility. For the period 2021-2022 four "matched couples" have been identified across CIPs for advancing state of art on innovative extraction of microalgae, physicochemical properties of multisource gelatin, aroma compounds in food (packaging) systems and seafood processing. This spring first Japanese students finally arrived in Norway and more student exchange is envisaged in the coming months to further strengthen Norway-Japan collaboration. In addition, a 1-week virual Training School was arranged in November 2021 amid global pandemic, with the aim to increase awareness of societal food challenges and to equip early-stage researchers with an innovation toolbox, international network and cross-cultural and disciplinary capacity in teamwork. The students reported high learning outcome and increased international network.
Conclusion:

As the international travel restrictions recede, this year's Training School for early-stage researchers is expected to take place in Japan, featuring world experts within food science and technology, in concert with a multithematic open workshop with international stakeholders.

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Polyphenol-rich grape seed extract towards bioactive and visually responsive smart food packaging systems

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Aim: The rising awareness on the environmental impact of conventional plastics and the rapid pace of food innovation have shifted the focus towards smart biopolymer-based food packaging materials to embed more complex and sustainable food systems. Smart packaging concepts are based on active (inclusion of anti-microbial/-oxidant compounds) and intelligent (real-time, *in-situ* and non-invasive monitoring of safety/quality indicators) packaging systems. Lately, consumer engagement on healthy and sustainable lifestyles have turned the attention to natural bioactive sources in food packaging towards safer products with prolonged shelf-life and premium sensory/nutritional quality. For instance, phenolic compounds, with broad spectrum of biological activity and patterned colour responses to pH variations, hold promising potential for smart food packaging and edible coatings. In this study, the potential of the polyphenol-rich grape seed extract (GSE) towards bioactive and visually responsive food packaging materials was investigated.
Method: Mechanical, barrier, antioxidant, and antimicrobial properties of alginate films (2% w/v) prepared with GSE aqueous extract (11,663±1,323 mg GAE/L), alone or in combination with 0.2% w/v citric acid, were assessed using up-to-date analytical methods.
Result: Crosslinking alginate with citric acid via ester bonds (FTIR analysis), improved film functionality, with 18% increase in tensile strength, 22% decrease in water vapour transmission rate and no effect on elongation at break. The incorporation of GSE into the alginate matrix significantly increased antioxidant activity (DPPH assay). The antimicrobial activity of GSE-alginate-citric acid films after 24 h at 37 ℃ resulted in 2.7 and 5.5 log reductions of *Escherichia coli* and *Staphylococcus aureus*, respectively (2.3 and 2.9 log reductions, respectively, in absence of GSE). Interestingly, replacing GSE by another antimicrobial agent, plasma activated water (PAW), resulted in 3.3 and 4.5 log reductions, respectively. The more pronounced inhibitory effect on Gram-positive bacteria was attributed to the different composition and structure of the cell wall. pH adjustment of the GSE film-forming solution from 2 to 10 caused a color change from yellow to red and shifted the UV/VIS spectra absorption peak from 450 to 500 nm.
Conclusion: This study has demonstrated the potential of GSE in combination with citric acid towards enhanced functionality and bioactivity of alginate films for smart food packaging applications.

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Quality changes of fried tilapia skins with different frying methods and their accelerated shelf-life testing

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Aim: Fried fish skin is a popular snack in Asia. The conventional frying (CF) could increase the oil content and lipid oxidation of fried fish skin leading to poor product quality. This study is to improve the application of frying processing approaches on tilapia by-products and to determine their shelf-life by accelerated shelf-life testing.
Method: We examined the physical (moisture, breaking force, L*a*b*), chemical predictors (peroxides, POV; conjugated dienes, CDV; malondialdehydes, TBARS) and sensory evaluation of fried fish skins under three different frying approaches, air frying (AF, 180°C/12 min), conventional frying (CF, 180°C/8 min) and vacuum frying (VF, 120°C/24 min), during storage at 25°C, 37°C, 50°C for 100 days.
Results: AF offers the better texture products (lower breaking force) and a higher L* value, while VF has a higher moisture content and water activity. Compared with CF, AF and VF can reduce formation of conjugated dienes. Besides, POV showed that VF has a longer induction time period, which can retard lipid oxidation. TBARS is merely suitable for AF but is worthless for CF and VF. The key deterioration parameters of AF and VF in sensory evaluation are crispness, and CF is greasiness. These attributes can represent the overall quality and be used as predictors for the end of shelf-life for the fried foods. According to the correlation analysis and Arrhenius equation, AF, CF and VF are able to store at 25°C for 132, 99 and 92 days, respectively.
Conclusion: So far, to our knowledge, the acceptance limit for fried foods has rarely been done. In this study, TBARS (11mg/kg for AF), and CDV (7 mmol/g for CF) could be recommended according to the rejection of sensory evaluation and oxidative status. Overall, AF is the best approach because it not only has the better texture, higher L* value and the lower lipid oxidation but also has a longer shelf-life.

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Characterizing the dominant microbial communities of vegetal by-products from the food industry through their processing

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Aim:
There is currently a rising interest for by-products as renewable materials that could contribute in reducing food wastes and losses. With 12.1 millions of tons produced each year in France according to a 2017 survey, identifying efficient ways of valorization is becoming more and more important, in order to obtain a more sustainable food system as well as meeting consumers' expectations for more clean-label food products. We previously shown(2,3,4) that vegetal by-products can be used as efficient stabilizing agents of emulsions, avoiding the use of surfactants. However, by-products are commonly rising doubts about their heterogeneity, variability and sanitary risk, such as microbial content. Obviously, they are not the main stream of the food industry, as a consequence 1) they are less controlled and 2) they are less studied. In the present work, a monitoring of the microbial content was carried out through processing of 3 vegetal by-products: carrot peels, cocoa shells and liquorice cake (coming from distillation process).

Method:
Seven culture media were used in order to count the main microbial populations such as lactic acid bacteria, bacillus, molds and yeasts, etc. The counting was carried out at each main process step: raw materials; after drying at 105°C and grinding into a powder; after formulating the powders in emulsions (50% oil content, 5% powder content). The dominant populations were identified from the most diluted concentrations. PCR amplification and Sanger sequencing of the 16S rRNA gene (bacteria) and the variable D1/D2 domain of the 26S rRNA gene (fungi) were finally performed in order to identify the main microbial populations and understand how process can remove or promote some of them, from the raw by-products to their formulation into emulsions.

Results:
The main results were that strains assigned to species of technological interest were detected within the 3 by-products, especially carrot peels. DNA was extracted from almost 60 colonies from dominant populations in order to identify the major strains. Only liquorice cake contained a dominant *Aerococcus* genus, known to be an opportunist pathogen.

Conclusions:
This pluri-disciplinary study combined physico-chemistry and microbiology approaches in order to reach a new TRL step in considering by-products not only as wastes but also as technological materials for formulating clean-label products based on up-cycled ingredients.

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Cooking and in-vitro digestion effect on fatty acids in novel seafood pâtés from marine by-products

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Aim:
Marine fish gonads (roe, milt) and liver are seldom eaten in Ireland but rather processed as fishmeal or discarded at sea. This study aimed to create new ready-to-eat seafood products and investigate the effects of cooking and *in-vitro* digestion on the fatty acid profile.

Method:
Four seafood pâté formulations were developed by combining marine ingredients in varying proportions: 1) 100% plaice roe (RO), 2) 75% roe/25% milt (RM), 3) 75% roe/25% liver (RL) and 4) 75% roe/12.5% liver/12.5% milt (RLM) along with plant-based ingredients. Fatty acid composition and thiobarbituric acid value (TBA-value) were measured in raw ingredients (roe, milt and liver) as well as raw, cooked (80°C, 45 min) and digested pâtés.

Results:
TBA-values changed significantly ($p<0.05$) when milt and/or liver was incorporated (RM, RL, RLM), compared to RO, with values highest in digested samples. There was a significant difference in fatty acid profiles of raw marine ingredients ($p<0.05$), with roe and milt having higher omega-3 levels than liver. The main fatty acids in roe and milt were C16:0, C18:1, C20:5 (EPA) and C22:6 (DHA) while liver contained significantly higher monounsaturated fatty acids, C16:1, C20:1, C22:1 ($p<0.05$) and less polyunsaturated fatty acids (PUFA). Milt contained highest PUFA (56%). This was reflected in significant differences in fatty acid profile of pâtés, ranging from 49% PUFA in RM to 36% in RL, uncooked. The cooking protocol did not significantly alter the relative fatty acid profile. The index of thrombogenicity (IT) and atherogenicity (IA) were low for all products and remained stable over the cooking process (0.17±0.01 and 0.37±0.01 for IT and IA, respectively for cooked products), while n6/n3 was 0.16 ±0.02. Both IT, IA and n6/n3 values were affected in some *in-vitro* digested samples but were < 0.25, <0.5 and <0.5, respectively, in all cases.

Conclusion:
Overall, the study showed significant potential to use under-valued marine ingredients towards the production of nutritionally beneficial food products. These new food products could be used for increasing intake of long chain PUFA in the diet of different population groups such as young and elderly consumers, while concurrently, reducing wasted ingredients discarded at sea.

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Developing Tasty and Nutritious Sustainable Foods Using Note by Note Cooking and 3D Food Printing

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Aim:
Note by Note (NbN) cooking and 3D food printing individually and in combination allow for the creation of customized nutritious and sustainable foods. NbN cooking involves making foods from pure compounds or mixtures of compounds and allows for reduction of food spoilage and increase of the global output of agriculture.
Method:
NbN recipes were developed using pure compounds and mixtures of pure compounds. and printed with a Procusini® 3D food printer. In this study, "Pasta" was selected, as the food item, for the soya and hemp samples and "Chocolate" for the pea protein sample. The recipes were prepared and the mixes were added to a 60mL cartridge, and then inserted into the printer which was then calibrated. The object for production was selected (lobster or cube). Production was started and the lobster (7 mins) or the cube (8 mins) were printed onto the silicone mat and then cooked for 15 mins at 150 ^{o}C in an Electrolux oven.
Results:
After a number of trials, to optimize the texture, a prototype savoury NbN recipe was developed which included cornflour, oil, sugar, salt, water, plant protein-rich ingredients i.e. either soya, hemp or pea-protein and dietary fibre. The three resulting mixes were printed either in a lobster shape (soya and hemp) or a cube shape (pea protein). During cooking of each sample there was loss of volume, due to water evaporation, but not of shape. The colour of each sample darkened and the texture became crisp. The final protein contents for the cooked soya lobster was 17.5%, 9.7% for the hemp and 12.9% for the pea protein
Conclusion:
The recipes are prototypes and can be produced in various shapes, colours, flavours (including odours) and textures. The customized foods can be served to diners or developed as food products and allow for an expansion in creativity and innovation which addresses the dietary and sustainability requirements of a growing number of consumers e.g. vegan and/or lactose-intolerant, dietary needs of sports athletes and reduction of food waste.

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Chitin nanowhiskers addition and Maillard reaction as combined strategies to improve functionality of gelatin films

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Chitin nanowhiskers addition and Maillard reaction as combined strategies to improve functionality of gelatin films
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Aim:
Despite considerable efforts being made to find sustainable alternatives to conventional plastics in the last decades, this subject is still in development. In this latter matter, gelatin is an abundant, renewable and biodegradable protein which has excellent properties for food packaging applications. However, gelatin-based films lack adequated mechanical properties and water stability mainly because of gelatin's hydrophilicity. In the present work, a combined strategy of chemical cross-linking via Maillard reaction (MR) and reinforcement of films through the incorporation of chitin nanowhiskers (CNW) was assayed to improve the performance of gelatin films for food packaging applications.
Method:
CNWs were produced by acid hydrolysis of shrimp chitin and then characterized in terms of morphology (TEM), structure (XRD), and thermal properties (TGA and DSC). Gelatin films with 0-4% CNW, 10% glycerol, and 10% glucose were produced by casting. Chemical cross-linking via MR was induced through heat treatment (105º, 24 h). The mechanical (tensile test), thermal (TGA and DSC), structural (FTIR, XRD, microscopy), optical (colour, light transmittance), water solubility and antioxidant (DPPH scavenging activity) properties of the films were characterized.
Results:
The films became less soluble (from 100% to ~10%), thermally more stable, had a notably improved UV–vis light absorption capacity, and presented significantly enhanced tensile strength (from 42 to 77 MPa) and Young's modulus (from 1476 to 2921 MPa), however, they also became less flexible (from 17% to 7%) and transparent, as compared to control (0 wt% CNWs, non-heat treated) gelatin film. These property alterations were mainly related to changes in crystallinity, the MR and, to a lesser extent, the formation of noncovalent (electrostatic and hydrogen bonding) interactions between CNW and gelatin. Furthermore, due to the formation of MR products, the films turned yellow/dark brown and released antioxidant compounds (inhibition ~33%) while immersed in water, which gave the films their active properties (stabilization of free radicals).
Conclusion:
This study shows that crosslinking via MR and nano-reinforcement via CNW compounding are feasible strategies to improve gelatin films' functionality for renewable and active food packaging development.

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Effect of High pressure debittered green table olives on the fermentation process

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Aim:
The commercial Greek-style green table olives includes a natural fermentation in brine (5-10% salt), that lasts up to 6 months. Fermentation is typically a spontaneous process, without any chemical debittering treatment, in which lactic acid bacteria (LAB) and yeasts coexist. LAB promotes the debittering of the olives through hydrolysis, lowers the brine pH and improves the sensorial characteristics of the final producst. A promising approach for controlling and accelerating fermentation is the use of LAB strains as starter cultures. Novel extraction technologies such as High Pressure (HP) could potentially be used in order to enhance extraction of oleuropein, decreasing the bitter-taste of olives in short time.
The aim of this study was to apply HP for table olives debittering process acceleration as pretreatment step, followed by fermentation. It was evaluated if this pretreatment step could affect the fermentation time and the quality of the final products as well it was compared with the conventional and with the enriched with LAB starter fermentation process.
Method:
The fermentation of table olives was carried out in acidified (pH=5) brine with 8%w/w NaCl and lasted for at least 3 months. There were three different samples: (a) control, (b) HP-pretreated (250 MPa for 15 min – as assisted de-bittering step) olives, (c) olives with starter cultures of *Lactobacillus plantarum* (10^8 logCFU/g). Oleuropein content and pH-value were measured throughout fermentation. Quality and sensory evaluation were also demonstrated.
Results:
HP pretreatment led to instant removal of oleuropein, decreasing its concentration up to 80% immediately after HP treatment compared to control. HP process did not affect the initial LAB population of olives, consequently the progress of fermentation. pH-value of brines dropped down below 4.0 and the intensity of bitter taste of olives was acceptable after approximately 90, 30 and 45 days fermentation for control, HP-pretreated and LAB-enriched samples, respectively. No differences on quality characteristics were observed between fermented olives.
Conclusions:
The results confirmed that HP as pretreatment de-bittering step was suitable and applicable in instantaneously decreasing of oleuropein content of olives and minimizing the fermentation time, while simultaneously did not affect the quality of final fermented table olives.

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Accelerated micro-oxygenation aging of balsamic vinegar – A kinetic study

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Aim:
Micro-oxygenation (MOX) technique was developed owing to the winemakers needs for improving their final aged products in shorter time than the barrel aged ones. MOX is based on the controlled diffusion of oxygen in liquids stored in stainless steel tanks, mimicking the slow uptake of oxygen during barrel maturation. Therefore the dosage and duration of oxygen addition (along with the potential use of woodchips for polyphenols increase and aroma enhancement) are the critical parameters in MOX treatment, leading to desired sensory properties, intense chroma and enhanced aroma in final aged products.
A kinetic study on the effect of accelerated MOX aging on the quality, aroma and sensory characteristics of balsamic vinegar was conducted in order to propose an optimized aging process.
Method:
Aging experiments were conducted using a multiple diffuser micro-oxygenator connected to 165 L stainless steel tanks. Oak chips (1 g/L) were added. MOX was carried out for up to 6 months duration with an oxygen flow ranging from 15 to 60 mg/L/month. Barrel maturation was simultaneously carried out for 2.5 years. The optimal MOX conditions were selected, based on the desired organoleptic characteristics of final aged products and the minimum required aging time. Quality, nutritional characteristics, bioactive compounds, aroma profile and organoleptic properties were also evaluated throughout aging.
Results:
MOX-aged vinegars had a 2-fold antioxidant activity increase after 6 months of accelerated aging compared to time t=0. The brown color of MOX-aged samples was more intense in only 2 months of aging compared to the 18 needed months for equivalent color alteration for the traditional barrel aged ones. Increased oxygen flow in MOX aging resulted in reduced aging time. The aroma profiles and the desired organoleptic properties of MOX-aged vinegars with the higher oxygen dosage (60 mL/L/month) were similar to traditionally aged ones (2.5 years barrel aging) in a period of only 3.5 months.
Conclusions:
An effective and attractive technique for accelerating the aging of balsamic vinegars using MOX with oak chips could be efficiently applied for vinegar-producing industries, resulting in final products of superior quality in significantly reduced needed time, compared to the traditional barrel aging.

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CO2 gas hydrate technology as innovative, high energetic efficient process for fruit juices concentration process

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Aim:
Now that the world opens up again after the COVID-19 pandemic, the global fruit juice market is projected to witness a CAGR of 4.85% during the upcoming years due to their proven health benefits. Furthermore, this increase is also attributed to the change in behavior of the consumers as they are now stockpiling the juices for in-home consumption instead of direct consumption. Thus, innovative preservation and concentration technologies are more crucial than ever. In the conventional method utilizing the thermal method, the quality of the products degrades due to the deterioration of thermosensitive substances, e.g., vitamin, polyphenol content, and microbial load. A novel technology utilizing carbon dioxide (CO_2) gas hydrate to concentrate fruit juices has grown in popularity due to the gentle conditions under which products can be refined without altering, or damaging valuable product contents.
Method:
Gas hydrate (GH) are ice-like crystalline solids, where small non-polar molecules are trapped inside cages formed by hydrogen-bonded, water molecules at “elevated pressure” and low temperature. There is no bond between the host and the guest molecules (i.e. host gas moves freely). The stabilization stems from van der Waals forces. Furthermore, because the cavities of the gas hydrates are very small, only water molecules will be severed from the concentrated juice, leaving the other components intact. Due to its inertness, CO_2 serves as an ideal compound for the gentle process of concentrating juices.
Results:
Using the gas hydrate technology, the hydrate was formed at a moderate temperature of 1.5 °C and 35 bar of CO_2 yet the products can reach a degree of concentration up to 98% which is significantly higher than the freeze concentration process. The dissociation enthalpy was found to be in the range of several dissociation enthalpies for the water/CO_2 system, meaning that the hydrate is composed only of water and carbon dioxide.
Conclusion:
High sugar recovery from fruit juices can be realized using gas hydrate technology. Gas hydrate technology's capability of energy savings, selectively only interacting with water, and not with other juices components, alongside having a negligible impact on product quality shows a promising emerging technology for potential industrial application.

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Yoghurt acid whey marinating for improving tenderness and quality of beef chuck roast: process optimization

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Aim:
Beef tenderness is one of the primary sensory attributes that is associated with the consumers' acceptability and preference. As a result, meat industry is striving to find efficient and natural ways of providing more tender meat products without affecting the nutritional profile, organoleptic properties and quality of meat. Yogurt acid whey (AW) – the main by-product of strained yoghurt production – contains a high amount of lactic acid and calcium that may lead to potential application in the meat industry as a tenderizing agent. Its use as a complementary food ingredient i.e. main ingredient in the marinating process, is considered an effective way for its valorization.
The aim of this study was to optimize the beef tenderness and evaluate its effect on quality of beef chuck roast slices using AW as a tenderizing agent.
Method:
Preliminary experiments for the selection of the dominant parameters that enhance beef slices tenderness while simultaneously minimally affecting their organoleptic characteristics were conducted. AW concentration, solid-liquid ratio and treatment time were the parameters selected. The Response Surface Methodology (Box-Benken design) was applied for selecting optimum pretreatment marinating conditions. Angus chuck roast slices (4x5x1 cm) were immersed to marinating solutions with different acid whey concentrations (0 as control, 5, 10 and 15%) and solid-liquid ratios (2:3, 1:1, 2:1) for different durations (4-24 h), followed by cooking (80 °C for 45 min). The effect of marinating conditions on tenderness (firmness decrease measured by texture analyzer) of cooked beef slices was evaluated. Quality indices and sensory evaluation of cooked beef slices were also evaluated and compared to control ones.
Results:
Beef tenderness was generally improved since firmness values were decreased after AW marinating at all the studied conditions. Marinated beef slices with 5% AW solution for 14 h had a 6-fold lower firmness compared to control ones. As the ratio meat/AW marinating solution was decreased, meat tenderness was achieved in shorter times.
Conclusions:
The use of AW in the meat industry could have a dual benefit: i. act as a tenderizing agent and ii. provide an effective way for AW valorization, leading to reduced risks related to its disposal.

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Mash Process Optimization for Rice Adjuncts

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Aim: Gelatinization of rice adjuncts in mashing processes occur at temperatures above that of Barley malt. An increase in temperature to facilitate rice gelatinization would have a negative effect on the enzymatic activity from the barley malt. Increasing rice gelatinization prior mashing could reduce total mashing time, thus energy cost and potentially increase fermentable sugar yields, thus intensify mashing based food and beverage production processing using rice adjuncts.
Method: Various two stage mashing processes with separate gelatinization stages for barley malt and rice were run at different malt to rice ratios and temperature-time profiles. Combination of batches allowed for rapid conversion of pre gelatinized rice in following conventional step mash. Subsequent chemical standard analysis and process energy cost analysis were used to evaluate the different process profiles.
Results: Pre gelatinized rice added to barley mash increased yield of dissolved sugars of up to 20% after 60 minutes and increased the rate of solubilization significantly. Additionally, increases in total yield of soluble sugars were observed after 90 minutes. Furthermore, changes in pH were significant between different processes, but of small magnitude while no significant change in free amino acids content was observed. Differences in final gravity after fermentation with *Saccharomyces cerevisiae* suggest differences in the composition of dissolved carbohydrates in the two stage mashing process.
Conclusion: Two stage mashing for rice adjuncts could reduce mashing times and increase fermentable sugar yields by separating gelatinization stage of barley malt and rice adjuncts at their respective optimal gelatinization temperature

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Sustainable pathways for delignification of barley straw for nanocellulose production

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Aim:
Barley straw is a source of lignocellulosic biomass, which is primarily comprised of cellulose, hemicellulose, and lignin, and is one of the world's least utilized bio-resources. Cellulose is the most abundant biopolymer on the planet, which can be converted into a high-value nanomaterial called nanocellulose. However, for the extraction of cellulose from barley straw, delignification is one of the most critical steps. Traditional delignification methods based on chemical treatments using sodium chlorite and hydrogen peroxide are environmentally harmful, expensive, and energy-intensive. Thus, the aim of this study is to develop sustainable, green, and economical delignification technologies for barley straw to produce nanocellulose.

Method:
In this study, ultrasound was combined with a green solvent such as deep eutectic solvents to evaluate their efficacy in the delignification of barley straw. Barley straw was mixed with deep eutectic solvent and was treated under ultrasound for 1h, 2h and 3h at a constant temperature of 80 °C.

Results:
Results showed that the hybrid technique ultrasound with deep eutectic solvent significantly reduced the lignin content in barley straw with an increase in ultrasonic treatment time from 1h to 3h at a constant temperature of 80 °C and a specific ratio of barley straw to deep eutectic solvent. The highest reduction of lignin content from 17.2% to 6.44% was observed in the ultrasonic treatment of barley straw for 3h using the deep eutectic solvent made with a higher molar ratio of Choline Chloride (ChCl) and Oxalic acid dihydrate. Whereas the lignin content was reduced to 6.94% when the sample was treated with a lower molar ratio of ChCl and the lactic acid.

Conclusion:
The results of this study demonstrated that the combination of the deep eutectic solvent with novel technologies such as ultrasonication could be a sustainable pathway for the delignification of barley straw for nanocellulose production.

Microbial diversity of Amasi, traditionally produced using metagenomic sequencing techniques (16S rRNA and ITS 1&2)

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EUFOST CONFERENCE ABSTRACTS

Microbial diversity of Bovine and Caprine Amasi, traditionally produced using metagenomic sequencing techniques (16S rRNA and ITS 1&2)

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ABSTRACT

Amasi traditional fermented milk is associated with several health benefits, such as probiotic activities, immune system modulation, as well as antimicrobial, antitumor and antioxidant activity. It is native to Southern Africa. In this study, traditionally produced Amasi was subjected to the unique Miseq sequencing techniques to investigate the bacteria 16S rRNA and the Fungai ITS 1&2 regions. This study investigated the microbial diversity of traditionally fermented Amasi (produced from cow and goat milk) to understand their microbial diversity and ecology. The Illumina Miseq platform was used to sequence the V4 region (primer 515 to 806), and sequences were assembled and categorized into operational taxonomic units (OTUs) and the core microbiome was subsequently visualized. The effective QIIME2 (Quantitative Insights into Microbial Ecology2) was used for the downstream analysis and data were presented using RStudio. Firmicutes, Bacteroidetes and Proteobacteria were the prevalent bacterial phyla, whereas *Lactococcus* was the prevalent bacterial genus. *Ascomycota, Basidiomycota, and Mortierellomycota* were the main fungal phylum, while *Alternaria*, *Aspergillus*, and *Candida spp*. were the main fungal genera. Genera with potential to be pathogenic included *Bacillus* (4%), *Salmonella* (0.85%), *Escherichia-Shigella* (0.38%), *Staphylococcus* (0.32%), *Listeria* (0.29%), *Clostridium* (0.28%), and *Cronobacter* (0.27%), as well as *Atopobium, Synechococcus, and Parabacteroides,* potential unique bacteria genera found at lower frequencies. There were relative similarities in the microbiota of cow milk Amasi and goat milk Amasi. Data from this study showed heterogeneity in diversity and abundance distributions between cow/goat milk and Amasi samples. Furthermore, spontaneously fermented milk is a repository of probiotic strains.

Keywords: Amasi, Probiotics, Health benefits, Microbiota, Illumina Miseq, QIIME2.

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Effect of gastrointestinal digestion on the lactoferrin antibacterial activity in dairy formulas against Listeria monocytogenes

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Aim:
The dairy industry generates by-products that cause an environmental problem. However, some of them, such as whey or buttermilk, contain bioactive compounds that can be of great interest to revalue them. Milk bioactive proteins, like lactoferrin, are essential for infant's health, since they protect against infections. Therefore, some of them are added to infant formula. In addition, lactoferrin can be used in some functional products for adults with special needs. Proteins can be digested differently if they have undergone modifications during industrial processing. The main objective of this study has been to evaluate the effect of gastrointestinal digestion on the antibacterial activity of lactoferrin and some dairy formulas supplemented with this protein and subjected to some technological treatments, against *Listeria monocytogenes*.
Method:
Commercial bovine lactoferrin has been used and different dairy formulas have been prepared, based on whey or buttermilk and supplemented with lactoferrin. The antibacterial effect of lactoferrin and dairy formulas against *L. monocytogenes* has been evaluated before and after *in vitro* gastrointestinal digestion. The digestion has been carried out *in vitro* following the INFOGEST procedure and the samples have been analyzed by SDS-PAGE after digestion. Furthermore, it has been analyzed the capacity of lactoferrin to inhibit the internalization of *L. monocytogenes* into Caco-2/TC7 cells, a model of human intestinal epithelium.
Results:
Lactoferrin exerted antibacterial activity against *L. monocytogenes*, both in the native state and after *in vitro* digestion. However, the dairy formulas had higher antibacterial activity against the pathogen after their digestion, especially after the intestinal phase. Furthermore, lactoferrin showed an inhibitory effect, directly proportional to its concentration, on the internalization of bacteria into Caco-2/TC7 cells, reducing the infection of cells by *L. monocytogenes* in more than 50%.
Conclusion:
The results derived from this study indicate that lactoferrin is a milk protein with a protective activity against *L. monocytogenes*, even after digestion. The release of low molecular weight peptides is probably the cause that would explain the enhanced antibacterial activity of the digested dairy formulas supplemented with lactoferrin. Therefore, this study suggests that lactoferrin has a great value and can be a potential ingredient for functional foods.

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Effect of hydrolysis and enzyme inactivation conditions on techno-functional properties of milk protein concentrate hydrolysates

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Aim:

Milk protein concentrates (MPCs) are ingredients rich in essential amino acids, which are used in protein fortification of foods to address the nutritional needs of older adults. While their commercial applicability may be restricted due to variability in their techno-functional properties, the potential enhanced efficacy of MPCs in the format of enzymatically derived milk protein hydrolysates (MPHs) warrants further investigation. This study investigated the impact of enzymatic hydrolysis conditions on the techno-functional properties (turbidity, solubility and viscosity) of MPHs with a view to determining their overall suitability as protein ingredients in fortified foods. "

Method:

MPC was enzymatically hydrolysed using Neutrase® (at an enzyme:substrate of 0.1 and 1% (v/w)). MPH samples were withdrawn at different time intervals (30 – 240 min) during hydrolysis, followed by pH adjustment (pH 4.5 – 7.0). Following thermal treatment (90^oC vs 10min) the turbidity, solubility, apparent viscosity (η_{app}) and degree of hydrolysis (%DH) of each MPH sample was determined. Residual enzymatic activity of Neutrase® was determined using the Azocasein assay.

Results:

Hydrolysis time, pH and Neutrase® addition level were shown to significantly affect MPC hydrolysate DH, while also affecting the solubility and the turbidity of the MPHs ($p<0.05$). At pH 4.5, the residual enzymatic activity of Neutrase® (0.03 $\Delta A_{450nm}/min^{-1}/\mu l^{-1}$enzyme) was significantly decreased compared to that at pH 7 (0.05 $\Delta A_{450nm}/min^{-1}/\mu l^{-1}$enzyme). Additionally, MPH precipitation at lower pH, led to increased turbidity and lower solubility compared to samples at pH 7. Meanwhile, the higher Neutrase® concentration (1% v/w) and longer hydrolysis time (240 min) led to a significant decrease in sample turbidity and residual enzymatic activity, while solubility increased. At pH 6.5, the η_{app} of MPH (3 cP) was lower than MPC (4 cP), while acidic pH resulted in precipitation before heating and gelation after heating.

Conclusion:

Hydrolysis conditions (i.e. hydrolysis time and enzyme concentration), and pH adjustmend before heat inactivation impact the techno-functional properties of MPHs. This in turn may impact MPH behaviour in different protein hydrolysate fortified food matrices. These conditions require careful consideration when formulating foods with MPHs.

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Calcium transport and phytate hydrolysis during chemical hardening of common bean seeds

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Aim:

Legumes are important staple foods and thus an important source of nutrtients in developing countries and are regaining interest in developed countries. Their utilization is however largely influenced by the hard-to-cook (HTC) defect. Some researchers initiated chemical hardening methods to accelerate the hardening in beans to detect the tendency of beans to develop HTC. In this study, two chemical bean hardening methods were used to investigate the changes in cooking behavior associated with Ca^{2+} transport and phytate hydrolysis to better understand their role in the pectin-cation-phytate hypothesis.

Method:

Red kidney beans were hardened by $CaCl_2$ solution (0.01M, 0.05M, 0.1M) or sodium acetate buffer (0.1M, pH 4.4, 41 ^oC). This study explored texture evolution calcium content in different bean substructures, phytate content and the pectin degree of methylesterification (DM) in the cotyledons during chemical hardening and cooking by using texture analyzer, HPLC-ELSD, Dionex and FT-IR, respectively.

Results:

The beans soaked in $CaCl_2$ solution at higher concentrations or in sodium acetate buffer for a longer time exhibited a delayed cooking behavior. The Ca^{2+} concentrations in the whole beans and cotyledons of beans treated by $CaCl_2$ solutions significantly increased while inositol hexaphosphate IP_6 content showed no significant changes. This indicates that the delayed texture drop in this case results from the influx of exogenous Ca^{2+} in the cotyledons and seed coats during cooking while IP6 was not hydrolyzed and did not release endogenous Ca^{2+}. For beans soaked in sodium acetate buffer, phytate profiling showed increased hydrolysis of IP6 with longer soaking time, suggesting migration of endogenous Ca^{2+} released from phytate hydrolysis contributing to the delayed cooking of these beans. No significant change in pectin DM was observed during chemical hardening, therefore limiting the delayed cooking to the role of Ca^{2+} transport.

Conclusion:

Outcome of both cases is inline with the basic principles of the pectin-cation-phytate hypothesis whereby pectin DM changes are hardly involved and different mechanisms of release/transport are involved. These results indicate that both an exogenous Ca^{2+} influx during soaking and cooking and an endogenous Ca^{2+} migration resulting from phytate hydrolysis can play an important role in the hardening of beans.

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Digestive fate of protein amyloid structures: A case study on α-lactalbumin, β-lactoglobulin and ovalbumin

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Aim: Food protein amyloid structures can be deliberately or unintentionally formed in foods, for example during spray or freeze drying. However, the link between amyloid structures and human pathogeneses raises concern regarding their digestive fate. Therefore, this study fabricated various amyloid assemblies, characterized them, and studied their gastro-intestinal and colonic digestibility.
Method: Fluctuations in pH and temperature (pH=2, 37-80°C) were applied to α-lactalbumin (ALA), β-lactoglobulin (BLG) or ovalbumin (OVA) to fabricate amyloid structures. These were characterized by DLS and TEM for size, shape and zeta-potential as well as Thioflavin T assay to affirm amyloid arrangement. Native proteins and the various fabricated assemblies were subjected to semi-dynamic *in vitro* digestion coupled to LC-MS/MS proteomic analyses. In addition, amyloid structures were screened for antimicrobial activity against gram negative and positive bacteria and studied for their impact on colonic microbiota using *in vitro* 24-hours batch fermentations of fresh feces from healthy male adults. Microbiota response was studied using 16S high-throughput sequencing and processed using various bioinformatic pipelines.
Results: This work provides evidence that amyloid structures attenuates the *in vitro* digestive proteolysis of ALA with bioaccessible peptides reduced from $(1.0\pm0.1)\cdot10^{11}$ to $(6.0\pm0.4)\cdot10^{9}$ upon digestion of ALA or ALA fibrils, respectively. These differences in generation of bioaccessible peptides was also observed for BLG and OVA amyloid structures. Antimicrobial activity of OVA (e.g., MIC=21µg/mL against *micrococcus luteus*) was abolished by amyloid formation which stimulated efforts to ascertain the possible effects on complex populations, like the gut microbiota. Colonic fermentations show biodiversity indices (e.g., alpha and beta diversity) are highly affected by protein amyloid arrangements, suggesting an extended proteolytic fermentation process.
Conclusion: Processing can be harnessed to fabricate functional protein architectures; however, their digestive fate requires further study to support or refute possible benefits or deleterious effects. Altogether, this research provides evidence that show amyloid structures may have a modulated digestive fate with possible ramification to the gut microbiota and perhaps consumer health.

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Lemongrass Oil-based Nanocomposite: An Active Material of Biobased Food Packaging Film

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Aim:
In our study, we aimed to synthesize nanocomposite, an active material of food packaging film comprising lemongrass nanoemulsion that encapsulates silver nanoparticles (Ag-LNE) to prevent the growth of *E.coli*, a food-borne pathogen.
Method:
Silver nanoparticles (AgNPs) were synthesized by a microwave-assisted method while high-energy sonication method was adopted for the synthesis of lemongrass nanoemulsion (LNE). AgNPs and LNE were further characterized by their size and other physico-chemical characterizations. Two nanocomposites NC1 and NC2 were synthesized by varying the concentration of AgNPs in LNE through high-energy sonication process and their antimicrobial activity was evaluated.
Results:
It was noted that the average size of silver nanoparticles belongs in the range of 10-30 nm, whereas the droplet size of the nanoemulsion is within 100 nm. Furthermore, the contact angle of lemongrass nanoemulsion (61.86 ±1.96) with the substrate was higher than crude lemongrass oil (46.08 ± 1.06) indicating the higher wettable behavior of the nanoemulsion.
Two nanocomposites NC1 and NC2 with varying concentrations of AgNPs-5 and 10 % respectively by encapsulating silver nanoparticles into nanoemulsion and it was evident by the increment in the size of nanocomposites. Furthermore, characterization of nanocomposites by FT-IR revealed the presence of functional groups which correspond to LNE and AgNPs. The antimicrobial activity of nanocomposite against *Escherichia coli* was significantly higher, by 36 % and 9 % than silver and lemongrass nanoemulsion respectively. In addition, a comparative study of antimicrobial activity declares that NC1 was more efficacious than NC2 and the minimum inhibitory concentration of the NC1 was 0.75 % to inhibit the growth of *E. coli*.
Conclusion:
Thus, the present study reveals that NC1 has the potential to inhibit the growth of *E. coli* which could be used as an active component of food packaging film for enhancing the shelf life of food-stuffs sustainably.

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Influence of processing paramters on the quality of defatted T. molitor

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Aim:
The increasing world population is in need of a secure, sustainable, global food supply. The market of meat alternatives is set to soar in value and is expected to increase by 40 % from 2022 to 2030. Insects such as *T. molitor* are a promising alternative protein source for human nutrition considering ecological and economic aspects such as rapid growth, high feed conversion rate, sustainable utilization of organic side streams and resource-saving production of macro- and micronutrients, especially proteins. The processing of insects is essential with regard to meet the individual product requirements, as well as to ensure the quality and safety of food and feed. Furthermore, the acceptance and willingness to consume insects or insect-based food in western countries increases with extent of preparation and processing.

Method:
This work generates a comprehensive analysis of technological parameters of dry processing of insects, using *T. molitor* as an example. Applied technologies are aimed at sustainable, regional, frugal, energy-efficient feasibility. The impact of individual unit operations on the processability and product quality of *T. molitor* is examined - following inactivation, drying and processing, in order to obtain constituent product fractions. Blanching and freezing, convection and microwave drying were compared regarding color changes, microbiological parameters, aW-value and the efficiency of mechanical pressing to produce protein-rich fractions.

Results:
Blancing has been considered the most effective inactivation method regarding simultaneous decontamination of *T. molitor* accompanying the inactivation of endogenous enzymes, such as the polyphenol oxidase, to limit enzyme induced browning reactions, especially during further processing. In terms of coloring, microwave drying resulted in a slightly higher lightness value (L) than conventional drying (27.37 vs. 32.46). Both methods reduced the aW-value blow < 0.6. The production of protein-rich fractions has been successful, including a maximum oil yield of 15.7 % achieved through mechanical pressing.

Conclusion:
The type of killing has an impact on enzymatic browning and thus influences the product quality and its processability. In addition to other factors, a standardized water content of the biomass is decisive for the performance of the pressing process.

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Influence of different packaging strategies on the quality and shelf life of tomatoes

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Aim

Particularly in the fruit and vegetable sector, a very large amount of food waste is generated. This results in a loss of the resources needed for primary production and the food is no longer available for human consumption. A reduction of waste can be achieved by a proper packaging of the product, but is often correlated to high amounts of packaging waste. Therefore, the aim of this work is to compare conventional and innovative, sustainable packaging for tomatoes that saves resources by extending the shelf life of the product while reducing packaging waste.

Method

Storage trials with tomatoes were carried out using different packaging materials (rPET package with lid, cardboard box wrapped with perforated film tube and ground wood packaging). The products were packed in different packaging and stored for 23 days at constant temperature of 20°C. The sample size was 72 tomato packages (24 per packaging). Tomatoes were analyzed for microbial, sensory, and physicochemical quality on eight examination days. To determine the microbiological quality, the total viable count, yeasts and molds, as well as Enterobacteriaceae were determined by classical enumeration techniques. Sensory quality was evaluated by a trained sensory panel based on a hedonic five-point scale. For physicochemical quality, pH, Brix, color, weight loss and texture were measured.

Results

The total viable count of tomatoes at the beginning of storage was 3.54 log10 CFU/g (± 0.18) and at the end of storage 4.1 log10 CFU/g (± 0.18). However, growth of spoilage bacteria did not follow a typical pattern, so other factors, such as sensory characteristics, color or texture were used to determine shelf life. Additionally, weight loss can be used as a reliable parameter to determine shelf life.

Conclusion

Based on the results, the shelf life of tomatoes stored at 20°C could be determined. In addition, the influence of packaging type on shelf life should be measurable. Thus, it is possible to compare conventional packaging with innovative packaging based on the shelf life extension and the associated food waste reduction. In addition, a life cycle assessment comparison can be made between the different packaging types.

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Sustainable fish products enriched with protein from fish and pea side streams

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Aim
To develop new and sustainable fish products enriched with protein from fish and pea side streams.
Background
Protein powders were recovered from seafood by-products by enzymatic hydrolysis and from pea side streams by purification and drying processes. These proteins were added to minced fish burgers as sustainable ingredients and can be enriched fish products.
Materials and methods
Frozen haddock and silver smelt were defrosted before blended and added ingredients as proteins (fish protein hydrolysates, pea protein, whey, casein), fat and texture modifiers (pea and potato starch). Fish protein hydrolysate made from by-products of salmon (*Salmo salar*) containing 97 % protein and pea protein powder (56 % protein) were used. Before pasteurization at 90°C for 10 mins, the homogenized products were filled in PA/PE casings (Betan, Naturin GmbH & Co., Germany) and sealed. The products were analysed for texture, liquid-holding-capacity, colour, cryosectioning and sensory evaluation.
Results and discussion
The texture of fish product could be modified to minced products in different recipes using both salmon protein hydrolysates and/or pea protein. Protein enrichment was in the range of 14.1 (no added) – 22.3 % (max added) total proteins. Limited amounts of fish hydrolysates and pea protein could be added, due to changes in sensory and physio-chemical properties. Firmness (N) increased with increasing enrichment but varied between the different protein enrichment combinations. Fish protein hydrolysates are known to have good water retention properties and can have a positive effect in retaining the moisture and making the product softer and juicier. Cryosectioning confirmed differences between the recipes but showed a firm distribution of proteins in the products.
Conclusions
- Model products of haddock enriched with fish protein hydrolysates and/or pea protein with a soft minced level were developed.
- The ratio and amount of liquid and protein affects the texture and sensory properties of the product.
- Enrichments with protein from salmon and pea side streams, were promising, and the range was 14.1 – 22.3 % total proteins in the minced fish products.

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Thermal stability of new vegetable oils with a programmed ratio of ω6/ω3 fatty acids

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Aim: Evaluation of the thermal stability of oils with a programmed ratio of omega 6 and omega 3 fatty acids.
Method: Oil blends with a 5:1 ratio of ω6/ω3 fatty acids were prepared using pressed oils. The new oils were characterized by a diversified profile of fatty acids and the tocochromanols content. Prepared oil blends were heated at 170 and 200 °C in a thin layer (pan frying model). Changes in the content of polar compounds, the increase of dimers and polymers of triacylglycerols, and changes in the content of tocochromanols were determined in the heated samples.
Results: Heating of individual oil blends led to their degradation, which depended on the temperature of the heating process and the type of oil. During heating, a constant increase in the content of polar compounds and an increase in polymers of triacylglycerols were observed. The content of polar compounds increased from 1.6 to 2.4 times at 170 ° C and from 2.0 to 4.2 times at 200 °C. The lower temperature of the process led to the formation of triacylglycerol dimers, but a small extent. A rapid increase of triacylglycerol polymers was observed at 200 °C. In addition, in three oils heated at 200 °C, the formation of triacylglycerol trimers was observed as products of an advanced polymerization. Rapid degradation of tocochromanols was also observed in the new oils. The final content of tocochromanols depended on the presence of tocopherols and tocotrienols in the composition of unheated oils and their ratio. The high content of tocotrienols decreased the rate of changes.
Conclusion: The obtained oil blends were characterized by a different rate of degradation during heating, due to the presence of tocopherols and tocotrienols and the fatty acid profile. The preparation of oil blends with a programmed ω6/ω3 ratio makes it possible to obtain products with relatively high thermal stability.

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Effects on psychrotrophic B. cereus using pressure assisted thermal processing (PATP)

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Aim
Food products get lower sensory and nutritional qualities due to high heat treatment. An alternative processing method is Pressure Assisted Thermal Pasteurization (PATP) which combines high-pressure processing with heat treatment (HT). Psychrotrophic *Bacillus cereus* spores were used to validate PATP for pasteurizing food.
Method
Psychrotrophic *B. cereus* (ATCC 9139) vegetative cells and spores were incubated in LB medium added NaCl (1, 2, 4%), KCl (1, 2, 4%), $NaNO_2$ (60, 125, 500 ppm), nisin (7.5, 15, 25 ug/ml), and grown at different pH values (3, 4, 5), at 25 °C. Growth was determined in Bioscreen C turbidometer. Inactivation experiments of spores were carried out in liquid LB medium, in minced meat and minced fish matrix using heat (85, 90 and 95°C, 5 min, in water bath) and PATP at 20, 40 and 55 °C, 600 MPa for 2 and 10 min.
Results

The results of the preservatives and pH values showed that *B. cereus* could grow in the salt and NO_2 concentrations but was inhibited by pH 3 and 4, and 25 ug/ml nisin. The decimal reduction values were D_{80} = 7.1 min and D_{90}=1.9min. In LB medium the inactivation was 1.88 log at 80 ^{o}C and 3.90 log at 90 ^{o}C. There was observed little difference in the inactivation of spores in minced meat and fish. The log reduction in minced meat (5 min) at 85, 90 and 95 ^{o}C was 0.84, 1.56 and 3.32 log. In combination with heat and high pressure 600 MPa (10 min) the log reductions were 0.3 (20 ^{o}C), 0.83 (40 ^{o}C) and 3.20 (55 ^{o}C).
Conclusion
Lowering pH and adding nisin gave growth inhibition of *B. cereus*. A similar reduction of spores was achieved in minced meat and fish with 600 MPa at 55 °C as heat treated at 95 °C for 5 min. It is possible to use lower temperature when high pressure processing is used leading to products with better sensory score and higher nutritional levels.

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Structure-function relationship of oat flour incorporated into wheat flour: Instrumental and Nutritional Quality Characterisation

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Aim
The present work was carried out to study the structure-function relationship of dry fractionated oat flours (DFOF) as a Techno-functional ingredient using bread as a model system.
Methods
Mechanically dry fractionated whole oat flour i.e. DFOF1: >224, DFOF2: 250-280, DFOF3: 280-500, DFOF4: 500-600 µm was blended with bread wheat flour at 10, 30 and 50% substitution levels for bread making. The blended flours and bread samples were assessed for their rheological, nutritional and structural characteristics.
Results
Results from Mixolab and Rapid Visco Analyser showed that DFOF3 at 50% exhibited highest water absorption value (69.53%) whereas DFOF1 at 50% showed highest peak viscosity. Analysis of bread samples showed that lower particle size and higher oat flour supplementation resulted in increased β-glucan levels (0.13 to 1.29 g/100 bread (db)), reduced fermentable monosaccharides i.e. glucose (1.44 to 0.33 g/100g) and fructose (1.06 g to 0.28 g/100 g). Bread samples showed volume reduction as the oat flour concentration increased; however, the effect of particle size was more pronounced than the substitution levels of oat flour. Colour analysis revealed that lightness (L*) of crust and crumb of the bread samples increased as particle size increased from DFOF1 to DFOF4 and oat flour supplementation increased from 10-50%. Texture Profile Analysis of bread samples showed the DFOF1 at 10% had lowest hardness value (403.62N) as compared to the highest value for DFOF2 at 50%. Additionally, 2D image analysis showed a reduction in number of cells from (n=1850) in the control to (n=1128) for DFOF4 at 50%. It was observed that dry fractionated oat flour in a lower particle size range had improved nutritional and techno-functional properties of bread samples at 10% substitution levels.
Conclusion
Results highlight the potential application of fractionated oat flour in modifying wheat flour properties for bread making applications.
Key words: Dry fractionation, oat flour, b-glucan, techno-functional characteristics

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Innovative approach for a deeper understanding of a model by-product emulsion stabilizing properties

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Aim:
Current by-products valorization strategies are often based on interest molecules extraction which still generates waste. Solid particles being known as efficient alternative to surfactants, vegetal by-products – in their entirety - make good clean-label candidates as they are composed of both insoluble and soluble compounds. Indeed, besides their strong ability to act as sole stabilizing agent in emulsion[1]–[3], by-products multifunctionality (polyphenols, thickening agents) may lead to reduced ingredients lists in formulated emulsions. Although very beneficial for the environment, the use of uncracked materials brings many challenges in understanding and decorrelating the mechanisms. This work introduces a novel multi-scale strategy to provide a better understanding of unpurified vegetal particles stabilized emulsions.
Method:
To understand and prioritize the emulsion structuring mechanisms, different fractions of apple pomace particles (whole particles, highly purified insoluble part, mildly purified insoluble part, soluble part) were compared in terms of composition, structural and surface-active properties and ability to produce fine and stable emulsions.
Results:
This study led to the following main results : 1) Solid particles showed surface-active properties as they efficiently decreased the oil-water surface tension by 0,5 to 2,5 mN/m depending on the fraction; 2) Confocal microscopy on diluted emulsions proved that some particles are strongly anchored at the o/w interface; 3) Particles ability to adsorbed at the o/w interfaces is linked to their surface-active properties; 4) Oil droplet sized were in the range of 22 and 82µm depending on the fractions and remained stable over a month for all fractions but soluble; 5) Soluble compounds play a key role in the initial droplet size whereas the stability over time is provided by the particles interfacial coverage and the particles three-dimensional networked in which droplets are embedded.
Conclusion:
Thus, the present work provides in-depth insight into the mechanisms involved in the physical stability of emulsions containing natural particles as sole emulsifier. This better understanding of mechanisms will lead to a better prediction of the potential of vegetal by-products as stabilizing agents in order to tackle the major issue of food waste by promoting the sustainable use of up-cycled raw materials.

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Investigation of lactose assimilation by microalgae for bioremediation of dairy waste

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Aim

Whey permeate is a major by-product of dairy production. The wastewater is rich in sugar (as lactose, 5% w/v) and other dissolved nutrients (e.g., nitrates and phosphates). Conventional wastewater treatment requires large amount of chemicals and represents a significant economic burden to dairy producers. Therefore, valorisation of this waste stream into more profitable co-products is of vital importance. Our study aims to use the latest microalgae biotechnology as a novel means to simultaneously treat and upcycle dairy wastewater into high-commodity products for food and feed applications. In this study, extracellular β-galactosidase synthesis and the pathway of lactose assimilation by *Nannochloropsis oceanica* will be investigated.

Method

Mixotrophic cultivation for *N. oceanica* was performed with f/2 standard growth medium with 10 g/L and 5 g/L initial lactose concentration. Culture without sugar addition was employed as a control group. Optical density and biomass concentration were used to determine the growth of microalgae. Chemical analysis was carried out to determine nitrate, phosphate and sugar (i.e., lactose, glucose and galactose) assimilation during the cultivation. In addition, extracellular β-galactosidase activity was determined in the meanwhile.

Results

N. oceanica cultivated with 1% (w/v) initial lactose concentration presented higher biomass concentration of 0.71±0.00 g/L at the end of cultivation period, which was increased by 1.6-fold compared to the control group. Lactose metabolization was observed in two sugar-added groups, which showed 57.2% and 37.4% reduction in the 1% and 0.5% (w/v) initial concentration. The highest extracellular enzymatic activity was found on the 8th cultivation days in these two groups, which was 41.47±0.33 and 33.11±0.26 U/g biomass, respectively. In addition, nitrate and phosphate in the medium were completely assimilated within two weeks.

Conclusion

This study demonstrated that *N. oceanica* could assimilate the lactose by generating extracellular β-galactosidase, therefore enhancing the algae growth. These results suggest the promising nature of whey permeate as a potential growth medium for the cultivation of *N. oceanica*. In the near future, we will test our microalgae cultivation system using whey permeate obtained from an Irish dairy producer and evaluate its capacity for bioremediation and ω-3 production.

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Food loss and waste in seafood value chains: causes, volumes and environmental cost

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Aim:
We aim to define food loss and waste (FLW) in the context of seafood supply chains and with a focus on selected case studies in fisheries and aquaculture in Norway and Iceland. Based on the description of the different study cases we will compare the similarities and differences between these two countries. We also aim to identify supply chain management related causes for FLW in the case studies, identify critical points for improvement and calculate the environmental costs of FLW.

Method:
We use as main method The Food Loss and Waste Accounting and Reporting Standard to quantify and report on food loss and waste so they can develop targeted reduction strategies and realize the benefits from tackling this inefficiency (flwprotocol.org). We use the standard guidelines to identify both the drives and causes of food loss and waste as well as the destinations of the FLW. The GHG emissions from FLW and the different destinations for seafood are quantified.

Results:
We identify and quantify the FLW as well as the causes for the entire supply chain. We also identify the current end destination of the losses and how they are handled and quantify associated GHG emissions from different destinatios. We highlight the similarities and differences on structure of the industry, regulation, consumer markets. The comparison is made based on aspects such as: different practices for handling loss or waste, different degrees of resource utilization, difference in regulatory framework, market price and profitability, distances, and logistics for resource utilization.

Conclusion:
Based on the mapping of FLW, we identify critical points for improvement and reductions of FLW and recommend better methods for end uses for the losses. Additionally, we identify knowledge gaps, and we recommend methods for possible knowledge transfers and/or synergies between the two markets (Icelandic and Norwegian).

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Use of rainbow trout (Oncorhynchus mykiss) hydrolysate as a valuable source of multifunctional bioactive peptides

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Aim:
Many studies have shown that enzymatic hydrolysis can release bioactive peptides, which some are multifunctional. However, extraction of bioactive peptides from farmed fish for noncommunicable disease prevention is underexplored, and the aim of the study was to fill this gap by identifying multifunctional peptides isolated from rainbow trout (*Oncorhynchus mykiss*).

Method:
Head-on gutted rainbow trout delivered from a local fish processing plant "Hofseth AS" (Ålesund, Norway), was used as raw material for enzymatic hydrolysis. Enzymes used in the hydrolysis was papain ad bromelain (0.05% of each), the temperature was 50±2°C.
The chemical composition and peptide sequences was identified, and the direct antioxidant activity of the hydrolysate by using a combination of ABTS, FRAP and DPPH assay was measured.

Results:
Trout peptide mixture can scavenge the ABTS and DPPH radicals. The response was dose-dependent, indicating hypotensive and anti-diabetic activities of the hydrolysate. At cellular levels, the same peptides reduce oxidative stress induced by H_2O_2 in Caco-2 cells.
Trout hydrolysate exerts a multifunctional bioactivity through the ability of reduction of the oxidative stress induced by H_2O_2 in human intestinal Caco-2 cells, as well as inhibition of ACE and DPP-IV activities.
The high presence of hydrophobic peptides within the hydrolysate is correlated to the antioxidant effect and other biological activities.

Conclusion:
The results indicated the potential of rainbow trout for production of a hydrolysate with bioactive and multifunctional peptides and a potential application in foods, pharmaceutical and nutraceutical products.

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Effect of polygalacturonic acid derivatives from fractionation and acidic hydrolysis on in vitro α-amylase activity

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Aims

Pectins as major dietary fibres can effectively regulate starch digestion which determines postprandial glycaemic responses, however, detailed mechanisms are not fully clear. Here, we aim to find active fractions for inhibiting amylase from a polygalacturonic acid (PGA) pectin and explore the underlying mechanisms.

Methods

One batch of PGA were hydrolyzed in 1 M HCl for 6, 24 and 48 h, the hydrolysates were centrifuged, dialyzed, and freeze-dried (denoted as PGA- 6h, 24h and 48h, respectively). Another batch of PGA were dispersed in water under 25, 37, 60 and 80°C for 18 h, respectively, and were centrifuged to obtain supernatants (S) and precipitates (P) which are denoted as PGA-25S and PGA-25P, etc. The monosaccharide compositions (MC) and molecular sizes of all derivatives were characterized by high performance liquid chromatography methods. The derivatives were incubated with α-amylase for 1 h at 37°C in pH 6.0 sodium acetate buffer and the activities of amylases were measured by the Megazyme assay kit. The in vitro digestibility of corn starch with and without PGA derivatives were also studied and processed by several models. Finally, the structural parameters of PGA derivatives were correlated with amylase inhibitory and starch digestibility results for mechanistic understanding.

Results

The acidic hydrolysis decreased the molecular sizes and galacturonic acid (GalA) contents of PGA, while they had no effect on amylase activity and starch digestion. PGA-Ps are (1) mainly composed of GalA (>90% of MC) compared to original PGA (80% MC) and (2) presenting larger hydrodynamic radius (>7 nm) than PGA (6.8 nm) and PGA-Ss (<6.2 nm). PGA-Ps and PGA-Ss could decrease the α-amylase activity, and their effects are stronger and weaker than PGA, respectively. PGA-Ps delayed the starch digestion but PGA-Ss somehow stimulated the digestibility to higher ratios.

Conclusion

PGA fractions with more GalA and larger molecular sizes have stronger effects on starch digestion and α-amylase activity. A decreased amylase activity by pectin may not guarantee a lowered starch digestibility, suggesting the complexity of the digesta. Pectin as a versatile DF can be a promising food additive in regulating starch digestion.

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Goat milk microbial biodiversity as an identification indicator of origin and terroir of dairy products

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Aim:
Goat milk and its products are well-known types of dairy product worldwide, even more so today as more of their beneficial properties for humans are being discovered. Detailed knowledge of the microbial profile of goat milk is of major interest for dairy producers. Hence, the objective of this study was to comparatively describe the microbial biodiversity of goat milk based on the breeds of the goats by using as identification indicators the origin and the terroir of the goat milk products.

Method:
Milk samples from two indigenous Greek goat breeds (Breed-1: Skopelou; Breed-2: *Capra Prisca*), were identified as markers that could trace the authenticity and the single-breed origin of goat milk products. The samples were analyzed by an established protocol using 16S rRNA genome sequencing, standard commercial DNA kits (DNeasy PowerFood Microbial Kit, Qiagen, Germany) and the Illumina MiSeq chemistry (Illumina Inc, USA).

Results:
The results demonstrate that the bacterial phyla Firmicutes, Proteobacteria, Actinobacteria, Bacteroidetes and Spirochetes were the most representative in the two goat milk samples (Breed-1: 27.61%, 50.12%, 12.75%, 7.96% and 0.67% of the sequences respectively; Breed-2: 26.70%, 34.12%, 31.21%, 6.77% and 0.29% of the sequences respectively). On genus level, *Corynebacterium* had the highest percentage in the two goat breed milk samples (Breed-1: 6.83%; Breed-2: 22.54%, respectively), while *Lactobacillus* had the second highest percentage (2.66%; 5.01%). The genera, *Streptococcus*, *Clostridium* and *Lactococcus* were present in goat Breed-1 samples with percentages of 4.26%, 3.06%, 0.71% respectively, and in goat Breed-2 samples with percentages 2.87%, 2.27% and 0.44% respectively.

Conclusion:
According to the results, the diversity of the microbial community composition of the goat milk could be linked with the goat milk origin. Bacterial taxonomy analysis of the goat milk enables the detection of goat product's authenticity in relation to the breed and appears to be an indicator for goat their traceability.

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Rationalized use of functional barriers to promote recycled materials for food contact

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Aim

According to the European "single-use" Directive 2019/904 and French "anti-waste" Law N°2020-105, plastics will be tolerated for food contact in future only if they are made from recycled materials. Recycled paper and coatings have been recently associated with major crises: mineral oils, printing inks, bisphenol-A. The use of recycled plastics for food contact is highly framed and managed by the regulation (EC) 282/2008. The prevailing principle is that recycled material must offer the same safety as virgin material by controlling the sourcing and decontamination level (DL). The functional barrier (FB) concept reports a new degree of freedom which is known and already recognized by Regulation (EU) 10/2011. Here we demonstrate that the binomial (DL, barrier) can be adjusted to the contamination profile of the streams: low molecular weight compounds are easily removed but not stopped by the FB, whereas high molecular weight compounds are persistent but easily stopped by a glassy layer.

Methodology

Without a loss of generality, the optimal design of FB was developed for rigid polypropylene (PP) films and containers made from recycled materials and whose contact layer is a virgin bioriented polyethylene terephthalate (PET) layer. The risk of mass transfer was evaluated for arbitrary contaminants and concentration levels by numerical simulation using the free volume theory of diffusion in polymers. Multicriteria optimization was used to reach a compromise between food shelf-life and the thickness of the virgin layer.

Results

The introduction of a glassy FB has two essential effects on mass transfer, it incorporates a contrast of chemical affinity (lower chemical affinity for glassy polymers) and delays the desorption to the food side. The results are expressed via a dimensionless formulation enabling a rapid reconstruction of design effects (barrier thickness) and the decontamination requirements for common contaminants, including repeated flexible or rigid patterns.

Conclusions

The feasibility of lowering decontamination behind a functional barrier for materials difficult to decontaminate or with a less controlled origin is demonstrated. The thickness of the functional barrier needs to be sufficient to accommodate food shelf-life and the storage of the material before use. An optimal decontamination profile for PET barriers is proposed.

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Evaluation Of Deep Eutectic Solvent Pretreatment Efficiency On Distiller's Dried Grains

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Abstract

Aim: to evaluate deep eutectic solvent pretreatment efficiency on distiller's dried grains (DDG)

Introduction: Lignocellulosic food industry wastes such as distiller's dried grains (DDG) are significant environmental burdens worldwide, including Ireland. DDG is well suited for use as a feedstock in a biomass-based biorefining process to synthesise specific high-value products, resulting in cost savings and waste reduction for bioethanol industries.
The chemical process involving the use of acid and alkaline has been investigated in the pretreatment of lignocellulosic materials to overcome recalcitrance and improve fractionation efficiency. However, most conventional methods are unfavourable and have less environmentally friendly processing conditions. Recently, deep eutectic solvent (DES) has gained attention as a novel ionic liquid with high efficacy for biomass fractionation. Therefore, this study evaluates the effect of different molar ratios, temperature, and reaction time on the pretreatment efficiency of deep eutectic solvent on distilleries' dried grain to determine the optimum pretreatment condition.

Method:
Three types of DES with different molar ratios were prepared by mixing choline chloride: lactic acid, choline chloride: urea, and choline chloride: glycerol, respectively, followed by vigorous agitation at 85 °C for two hours. Properties of deep eutectic solvent, including viscosity, pH, and heat capacity, were determined. Extractive-free raw distiller's dried grains and DES-pre-treated distiller's dried grains were subjected to compositional analysis and pretreatment performance analysis to evaluate deep eutectic solvent fractionation and de-lignification efficacy on distiller's dried grains.

Results:
The results showed that all the three deep eutectic solvents significantly influenced the cellulose, hemicellulose, and lignin content. A substantial reduction was observed in lignin content, whereas a significant improvement in cellulose content was recorded in the sample treated with DES. On the other hand, the DES-treated distiller's dried grains showed a slight dissolution of hemicellulose.

Conclusion:
DES showed promising potential as an efficient, green single-step de-lignification and fractionation method for distillers' dried grain.

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Effect of dietary silage from agro-industry by-products on pork performance, meat composition and oxidative stability

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Aim: Some agro-industry by-products are rich in bioactive compounds and could find uses in animal nutrition. In this dietary experiment a novel silage created with olive mill wastewater, grape pomace and deproteinized cheese whey from the Greek agro-industry sector was fed to finishing pig and the effects on pig performance and meat quality characteristics were investigated.

Method: Eighteen crossbreed finishing pigs 120 days-old were individually ear-tagged, randomly allocated to three treatments, and fed the tested silage at 0% (Treatment A), 5% (Treatment B) or 10% (Treatment C). Performance data were collected for 60 days (180 days old). Then pigs were slaughtered and meat samples were taken (shoulder and pancetta). Meat chemical composition was evaluated with a FoodScan analyser in cold carcasses and pH was determined with a portable pH meter. Then after one month of frozen storage, meat pH was measured again, total phenols and antioxidant status were evaluated.

Results:
Pig final live weight and total weight gain did not differ ($P>0.05$) between the three treatments. Meat fat, protein, collagen, ash, and pH did not differ ($P>0.05$) between the control A and the supplemented treatments B and C for both shoulder and pancetta.
In the meat from the frozen storage analyses it was found that shoulder meat total phenols where higher ($P\leq0.05$) in treatment C compared to A; the pH of shoulder meat was increased ($P\leq0.001$) in treatment B compared to the others; the pH of pancetta meat was reduced ($P\leq0.001$) in treatment C compared to the others; Thiobarbituric acid reactive substances did not differ ($P>0.05$).

Conclusion: Based on the results of this feeding trial, the examined silage created with by products from the Greek agro-industry sector can be used on finishing pig diets without negative effects of growth and as a potential source of bioactive phenolic compounds for the pork meat.

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Nutritional, Physicochemical and Microbiological Quality of Selected South African and Russian Dairy Fermented Beverages

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Nutritional, Physicochemical and Microbiological Quality of Selected South African and Russian Dairy Fermented Beverages

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ABSTRACT
Consumer interest in the potential health benefits of fermented foods and beverages continues to grow around the world. In this study, South African fermented milk (Amasi) and Russian fermented milk (Kefir and Ryazhenka) were produced through lactic acid fermentation using cow, goat, and buffalo milk. The nutritional, physicochemical and microbiological parameters were investigated during storage. Nine fermented milk samples were produced through inoculation with selected bacteria cultures. Fermented milk samples were stored for 20 days in a refrigerator at 4 ℃. The proximate, physicochemical, and microbiological analysis was conducted on the fermented milk samples. The protein content ranges from 4.34 to 2.06%. The fermented buffalo milk samples had the most significant increase ($p<0.05$) in protein, fat, and amino acid composition. The fermented goat milk samples had the lowest fat and protein contents ($p<0.05$). The Lactobacillus spp. (LAB) counts increased as the storage days increased for both Amasi and Kefir samples ($p<0.05$) and both products had a significant LAB count ($p<0.05$) after 20 days of storage. Ryazhenka products (Rc and Rb) had the highest LAB count ($p<0.05$) after 20 days of storage. Fermented milk samples: Kefir, Amasi, and Ryazhenka products all had similar quality parameters. The fermented milk products in this study showed acceptable nutritional, physicochemical and microbiological parameters necessary for a healthy dairy beverage.

Keywords: Ryazhenka, Amasi, Kefir, buffalo milk, goat milk.

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Double emulsions stabilized with cocoa butter fat crystals as Pickering particles

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Aim: In recent years, Pickering stabilization has gained significant research attention in the food industry, because of the ultrastability it provides to an emulsion system. However, little work has been done in designing Pickering double emulsion (DE) such as water-in-oil-in-water (W/O/W) emulsions, in the latter long-term stability is a major concern. The aim of this study was to use fat crystals to create particle-stabilized primary emulsion in a W/O/W emulsion.
Method: Water-in-oil (W/O) emulsions were stabilized by using cocoa butter crystals (CB) dispersed in high oleic sunflower oil (HOSFO) and then this was used as the dispersed phase in a W/O/W stabilized by whey protein. The capability of the CB crystals (5-23 wt% CB) to form W/O and subsequently a W/O/W emulsion was characterized using cross-polarized light microscopy, cryogenic scanning electron microscopy, confocal light microscopy and static light scattering. Meanwhile the characterization of the crystallization process and fat crystal polymorphism in cocoa butter was evaluated by small angle and wide angle X-ray scattering and differential scanning calorimetry.
Results: Results showed that the concentration of CB affected both the formation and stability of W/O/W emulsion. CB crystals not only were able to stabilize the water-oil interface and provide physical stability over one month without a significant change in the droplet size (0.013 µm). The viscosity of the primary W/O emulsion was crucial during the emulsification process, as few W/O/W droplets were formed with 20 wt% CB at 23 °C. Decreasing the concentration of CB crystals to 13 wt% allowed forming W/O/W with droplet size of 10 µm.
Conclusion: CB crystals stabilized the water-oil interface in a W/O emulsion without any surfactant for a month, and were able to resist form stable W/O/W emulsion droplets such that the oil globule size was maintained and the internal water phase was retained over a storage period of one month. Such stable Pickering systems with double emulsion morphology offer new promise for designing healthy low fat foods for nutrients delivery.

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Shelf-life extension of mycoprotein-based meat-alternative by using high CO_2 modified atmosphere to control Bacillus cereus

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Aim: Due to the ongoing protein transition and increasing consumer interest, there is high demand for healthy and sustainable protein sources as alternative to animal-based counterparts. Alternative protein sources along with new applications can bring new food safety challenges. To assure the safety of these products, it is important to evaluate the relevant microbial hazards, their growth potential and the effectiveness of preservation strategies.

Mycoprotein is an upcoming alternative protein source, however, it is prone to microbial growth if preservation hurdles or treatments are not applied. For vacuum-packed products that require chilled storage, non-proteolytic *Clostridium botulinum* is a hazard and a pasteurization treatment of 90°C for 10 min is needed to inactivate *C. botulinum* spores. However, spores of *Bacillus cereus* are likely to survive this treatment and are an important hazard for this type of products.

Method: In this study, the effect of modified atmospheres containing carbon dioxide (CO_2), nitrogen or vacuum levels has been studied in a challenge with mycoprotein and *B. cereus* spores and cells. Three psychro-tolerant *B. cereus* food isolates and the reference strain ATCC 14579 were included.

Results: Storage under 30% CO_2 at 7°C was highly effective to control *B. cereus* resulting in a bacteriostatic effect on both vegetative cells and spores for over 50 days. Moreover, storage under 50% CO_2 resulted in inactivation of *B. cereus* vegetative cells at 7°C. However, at ambient temperature, 30% CO_2 was not effective and did not inhibit the outgrowth of spores. In mycoprotein packed either under nitrogen or vacuum atmosphere, *B. cereus* was able to grow at 7°C and reached the maximum level of 7 Log CFU/g within 10 days. This highlights the importance of controlling *B. cereus* in high proteinaceous products and this research emphasizes the importance of combining multiple preservation hurdles for alternative protein sources.

Conclusion: Packaging under elevated levels of CO_2 in combination with storage at 7°C is an effective strategy to control *B. cereus* on mycoprotein and expand the shelf life.

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Determination the Parameters for Chicken Meat Thawing by Radio Frequency and Process Effect on Quality

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Determination the Parameters for Chicken Meat Thawing by Radio Frequency and Process Effect on Quality

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Aim:
Recent studies have demonstrated the radio frequency (RF) thawing as a novel approach to reduce process time by maintaining the quality. The poultry industry is currently seeking an efficient thawing process instead of conventional ones, and determining the industrial scale process conditions is a significant concern. Therefore, optimized RF thawing process conditions for frozen bulk chicken thigh and evaluation the quality changes compared to a conventional process was aimed in this study.

Method:
A free oscillating pilot-plant scale staggered through field RF system (10 kW, 27.12 MHz) was used for thawing (10 kg frozen thigh in a retail box of 60×40×10 cm) process at five different electrode gaps (8, 10, 11.5, 12, 17.5 cm) and two power levels (3000, 5000 V) until the internal target temperature reached to ≈ -1°C. Temperature changes were measured by fiber optic sensors at 4 different locations, and the process conditions were optimized with respect to the experimental temperature data. Following this, the results were compared with conventional methods of air thawing at 4±0.1°C (CA4) and 22±0.5°C (CA22) where the thawed samples were analysed for proteolytic changes and microbiological quality, and the results were statistically evaluated.

Results:
The optimized RF process was at 5000 V - 17.5 cm electrode gap for temperature uniformity where the internal temperature increased to -0.34°C in 70 min. compared to 4 h 42 min and 47 h for CA22 and CA4, respectively. The highest drip loss was from CA4 (6.38%) followed by CA22 (1.09%) and RF (0.78%). Total and myofibrillar protein solubility were lower in CA22 compared to RF. Sulfhydryl amounts and SDS-PAGE protein profiles did not change while carbonyl content (μmol/mg protein) was higher in CA22 (211.6) and RF (140.8) compared to fresh samples (94.6) while it was the lowest in CA4 (49.6). Differences were observed in DSC thermograms and textural properties, and total viable bacteria and *Salmonella* spp. counts were affected.

Conclusion:
RF was demonstrated with promising results to decrease process time and minimize quality losses regarding proteins during thawing of chicken thigh in an industrial scale process.

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Dietary silage from olive mill wastewater, grape pomace affects intestine and meat pork microflora

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Aim:

Recently agro-industrial by-products that traditionally were discarded as wastes are under evaluation as novel feed ingredients to improve animal health and meat quality. A novel silage that combined olive mill wastewater, grape pomace and deproteinized cheese whey from the Greek agro-industry sector was tested as a bioactive feed to improve pork intestinal microflora and meat microbial safety and quality.

Method:

Eighteen crossbreed finishing pigs 120 days-old were individually ear-tagged, randomly allocated to three treatments, and fed the tested silage at 0% (Treatment A), 5% (Treatment B) or 10% (Treatment C). After 60 days (180 days old) pigs were slaughtered. Shoulder and pancetta samples were taken from the carcass after slaughter. Moreover, intestinal samples were taken aseptically from the ileum and the large intestine during evisceration. Bacterial populations were enumerated after sample processing, dilution, and cultivation in appropriate agars. Bacterial isolates were identified by Bruker MALDI Biotyper (Microflex LT instrument, Bruker Daltonics, Germany) after processing the mass spectra.

Results:

In the shoulder meat, *Campylobacter jejuni* was lower (P≤0.05) in treatment C compared to A. Other microbial populations (total mesophilic count, *Staphylococcus aureus*, *Staphyloccus* spp., *Escherichia coli*, Sulfite reducing *Clostridia*) did not differ (P>0.05) between the treatments in shoulder and pancetta samples. In all treatments, there was absence of *Salmonella* sp. and *Listeria monocytogenes* per 25g. In shoulder meat there was also absence of *Escherichia coli* in all treatments, however a low population of *E. coli* was present in pancetta samples. Concerning intestinal microbes, in the ileum *Enterobacteriaceae* and *Enterococci* were reduced (P≤0.001), while *Lactobacilli* were increased (P≤0.001) by the silage supplementation; Similarly, in the cecum *Lactobacilli* tended to increase (0.05<P≤0.10) and *Enterococci* were reduced (P≤0.001) by the silage supplementation.

Conclusion:

The use of the novel silage led to improved intestinal and meat microflora increasing beneficial bacterial and decreasing saprophytic bacteria, potentially producing safer pork meat.

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FitNESS 2.0 - Open courseware on food packaging

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Aim

The *Food packaging open courseware for higher education and staff of companies* 2.0 *(FitNESS 2.0)* project relies on creating up-to-date content on food packaging with mutual recognition between countries, universities, and prominent research and technological institutions. The material is available on a cloneable platform, FitNESS, https://fitness.agroparistech.fr/ ,developed within the project FitNESS version 1 (Erasmus+, contract 2017-1-FR01-KA202-037441). The platform already proposes three months of free teaching and training.

The ambition of the new FitNESS 2.0 project is to reach a broader audience in the food packaging value chain, from the chemical industry to recyclers, and to offer certified courses validated by online tests. The non-centralized architecture of the FitNESS platform shared between universities and technical laboratories contributes to accelerating the digital transformation of education and training systems in the EU by (i) bridging education, research, and innovation, (ii) creating a global community on a particular topic instead of disciplines, (iii) offering new training paths for current and future professionals.

Method

The FitNESS 2.0 project will prepare a large community of teachers, students, and professionals for an ecological transition whose application modalities do not exist in the textbooks. An original pedagogical content obtained through a significant consensus between institutions and industries will be disseminated via an efficient platform to learn how to solve some of tomorrow's most technical, economic, and environmental issues. The proposed teaching breaks the disciplinary shackles and opens rational and responsible engineering of the use of food packaging: safe for humans, safe for the environment, parsimonious.

Results

FitNESS 2.0 will contribute to accelerating the digital transformation of education and training systems by bridging education, research, and innovation, as well as by creating a global community within the field on a particular topic instead of disciplines and offering new training paths for current and future professionals.

FitNESS 2.0 will organize an evolution of the packaging uses which adapts to the regions, the habits, and the local policies while guaranteeing the food safety and competitiveness of the industries.

Conclusion

The audience will be able to use all the teaching/training content available as well as to clone the platform.

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A dialysis membrane process for simulating bile acids absorption during in vitro digestion

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Aim:
Currently, there is high demand for representative *in vitro* digestion model systems, which food industry can use to evaluate health effects of foods. This study aimed to develop and model a dialysis membrane process for mimicking the intestinal absorption as characterized by the uptake of bile acids (BAs). Given their antimicrobial properties, BAs are a key component when establishing microbial communities in *in vitro* digestion model systems.
Method:
An average meal digesta, obtained using the INFOGEST standardized static *in vitro* digestion method, was recirculated through a commercial hemodialysis hollow fiber cartridge, with a transfer area of 1.8 m^2 and a molecular weight cut-off of 5000 Da, whilst a dialysate solution was simultaneously pumped through the shell of the membrane in counterflow. Three different flow rates were examined, i.e., 20, 50 and 80 mL/min, to determine the relationship between the systems operating parameters and the reduction of BAs concentrations in the digesta, which were measured though HPLC analysis. Moreover, a one-dimentional mathematical model was constructed to describe and interpret the dialysis process.
Results:
Based on the analysis of the experimental data through the developed mathematical model, it was discovered that the reduction of BAs depends both on (i) the diffusive and convective transport of unbound BAs through the membrane and (ii) an unbinding reaction that releases bound BAs to unbound BAs. It was found that not only the transport rates were dependent on the flow rate, but also the reaction rate of the release of bound BAs depends on the dialysis flow rates. Specifically, the results demonstrated that using a sufficiently high flow rate, the proposed system can succesfully mimick BAs absorption in the small intestine with realistic uptake rates of 70 – 80 % within 2 hours.
Conclusion:
This work demonstrates a method for simulating intestinal absorption based on BAs uptake. The computational analysis of the experimental data provided insight into the underlying mechanism of reducing BAs concentrations through a dialysis process, thereby providing the information that is required for this method to be implemented in virtually any *in vitro* digestion model systems.

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Dissolution of Cellulose in Ionic Liquids to Enhance Valorisation Opportunities

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Aim:
Cellulose is abundantly available in nature and plays an important structural role in biological resources from microalgae to plants. Biomass such as that from algae, plants and trees is vital to the success of the Bioeconomy in Europe. However, the poor solubility of cellulose in water can limit the valorisation of different biomass sources due to challenges with breaking down the material and thereby valorising the contents. The aim of this study is to investigate the potential of ionic liquids to solubilise cellulose thereby enhancing the valorisation of different biomass sources. Cellulose is a renewable material with emerging applications in biodegradable food packaging, novel drug delivery systems and sustainable biofuel production (Baranwal, 2022; Hoffman, 2021).

Method:
Cellulose was dispersed in ionic liquid solutions (1-butyl-3-methylimidazolium chloride (95% w/w)) at 10 ℃ intervals from 40 – 90°C using an Ultra-Turrax at 24,000 rpm. Solutions were kept in a water bath to maintain temperature. The solutions were agitated for 19 hours using a magnetic stirrer prior to analysis. Cellulose dissolution across the temperature range was determined spectrophotometrically using a wavelength of 633 nm. Cellulose crystal dissolution was captured visually using a light microscope 40x magnification.

Results:
Cellulose dissolution in ionic liquid is temperature dependent. Limited solubility was observed between 40 – 60 ℃, however solubility increased from 60 ℃ to 80 ℃ and subsequently plateaued at 80 ℃ with a concentration of 2.5 mg/g. Light microscopy images correlated with the dissolution experiments and confirmed the absence of cellulose crystals above 80°C. Further analysis showed a correlation between ionic liquid concentration and cellulose solubility maximum.

Conclusion:
Cellulose can be dissolved in BMIM Cl. Ionic liquids may be used for the valorisation of cellulose to maximize its economic potential.

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Application of bigels for fat reduction and delivery of essential oils in fermented sausages

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Aim
Bigels are biphasic systems formed from two different gels, one oil-based and one water-based. Bigels have been used by the pharmaceutical and cosmetic industry as delivery systems for the controlled release of various substances. Because of the different lipids and structurants that can be used, these systems can be highly customizable and can offer diverse mechanical and rheological properties. Bigels can be designed to mimic animal or solid fat, so there is increased interest by the food industry for the use of such structures as fat substitutes and delivery systems for bioactive compounds. The objective of this study was to incorporate olive oil bigels in fermented sausages, aiming to reduce animal fat, improve nutritional value, decrease the saturated fat content and utilize the bigel as a delivery system for oregano essential oil (OEO).
Method
The bigels were produced using an olive oil oleogel structured with 15% monoglycerides and a hydrogel structured with 10% gelatin and 3.78% sodium caseinate. Pork sausages were formulated with either 20% pork backfat (control) or 10% pork backfat and 10% bigel. Two types of sausages with bigels were produced; one with plain bigel and one with added 0.5% OEO in the bigel. Microbiological (Total viable counts, Enterobacriaceae, LAB, Staphylococcus-Micrococcus) and physicochemical (% weight loss, pH, a_w) characteristics were measured on the 0, 1, 3, 6 and 13 d after manufacture on all three treatments.
Results
Sausage treatments formulated with bigels exhibited higher weight loss at the end of fermentation/drying period (39% compared to 31% of the control). The control treatment had a lower a_w (0.933) than the treatments with bigel (0.943 for plain bigel and 0.941 for OEO bigel). The pH and the microbial counts did not present significant differences in any of the three treatments during the fermentation/drying period. The sausages with bigels exhibited better nutritional characteristics, showing a decrease in total energy, saturated fatty acids, and cholesterol content.
Conclusion
In conclusion, the olive oil bigels were successfully used as animal fat substitutes in fermented sausages, improving the nutritional value of the sausages, without affecting the microbiological and physicochemical stability of the products.
Acknowledgements: The research work was supported by the Hellenic Foundation for Research and Innovation (H.F.R.I.) under the "First Call for H.F.R.I. Research Projects to support Faculty members and Researchers and the procurement of high-cost research equipment grant" (Project Number: 3601).

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Lactoferrin – one of the natural inhibitory substances in milk and whey

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Aim:
Although milk and dairy products are associated with the negative climatic consequences of cow farming, plant milk alternatives have not been shown to be more beneficial to human health and the environment. Milk and dairy products provide all the necessary nutrients for a healthy living. Among other things, milk contains a wide range of biologically active substances, including the whey protein lactoferrin. It is an iron-binding multifunctional glycoprotein that has various antimicrobial and other biological effects. The aim of this study is to determine the amount of lactoferrin in cow's whey depending on various factors.

Methods:
Raw cow's milk taken from farms in the Czech Republic was defatted by fat centrifugation and then precipitated with acetic acid to pH 4.6. The proportion of lactoferrin in the centrifuged whey was determined by means of a liquid chromatograph with a photodiode array detector.

Results:
The amount of lactoferrin in cow's milk ranged from 81.0 to 635.3 mg/L. The lactation period had the greatest effect on the amount of lactoferrin, as the highest amount of lactoferrin was found in the samples originating from the beginning of lactation and with the advancement of lactation the amount of lactoferrin decreased.

Conclusion:
Lactoferrin is an important natural milk inhibitor that, together with other biological substances, can turn concentrated whey products into nutritionally important foods for human health.
Acknowledgment:

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Design and evaluation of novel bigel systems with coconut and olive oil blends

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Aim
Bigels are biphasic systems formed by two gelled phases, the oleogel and hydrogel. The combination of both phases in a structured biphasic system could offer advantages over simple emulsions, hydrogels or oleogels. Bigels can be used as delivery systems for bioactive compounds and, potentially, as animal fat substitutes in food systems. The oleogel/hydrogel ratio, the type of oils used in the lipid phase and the type and concentration of structurants, are important parameters that determine the properties of bigels. The aim of the study was to develop and study the properties of bigels formed by mixing oleogels containing different ratios of coconut and olive oil, structured with 10% w/w monoglycerides with or without 5% w/w phytosterols, and hydrogels structured with 10% w/w gelatin.

Method
Bigels were produced by preparing the hydrogel and oleogel phases separately and mixing them at 55°C under constant stirring. The ratio of coconut to olive oil ranged from 0:100 to 100:0. The mixing ratios of oleogel to hydrogel were 40:60 and 60:40. The mechanical characteristics of the bigels were studied by instrumental texture analysis, while the microstructure of bigels was investigated by polarized light microscopy. The instrumental colour parameters of the bigels were determined using a chromameter.

Results
The micrographs of 40:60 bigels revealed the presence of spherical oil droplets suspended within the continuous aqueous phase, indicating the formation of an oleogel-in-hydrogel system. The smaller oil droplet size for the 40:60 bigels was achieved using 100% olive oil oleogels. An increase of the oleogel phase (60:40) resulted in a bi-continuous type bigel. Addition of phytosterols altered the crystal morphology and enhanced the hardness of the bigels. The higher oleogel ratio (60:40) resulted in decreased gumminess and chewiness of the bigels. Regarding instrumental color, the 60:40 bigels exhibited higher L* and b* values compared to 40:60 treatments.

Conclusion
The type of oil and oleogelator used to form the oleogel, and the oleogel/hydrogel ratio affected the microstructural and the mechanical characteristics of the resulting bigels, allowing for the formation of diverse bigels that can be designed for targeted food applications.

Acknowledgements: The research work was supported by the Hellenic Foundation for Research and Innovation (H.F.R.I.) under the "First Call for H.F.R.I. Research Projects to support Faculty members and Researchers and the procurement of high-cost research equipment grant" (Project Number: 3601).

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Impact of acid chemical properties on Bacillus weihenstephanensis germination and outgrowth inhibition in oil-in-water emulsion

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Aim: Many organic acids including fatty acids are known to inhibit bacterial growth and can be used as antimicrobial in food products. Bacterial inhibition by organic acids in aqueous medium are well defined in literature, but, authors showed that the food structure may influence their inhibitory effectiveness. There is a large demand for knowledge about how to use them wisely in a context of clean label. The objective of this work was to investigate the effect of the physicochemical properties of organic acids on the germination, outgrowth and growth of *B. weihenstephanensis*. The experiments were done in aqueous medium and in oil-in-water model emulsion to study the interactions between bacteria and inhibitors in biphasic systems.

Method: Lactic, propionic, caprylic and lauric acids were studied according to their carbon chain length and their physicochemical properties (number of carbons, pKa, partition coefficient). The minimal inhibitory concentration (MIC) of each compound for *B. weihenstephanensis* KBAB4 vegetative cells were estimated in nutrient broth using a Bioscreen C reader, at pH 6.0 and 5.5. The inhibitory activity of those acids were also assessed in emulsions by plate enumeration, at two pHs and 30°C. Model emulsions were prepared by sonication with hexadecane as oil phase, nutrient broth as aqueous phase (ratio 50/50) and stabilized by Tween80 and Span80.

Results: The antimicrobial effect of short carbon chain acids (lactic and propionic acid) in aqueous medium was due to their undissociated form. However, the inhibitory property of lauric acid was related to the total concentration of the acid in nutrient broth. In model emulsion, the lag period and the growth rate increase compared to nutrient broth and acid antimicrobial activity was impacted. This phenomena is due to the presence of oil droplets interacting with the acids. The complex structure of an emulsion and the coefficient partition of components are the main factors explaining inhibitor availability in biphasic systems.

Conclusion: Understanding the interactions between bacteria, inhibitors and emulsion structure according to the chemical structure of the inhibitors allows to optimize their availability in food matrix and to ensure their bacterial inhibitory efficiency

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Gelatinization properties of sprouted sorghum flours over a wide range of water contents

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Aim:
Sorghum starch granules are encapsulated in a strong protein matrix which prevents the granules from fully swelling and gelatinizing. Sprouting affects sorghum gelatinization properties, but no studies have yet focused on evaluating these properties over a wide range of water content. This study evaluated the gelatinization properties of sprouted and unsprouted sorghum flours in systems with different water:flour ratio, from a macroscopic to a molecular level.

Method:
Two sprouted [for 72 h and dried at 50°C for 6h (S1) or at 40°C for 12h (S2)] and unsprouted (US) sorghum flours (*Sorghum bicolor* [L.] Moench) were studied. The water:flour systems were set at ~38, ~56, ~73, ~82 and ~91% water content (100 g water/100 g sample). The starch swelling power (Sp), enthalpy (ΔH, J/g) and temperatures of the starch gelatinization transition (by DSC), were measured. Flour components - water interactions at a molecular level, both in heated and unheated samples, were evaluated by low-resolution ^{1}H NMR (^{1}HFID and CPMG sequences).

Results:
The Sp increased with the increase of the water amounts and was lower in S1 and S2 if compared with US, as expected. S2 showed the lowest Sp values, likely due to a stronger amylase activity and hence, starch destructuring, in samples dried at 40°C than at 50°C. Sprouting increased gelatinization temperatures, both in S1 and S2. However, these differences disappeared for water contents ≥~73%. In addition, at ~73% water content, all the samples reached their maximum gelatinization enthalpy. Interestingly, S2 generally showed higher ΔH values than S1. ^{1}H FID and $^{1}HT_2$ results showed the presence of two and four populations, respectively. Heating and water content significantly increased the mobility and relative abundances of all populations, as expected. These changes were attributed to physico-chemical and structural changes that occurred with gelatinization and the hydration of the system.

Conclusion:
Sprouting combined with its subsequent drying treatment affected the gelatinization properties in all samples. However, the water content modulated the effect brought by sprouting, leading to interesting results depending on the hydration level of the system. This may help to better understand the functionality of sprouted sorghum flours.

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Recovery of bioactive compounds from fruit juice waste streams by industrial Ultrasound Assisted Extraction.

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Aim:
Orange and apple juice industry generate million tons of waste per year.
The aim of this study is to extract bioactive compounds from orange peels and apple pomace using ultrasound at pilot scale and to assess their antioxidant and antimicrobial activities.

Method:
Fresh orange peel and apple pomace, obtained from juicing processes, were subjected to ultrasound in water at 20 kHz (Hielschier UIP2000hdT) and 1:4 sample to water ratio. A response surface design was done to optimise the ultrasonication conditions (time and amplitude). The extracts were then either spray dried with pectinase pre-treatment or freeze dried and analysed for total phenolic content (Folin-Ciocalteu method); antioxidant activity using Ferric Reducing Ability of Plasma (FRAP), and radical scavenging (DPPH and ABTS); and antimicrobial activity (disk diffusion assay).

Results:
The extracts produced had a high total phenolic and antioxidant content which were proportionally significantly increased ($p < 0.05$) with the increasing ultrasonication time. Spray dried extracts expressed similar or higher antioxidant response than the freeze-dried products. The highest phenolic content was 2181.39 ± 21.78 and 80.01 ± 2.72 µM gallic acid equivalents for orange peel and apple pomace spray dried extract, respectively. The highest antioxidant content was 636.01 ± 7.46 and 36,20 ± 0,40 µM of trolox equivalents (ABTS), 232,82 ± 1,79 and 16,24 ± 0,07 µM gallic acid equivalents (FRAP) for orange peel and apple pomace spray dried extract, respectively. No antimicrobial activity was detected against *Candida albicans*, *Saccharomyces cerevisiae*, *Escherichia coli*, *Staphylococcus aureus*, and *Bacillus subtilis*.

Conclusion:
This work showed how the extracts from orange peel and apple pomace produced by ultrasound were rich in phenolic compounds with high antioxidant capacity. The results provide a better understanding on the performance of the ultrasound which helps for next steps in development of new food ingredients.

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Optimal germination condition for increased antioxidant activities of chickpea (Cicer arietinum) using Box-Behnken Design

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Aim: This study aims to find the optimal conditions for chickpea germination using Box-Behnken design (BBD) through response surface methodology (RSM).

Method: Germination conditions to be optimized were soaking time (6, 12, 18 h), germination temperature (20, 25, 30 ℃), and germination period (2, 4, 6 d) with respect to the responses of antioxidant properties (DPPH, 2,2-diphenyl-1-picryl-hydrazyl radical scavenging activity; TEAC, trolox equivalent antioxidant capacity; FRAP, ferric reducing antioxidant power), bioactive components (TPC, total phenolic content; TFC, total flavonoid content), phytic acid content, and soluble protein content.

Results: The values of antioxidant activity showed the highest value of DPPH (3.47 and 3.32 μM TE/g), FRAP (0.25 and 0.32 mg $FeSO_4$/g), and TEAC (10.87 and 10.97 mM TE/g) in germination period on 6 day. Also, the values of bioactive components showed the highest value of TPC (2.00 and 2.02 mg GE/g), TFC (0.54 and 0.50 mg CE/g) in 6 day. As soluble protein contents were increased, soaking time were decreased and phytic acid contents were decreased in the higher temperature.

Conclusion: These results indicated that the optimal condition of chickpea germination was soaking time (6 h), germination temperature (30 ℃), germination period (6 d).

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Effects of proteases, solvents, and processing methods on kelp usability as a food ingredient

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Aim:
There is an increasing interest in the use of sugar kelp in food applications, but there are some bottlenecks in relation to physical-chemical properties of kelp that must be solved. The objective of this study was to document how a range og pre-processing treatments change the feasibility of kelp as a food ingredient with respect to basic quality characteristics and content of potentially toxic elements.
Method:
Farmed sugar kelp (*Sacharina latissima*) was treated by a range of methods. For pre-processing, chopped kelp leaves was exposed to pulsed electric fields or high intensity ultrasound. The pre-processed as well as non-processed kelp was then placed in six different baths with one of the commercially available proteases Flavorzyme, FoodproPNL, MaxiproNPU, Endocut (0,1), Papain and Corolase 7089 dissolved in the bath and kept there for 16 h at 40 °C. The enzymes were inactivated by a heat treatment at 90 °C for 60 min. As an alternative to enzyme treatment both pre-processed and non-processed samples were subjected to ethanol extraction.
The dry matter content and color were measured for all samples and compared as well as the physical properties of the samples. Chemical composition of the kelp and the liquids used for treatment were analyzed.
Results:
The dry matter content of all samples was significantly lower than the control (untreated) specimen caused by absorption of liquid as well as loss of dry matter to the treatment fluid. During the processing steps the sugar kelp color changed from light brown to dark green for all treatments except the ethanol extraction which resulted in a pale, light brown color. The dark green color is comparable to sugar kelp blanched without any pre-processing of enzymatic treatment.
Conclusion:
It is possible to use pulsed electric field and ultrasounds followed by enzymatic extraction of targeted components and still use the resulting material as food ingredient. It should be further investigated how this may improve the commercial value of the sugar kelp.

Date-palm coproducts (Oriol cv) as a new ingredient for dry-cured sausages: Technological and physicochemical properties

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Date-palm coproducts (Oriol cv) as a new ingredient for dry-cured sausages: Technological and physicochemical properties

Date (*Phoenix dactylifera*) coproducts are a big problem under environmental point of view. Spanish dates production is aprox. 12000 tons/year. Only 2% is processed. Thus, there are a great opportunity to obtain functional ingredients, and Intermediate Food Products (IFP) that can use in the development of healthy foods, such as meat products.
Aim: to apply a sustainable date palm (Oriol cv) intermediate food product (IFP) to a meat snack (paprika-added dry-cured sausage-SPADCS) and to study the influence of this IFP upon technological and physicochemical properties processing.
Method: The IFP was obtained from the *Oriol* valorization. The SPADCS (18-22 mm diameter) was made using and industrial formulation (pork: 60% lean meat, 40% backfat), 4.5% paprika, IFP (0% control-C and 3%), 0.2% spices, and curing agents. Parameter under study were weight loss-WL, width, and length (all expressed as %). Meanwhile, the measured physicochemical parameters were pH. colour parameters (CIELAB-AMSA colour evaluation) and reflectance spectra (360-740nm). Processing conditions were temperature (16-18 º C); relative humidity (80-85%) and time (4 days). The experimental design was measurements 4daysX2 concentrationsX3batchesX3samplesX3measuremets. ANOVA and Tukey´s tests were applied.
Results: All parameters were affected by the addition of IFP ($p<0.05$). Both reach the required commercial WL (>30%), exactly, C: 41.56±1.66%; 3%: 31.34%± 0.89. For width and length, the reductions were higher ($p<0.05$) in C samples 24.15± 1.22% and 6.6.% ± 1.23 respectively; 3%: 9.21± 078% and 4.54±0.65%. pH in both SPADCS decreased during processing. Samples with IFP showed lower pH values 5.36±0.05. Processing time affects CIELAB parameters. Thus IFP increased a* and b* coordinates (higher than control) and decreased L*. In both SPADCS, reflectance spectra showed isosbestic points from 360-620 nm (0 days), and in IFT samples reflectance was lower from 630-740 nm. At 4 days only 540nm showed an isobestic point between samples.
Conclusion: The use of *Oriol* IFP is suitable as new ingredient for SPADCS and could be commercialized. Technological parameters are higher IFP samples. Colour evolution is quite similar between SPADCS. IFP samples were more redness and yellowness but duller.

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High-pressure homogenization and partial cell wall polysaccharides extraction determine the texturizing potential of citrus by-products

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Aim: After pectin extraction from citrus by-products, substantial residue is left which contains cell wall polysaccharides. With high-pressure homogenization (HPH), this residual cell wall materials (CWM) can be functionalized into a texturizing ingredient with good rheological properties. This study aims to understand the effects of the CWM characteristics on their potential to be functionalized.
Method: This study examined the functionalization of the residue after acidic pectin extraction obtained from various citrus by-products (peel and pulp of grapefruit, orange and lemon) by resuspending the residues and high-pressure homogenized them at 20 MPa. The rheological properties of the suspensions and the physicochemical properties of the CWM were characterized and correlated.
Results: Based on the storage modulus (G') of the suspensions before and after HPH, the residues after acidic pectin extraction from citrus by-products show a high potential to be functionalized. The G' of the suspensions improved significantly after HPH. By-products from the peel of lemon and grapefruit had significantly higher G' compared to others and thus can be considered as preferable sources of CWM to be functionalized. The improvement of the rheological properties of the suspensions were postulated to be effected by the fragmentation and aggregation of the CWM particles which can be observed from the microscopy and particle size analysis results. However, the particle size and morphology did not affect the functionality of the CWM. The polysaccharides composition of the residue as indicated by their monosaccharides content also did not significantly influence their functionality. By comparing the CWM before and after acidic pectin extraction, it can be concluded that the pectin removal is favorable to the functionalization of the CWM due to the opening of the matrix structure.
Conclusion: The upcycling of the residue after pectin extraction from citrus by-products is possible by using HPH. The change in the structure of the CWM particles have the most influence in the rheological properties of the suspensions.

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Comparison of protein quality of insect powders obtained by thermomechanical or by CO2 supercritical processes.

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Aim: The food industry is seeking to introduce new sources of protein to reduce the amount of conventional animal protein in products, which has a strong environmental impact. Mealworm (Tenebrio Molitor) and black soldier fly (Hermetia Illucens), already known in the animal feed sector, also have a significant nutritional potential for human consumption, due to their richness in proteins. A key issue is to optimize the process to obtain fractions with interesting functional properties. The objective of this study is to characterise the proteins of insect powders obtained by two different extraction processes: a thermomechanical transformation process followed by the elimination of the lipidic fraction and a more innovative process of protein extraction by supercritical CO2.
Method: Powders obtained during the extraction by thermomechanical process (three various fractions) or by supercritical CO2 process (one powder) are analysed separately. Protein characterisation includes: water solubility as a function of pH and ionic strength, molecular weight distribution and in vitro gastric digestibility.
Results: The crude protein content varies from 44 to 77% depending on the dried fractions. The solubility of the two insect powders is pH dependent, but is not affected by the concentration of the 0 to 3M salt. Mealworm powders are more soluble in water (up to 97%) than fly larvae powders, at alkaline pH between 9-11. The supercritical CO2 process decreases water solubility as a function of pH, when compared to the thermomechanical process, for both insects. The isoelectric point is around pH 4. The molecular weight range for the soluble proteins is 14 - 170 kDa. After six hours of in vitro gastric digestion, mealworm proteins are more digested than those of the black soldier fly. The insect processing does not affect the digestibility of the mealworm and black soldier fly proteins.
Conclusion: The insect processing method has an impact on the properties of the resulting protein fractions. CO2 SC leads to a decrease in protein solubility, but does not seem to affect in vitro digestibility. Further studies are needed to optimise extraction processes or to study their functionality as food ingredients.

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Subchilled storage of Atlantic salmon fillets initially stored in refrigerated seawater for 7 days.

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Aim:
The concept of direct sea cage slaughter onboard a fishing vessel and subchilling gutted Atlantic salmon below 0°C in refrigerated seawater (RSW) during transport has been practised, bypassing steps in the fish value chain. Previous studies have shown that storing whole salmon in RSW for 4 days gives good quality and microbiological shelf life after filleting, packaging, and cold storage. This study examines the storage of whole gutted salmon in RSW for 7 days at -1°C, combined with modified atmosphere packaging (MAP, 60%CO_2:40%N_2, gas to product ratio: 1.8) after filleting, and storing in subchilled conditions at -1°C. This method was compared against the traditional method of ice storage for 7 days at 0°C and then at 4°C after filleting and MAP.
Method:
The RSW and ice-stored fish were monitored for a total of 56 and 21 days, respectively. Quality parameters were periodically analysed including gas composition, drip loss, water holding capacity (WHC), water content, texture and microbiological shelf life.
Results:
The freezing point of salmon was measured at -1.3±0.2°C. The study showed a significant weight increase of 3.0±0.4% with a higher WHC (91.3±1.2%) and water content (60.2±2.8%) after 7 days of RSW storage, in comparison to 0.4±0.3% weight loss, WHC (85.4±1.7%) and water content (57.4±2.6%) for ice-stored fish. After processing and storage, the water content of RSW-stored fillets was consistently higher than ice-stored fillets. The CO_2 decreased, while O_2 composition increased more rapidly within the package for the RSW-stored fish. From microbiological parameters, the ice-stored fish were spoiled after 14 days. In contrast, the RSW-stored fish had a longer shelf life of around 49 days. On day 49, the total psychotropic, and total aerobic plate count, including H_2S-producing bacteria for RSW-stored fish were 5.0±0.1, 5.0±0.2 and 3.5±0.1 log cfu/g, respectively. Textural parameters indicated a decrease in breaking force and firmness throughout storage for both groups.
Conclusion:
This study shows the possibility of prolonging salmon's shelf life through RSW immersion and subchilled storage throughout the whole value chain, providing a good quality product and significantly removing the need for ice.

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Bioactive compounds from herbs used for feed and packaging materials

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Aim
The aim is to use selected bioactive compounds (phytogens) from 9 different herbs for addition to feed to 1) increase shelf life of salmon feed, 2) improve the health and intestinal flora in poultry, and 3) for use to design biodegradable and antimicrobial packaging materials.
Background and scope
This is a presentation of the project "Biofarming for bioactive compounds" (2021-2023) which is a competence and knowledge project, using bioactive extracts in three very different scientific directions.
Material and methods
Effect of variety, cultivation system and climatic factors on concentration of bioactive compounds are studied in the nine herb species oregano, yarrow, peppermint, hops, roseroot, maral root, sweet wormwood, purslane, and rosemary. Extracts of bioactive compounds have been extracted and tested for antioxidant, antimicrobial properties against the Atlantic salmon pathogens, *Aliivibrio* spp. *Moritella* spp. and *Tenacibaculum* spp. in laboratory models. The extracts were prepared in three different extraction solvents: dichloromethane (DCM), ethanol and water. The commonly used antioxidant methods, ABTS and DPPH assays, were used to study the antioxidant capacity of extracts. Agar disc diffusion assay was used to test the susceptibility of bacterial strains to extracts.
Results and future work
Extracts from oregano, hops, sweet wormwood (Artemisia) and rosemary have shown good antimicrobial and antioxidative properties. Effects will further be measured on growth, health and immunity of salmon. Effects from extracts added to feed for boilers will be investigated in laboratory studies and in a feeding experiment with broilers. Selected effects will be documented on performance, levels of intestinal pathogens, intestinal inflammation (necrotic enteritis lesions) and immune cells in peripheral blood and intestinal tissue. The third use of the extracts is to design new packaging materials for the food industry where antimicrobial herbal extracts are inserted into the packaging using technologies such as high-pressure treatment, ultrasound and electrospinning.

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The quality of sucrose-reduced cakes is improved by altering the batter mixing atmosphere

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Aim:

Reducing the sucrose content in cake recipes results in lower quality cakes. We here set out to improve the quality of sucrose-reduced cakes by altering the batter mixing atmosphere. We reasoned that changing the atmosphere would improve (i) the stability of the batter/gas-water phase and/or (ii) leavening during baking, due to differences in water solubility of its gas constituents.

Method:

Three different mixing atmospheres [air (= 78% N_2, 21% O_2), N_2 and CO_2] were tested for two cake types [*i.e.* sponge (= foam-type) and cream (= emulsion-type) cakes]. The effects of these atmospheres on batter stability/density, leavening (height development and gas release) and cake quality (texture and volume) were evaluated for regular and sucrose-reduced cakes.

Results:

N_2-atmosphere improved neither batter density, leavening nor the quality of either sponge or cream cake. This was explained as resulting from the high percentage of N_2 in air and low water solubility of both O_2 (0.040 g/L) and N_2 (0.017 g/L). Regarding sucrose-reduced cakes, small improvements in foam stability/density could be detected for sponge cakes, while no differences were observed for cream cakes. This was due to the gas-water interphase stability being more crucial in foam-type cakes than in emulsion-type cakes.

When using CO_2-atmosphere, density of sponge cake batter increased significantly more than that of cream cake batter. This was due to the high water solubility of CO_2 (1.450 g/L), which decreased the uptake of gas. During baking, solubilized CO_2 became gaseous and contributed to leavening. Sponge cake quality was not improved due to its batter/foam being too negatively affected by CO_2, but cream cake quality clearly improved. Similar effects of CO_2-atmosphere were observed regarding sucrose-reduced cakes, indicating that it could be used as a quality enhancing solution for sucrose-reduced cream cakes.

Conclusion:

Altering the mixing atmosphere from air to N_2 had barely any effect on cake quality due to N_2 and O_2 having similar water solubility. Using CO_2-atmosphere (which is highly soluble in water) results in low quality foam-type cakes due to its negative effect on foam stability, but leads to high quality emulsion-type cakes due to its positive effect on leavening

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Translating meta-analysis and OECD Guidelines: Pharmaceutical pollutant soil-water partitioning to evaluate wastewater reuse for irrigation.

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Aim:
Wastewater reuse for irrigation is a widespread practice that relieves environmental and economic pressures of agriculture. However, pharmaceutical drugs reside in treated and untreated wastewaters and their fate in soils following wastewater irrigation has implications to bioavailability and uptake and entering the wider food chain. There are a number of sorption studies for pharmaceuticals in soil/water yet understanding their environmental relevance can be limited. The aim of this study was to gain insights from a meta-analysis of batch sorption literature studies and consider the opiate, tramadol as a case study to evaluate soil/water partitioning under environmentally-relevant conditions.

Method:
Peer-reviewed publications following OECD Guideline 106 and reporting ≥90% experimental variables were used to build the meta-dataset. The soil/water partitioning coefficient (K_d) was the independent variable with dependent variables and ranges classified under pharmaceuticals, soil characteristics, and experimental conditions groupings. Principal component analysis and partial least squares assessed the variables having a significant effect on pharmaceutical sorption behaviour. For the case study, kinetics and isotherm studies for three soils were undertaken per OECD Guideline 106 for tramadol 500-100,000 ng L^{-1}. Wastewater (tramadol 725 ± 21 ng L^{-1}) and spiked (to 20,725 ng L^{-1}) was used to further evaluate environmental relevance.

Results:
The meta-analysis identified recommendations where future design of experiments can increase environmental relevance of pharmaceutical sorption studies and support upscaling to field studies. Tramadol soil/water partitioning was both pollutant concentration and soil dependent with hysteresis observed in all soils, indicating tramadol accumulation. Higher tramadol sorption correlated with higher clay content, with K_d of 5.5 ± 13.3, 2.5 ± 3.8 and 0.9 ± 3.0 L kg^{-1} for soils with clay contents of 41.9%, 24.5% and 7.4%, respectively. A comparative kinetics study between tramadol in soil/calcium chloride buffer (OECD Guideline 106) and soil/wastewater demonstrated significantly higher ($p < 0.05$) tramadol sorption to soil from wastewater.

Conclusion:

This study demonstrates the importance of environmentally relevant conditions in batch sorption studies to better understand sorption mechanisms and pharmaceutical environmental fate in agri environments. Utilising the OECD Guideline 106 as a benchmark and comparing alongside wastewaters facilitates best case for translating experimental results to practice.

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Extraction of Raffinose Family Oligosaccharides from Pulse derived fractions and their Application in Fermentations

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Aim:

Pulses are rich in constituents with favorable nutritional effects, most notably proteins and dietary fiber. However, due to potential issues with constituents which qualify as fermentable oligo-, di-, monosaccharides and polyols (FODMAPs), there is industrial interest to obtain material that is concentrated in protein and/or lower in FODMAPs. The aim of this work is

1) to develop a sustainable and industrially feasible process for the extraction of raffinose family oligosaccharides (RFOs) from protein concentrates and residuals derived from pulses (peas and fava beans) without using organic solvents,

- utilize these oligosaccharides as substrates in microbial fermentations and follow their fate with a recently developed in-house labeling method. This may lead to production of value-added products such as bacterial exopolysaccharides (EPS).

Method:

To extract the RFOs from the milled plant material, a water-based pilot-scale process (200 L) was designed that utilizes solubilization in a stirred-tank, 2-phase separation, and ultra/nano-filtration (1000 & 300 Da cut-off) to produce a concentrated oligosaccharide extract. The freeze-dried extract was then used as carbon source in fermentation screenings with different lactic acid bacteria or yeasts (e.g., *Saccharomyces*). Screenings were carried out in small-scale fermenters (50 mL) under controlled agitation, pH, and temperature.

Results:

The developed process allowed for kilogram-scale extraction of high purity RFOs from the initial plant material. The freeze-dried RFO powder was shown to be a fermentable carbon source for a variety of food-grade microorganisms (e.g., *Weissella confusa*), opening up the possibility for EPS production. Furthermore, preliminary analysis suggests that the residual material after RFO extraction had increased protein content in comparison to the starting material, making it potentially better suited for processes like extrusion.

Conclusion:

A sustainable water-based extraction with industrially relevant equipment enabled the production of two fractions, an RFO extract and one fraction reduced in RFOs and proteins enriched. A successful combination of the process with microbial fermentation of the RFO extract could generate novel products with lower RFO content than in the initial pulse-derived fractions. Further work is underway to explore process improvement (e.g., using spray-drying or decanting), as well as a wider range of selective microbial fermentations and characterize fermentation products.

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Designing of Active Packaging Incorporated with eucalyptus oil – TiO2 and its application on cheese

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Abstract

Aim:

The primary goal of active packaging is to keep food as fresh as feasible while also meeting industrial and consumer needs, assuring food safety, and reducing environmental impact using additives like antimicrobial agents. The project aims to develop and characterize the active packaging film with TiO_2 and eucalyptus oil.

Method:

By solvent casting method Poly(lactide)-Poly (butylene adipate-co-terephthalate) films were developed incorporated with titanium dioxide and eucalyptus oil in various concentrations. Different properties of developed films such as optical and mechanical properties, surface hydrophobicity, chemical composition, antimicrobial activity chemical composition, antimicrobial activity, biofilm inhibition. The application of the developed food packaging was also studied on cheese.

Results:

The tensile strength of the eucalyptus oil film had decreased by 1.5-fold with the addition of eucalyptus essential oil. The composite film showed a slight yellowish tint with the incorporation of eucalyptus essential oil and displayed a high UV-light barrier property. Moreover, the incorporation of essential oils to PLA-PBAT-TiO_2 blend films did not change its chemical composition. Inhibition of the composite film increased from 21% to 92% as the concentration of eucalyptus increased,

showing that high concentration of the eucalyptus composite film inhibited biofilm formation against *E coli*. In addition, eucalyptus incorporated composite film completely inhibited *E. coli* growth and delayed rancidity in the cheddar cheese up to 12 days of storage.

Conclusion:

Overall, composite film having high concentrations eucalyptus oil exhibited the best properties and has the potential to be utilized in active food packaging applications for cheese to improve quality and increase shelf life.

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RHEOLOGICAL PROPERTIES OF LIPOSOMAL NANOSUSPENSIONS THAT ENCAPSULATE GRAPE SEED TANNINS

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Aim: The rheological properties determination allows for evaluating the texture of the product, which is perceived by the mouth, allowing the industry to advance in the transformation of semi-solid fluid foods to suit the consumer. In this context, the objective of this research was to study nanoliposomes encapsulating grape seed tannins (TLS) to obtain information about their structure and changes associated with temperature.

Method: To determine the viscoelastic behavior, samples of tannins in suspension (TS), liposomes in suspension (LS), and tannin-encapsulating nanoliposomes (TLS) were tested at temperature scans increasing from 0ºC to 80ºC and decreasing from 80ºC to 0ºC at a heating/cooling rate of 2°C/min, 1% deformation and 1Hz of angular frequency in a rheometer (Discovery Hybrid Rheometer HR2, TA Instruments, England).

Results: The results for TS indicate an increase in the storage (G') and loss (G") modulus from 45ºC. This increase is explained by the formation of aggregates or complexes that cause an increase in apparent viscosity, modifying its rheological behavior. Similar behavior was found for LS at 52ºC; in the case of lipid membranes, these changes are related to a phase transition from liquid to gel. The TLS sample increased the modulus G' and G" for the temperature range from 52 to 68ºC. This difference in the phase transition with respect to the references (TS and LS) may be due to interactions between tannins and phosphatidylcholine. This rheological behavior is similar to those reported by other authors for gelatin and pectin coacervates with high methyl content cross-linked with tannic acid. It should be noted that all the samples showed the same behavior for the ascending/descending sweep from 0 to 80ºC, so they do not show any thixotropic behavior.

Conclusion: The rheological study of nanoliposomes that encapsulate tannins showed that it is possible to work within a wide range of temperatures, which favors its application in the food industry, either as an ingredient in a formulation or as an edible coating.

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Textural properties, microstructure and spectroscopic characterization of edible gelled systems

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Aim:

Oleogels are semi-solid systems formed by an oil gelation process induced by the addition of structurants, creating a three-dimensional network that efficiently entraps the liquid oil. Hydrogels are usually structured by physical or chemical interactions among the polymeric chains of a gelling agent, also resulting in a three-dimensional network that can immobilize large amounts of water. The intermixing of these two structured phases leads to the formation of a bigel, that exhibits enhanced physicochemical and thermodynamic stability. The objective of the study was to design novel edible bigels and study their microstructure and textural properties.

Method:

For the preparation of the oleogel, 15% w/w monoglycerides were used as structurants of olive oil. Hydrogels were structured with i) 8%, 10%, or 12% w/w gelatin, ii) 1% w/w κ-carrageenan, or iii) the combination of 8%, 10%, or 12% w/w gelatin and 1% w/w κ-carrageenan. For the formation of the bigels, each phase was prepared separately and the two phases were mixed into two different ratios of oleogel to hydrogel (40:60 and 20:80). The mechanical characteristics of the oleogels, hydrogels and bigels were studied by texture analysis, while the microstructure of the oleogel and bigels was investigated by polarized light microscopy. The chemical interactions among the components of the gels were studied by FTIR spectroscopy.

Results:

The 40:60 oleogel ratio led to a decrease in hardness and an increase in the cohesiveness of bigels. The addition of κ-carrageenan increased the hardness and decreased the cohesiveness of the bigel. Microscopy revealed that for both oleogel/hydrogel ratios, an oleogel-in-hydrogel bigel system was formed. When plain gelatin was used as a hydrogelator, significantly smaller oil droplets were formed. FTIR analysis documented the formation of a complex between gelatin and κ-carrageenan based on chemical crosslinking and confirmed that the formation mechanism of bigels is based on physical interactions between the two structured phases.

Conclusion:

The microstructure and the structural properties of the bigels were greatly affected by the composition of the hydrogel phase and the oleogel/hydrogel ratio. Bigels are promising systems that could be utilized as animal or solid fat substitutes and delivery systems in foods.

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D-optimal mixture design to develop novel W/O food emulsions

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Aim:
In a system containing a similar amount of oil and water phase, the creation of W/O or O/W emulsion could depend on the emulsifier system, and the gelling/structuring agents used. Few researchers focused their attention on the impact of formula composition on the physical properties of such systems. The objective of this research was to assess the effect of the formula composition on the physical properties of food emulsions and to develop W/O emulsion systems to be used as vegetable creams, spreads or hard fat replacers.
Method:
A D-optimal mixture design with five components (sunflower oil, water, a mixture of Span80 and soy lecithin as emulsifiers, stearic acid, and guar gum) was selected and a special regression cubic model was chosen. The ingredients varied in the following range: oil and water content from 40 to 55%, emulsifier system from 1 to 5%, stearic acid from 0 to 3%, and finally guar gum from 0 to 0.3%. 32 formulations come out and were characterized in terms of particle size distribution (PSD), rheological properties and physical stability.
Results:
29 out of 32 formulations were W/O emulsions, with a PSD varying from a bimodal to unimodal and D4,3 values ranging from 8 to 150 µm. Almost all formulations behaved like shear-thinning fluids, differing in viscosity values. The most stable formulations were those with the highest guar gum concentration. ANOVA revealed that formula composition significantly affected emulsion properties. The parameters significantly affected by the formulation were used as response variables in different regression models. Response parameters were explained through a special cubic model for several PSD and rheological parameters, highlighting that the components interact with each other. Linear models were used to explain physical stability in terms of Turbiscan stability index (TSI).
Conclusion:
Different optimized W/O formulations were found, minimizing both D4,3 and TSI values, at different levels of the rheological parameters, through the desirability function. These emulsions could be used to design foods with enhanced nutritional value.

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Physical properties and sensory perception of active sodium caseinate-guar gum coating enriched with essential oils

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Aim:
Active biopolymer coatings with natural additives, such as essential oil (EOs), are an innovative and sustainable preservation technology to extend the shelf life of perishable fruits. The EO inclusion in a biopolymer coating could affect both the physical properties of the coating and the sensory perception of the food on which it is applied. Thus, the present study aimed to evaluate the effect of 3 EOs on the physical properties of a biopolymer blend and to assess the odor perception of these coatings when applied to food.

Method:
Thyme oil (TEO), peppermint oil (PEO), and lemon oil (LEO) at 1.5% (v/v) were included in a sodium caseinate-guar gum blend. The blend systems were characterized in terms of the particle size distribution (PSD), zeta potential, physical stability, and rheological properties. Odor perception of both coating and fruit-coating pair (pear and strawberry) was evaluated, in terms of odor liking, intensity and irritation. Finally, participants were asked to determine the appropriateness of the fruit-coating pair.

Results:
LEO-based blend presented 2 different particle populations in the range 0.1-100 µm, meanwhile, PEO and TEO-based blends presented a monomodal curve, with a left shoulder (3-300 µm). D4,3 values varied from 72 µm for the PEO-based blend to ≈ 50 µm for the other two blends. Low uniformity and span values were observed for all the EOs-based blends. Blends presented high values of zeta potential, from -30 mV for PEO to -54 mV for LEO. Blends showed a shear-thinning behavior, and EOs inclusion reduced the viscosity of the blends from 1 to 0.8 Pa·s at 1 s^{-1}. LEO received both the lowest odor and irritation intensities. TEO was slightly liked, meanwhile PEO and LEO were moderately liked. Odor liking for TEO was negatively affected by the strawberry-TEO pair. Only LEO coating was considered appropriate when paired with strawberries and pears, meanwhile, PEO was considered appropriate only with strawberries.

Conclusion:
LEO based blend could be used as a coating for perishable fruits. For PEO and TEO other strategies should be developed to eventually use them, reducing the EO concentration or varying the fruit type.

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Antioxidant, anti-inflammatory and anti-proliferative effects of artichoke and ginger extract and improvement of gastrointestinal disorders

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Aim: This study aims to focus on the investigate the antioxidant, anti-inflammatory, and anti-proliferative effects of artichoke and ginger extract powder, and to confirm the effect of improving gastric diseases.

Method: Antioxidant capacities, including Total phenolic content(TPC), Total flavonoid content(TFC), ferric reducing antioxidant power(FRAP), trolox equivalent antioxidant capacity(TEAC), and 2,2-diphenyl-1-picryl-hydrazyl radical scavenging activity(DPPH) were determind. Anti-inflammatory effect was measured with NO production. To examine the antiproliferative effect, the extract powder was treated on gastric cancer cells AGS and KATOⅢ.

Results: TPC and TFC, which are related to the antioxidant activity of artichoke and ginger extract powder, were 100.6±0.7 mg GE/g and 77.3±0.4 mg CE/g, respectively. The FRAP of extract powder were 469±3.7 mg Fe^{2+}/g, and DPPH and TEAC showed more than 80% scavenging ability. The NO production was significantly decreased in the LPS induced cells treated with artichoke and ginger extract powder compared to LPS induced cells. In addition, the cell proliferation of AGS and KATOⅢ cells were inhibited by more than 80% at 0.25 mg/mL and 1 mg/mL, respectively.

Conclusion: In conclusion, artichoke and ginger extract powder contained high phenolic and flavonoid content, and showed high antioxidant activity. Also, extract powder has anti-inflammatory and anti-proliferative potential. Therefore, this study indicates that artichoke and ginger extract powder have the potential to serve as functional foods to prevent gastric diseases.

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Spent Coffee Grounds (SCGs): food waste or new ingredient for fermented beverages?

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Aim:
Coffee is one of the most popular beverages and largest traded commodities worldwide with a large social, economic, and environmental impact through the food value chain. The spent coffee grounds (SCG) (solid residues discarded after brew preparation) are considered an underutilized by-product by its high content of fiber and presence of antioxidant compounds.
Kombucha is obtained from the fermentation of sugary infusions using a symbiotic culture of bacteria and yeasts (SCOBY). Generally, black, or green tea are used to make the infusion. However, SGC could be an interesting alternative ingredient to make this beverage.
The aim of this study was exploring the usage of SCG, an important by-product in restaurants and coffee shops, as an alternative substrate in order to obtain a value-added food product developing a novel kombucha beverage.
Method:
In this study, 3 concentrations of SCG (10, 40 and 80 g L^{-1}) were evaluated as new ingredient for kombucha elaboration. Black tea (10 g L^{-1}) infusion was used as control and 3 independent batches (3 L) were made for each kind of kombucha. Total acidity, pH, total soluble solids (TSS), instrumental color and total polyphenolic content (TPC) were evaluated during fermentation at 0, 1, 3, 10 and 14 days.
Results:
The results showed that the type of brew (e.g., the concentration or the ingredient) and fermentation time had a significant effect on the parameters evaluated. The final pH of all kombucha beverages fell into the pH range 2.5 to 4.2 after starter inoculation, considered safe for human consumption. SGC kombuchas (10, 40 and 80 g SCG L^{-1}) showed lower TPC (64.9, 145.7, and 270.7 mg acid gallic L^{-1}, respectively) than control (821.2 mg acid gallic L^{-1}). In order to reach the similar TPC that black tea kombucha, higher concentration of SCG should be tested.
Conclusion:
The replacement of tea by SCG to produce kombucha is a viable alternative for adding value to this by-product, reducing waste, and, at the same time, obtaining a novel fermented beverage.

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Gloss estimation of chocolate sprinkles with hyperspectral imaging

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Abstract

Aim. Gloss is an important characteristic in the quality evaluation in chocolate production. However, standard glossing measuring devices face several challenges when measuring food products, in particular those with curved surfaces and small, such as chocolate sprinkles. Therefore, gloss evaluation of chocolate sprinkles is typically done by human visual assessment. In this respect, hyperspectral imaging (HSI), combining spectroscopy and imaging, has gained attention as a non-destructive and non-contact real-time detection tool for food quality analysis and control. This technique adds an extra dimension to traditional machine vision techniques by providing images at a larger number of more narrow wavebands. This can potentially increase the discrimination power.

Method. We investigate the potential of HSI as a gloss measurement technique for chocolate sprinkles. For this purpose, we use a snapshot hyperspectral camera with 16 bands in the visible range (470 to 630 nm) and a 512x256 pixel resolution. In addition, this portable and compact camera allows fast acquisition enabling real-time automation of product inspection. We developed an inspection prototype consisting of a cabinet with a D65 illumination system and a snapshot visible (VIS) camera. We evaluated 42 samples of chocolate sprinkles extracted after different processing steps (extrusion, sugar glaze and 3 different shining steps) and corresponding to different gloss levels. Two gloss estimation models have been tested. The first model uses means of the reflectance spectra, extracted from a sample region of interest, and support vector machines. The second model adds spatial information to the spectral domain to fine-tune a state-of-the-art convolutional neural network (Hybrid3D2D-CNN). This network is specially designed for hyperspectral images and does not require large training datasets.

Results. Both methods show remarkable performances, achieving about 80% and 93% classification accuracy, respectively.

Conclusions. Overall, we highlight the combination of HSI with a lightweight CNN as a promising and easy-to-deploy technology for automation of real-time gloss estimation in challenging food products such as chocolate sprinkles.

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Production of high-functional fruits snacks by combination of mild technologies

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Aim:

Vacuum impregnation (VI) represents a promising mild non-thermal technology for development of functional foods of these recent years. In this study, vacuum impregnation combined with drying was used to incorporate prebiotic fructooligosaccharides (FOS) from Yacon juice into different fruits: apple slices and entire strawberries to produce snacks and ready-to-eat fruits with improved prebiotic functionality. The present work was performed in the framework of MILDSUSFRUIT European project.

Methods:

Apple slices and entire strawberries were subjected to VI with Yacon juice (10 minutes; 200 mbar). After impregnation, fresh strawberries were stored at 4 °C while apple slices, were dried at 70 °C for 8 hours in convection oven. On these products microbiological shelf-life, technological parameters (a_w, texture) and prebiotic properties (FOS, polyphenolic compounds and antioxidant activity) were investigated. The ability of VI fruits to promote the vitality or the growth of selected probiotic strains from *Lactobacillus* (*L. rhamnosus* GG and C112) and *Bifidobacterium* ((*B. breve* 20091and *B. longum* 20088) genus was evaluated in simulated intestinal fluid (SIF: 0.1% w/v pancreatin, 0.15% w/v Oxgall bile salt, 100 mM phosphate saline buffer pH 8) for 24h.

Results:

Introducing Yacon juice into tissue of the apple fruit and strawberries, resulted in increased content of FOS, polyphenolic compounds and antioxidant activity. Low water activity in the obtained dried apple slices improved the microbiological safety up to 50 days of storage. Ready-to-eat strawberries showed 5 times more FOS compared to the untreated samples. Moreover, a positive effect of impregnation on the antioxidant stability of the fruit after drying was noted. Ready-to-eat strawberries and dried apple slices sustained the vitality of selected probiotics strains or reduced their death kinetics in SIF during 24h especially of the *Bifidobacterium* species considered.

Conclusion:

VI of fruits with functional compounds could be considered as a valid method to produce high nutritional value ready-to-eat products. The combination of vacuum impregnation and drying is a suitable way for the production of snacks with improved nutritional and functional properties.

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Comparative investigation of anti-cancer potential in collagen hydrolysate fractions extracted from Alaska Pollack skin

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Aim:

The objective of this study was to investigate the anti-cancer potential of collagen hydrolysate fractions extracted from alaska pollack skin using enyme- or ultrasound- assisted extraction methods.

Method:

Extraction of collagen was accomplished by conventional extraction, enzyme-assisted extraction, ultrasound-assisted extraction, and enzyme-ultrasound-assisted extraction. Then, the extracted collagen hydrolysate was fractionated on molecular weights of <3 kDa, 3-10 kDa, 10-30 kDa, and > 30 kDa. Distribution of molecular weights from collagen hydrolysate fractions was measured with matrix-assisted laser desorption ionization time-of-fight flight mass spectrometry (MALDI-TOF-MS). Cell proliferations on AGS and KATO cells treated with collagen hydrolysate fractions were determined with MTT assay. Western blots were conducted to observe gene expression related with cell death and apoptosis.

Results:

Extraction methods exerts a significant impact on antiproliferation of both cancer cells (AGS and KATO Ⅲ) treated with collagen hydrolysate fractions by enzyme-ultrasound-assisted extraction. The samples of > 30 kDa showed the highest inhibition effects on cell proliferation of cancer cells (AGS and KATO Ⅲ) with increased levels of BAD expression, p-53 and caspase 3, and decreasement of bcl-xL, bcl-2, mTOR, ERK, and JNK.

Conclusion:

These results clearly exhibited that the different types of extraction methods exert the significant impact on the different molecular weights of collagen hydrolysate fractions, and the application of a combination of enzyme- and ultrasound- assisted methods for collagen extraction in this research could applied to improve diseases such as cancer.

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High-added value compounds obtained from fish waste using microorganisms endowed with proteolytic and lipolytic activity

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Aim:
Following the growth of the global population and the subsequent rapid increase in urbanization and industrialization, fish processing industry has experienced significant expansion, playing an important role in the world economy. This has generated the production of higher amount of fish waste and by-products. The exploitation of underused or discarded marine materials through biotechonological processes can represent a sustainable strategy to promote circular bioeconomy. In fact, low-value products can be transformed into added-value compounds, such as bioactive and functional peptides, lipids, and chitosan or used as microbial substrates to produce enzymes (lipases and proteases), flavouring agents or single cell oils that have a great potential in agricultural, medicine, and food industry applications. The main aim of the present study, performed in the framework of the European Project “NewTechAqua”, was to use microbial fermentation as a safe, ecological and profitable technique to obtain a wide variety of these compounds.
Method:
Different strains of bacteria (*Lactiplantibacillus plantarum, Lacticaseibacillus paracasei, Bacillus subtilis, Pseudomonas* spp.) and yeasts (*Yarrowia lipolytica*, *Debaryomyces hansenii*) were selected for their enzymatic properties (proteolysis and lipolysis) and then incubated for 72h in a solution containing 10 g of feesh waste (fish bones, shrimp shells, viscera and blood) and 10 ml of glucose 30%. After fermentation, the supernatants containing protein hydrolysates were collected by centrifugation, quantified using Bradford and OPA assaies, and assessed for their antioxidant (DPPH, ABTS, TBARS), anti-hypertensive (anti-ACE assay), and antimicrobial activity against pathogenic bacteria. Moreover, the production of flavouring compounds was evaluated by SPME/GC -MS technique. Eventually, single cell oils and lipids produced by *Y. lipolytica* were extracted with the Folch method, derivatized and analysed by GC-MS.
Results:
A strain-specific pattern of hydrolysis was obtained. *Y. lipolytica* generetaed more functional peptides endowed with antioxidant and antimicrobial activity. Volatile molecule profiles showed an increase in these samples of aldheydes. Instead, Lactic acid bacteria and bacilli produced more proteases.
Conclusion:
Microbial fermentation of fish by-products and waste represents a sustainable and eco-friendly tool to obtain new functional peptides, enzymes, and flavouring agents to be applied in the food sector.

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Replacing egg yolk in homemade mayonnaise by food by-products: effect of formulation and process parameters

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Aim:
Food by-products valorization is identified as an interesting lever towards a more sustainable food system. However, current eco-responsible strategies are often based on extracting molecules of interest from existing by-products, which still generates waste. Solid particles have been extensively studied as an interesting alternative to surfactants for stabilizing emulsions. Vegetal by-products – in their entirety - could be good clean-label candidates as they are composed of both insoluble and soluble compounds. Indeed, the strong ability of juice industry side streams for example (such as apple and orange pomaces) to act as sole stabilizing agent in model emulsions has been proven in previous studies[1]–[3]. The present work aimed at extending this concept towards more complex emulsified systems and popularizing the use of food by-products as an alternative to the usual emulsifiers towards the general public.
Method:
To this end, mayonnaise was chosen as a well-known, popular and homemade sauce as work support. The challenges were 1) to use only processes and ingredients that could be found in every kitchen or high school lab, *i.e.* to scale-down some results already obtained at ambient temperature but with high shear material; 2) to build a framework that could be used for communication towards the scientific community and towards a much larger public; 3) to help the future developments of vegan and/or low-fat mayonnaises. As a major hedonic dimension of sauces, the formulation was optimized so that yolk-free mayonnaises only stabilized by juice side streams reach the textural properties of a reference mayonnaise stabilized by egg-yolk.
Results:
The main results were the following: 1) The oil droplets size is driven by the powder to oil ratio, which is consistent with literature about Pickering emulsions; 2) The feasibility of carrying out a fine emulsification with a hand blender was demonstrated; 3) Stable sauces with textural properties close to the traditional mayonnaise were obtained with oil levels as low as 25%.
Conclusion:
As a conclusion, stable low-fat and vegan mayonnaises only stabilized by-products were formulated in 4 minutes at ambient temperature with a hand blender, meeting the growing consumer demands for clean-label and nutritionally improved products.

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Proteomics for quality&safety and shelf life evaluation of high-pressure (HP) processed european sea bass fillets

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Aim:
Fish are a valuable source of essential nutrients in the human diet but are highly perishable and this negatively influences the sustainability of the seafood sector and supply chain. Novel-eco-friendly technologies, as high-pressure processing (HPP) are being investigated as a means to extend shelf life, reduce waste and improve the quality&safety of fish products. Although HPP of fish has a relatively small effect on sensory parameters, its impact on quality&safety parameters (including allergenicity) are not well known and need to be systematically investigated. In the present study the impact of HPP on the proteome of sea bass (*Dicentrarchus labrax*) fillets was investigated and putative markers for quality&safety monitoring identified.

Method:
Raw fillets of sea bass from aquaculture were treated with HP in a pilot scale (with 300/450/600 MPa, during 2 or 5 min, 25°C) and stored with the control (C) under isothermal conditions (2°C) up to 11 days. Samples of C and HP fillets were collected one or 11 days after HP treatment (n=8/experimental condition) and analyzed using histology (H&E) and SWATH quantitative proteomics. The potential of HP on the allergenicity of sea bass proteins was investigated by western-blot of the major allergens, parvalbumin and tropomyosin.

Results:
Analysis of tissue structure revealed significant impacts of HP on the fish muscle fibers, appeared more compact. HP treatments modified the proteome of sea bass fillets and decreased the protein solubility in comparison to the control. The duration of HP did not affect the protein solubility but modified the proteome. From the 519 quantified proteins, around 23% had >2-fold modified levels ($p<0.05$) in between C and HP treated fillets, at the end of storage. HP600/2min (n=180) had the highest number of modified proteins and the lowest occurred at HP300/5min (n=26). HPP affected the allergenicity of the proteins in the sea bass fillets by affecting the availability of their IgE epitopes.

Conclusion:
HPP changed the morphology, proteome, protein solubility and allergenicity of sea bass fillets. Promising biomarkers for quality&safety assessment of sea bass fillets were obtained from proteomics and it will be of interest to establish if they are suitable for application to other commercial fish species.

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Hemp seed milk sonication for enhanced beverage quality

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Aim:
The interest in plant-based alternatives to dairy milk has increased over the years. This is due both to the raised consumers' awareness about environmental sustainability and to the escalated rate of allergies development and changes in diets (veganism). Hemp seed milk is considered an optimal and nutritious alternative to dairy, soy, and nut milks. It was proved to give several health benefits and, being lactose-free, it has a low allergenicity. Goal of this study was the development of a hemp seed milk thickened with gellan and stable over time thanks to an *ad hoc* ultrasound treatment.

Method:
Hemp seeds were dispersed in water and grounded using a kitchen blender. The solution was filtered (80 µm), a thickener was added in solution and soy lecithin was added as emulsifier. Heat treatment at 65 °C for 30 minutes was performed over the product under stirring to allow the complete dissolution of all components. This drink was chemically and physically characterized. The effects of ultrasound (40 µm for 10 min and 80 µm for 5 and 10 min) application on its viscosity, stability (phase separation) and nutritional value (ω6 to ω3 ratio) were investigated.

Results:
The chemical characteristics, including the fatty acid profile, of the hemp seed milk did not change after the ultrasound treatment. Differently, the viscosity was highly influenced. With respect to the untreated sample (2.83 Pa*s), sonicated milk resulted in an increased viscosity reaching the highest value (20.25 Pa*s) at 80 µm for 10 min as a consequence of protein denaturation induced by cavitation. Sonication positively acted also on the reduction of gravity separation during the 4 days of monitoring.

Conclusion:
The 'green' strategy of adopting ultrasounds for improving the final quality of the hemp seed milk gave positive outcomes in terms of drink viscosity and stability. This is the starting point to investigate the effects of cavitation on macro-components and to deepen product characterization. Furthermore, the formulation here studied can serve as a principle to improve and optimize both the product formulation and its physical processing.

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Tomato pomace as a bio-energy source in a circular economy: methane production intensification using ultrasounds

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Aim:
In 2020, the worldwide fresh tomato production exceeded 187 million tonnes. Their processing into tomato paste generates between 3 and 6 million tons of tomato pomace (skin and seeds) every year. Many are the biorefinery options to valorise such organic residue in a circular economy approach. The practical solution here proposed is the energy recovery through anaerobic digestion. In particular, ultrasound pre-treatment was carried out in order to increase the final bio-methane yield.

Method:
Ultrasound pre-treatment was applied setting two different wave's amplitude, 80 and 152 µm, at a frequency of 20 kHz, for 5, 15, and 30 minutes. The subsequent biomethane potential tests were performed in 500 mL batch reactors under mesophilic conditions. Anaerobic granular sludge was used as inoculum. Substrate to inoculum ratio was fixed at 1 gVS/gVS and substrate concentration was 4.8 gVS/L inside each reactor. Blank tests using the inoculum alone were also prepared to measure the quantity of methane produced only by the sludge. The volume of biogas produced was monitored as well as its composition in terms of CH_4 and CO_2 content.

Results:
Tomato pomace pre-treated at 80 µm displayed no improvement in terms of bio-methane production with respect to the control. Samples sonicated at 152 µm yielded an improved methane production potential (max. +5%), even though, the best condition (15 min) among those tested revealed a yield of only 250 m^3CH_4/t_{VS}. The kinetic study results for first order kinetic model and modified Gompertz equation revealed a degradation kinetics speed up when tomato pomace was treated at 152 µm.

Conclusion:
The adopted energy-oriented approach to valorise tomato pomace as an energy source through anaerobic digestion using ultrasound pre-treatment gave positive outcomes especially in terms of faster kinetics. However, from a cost and benefit analysis, the final increased methane yield could not be considered enough to justify the energetic requirements for ultrasonication. Therefore, the

absence of economic feasibility was also evidenced. A possible improvement might be reached testing higher substrate to inoculum ratios or co-digesting this substrate with other organic waste streams.

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ENHANCEMICROALGAE PROJECT: Stimulating Microalgae Research, Industrial Development and Transnational Cooperation in Europe

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Aim

EnhanceMicroAlgae main objective is contribute to the competitiveness of microalgae-based industry in the Atlantic Area through the transfer of technological and economic expertise to the business sector, facilitating production of large biomass volumes and optimizing production processes. EnhanceMicroAlgae was launched on the 1st of November 2017 and run until the end of October 2020 and now has gained an extension until June 2023.

Methods

The work program has included an in-depth review of the existing Atlantic Area microalgae sector including strengths and weaknesses, level of expertise, industrial development opportunities, and regulatory and legal frameworks. Also, innovative research activities and innovation transfer from laboratories and research platforms to the industrial sector has been carried out promoting the launch of new products, services and processes encouraging the creation of spin-offs and the development of case studies supported by Decision Support Tools (DST). EnhanceMicroAlgae extension will comprise new activities focus on pilot demonstrations, dissemination and clustering activities focused on the microalgae business sector.

At ANFACO-CECOPESCA a comparative research work is being carried out to study the efficiency of lipid extraction from different species of commercial freeze-dried microalgae and also some microalgae species growth at ANFACO-CECOPESCA aquaculture facilities. Different traditional methods are being compared with the aim of obtaining a gravimetric method that allows us to characterize the lipid content of small initial amounts of microalgal culture.

Results

In global, main EnhanceMicroAlgae project results include:

1) Microalgae information dissemination, including through comics and illustration
   - Spin-off and start-up support programs
   - Online database of stakeholders and other key experts of the microalgae sector in the Atlantic
   - A decision support tool to help SMEs decide on culture system
   - A microalgae catalogue strain
   - A virtual marketplace as a platform for services and interests exchanging, supported by project partnership
   - Training sessions & Workshops
   - Scientific publications including innovative research results

Conclusions

All the Atlantic Area regions are represented in the EnhanceMicroAlgae consortium. More information: https://www.enhancemicroalgae.eu/

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Valorization of fruit and vegetable by-products as novel ingredients towards zero waste

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Aim:

According to FAO more than 1.3 billion tons of world's food production is wasted along the whole food supply chain. Large amount of waste generated came from fruit and vegetable production that can be processed into a stable value-added product by dehydrating at low temperature so that the nutritional properties of the food are not lost, being useful to obtain high quality products from wasted food. The aim of this research was to determine physical-chemical and instrumental parameters of fruits and vegetables samples dehydrated.

Methods:

In this study, 17 samples of different dehydrated and grounded fruits (lemon, apple, pomegranate, orange, tomato) and vegetables (spinach, carrots, beetroot, leak, artichoke, kale, pumpkin, broccoli, chard, lettuce) were analyzed. Dry matter (gravimetric method), instrumental color (CIELab coordinates), total polyphenol content (TPC) (Folin-Ciocalteu method) and sugars (glucose, sucrose, and fructose) by HPLC-PAD method were determined.

Results:

The dry matter content of the samples was between 82.9% (tomato) and 92.47% (beetroot). TPC ranged between (115 (carrot) - 1133 (pomegranate) mg gallic acid (GA) / g dry matter). Among the 17 samples analyzed, pomegranate powder had the highest total polyphenol content, followed by lemon and artichoke with 320 and 330 mg GA /g dry matter, respectively. According to sugars concentration studied tomato and orange samples showed the highest glucose (162.83 and 141.46 mg/ g dry matter, respectively) and fructose content (225,119 and 139,359 mg/ g dry matter, respectively). Beet samples also showed high sucrose concentration as pumpkin (523,49 and 308,52 mg/ g dry matter, respectively). Therefore, these by-products could be used as natural sweeteners.

Conclusions:

The incorporation of these by-products as ingredients in the development of products allows improving the nutritional composition (considering its polyphenol content) as well as the appearance if their color properties are considered. Results of the study allow a better understanding of the by-products in order to introduce wasted fresh products transformed into powder into the food products as novel ingredients.

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Supercritical carbon dioxide as an emerging tool for apple by products valorization

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Aim: Apples are industrially used for juices, purees and snacks production. After processing, almost 25 % of the apple is discarded as a waste, the apple pomace. This by-product is rich in bioactive compounds such as fatty acids and antioxidants. Apple seeds represents 4-5% of this pomace. From the apple seeds an oil can be extracted and used as ingredient for different applications. Supercritical fluid extraction is a green technology that has been often applied for the extraction of oils from fruit seeds. Indeed, it requires the use of carbon dioxide as a supercritical fluid, an apolar and not toxic solvent that can be easily removed after the extraction. Thus, the aim of this study was to apply this technology for the extraction of oil from apple seeds.
Method: Apple seeds were dried and then milled. The extraction with supercritical carbon dioxide was performed at 26 MPa, 40°C and 1 L/h for 180 min. The antioxidant activity, total phenolic content and oxidative stability were measured spectrophotometrically. The fatty acids profile was assessed by GC-FID analysis, while with HPLC-MS analysis the phenolic profile was determined. As a reference, apple seed oil was extracted with the conventional Soxhlet extraction (1:5 seeds to hexane, 180 min) and fully characterized as mentioned.
Results: The oil was extracted with a comparable yield with respect to the Soxhlet extraction. It was found to be rich in unsaturated fatty acids, mainly linoleic (58%), oleic (32%), palmitic (6%), stearic (1.5%). The level of lipid oxidation was lower that the Soxhlet extracted oil. From the phenolic profile obtained, it emerged that amygdalin, a toxic compound that generates cyanide after ingestion, was not present while it was detected in the oil extracted with Soxhlet.
Conclusion: Supercritical fluid extraction produced an oil of high quality and with yields comparable to the solvent-based technique. The fatty acids composition was found similar to other edible vegetable oils, i.e. pumpkin seed oil and sunflower seed oil. Interestingly, in the oil amygdalin was not detected opening the possibility to further investigation of a possible use of this oil for food application.

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Interest of malted flour for flat bread application: impact of heating-rate on staling

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Flat bread, a staple food from the Mediterranean area, faces the challenge of food waste due to its short shelf-life. This product is characterised by a magnified staling effect due to a high heating rate during baking (1). In order to give the bread a flat shape, a rapid baking at high temperatures – 300°C/2 min per side yields high heating rates up to 50°C/min unlike conventional breads (ca~7°C/min). The most accepted technique against staling is the addition of exogenous enzymes (often “bacterial”) such as xylanase and amylase. Malted flour addresses the interest of a natural source of enzymes; however, the corresponding endogenous enzymes can’t compete with bacterial ones which are much heat stables. This contribution aims at investigating the performance of a malted flour used to delay the staling process with respect to the heating rate of a conventional flat bread making process and a modified process. The methodology involved the production of a wheat based malted flour using a conventional germination step (4 days at 18°C). The enzymatic activity was assessed with a Malt-Amylase-kit (Megazyme). Six breads were produced using three heating rates – 5, 20 and 40°C/min – and two different dough preparations, one at 25 °C and one with a boiling water to induce a partial gelatinization of the flour. Breads were baked using a miniaturized heating system based on a Pelletier heater (1). The staling was monitored by measuring the Young modulus of the baked crumb and the melting enthalpy of amylopectin crystallites during two weeks storage at 10 °C. The dough stickiness was assessed using a Kieffer-ring system. Results showed a significant impact of the heating rate on the kinetics and magnitude of staling. The amylopectin retrogradation was higher with increasing heating rate, showing a lower action of the malted flour’s enzymes. The malted flour yielded higher dough stickiness. As a conclusion indicates that malted flour addresses several challenges in the case of rapid baking conditions such as those encountered with flat bread production. A modified dough production is envisaged based on a predough process to mitigate the staling issue.

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Essential Fatty Acids of Multispecies Swards Grown in Ireland – Possible sustainability and environmental implications.

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Aim: Essential fatty acids (EFA's), particularly α-linolenic acid and linoleic acid - which are the most abundant in swards - have been shown to positively impact the performance and health of ruminants by increasing fertility, modulating the immune response and reducing inflammation. Furthermore, EFA's can improve the nutraceutical properties of animal products; α-linolenic acid is the main precursor for conjugated linolenic acid (CLA), which is a fatty acid commonly found in milk with anti-obesity, anticarcinogenic, and antidiabetic properties. Since ruminant products are the main source of CLA in human diets, there is an interest in increasing levels of EFA's consumed by animals.
Traditional monoculture grazing systems contain EFA's, but require intense management and input (e.g., fertiliser). Multispecies systems consisting of different swards (e.g., grass, legumes, and herbs) have been recognised more sustainable, as they need less fertiliser, increase biodiversity, and improve soil function. Nevertheless, while there is enough data on the concentration of EFA's in monocultures systems, information on the multispecies is still scarce.
Method: The present study compares the EFA composition of multispecies systems (consisting of perennial ryegrass, timothy, white clover, red clover, chicory and plantain) to two other conventional grazing systems (i.e., mono-species perennial ryegrass and binary-species perennial ryegrass and white clover) during the Irish grazing season (June-September). Determination of EFA's in swards was carried out by Gas-Chromatography/Triple-Quadruple Mass Spectrometry. The EFA composition of each forage species was also assessed individually.
Results: Preliminary results showed that the three grazing systems had similar levels of α-linolenic acid ($p>0.05$), with concentrations having a threefold increase through the grazing season. However, linoleic acid appeared to be higher in multispecies systems, particularly later in the season. Overall EFA's levels were higher in red clover, white clover, and plantain in comparison to the other forages ($p<0.05$). Variations in EFA's were more significant between species ($p<0.001$) than between season within species.
Conclusion: Multispecies swards could be included in ruminant production systems as a sustainable alternative to monoculture swards, providing equivalent sources of α-linolenic and linoleic acid concentrations for animal diets.

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Evaluation of affine ligands for capture of Clostridium tyrobutyricum spores by magnetic particles in milk

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Aim: *Clostridium tyrobutyricum* is the main causative agent of late blowing defect in hard and semi-hard cheese and causes important economic loss. The development of a fast and specific method for detecting *C. tyrobutyricum* spores is required to decide milk destination in cheese industry, as the current microbiological methods require long time for results. Therefore, the aim of this study has been to develop a procedure based on magnetic particles coated with specific ligands to capture *C. tyrobutyricum* spores.

Method: An affine peptide named pCZS1 was selected by phage display technique and further synthesized incorporating a FITC molecule. A second ligand composed by G3P protein of M13 phage and pCZS1was designed and expressed as recombinant protein (rG3P) in *E. coli* BL21. The affinity of both ligands was evaluated by isothermal titration calorimetry (ITC) and flow cytometry (FC). Magnetic particles, with thiol, iodoacetyl (1 m) or Ni-NTA (250 nm) activated groups, were coated separately with both ligands to evaluate the capture efficiency (CE) of 10^3 *C. tyrobutyricum* spores in phosphate buffer (PBS) and cow milk. Polyclonal antibodies from rabbit were isolated by affinity chromatography and used to coat protein G (1 µm) and protein A (250 nm) magnetic particles. After immunocapture with protein A particles in raw milk, *C. tyrobutyricum* spores were detected by qPCR.

Results: ITC and FC revealed that pCZS1 and rG3P bound to *C. tyrobutyricum* spores with different affinity. CE values for 10^3 *C. tyrobutyricum* spores were around 90% for pCZS1-particles in PBS, though the assay was not efficient in milk. rG3P-particles did not recover spores neither from milk nor PBS. Antibodies were bound to protein G and A particles and CE values for spores in milk were between 80-90% for both particles. qPCR was combined with a previous immunocapture step using protein A particles in spore spiked milk, demonstrating that this qualitative assay is fast and specific.

Conclusion: In this study, polyclonal antibodies provided better results than pCZS1 and rG3P, as ligands for *C. tyrobutyricum* spore capture. Moreover, protein A particles coated with specific antibodies allowed recovering the spores from raw milk and its detection by qPCR.

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Effect of ultrasound disruption on lipid extraction from the microalga Nannochloropsis sp.

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Aim:
Photoautotrophic microalgae are a novel source of biomass rich in lipids containing nutritionally interesting n-3 long-chain polyunsaturated fatty acids (n-3 LC-PUFA). However, microalgae incorporated into foods as whole biomass may lead to limited n-3 LC-PUFA uptake by the human body. Incorporation of microalgal oil instead of whole biomass is an interesting alternative. The extraction efficiency of these lipids can be enhanced by adding a cell disruption step during lipid extraction. Ultrasound assisted extraction (UAE) to enhance lipid recovery from microalgae has been covered in recent literature. UAE is used to speed up lipid extraction for analytical purposes or for industrially applicable lipid extraction of microalgae. In addition, the ultrasonication and lipid extraction by organic solvents of microalgal biomass has been performed in different set-ups: simultaneous ultrasonication and lipid extraction or ultrasonication and subsequent lipid extraction, ultrasonication of wet biomass or dry biomass. Often, no reference method is included to which the lipid extraction efficiency using UAE is compared and the total lipid content of the biomass is not always specified making it impossible to calculate the extraction efficiency. Therefore, the effectiveness of this cell disruption technique for industrial microalgae processing has not consistently been proven in literature.
Method:
This study investigates the effect of UAE of *Nannochloropsis* sp. biomass on the lipid extraction efficiency and the lipid quality, expressed as free fatty acid content and peroxide value. The effect of UAE on wet biomass in presence of organic solvents is compared to control extractions at room temperature and elevated temperatures corresponding to temperatures reached during ultrasonication. The effect of ultrasonication power and ultrasonication time is studied.
Results:
The results show that the lipid extraction efficiency increases after UAE when ultrasound was applied at high power. Control extractions at elevated temperatures, mimicking the temperature profile observed during UAE, result in similar lipid extraction efficiencies as observed after UAE.
Conclusion:
UAE and control extractions at elevated temperatures increase the lipid extraction efficiency of N*annochloropsis* sp. to a similar extend.

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Gastronomy to engage citizens for a more sustainable future: Espelette pepper as a case study

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Aim: Improvement in the global food system is necessary to increase sustainability, but the main challenges are region-specific; therefore, solutions must be local . Gastronomy has the potential to accelerate and drive the transition to a more sustainable future since it has the ability to impact both food production and consumption. This project has a dual purpose: (i) to identify the key issues associated with the sustainability of the food system in the Basque Country; and (ii) to perform a specific new product design and development case study/pilot to address the challenges identified by stakeholders.
Method: First, to identify challenges and potential solutions, 4 focus groups (n = 6-8) were conducted including: experts on sustainability, producers/suppliers, chefs, and consumers. Moreover, 17 restaurant managers were interviewed to detect innovative actions/products that could improve the sustainability of their business. A napping test was conducted to compare the properties of the developed product with 10 commercial sauces, using a semi-trained panel (n = 15).
Results: Food waste was one of the main problems detected by most of the agents of the food value chain. Among some of the mentioned example products, green chilli peppers from Espelette were cited since they represent an important agricultural surplus with low commercial value. Also, among the culinary innovations mentioned by some chefs, the use of local products was mentioned multiple times. With the information gathered from the interviews, a new product was created: a hot sauce based on the surplus of the local green chilli pepper from Espelette, as the Basque market is dominated by foreign goods (mostly coming from Latin America or Asia). The results of the sensory test revealed that the products were grouped into distinct clusters, and that the new product had unique characteristics that could be used to communicate its profile and encourage the selection of local products over imported ones..
Conclusions: Gastronomy, through its multidimensional approach, can be a useful tool in the transition to a more sustainable and delicious food system.

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Development of new foods rich in animal proteins adapted to the masticatory capacity of seniors

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Aim:
Elderly often avoid eating meat because of chewing and swallowing difficulties. Consequently, this increases the risk of malnutrition and sarcopenia. To ensure that the elderly continue to consume meat, a common solution is to offer them ground products. In this form, meat products are unpalatable and they no longer stimulate chewing. Chewing allows to better feel the taste and texture of food and activates the digestion. In this context, it is of importance to develop new animal products with a structure able to stimulate the mastication of seniors. To do so, we have developed a food recipe rich in animal proteins adapted to 3D printing, and tested its printing and textural characteristics.
Method:
In a previous study, a 3D printer prototype was developed to validate printing parameters using gelatin as model food. This prototype was improved to print more complex food. Different mixtures were prepared in order to be extruded in the printer nozzle and to form a stable structure of 1cm high. It was composed of beef ground in liquid nitrogen, gel of gelatin and/or linseed mucilage and flour in various proportions. To maintain the mixture in a sufficiently fluid state, the syringe and the nozzle were introduced into a heating system regulated at 45°C. The food was printed on a tray cooled to 4°C by a Peltier system. Then, the printed food was cooked in an oven for 10 minutes at 180°C. Texture was analyzed with a TPA system.
Results:
All the mixtures were printable and could form a filament and a stable structure. The cooled tray was necessary to stiffen the gel and hold the printed structure in place. During printing, mixtures with high proportion of flour had grainy textures. After cooking, the preparation with gelatin showed more elasticity than the one containing only mucilage. The latter being more brittle.
Conclusion:
These preliminary results show the possibility of using 3D printers to create meat foods with complex structures. A forthcoming study of the effect of structure and formulation on mastication will provide new perspectives on the development of this new type of food.

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Microwave-assisted extraction of bioactive compounds from agro-food and fish by-products

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Aim
One of the basic pillars with regards to circular bioeconomy strategy, focusing on a sustainable processing, is the extraction of bioactive compounds from agricultural and fish by-products and their transformation into high added biological and economical value products. Bioactive compounds (BACs), such as polyphenols, carotenoids, lipids (ω-3 fatty acids), present in agricultural and fish by-products, have been reported to show antimicrobial, antioxidant, and anti-inflammatory properties. Microwave-assisted extraction (MAE) has a great potential as an alternative method for the recovery of thermolabile substances from agro-food and fish by-products, complying with environmental and economical requirements to ensure safe and high-quality extracts. Its main advantages include high extraction performance, while requiring low temperature, short processing time, and reduced energy consumption.
Thus, MAE was performed to rupture the cell wall structures and release compounds from olive pomace, tomato seed and skins, and fish processing discards for increased and efficient recovery of BACs.

Method
Different MW conditions and solvent concentrations at 30-50°C for 10-30 min were studied (500-700 W and methanol for olive pomace, 500-700 W and ethanol for fish by-products and 150-500 W and ethyl acetate for tomato skin and seeds). The characterization and quantification of the extracts were carried out using HPLC analysis (total carotenoids, lycopene), Folin-Ciocalteu method (total phenolics) and DPPH assay (antioxidant activity). Fatty acids profile of extracted fish oil was determined using GC analysis (ω-3 fatty acids).

Results
MAE has found to be an efficient method for the recovery of polyphenols, lycopene and ω-3 fatty acids, with high extraction efficiencies in significantly reduced time. The olive pomace extracts with the highest antioxidant activity were obtained with 60% methanol at 45°C. The optimum conditions regarding the recovery yield for lycopene were microwave processing at 400 W for short times and at medium temperatures (35-40°C). MAE allowed the recovery of 70-90% of the total lipids from fish by-products in up to 15 min.

Conclusions

The reliability of MAE for the recovery of BACs from agricultural and fish by-products was confirmed. The application of MAE in natural, inexpensive raw materials could be an economical alternative to traditional extraction methods thus satisfying modern industry demands for sustainable development.

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Valorization of fish industry side stream via recovery and nano-encapsulation of ω-3 rich lipids

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Introduction
Seafood processing industries' expansion leads to high quantities of side-streams which are mainly used as animal feed or as organic fertilizer despite being rich in valuable compounds such as polyunsaturated fatty acids (PUFA) which can be recovered and used as ingredients in food, pharmaceutical, nutraceutical applications. The efficient valorization of fish discards by extracted PUFA, can play an important role in the circular economy improving economic and environmental sectors. PUFA are highly susceptible to oxidation, leading to the formation of volatile products with unpleasant smell and taste. Thus, the development of an efficient delivery system is needed. This study aims to evaluate the effect of different solvents on yield recovery and quality of extracted lipids of seabass by-products and to examine different nanoencapsulation systems in terms of encapsulation efficiency.
Methods
Seabass by-products (*Dicentrarchus labrax*) were freeze dried and then solvent extraction with ethanol or hexane was carried out to recover fatty acids. Extraction temperature (20-50^{o}C), solvent to solid ratio (10:1-50:1) and time (up to 30 min) were investigated. The total yield, profile of fatty acids and oxidation were determined for each solvent. At the optimum conditions, nanoemulsions of fish oil powders were prepared using spray-drying and freeze drying with maltodextrin as wall material and Tween 80 and/or whey protein concentrate as emulsifiers.
Results
Ethanol achieved the highest lipid recovery (33.3%), highest concentration of PUFA and oxidation levels lower than the limits adapted by FAO for fish oils appropriate for consumption. Recovery of oil increased with time and reached the maximum value within the first 10 min. Extracted lipids with high viscosity led to low encapsulation yield. Mixture of 20% wt maltodextrin and 10% wt whey protein-Tween 80 (1:1) resulted in nanoemulsion-powders with high encapsulation yield. Nanoencapsulation masked the characteristic sensorial attributes of ω-3 lipids and further protected them from oxidation during storage.
Conclusion
Seabass side-streams are a rich fish oil source suitable for further valorization. Environmentally friendly solvents can be used for the recovery of fatty acids in a framework of a more sustainable utilization of fish processing side streams. Moreover, encapsulation significantly protected quality deterioration of oil and improved its sensory characteristics.

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Spray drying of herbs with basil as model system

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Aim: The shelf life of fresh herbs can be improved by drying, which is typically done as tray drying in the industry. During this process, enzyme reactions, oxidation and thermal damage lead to changes in the aroma profile. To minimize these effects and increase the quality of the dried product, spray drying is being investigated as alternative process for herb drying. With spray drying, the drying time is reduced to a few seconds, and the product temperature is as low as the wet bulb temperature. Drying in a nitrogen atmosphere reduces oxidative reactions. Using basil as example, the potential of spray drying as a process for gentle drying of herbs was studied.
Method: A feed solution was prepared from frozen leaf material by grinding, defrosting and separating out fibers. Only native dry matter was used, no carrier was added. The effect of different process parameters in spray drying on the essential oil content of dried herb powders was investigated. In addition to the inlet and outlet temperature of the drying air, droplet size during atomization, residence time in the tower, and nozzle type were varied. Essential oil content and volatile composition of the obtained powder was determined via TD-NMR and GC-MS analysis, respectively.
Results: Trials showed that a fast and oxygen free processing of the leaves to a feed solution is crucial to avoid the development of bitter notes in the later product. Upon spray drying, increasing the inlet air temperature as well as lowering the outlet air temperature improved essential oil retention. Larger particles increase the retention due to a lower surface to volume ratio. Keeping the residence time to a minimum avoids heating of the dry particles and volatilization of essential oils. To which extent these results confirm Thijssen's selective diffusion theory or if other phenomena apply is to be investigated by physical modelling.
Conclusion: The influence of drying parameters on the essential oil content of spray dried basil was shown. Besides the adaption of process parameters, the retention can be further improved by enhancing the dry matter content in the feed material to promote fast crust formation.

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Investigation of the 3D bread dough structure using complementary approaches: label-free multiphoton and confocal microscopies

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Aim:
Bread dough can be described as a dispersion of gas cells (GC) in interwoven phases of gluten network and of highly concentrated aqueous suspension of starch granules. During breadmaking, GCs undergo continuous expansion while the thickness of the gas cell wall (GCW) separating them is reduced from several hundreds to a few µm, until rupture. It is well accepted that the GCW rupture moment is crucial to the good aeration and fine texture of crumb. However, the exact mechanisms involved in the GCWs stability are not fully understood, especially those involving dough constituents other than gluten, such as starch. Additionally, macroscale observations do not allow to differentiate the multiple roles played by starch, and microscopic observations at GCW scale are few in literature. In this context, this work aimed to characterize the 3D structure of the GCWs focusing on the starch granules' distribution, using an innovative label-free approach with Non-Linear Optical Microscopy (NLOM) and a confocal microscopy (CLSM) with fluorescent labeling.
Method:
NLOM integrated two photon excitation fluorescence (TPEF) and Second and Third Harmonic Generation (SHG, THG) imaging. Gluten network was observed by TPEF, starch granules by SHG and interfaces using THG. SHG was obtained from linear polarized illumination (Nikon A1RMP+). CLSM (Zeiss LSM780) with proteins' staining (*Alexa* Fluor 546) was used to locate starch granules from negative staining. 3D exploration of the GCWs was performed using Avizo software (Thermo Fisher Scientific).
Results:
Despite some limitations, NLOM images allowed distinguishing starch granules using SHG and the gluten network using endogenous fluorescence, without labeling. Unexpectedly, we observed poorly aligned granules and a higher concentration of granules than in bulk dough. A very thin envelope of gluten strands was observed using higher autofluorescence. CLSM combined to protein's labelling allowed to delimit the edges of the starch granules, with potential for a good 3D reconstruction of the GCWs.
Conclusions:
NLOM label-free approach is a promising tool to image dynamic processes in fermented dough. Furthermore, fluorescent gluten staining with *Alexa* allows to detect the starch granules using both NLOM and CLSM, with potential to analyze the 3D structure of GCWs in bread dough.

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Consumers' perception of fish sustainability, the case of tuna

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Aim

Fish products are widely consumed in different European countries. However, there are still several issues related to fish products, connected to the sustainability of the fishing system and the authenticity of fish species. In recent years, more and more consumers have become sensitive to environmental impact issues, which has led to increased consumer attention at purchase time. In particular, the purchase intentions are oriented to eco-labeled or green products. However, consumers do not have methods to assess the authenticity of the purchased species, so fraud often occurs.

This study aimed to identify the peculiar sensory characteristics of two species of tuna, yellowfin tuna (*Thunnus albacares*) and bluefin tuna (*Thunnus thynnus*). Secondly, tuna species were tested to assess whether the eco-label Marine Stewardship Council (MSC) could affect the consumers' judgment.

Methods

A classic descriptive analysis was carried out with two tuna species, both raw and cooked, and with seven assessors (females = 5, average age 29 years old). Secondly, to assess the influence of the MSC eco-label a blind test was first carried out, during which no information about the evaluated tuna was provided to 100 consumers; then, after one week we asked them their liking for the same tuna but presented with the MSC eco-label. In each session, both raw and cooked samples were tested; consumers evaluated the overall liking for the appearance, the smell, and the price they would pay for that sample, and only for cooking samples, they also evaluated the taste and texture. A 9-point hedonic scale (1: Extremely disliked; 9: Extremely liked) was used for the evaluation.

Results

The descriptive analysis showed significant differences between raw species ($p<0.05$), but the differences appeared minimal when the samples were cooked. As expected, hedonic results showed a significant increase in liking for all the evaluated attributes when the eco-label information was provided to consumers ($p<0.05$).

Conclusion

In conclusion, the cooking process flattens the differences between two extremely different raw tuna species. Moreover, consumers are influenced by the information they receive at purchase time. Therefore, dissemination strategies are still needed to make aware consumers of authenticity aspects.

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Milling: a tool for changing the mechanical properties and structure of lentil heat-induced gels

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Aim: The growing population and changes in consumer nutritional habits has created the necessity to explore the physio-chemical functionality of sustainable and high protein plant sources, within food product microstructures. One of those sources could be lentils due to their low agricultural input and 20 – 30% protein content. The food industry typically uses isolated and/ or modified starch and proteins for semi-solid foods with these processes usually requiring high quantities of chemicals, energy and water. Physical modification of whole flours as a chemical-free method requiring minimum energy and water could instead to be used to produce modified starch and proteins with comparable functionality. The research investigated the mechanism of heat-induced gelation using whole lentil flours in native and physically modified states.
Methods: Dry ball milling was used to produce physically modified flour (4 hours) from previously hammer milled lentil grains (control flour). Heat-induced gels were prepared using a Rapid visco analyser (RVA) heated to 95 ^oC followed by quiescent cooling to 25 ^oC. The water holding capacity of all gels was measured using a centrifugal method. Gels were stained with Rhodamine b, FITC, and Calcofluor to observe the protein, starch and fibres under fluorescent light. The elasticity and uniaxial compression (80%) of all gels using a TA.XT2 texture analyser were investigated.
Results: All gel microstructures prepared with the control flours showed starch domination. The modified GWL, RSL and RWL flours resulted in gels with starch, protein and starch-protein domination respectively. Enhancing the role of the protein in the gel structure by using physically modified flours significantly decreased gels' water holding ability. Proteins' increased domination enhanced the ability of the gels to withstand rupture (80%) but decreased elasticity. Proteins could act as physical barriers to starch gelatinisation or create a stronger gel matrix. The variability in the flours' behaviour under gelation could indicate a dependency on the components' distribution after milling.
Conclusion: The present study investigated the effect of physically modified flours on heat-induced gelation in three different types of lentils. The structure and mechanical properties of the gels could be attributed to the behaviour of each type of lentil to flour preparation and modification.

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Free and bound phenolic profile in the orange juice co-product. Contribution to its antioxidant activity

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Aim:
The antioxidant activity (AOA) of vegetables is related to their phenol content, which can be found free or bound, mainly in the form of β-glucosides. Although the latter are not absorbed in the small intestine, they may act as prebiotics in the colon. Most studies on phenolic compounds and their AOA have been carried out mainly determining free phenolic compounds, giving an underestimation of their physiological potential. In addition, it is well known the high volume of waste generated by the vegetable food processing industry and its high content of phenols, among other bioactive compounds. In this study, the main phenolic compounds of the orange juice coproduct (CoJ), responsible for its AOA, were identified, analysing in what proportion they are present in their free and bound form.

Method:
Total phenolics (TP) were extracted by means of a classic methanolic:water at room temperature. Phenolic fractions: free phenols were extracted with methanol at 30 °C (FF_{30}) and 60 ºC (FF_{60}) and the bonds after base (BF_b) and acid (BF_a) hydrolysis. TP (mg GAE/100 g CoJ d.b.) were quantified in each extract. Major phenols (HPLC) and AOA (DPPH) were determined in all the five extracts.

Results:
TP was 436±22 and their AOA 7.93±0.08 mmol Trolox/100 g CoJ (d.b.). As for the fractions, much more phenols were extracted, of which 50% were FF_{30} (531±50), 25% FF_{60} (270±29), 15% BF_b (163±26) and 10% BF_a (101±29). Major flavonoids: hesperidin (HES=78.29%), narirutin (NAT=14.31%), didymin (DID=3.92%) and sinensetin (SIN=3.48%). HES and NAT were 99.58 and 98.72% present in free form, of which 6.03 and 22.3% could only be extracted when the sample was heated to 60 ºC, and 0.42 and 1.28% in bound form, namely 0.24% of HES as BF_b and 0.18% as BF_a, while all NAT was BF_a. For DID and SIN, 100% were FF_{30}.

Conclusion:
The results of this study determine the need to replace the routine method of analysis of TP by a more specific one, at least in studies that intend to establish correlations between the presence of these compounds and their potential functional value, in this case based on its AOA.

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Decrypting phenomena and transfers involved in the transformation of kidney beans to drive their processing

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Aim: Seed legumes, such as the kidney bean chosen for this study, are recognized for their high nutritional density, their benefits on health and on the environment. The long cooking times required for some seeds, as well as the development of the hard-to-cook defect in the domestic or industrial processing of seed legumes, are a major obstacle to their consumption. The rigidification of the cell wall can be explained in several ways. Highlighting of water transfers in beans during cooking, link with structural modification of the matrix, gelatinization of the starch, modification of the pectinic walls and evolution of the texture should allow a better control of cooking and the use of alternative thermal processes.
Method: The resolution strategies focus on (i) the understanding of the physical, chemical and biochemical mechanisms, through an adapted experimental metrology and analyses dedicated to the products and (ii) the application of an experimental methodology to determine the optimal operating parameters. Structural modifications and thermal behavior were characterized by sensory analysis correlated with textural analysis, DSC profiles and MEBE observation.
Results: The aging of beans modifies the internal structures and thus the kinetics of water uptake during soaking, as well as the direction of the cooking gradients inside the cotyledons. Soaking temperatures change the state of the pectin walls and the water accessibility of the bagged starch in the plant cells. The destructuration of the matrix occurs in two steps during cooking, with a two-step gelatinization of the starch. A heat treatment in excess of water is necessary to depolymerize the cell wall compounds and make the starch accessible. The time and temperature of soaking, as well as the condition of the bean before processing, have a strong impact on its cooking time and final characteristics.
Conclusion: The microstructure of the beans was shown to have an impact on their density and water holding capacity. A database gathering the data collected in this project has made it possible to develop densimetric and NIR sorting methods to predict the cooking behavior of different batches.

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Characterization of orange juice co-product for its valorisation as a food ingredient

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Aim:
The waste generated from the citrus processing industry is rich in macronutrients, including fiber, and other bioactive compounds of great interest for their potential health benefits. In this sense, recovery for use in human food, as an integrated zero-waste process, seems to be an interesting field of study as to ensure environmental protection, promote economic development and, at the same time, contribute to sustainable and healthy diets. This study focuses on the valorization of the co-product resulting from the extraction of orange juice (CoJ), to offer it as a versatile, high quality and stable natural food ingredient in powdered form.

Method:
Powdered CoJ was obtained after freeze-drying and crushing (DOI 10.1007/s42824-021-00036-0). The powder was characterized in terms of its water content (x_w), mean particle size (MPS), hygroscopicity (Hy), wettability (W), dispersibility (D), solubility (S), water and oil retention capacity (WRC and ORC), emulsifying and foaming capacity (EC and FC) and emulsion and foam stability (EE and FE) (DOIs 10.1007/s11483-021-09667-x; 10.1007/s42824-021-00036-0; 10.1016/s0260-8774(03)00135-3; 10.1007/s11947-017-1998-9; Yasumatsu et al., 1972, Agric. Biol. Chem., 36(5), 719-727; Narayana and Rao, 1982, J. Food Sci., 47, 1534-1538).

Results:
Characterized CoJ powder was x_w = 3.2±0.2 g water/100 g powder and MPS = 419±16 ⍰m. The properties S = 55±2 g soluble solids/100 g total solids; WRC = 8.7±1.3 g water/g dry powder; ORC = 2.91±0.11 g oil/g powder; Hy = 3.7±0.3 g of water gained/100 g dry solids; W = 1037±50 s were similar to those reported by Tejada-Ortigoza et al. (2017) for orange peel dietary fiber (DOI 10.1007/s11947-017-1998-9) and Camacho et al., 2021 (DOI 10.1007/s42824-021-00036-0). The other properties measured, for which no published values have been found, were D = 14±5 g ss sieved/g dry solids; EC = 5.3±0.9 %; FC = 3±1 %; EE = 5.4±0.6 % and FE = 95.1±1.1 %.

Conclusion:
This characterization of the powdered CoJ, together with its high content of bioactive compounds (DOI 10.1108/BFJ-06-2021-0616) and its already known physical properties (DOI 10.1007/s42824-021-00036-0) will allow the selection of the best applications as an ingredient for use in human food.

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Fluid bed drying of dairy gel granules supported by in-line monitoring of the water content

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Aim: The drying conditions of dairy gel granules, an intermediate in cheese production, should be adapted to ensure the lyogel quality, shelf life and rehydration behaviour. On the one hand, a fast drying rate is beneficial to maintain the structure and reduce shrinkage achieving a fast rehydration with good wettability. On the other hand, case-hardening restricts the moisture transfer to the granule surface strongly increasing the required drying time. Additionally, the on average six to eight millimetres large granules tend to sinter, if they are not constantly in movement, and fat is already exudated at temperatures as low as 40 °C. Therefore, fluid bed drying has been considered due to the intensive heat transfer and homogenous mixing.

Method: The influence of temperature and volume flow in the fluid bed on the granule properties are investigated. A multilevel categorical design of experiments is performed using dairy gel granules from skim milk with water content, a_W value, particle size, bulk and tapped density as response values. A capacitive moisture sensor and a near infrared reflection probe were calibrated to predict the water content by taking samples during drying. Consequently, a dynamic drying process shall be achieved through in-line monitoring of the product moisture.

Results: When varying the temperature and the volume flow during fluid bed drying of dairy gel granule, only the drying rate was significantly influenced. The other responses were not significant because of high deviations in the water content and the particle size distribution of the initial product. This emphasises the importance to establish a dynamic drying process. Thus, a calibration of two in-line sensor responses to the water content were set up for monitoring and control. Furthermore, experiments with fine and coarse fractions of the granules were performed.

Conclusion: Fluid bed drying of dairy gel granules was evaluated regarding volume flow and temperature. Furthermore, two sensors were calibrated to the water content. This will enable establishing a dynamic process for optimal drying results of the highly challenging product.

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Can samphire be the new salt?- understanding the saltiness perception of samphire.

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Aim:

The use of plant extracts from Salicornia species have recently been explored as a substitute for salt used in meat products. However, there is limited knowledge on the mechanism behind its saltiness. The objective of this study was to determine the nutrient, taste and odour profile of samphire from the UK to assess its potential use as salt-substitute in food products.

Method:

Fresh samphire purchased from Totally Wild Foods UK was freeze-dried and ground into a fine powder and minerals and free amino-acids were measured. SPME analysis was carried on the freeze-dried powder, followed by GC-MS and odour profiling was carried out using the gLMS scale with a trained sensory-panel (n=13). Freeze-dried samphire powder was added into a nachos base at 2.5% and 3.4% (w/w), while nachos with 0.7% and 1.0% salt (NaCl) were used as controls at an equivalent in sodium content. Sensory profiling using a structured labelled-magnitude-scale (gLMS) was carried out on nachos by a trained sensory-panel (n=14) to understand their taste profile.

Results:

Mineral composition of samphire was Na (12-14g/100g), K (1-1.5g/100g), Mg (0.3-0.5g/100g), etc.; while 16 free amino-acids, including lysine, glutamic acid, arginine known to influence salty taste, were present. The odour-profiling highlighted odours like grass, green-sweet and seaweed, which could be attributed to compounds such as hexanal, beta-ionone and 2,4-decadienal, identified in the samples by GCMS. The nachos' result concluded that 2.5% addition of samphire powder significantly increased salty taste compared to the control product at the equivalent sodium level (0.7% NaCl), from "weak" to "moderate" on the gLMS and reached comparable salty taste to the 1% salt control. However, no difference was observed in the salty taste when the samphire level was increased from 2.5% to 3.4%. Umami taste was also significantly higher with samphire samples compared to the salt controls, attributed to the presence of glutamic acid in the powder. No undesirable aroma, taste or aftereffects were highlighted by the panellists.

Conclusion:

The minerals and amino-acids may contribute to the salty taste of samphire powder. As a salt substitute, samphire powder may offer an herby and umami note to food products, but the impact may depend on the processing method such as heating. Therefore, samphire can be used to achieve sodium reduction in variety of food products without introducing noticeable changes in flavour.

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Immunoreactive properties of black elderberry (Sambucus nigra L.)

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Aim:
Black elderberry (*Sambucus nigra* L.) is the plant commonly found in temperate regions. Due to its pro-health properties, mainly shaped by the high content of bioactive compounds but also thanks to its unique sensory properties, elderberries are widely used in food production. The fruits of *Sambucus spp*. give food products flavour and a characteristic navy-blue colour. Preparations based on elderberry extracts are also appreciated in herbal medicine. Elderberry extracts have anti-infective activity and are commonly used as a home antidote for colds. Black elderberry contains also allergenic proteins. The aim of the study was to determine the immunoreactive properties of fruit and flowers of the black elderberry *Sambucus nigra* L.
Methods:
The protein contents were determined by: Kiejdahl method (Nx6,25) in fruits and flowers and by Bradford in extracts. Immunoreactive properties of *Sambucus nigra* L. five cultivars, flowers and ripe fruits were studied by blotting techniques. The sera of pollen-food allergenic patients as well as antibodies recognizing the main allergen of birch (Bet v1) timothy grass *(*Phl p5b) and artemisia (Art v1) were used as recognizing antibodies.
Results:
It was noticed that elderberry flower samples contain more protein compounds than the fruit samples. The average soluble protein content in flowers was 3,25% and was 46% higher compared to berries (2,22%). However, protein content in each varieties differed statistically significantly, especially in the case of fruit. SDS-PAGE protein patterns of all analysed samples were differed but have shown beside others presence of protein fraction with molecular weight about 32kDa, similar to the allergenic Sam n1.
Conclusion:
The allergenic fraction with a molecular weight of approx. 32 kDa was recognized in extracts only by IgE present in sera of individuals with high allergenicity. The plant variety as well as their morphological part don't influence on immunoreactive (allergenic) properties of Sambucus nigra L. It was also concluded that elderberry flowers and fruits are not show cross-reactions with the main allergens of birch (Bet v1), timothy meadow (Phl p5b) and artemisia (Art v1).

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Optimising whey protein gels extrudability by complexation with citrus pectin for 3D food printing applications

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Aim:
3D food printing (3DFP) enables the production of foods with complex structures and customised nutritional and sensory properties. Extrusion-based printers are commonly used in 3DFP as foods can be formulated with suitable viscoelastic properties to form a structured 3D object. At a critical concentration and upon heating (≥ 60° C), whey proteins can form a viscoelastic material (i.e., gels). It is well known that protein-polysaccharide complexes change the viscoelastic properties of protein gels. This study focuses on assessing the heat-induced gelation of a whey protein isolate (WPI) solution (12% w/w, pH = 7) and a WPI-pectin complex solution (by the addition of citrus pectin (1% w/w) at pH = 2). Additionally, the printability of the resulting gels were evaluated.
Method:
The gelation behaviour was assessed using storage modulus (G') development, upon heating to 85°C via a cycled-temperature ramp (heating-holding-cooling) using a controlled strain/stress rheometer (strain = 1 % and frequency = 1 Hz) in duplicate. Cylinders (r = 1 cm and h = 1 cm) were printed using a custom-designed syringe-based 3D printer, using heat-induced WPI (85°C/ 30 min) and WPI-pectin complex (85°C/ 15 min) gels, and the printability of the final product was visually assessed based on layer fusion and shape formation.
Results:
The WPI-pectin complex formed a stronger and faster heat-induced gel than WPI, as the final G' values were 0.05 ± 0.01 and 3.81 ± 0.14 kPa, and the gel transition (G' ≥ 1 Pa) happened at 16 and 21 min, respectively. The printability of the WPI gel was generally poor. The extrudability and fusion between layers were not considerably improved by heating the gel or changing the extrusion diameter. The WPI-pectin complex gel displayed good printability. The material showed good extrudability and fusion between printed layers but required a large nozzle diameter (1.7 mm) for successful extrusion.
Conclusion:
The WPI gel was not optimal for 3DFP, as the gel was brittle and was destroyed upon extrusion. The WPI-pectin complex formed a stronger gel than the WPI but with a smoother texture post-extrusion, which demonstrated good printability.

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Understanding plant – salivary protein interactions to reduce astringency perception

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Aim:
Mouthfeel perceptions such as astringency are governed by the properties of the food-saliva mixtures. The interactions between food components and saliva are therefore a key aspect to consider in the context of food products reformulation with alternative proteins. However, very little is known about the interactions between plant and salivary proteins. Pea was chosen as a model plant protein, and the study was meant to identify the pea and salivary proteins involved in interactions. These proteins triggering aggregation are likely to influence mouthfeel perception.

Methods:
Three different pea protein fractions, named after the main storage pea proteins (legumins, vicilins and albumins) were obtained from a commercial pea flour. The protein fractions were incubated with human whole saliva, and turbidity measurements were performed to investigate their reactivity over a large range of protein concentrations (0.1 to 5 mg/mL). Proteins involved in interactions were identified and relatively quantified through proteomics approaches. These analyses were performed at low pea protein concentrations to focus on proteins triggering the aggregation between pea and salivary proteins. Finally, a computational approach was used to predict protein binding sites and visualize the protein complexes for the most promising pea and salivary proteins identified in the experimental study.

Results:
Turbidity measurements evidenced that protein aggregation happens at very low pea protein concentrations, and that the three protein fractions do not have the same behavior when mixed with saliva. Proteomics analysis is a powerful tool to investigate protein-protein interactions and evidenced that some abundant salivary proteins are involved in interactions with all the pea protein fractions (mucin 5B, mucin 7, ?-amylase, cystatins, lysozyme) whereas others seem to interact preferentially either with the legumin and vicilin fractions or with the albumin fraction. Among the protein candidates identified experimentally, the computational approach highlighted pea proteins with antifungal properties (defensins), enzymes (seed trypsin inhibitors) and fragments or subunits of storage proteins (legumin fragments) as the proteins with the highest probability to be involved in interactions with saliva.

Conclusion:
We conclude that gaining fundamental understanding about protein-saliva interactions is essential to guide the development of future plant protein-rich reformulations with optimal sensory attributes.

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Allergenicity risk assessment by the European Food Safety Authority – Knowledge gaps and research needs

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Aim:

Allergenicity risk assessment is facing a game-changing paradigm shift to keep up with the rapid pace of food innovation and molecular biology advances, in a world that demands more sustainable food systems. The current “weight-of-evidence” approach for allergenicity risk assessment embedded into EFSA (European Food Safety Authority) guidelines is based on Codex Alimentarius principles from 2003-2009, which are mainly targeted to the assessment of few newly expressed proteins in foods derived from biotechnology. The present work aims to highlight knowledge gaps and research needs to improve EFSA’s allergenicity risk assessment of innovative proteins, e.g. novel foods or genetically modified organisms.

Method:

A comprehensive review of relevant EFSA guidelines and scientific opinions was conducted.

Results:

The body of evidence for the allergenicity risk assessment typically includes information on: (i) Protein content (analytical challenges for its full characterisation within food matrices); (ii) Literature outputs (often scarce) on e.g. clinical incidence/relevance, cross-reactivity, prior EFSA assessments; (iii) History of safe use (lack of consensus definition) for the source, product under assessment (in third countries) or production microorganism; (iv) Bioinformatic studies to predict cross-reactivity (highly conservative and untargeted for current assessment purposes; highly dependent on expert judgement; poorly developed for *de novo* sensitisation); (v) Protein stability and digestion (high complexity of the digestion and absorption processes to be unravelled); and (vi) Effect of food matrix and processing (scarce and inconsistent evidence). On a case-by-case basis, other elements adding to the assessment are: (i) Unintended allergen presence (unavoidable); (ii) Absence of food allergens under mandatory labelling (not relevant for *de novo* sensitisation); (iii) *In vivo* tests (need for improved, harmonised guidelines); and (iv) Post-market surveillance data (lack of monitoring systems).

Conclusion:

EFSA's roadmap towards improved allergenicity risk assessment of innovative proteins proposes the consideration of clinical relevance, exposure route and potential food allergens thresholds when available, updated in silico tools with more targeted databases, and better integration and standardisation of test materials and in vitro/in vivo protocols.

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Effect of High Pressure Homogenization on recovery kinetics of proteins from Chlorella pyrenoidosa

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Aim:
Microalgal proteins contain all the essential amino acids for human diet and can replace animal-based proteins, while having lower carbon footprint per kilogram. *Chlorella pyrenoidosa* is a photosynthetic microalga, characterized by its high protein content (40-50%). However, significant extraction barriers are posed by its cell wall and thylakoids. High pressure homogenization (HPH) is a mechanical nonthermal process in which cell suspensions are forced under high pressure through a micrometric disruption chamber. Mechanical stress causes physical disruption of cell walls and membranes, enhancing recovery of intracellular compounds. The aim of this study was the investigation of HPH pretreatment on the recovery kinetics of proteins from *C. pyrenoidosa*.

Method:
Untreated and HPH-treated (400-800 bar, 1-4 passes) *C. pyrenoidosa* suspensions (2.5% w/w) were incubated under constant stirring in a water bath at 20-40°C for up to 24 h, after adjusting their pH value to 13. At regular time intervals, aliquots of the incubation mixtures were removed, centrifuged, and the supernatants were collected. The concentration of proteins in extracts was determined via the Lowry method. The kinetics of protein release were mathematically modelled using a first order exponential model.

Results:
HPH treatment significantly increased both the initial and final protein recovery yield. Specifically, the initial yield of HPH-treated samples (800 bar, 4 passes) reached the value of 186.2 mg protein/g biomass compared to 48.9 mg protein/g biomass of untreated samples. After 24 h at 20°C, protein recovery yield increased to 248.0 and 102.8 mg protein/g biomass, respectively. The increase of incubation temperature to 40°C resulted in significantly higher yields (248.0 to 374.7 mg protein/g biomass after 6 h) at treated samples (800 bar, 4 passes). Finally, HPH pretreatment of *C. pyrenoidosa* suspensions at 800 bar, 4 passes incubated at 20°C increased the initial protein recovery rate (rp(i)) up to 275%, compared to untreated ones, while incubation temperature increase to 40°C increased rp(i) of HPH-treated suspensions up to 228%.

Conclusion:
Mathematical modelling of protein recovery from *C. pyrenoidosa* suspension indicated significant enhancement of protein recovery yields via the application of HPH technology. Additionally, protein recovery was accelerated by applying higher incubation temperatures.

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Glucosinolates and potential antioxidant of broccoli (Brassica oleracea) as affected by different vacuum drying temperatures

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Aims: Broccoli (*Brassica oleracea* var. italica) is considered a potentially beneficial food for health due to its high nutritional value and bioactive compounds. Epidemiological studies have shown that its frequent consumption is associated with the reduction of non-transmissible diseases, this is mainly due to its antioxidant activity and its abundant content of bioactive compounds such as phenolic compounds and flavonoids, especially glucosinolates and their degradation products. Broccoli has a high moisture content, which is directly related to the growth of microorganisms and undesirable chemical, physical and enzymatic reactions responsible for rapid deterioration. Vacuum drying is a widely used method for the preservation of temperature-sensitive foods and acts by removing a large part of the water present in them. Evaluating the effect of vacuum drying temperature on the content of bioactive compounds is essential to know the optimum drying temperature with the highest retention of biocompounds.

Method: Small broccoli florets were vacuum dried at five different temperatures (50, 60, 70, 80 and 90°C). The dried broccoli samples were compared with a fresh broccoli sample. Drying kinetics, antioxidant activity, total polyphenols, total flavonoids and glucosinolates were determined.

Results: The results showed that vacuum drying affected significantly ($p < 0.05$) the glucosinolate content and potential antioxidant of broccoli. Nonetheless, no significant changes in total phenolic and glucosinolate contents were observed under vacuum drying at higher temperatures (80 and 90 °C) compared to the fresh sample. The highest retention of flavonoid compounds was found in dried broccoli at 80 °C (7.11 mg quercetin equivalent [QE]/g dry matter [d.m.]) and at 90 °C (7.10 mg QE/g d.m.). Although antioxidant activity was significantly ($p < 0.05$) affected at all vacuum drying temperatures, the least decrease of antioxidant activity occurred at 80 and 90 °C when it is measured by ORAC and DPPH assay, respectively.

Conclusion: Based on these results, the study concludes that vacuum drying temperatures at 80 and 90 °C can be applied to better maintain the glucosinolates and potential antioxidant of broccoli.

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Phenotypic Enhancement of Chlorella vulgaris for Food Applications

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Aim:
Due to their rapid growth and low water footprint heterotrophic microalgae have become an attractive source of sustainable plant based protein for the food industry. The green microalga *Chlorella vulgaris* in particular has gained a lot of attention due to the fact that it is one of the few microalgal species that are declared safe for human consumption. However, the green pigmentation of *C. vulgaris* can be detrimental when it comes to the use of its biomass as an ingredient in nutrition related applications where consumer perception of the final product is of importance. Hence, there has been a high demand for the development of *C. vulgaris* strains with reduced chlorophyll content that will not affect the final image or taste of the product.

Method:
Random UV-based mutagenesis was used for the creation and isolation of *C. vulgaris* mutant strains that have low chlorophyll content and high doubling times. 3 of the mutant strains were then cultivated in 1.5 L fermenter units using glucose as carbon source and under conditions close to an industrial scale production.

Results:
The 3 isolated mutants have low chlorophyll content and have doubling times which are equal or higher to that of the wild type (0.103 h^{-1}). Moreover, the mutants were able to reach much higher biomass concentration levels (#1: 3.6 g/L; #2: 4.2 g/L; #3: 4.4 g/L) than the wild type (1.5 g/L). In addition to that, the mutants have increased maximum volumetric lutein concentrations (#1: 14.2 mg/L; #2: 10.4 mg/L; #3: 11.7 mg/L) when compared to that of the wild type (3.4 mg/L).

Conclusion:
The approach has proven effective for the phenotypic enhancement of *C. vulgaris* and the creation of 3 colorless strains with high biotechnological potential. Furthermore, the strains could also be cultivated as an alternative source of lutein and hence compete with conventional sources such as the marigold flower. The obtained results can be used for the further upscaling of the biomass production process.

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Delivering nutraceutical flours through valorization of fruit peels using extrusion technology

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New strategies for industrial fruit by-product valorization are helpful not only in decreasing the volume of food waste produced, but also, offer opportunities for novel processes and products, increasing the economic value of the food processing chain. Byproducts represent an interesting source of valuable compounds, such as polyphenols and dietary fibre, with high antioxidant activity. Non-gluten flours are characterised for as poor in fibre and natural antioxidants such as polyphenols. The addition of valorized by-products, for example as natural flavours and colorants, can enhance nutritional and healthy profiles of gluten-free products. The extrusion cooking technology offers advantages for low cost, sustainable, and versatile formulation of novel nutraceutical gluten-free foods.

Aim:
This study focuses on the application of extrusion technology to deliver a gluten-free flour with enhanced nutritional and antioxidant properties.

Method:
Royal Summer nectarine peel (RSF) at 5 and 15 % was mixed with corn flour. The moisture content of the final mixture was adjusted to 150 g kg^{-1} and maintained overnight at room temperature to favour homogenous flour hydration. Corn (100%) and blend flours were extruded using a single-screw lab-scale extruder. The extruder (L/D25) screw was set at 150 rpm, and final zone temperature at 150 ◦C. T. Total phenol content (TP), phenolic profile, total antioxidant capacity (ORAC, DPPH, ABTS, FRAP), glycemic index (GI) and techno-functional properties (water absorption_WAC and Swelling_SC capacities) were evaluated.
Results:
Total phenol content of RSF was ten times that of corn flour (282.47±7.28 vs. 26.93±0.87 mg GAE 100 g^{-1}). Similarly, antioxidant capacity of RSF was 7 to 15 times higher than corn, depending on the method used. After extrusion, increases in TP of 13 and 45%, in ORAC values of 45 and 83% and in FRAP of 36 and 100%, were observed with RSF at 5 and 15%, respectively. The use of extrusion combined 15% RSF formulation allowed a 3-fold increase in dietary fibre, and a significant reduction of GI. RSF formulation reduced WAC and increased SC.

Conclusion:
Formulating corn flour extruded flours with 15% nectarine peel (RSF) resulted in increased antioxidant activity up to 100% and reduced GI.

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How vegetable oil affects complex rheological properties of wheat gluten for meat analogue applications

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Aim:
An increasing number of consumers are reducing their consumption of animal proteins for environmental, health and ethical reasons. Therefore, meat analogues that resemble meat in terms of appearance, color, and texture are gaining greater interest. A widely used process for producing such meat analogues is high-moisture extrusion of plant proteins. During extrusion processing, proteins form a multiphase system that is deformed along the flow direction in the cooling die, resulting in the formation of an anisotropic, meat-like structure. For wheat gluten, thermomechanical treatment in the extruder leads to the formation of intramolecular disulfide bonds, resulting in distinct changes in rheological properties.
However, many consumers are not convinced by the mouthfeel of such plant protein-based meat analogues, describing them as dry compared to real meat. It is well known that the characteristic juicy mouthfeel of meat is generated by the combination of muscle fibers and intramuscular fat. Therefore, it can be assumed that the sensory properties of meat analogues can also be significantly optimized by adding fat or oil. Moreover, the addition of oil offers the possibility of introducing nutritionally valuable fatty acids, fat-soluble vitamins and trace elements into the product, thus enhancing the product properties.

Method:
During extrusion processing, the rheological properties of the material play a crucial role, as they influence the deforming stresses in the die and thus the formation of anisotropic product structures. In order to determine how the addition of oil influences the rheological behavior of wheat gluten under extrusion-relevant conditions an offline closed cavity rheometer was used.

Results:
Changes in rheological properties due to crosslinking reactions of wheat gluten could be detected. The results show that the addition of oil has an influence on the rheological behavior of wheat gluten. In particular, in the large amplitude oscillatory shear (LAOS) region, which is of great importance for extrusion processing, the influence of oil is more pronounced than in the small amplitude oscillatory shear (SAOS) region.

Conclusion:
The correlation of oil content and rheological behavior under defined extrusion-relevant conditions allows for adjustments in the extrusion process to tailor the product properties to the needs of the consumer.

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Bi-functional chimeric enzyme for prebiotic xylo-oligosaccharides production from agricultural wastes

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Aim:
Xylo-oligosaccharides are prebiotics obtained via hydrolysis of hemicellulose of agricultural wastes. Lately, they gained industrial interest due to the positive effects on microbiota regulation, treating dysbiosis, preventing infections, and improving nutrient absorption. However, a hindrance for the industrial application is the cost related to enzymes. A strategy is to fuse the main required enzymes in a single molecule, decreasing production time and costs. Additionally, fusing enzymes may even increase the activity and thermostability due to conformational changes. Arabinoxylan is one of the most abundant hemicellulosic fractions in agricultural wastes, composed by a xylose backbone and arabinose side chains. The endoxylanase is responsible for breaking the backbone into short oligosaccharides, and the arabinofuranosidase eliminates the side chains and increase the linear xylose chain disposition for endoxylanase. Hence, this study designed a novel chimeric enzyme by fusing an endoxylanase and an arabinofuranosidase for the propose of increasing xylo-oligosaccharides obtainment from arabinoxylan of corn and soy hulls.

Method:
The sequencies of GH10 β-1,4-endoxylanase from *Papiliotrema flavescens* and GH62 α-L-arabinofuranosidase were fused with a flexible linker $(GGGGS)_{2,}$ cloned in pGAPZαA vector, and expressed in *Komagataella pastoris.* Arabinoxylan was extracted from corn and soy hulls with 5% KOH (120°C, 30 min), neutralized with aced acid, and precipitated with 3 volumes ethanol. The hydrolysis conditions were 48h and pH 5. Temperature and solid loads were optimized via CCRD. The chimera's, parental enzymes', and Sherazyme (NS50030- Novozymes®) yields where compared.

Results:
Xylobiose and xylotriose yields, which present the higher prebiotic potential, improved 15.5% and 33%, respectively, compared to the parental enzymes' mixture. Up to 7 g/L XOS was achieved from 4% corn hull arabinoxylan hydrolysis. 1% corn hull arabinoxylan hydrolysis yielded 2.40 g/L XOS, against 0.46 g/L using Sherazyme. 1% soy hull arabinoxylan hydrolysis yielded 1.37 g/L XOS, against 0.84 g/L using Sherazyme.

Conclusion:
The chimeric enzyme was able to increase the arabinoxylan hydrolysis yield 5.22 times, proving the synergy between arabinofuranosidase and endoxylanase for the efficient depolymerization of arabinoxylan from lignocellulosic biomass. The molecular fusion of synergic enzymes is a promising strategy to produce more efficient and thermostable enzymes and reduce operational costs.

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Application of young bamboo culm for the bioproduction of prebiotics, nanocellulose and bioethanol

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Aim

In the context of biorefinery and the green and circular economy, researchers have been looking for lignocellulosic biomass to produce the most diverse compounds that may be economically viable and applicable in the most different industrial sectors. In this scenario, bamboo appears as a plant matrix of great interest, given the high content of cellulose and hemicellulose in its culm. Therefore, this work aimed to evaluate the production of xylo-oligosaccharides (XOS), nanocellulose and bioethanol, using the cellulosic and hemicellulosic fractions of young bamboo culm through enzymatic hydrolysis.

Method

Alkaline extractions were performed to obtain xylan and cellulose. For the hydrolysis, a solids load of 2% was applied, applying the enzyme cocktails Shaerozyme (7.5 mg/mg of substrate), Celluclast (20 FPU/g of substrate) and Cellic Cetec 2 (10 FPU/g of substrate), to produce XOS, nanocellulose and glucose respectively, at a temperature of 50 ºC, pH 5, agitation at 1000 rpm, for 72 h. To produce bioethanol, the yeast *Saccharomyces cerevisae PE-02* was used to consume the obtained glucose. Bioproducts concentrations were estimated from High Performance Liquid Chromatography.

Results

The xylan extraction yield was 23.58% and an extraction efficiency of 92.7%. The best test of enzymatic hydrolysis of xylan from young bamboo stems was observed within 24 hours, in which a high concentration (4.95 g/L) of short-chain XOS was obtained, especially xylobiose and xylotriose, which have a remarkable prebiotic effect. The cellulose extraction yield was 41.87% with an extraction efficiency of 86.76%. The high average yield of nanocellulose production of 52.6% was obtained in 48 h of enzymatic hydrolysis. For bioethanol production, a maximum concentration of 7.84 g/L was observed after 4 hours of fermentation.

Conclusion

All these results highlighted the possibilities of using bamboo culm in the most diverse bioprocesses for the sustainable production of ingredients of interest to the food, chemical and pharmaceutical industries.

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Evaluation of quinoa leaves as a protein source

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Aim:
With the growth in the world population and the increasing drive towards a more sustainable diet, there is a growing demand to explore alternative sources of proteins for food applications. Green leaves contain the enzyme RuBisCO, a soluble protein which participates in the photosynthesis process. This is considered the most abundant protein on Earth and therefore, green leaves are proposed as a potential source of protein for food applications, with good nutritional value and functional properties for food formulation and structuring. Moreover, this novel application would convert the waste material from different crops such as quinoa into a valuable co-products. This work characterizes protein extracts obtained from different quinoa leaves and investigates the functional properties required to assess further applications in food products.

Method
Different species of quinoa leaves were harvested, dried and mill. The preserved quinoa leaf powders were resuspended in water, centrifuged to remove insoluble components and cell debris and obtain a supernatant containing soluble proteins and other soluble compounds. These soluble proteins were then separated and concentrated by acid precipitation at pH 4, resuspended in water and adjusted to pH 7 prior to freeze-drying. The protein extracts obtained from the different green leaves were characterized in terms of proximal and detailed protein composition, and their functional properties such as gelling and emulsifying characteristics were determined at different pHs.

Results
The selected species of quinoa leaves showed different behaviors during the preparation and extraction process, with a wide range of extraction yields, between 0.97 and 3.98 g protein extract/100g of quinoa leaves powder, and composition differences.. The protein extracts obtained presented unique solubility profiles largely affected by the isoelectric point of RuBisCO, with the lowest solubility around pH 4 while solubility improved at higher pHs. The functional properties of the proteins were widely influenced by their solubility profile.

Conclusion

Protein extracts from quinoa leaves are a promising source of proteins for food applications to either replace or combine with conventional proteins such as whey and soy protein isolates. Further research is needed to select the optimal conditions for growing and harvesting the raw material.

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Impact of varying pasture allowances on the compositional, quality and nutritional properties of milk

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Aim:
To examine the impact of varying pasture allowances on the compositional, functional, and nutritional properties of milk.
Method:
Fifty-four spring calving Friesian cows were randomly assigned to one of three treatments (n=18), with each group allocated to one of three feeding systems. Group 1 (GRS) was maintained outdoors for the entire lactation with grazed pasture (Lolium perenne L.) accounting for ~95% of their annual dry matter intake (DMI) supplemented with ~5% of DMI as concentrates. Group 2 consisted of a total-mixed ration system (TMR) whereby cows were maintained indoors and consumed TMR consisting of grass silage (20% DMI), maize silage (40% DMI) and concentrates (40% DMI). Group 3 consisted of a partial-mixed ration feeding system (PMR), whereby cows were maintained outdoors pasture feeding during the day and maintained indoors on TMR at night, overall consuming ~50% grazed pasture. Bulk milk from each group was collected weekly, collated from both a.m. and p.m. milkings and subsequently analysed for gross composition, techno-functional properties, free amino acid (FAA) content and fatty acid (FA) profile across 38 weeks of lactation.
Results:
Dietary treatment significantly affected ($p<0.05$) the FA profile of milk, with 19 FA out of 22 FA quantified, varying significantly with diet. The GRS-derived milks contained higher proportions of CLA cis-9, trans-11 (rumenic acid), C18:1 n-9 cis (oleic acid) and C18:3 n-3 (α-linolenic acid) and lower proportions of short chain FA C6:0 – C13:0 compared to that of TMR and PMR milks. A further 19 FA varied significantly with time. The GRS-derived milks had the lowest somatic cell count (SCC). The TMR-derived milks had the highest proportions of protein, total solids and lactose. The PMR-derived milks had the highest SCC and FAA content, and the lowest fat and total solids content across treatments. The GRS-derived milks were associated with the highest yellow colour score (highest b*-value) while TMR demonstrated the lowest b*-value.
Conclusion:
Increasing pasture allowance provokes an increase in health promoting FA such as α-linolenic acid and rumenic acid, as well as a reduction in the n-6/n-3 ratio, resulting in milk with a more nutritionally beneficial FA profile for human consumption

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Kinetic study of quality indices modification of chicken breast during cooking

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Aim:

Chicken meat is the second most consumed meat in the world for its high nutritional quality and cost effectiveness and one of the most requested items in food service. During cooking, meat undergoes several chemical and physical changes influencing final quality and consumer acceptability. A kinetic study of the indices evolution during cooking represents a powerful tool for predicting the quality changes during cooking in order to optimize the process. The aim of this study was to investigate the evolution over cooking time of quality indices of chicken breast cooked according to different cooking methods and temperatures.

Method:

Thawed chicken breasts were cooked according to different cooking methods, forced convection (FC), grill (G) and sous vide (SV). Three different temperatures of processing were considered for each (FC: 150, 170, 190 °C until reaching 85 °C at the core; G: 240, 260, 280 °C until 75 °C at the core; SV: 80, 95, 120 °C with 100% humidity until 75 °C at the core). During cooking, evolutions of weight loss, shear force and color were followed. Kinetic models were studied and zero order constant rates were extrapolated. Decimal reduction time (D_T) and activation energy (Ea) of quality indices modification were calculated.

Results:

Cooking loss, shear force and color zero order rate constants were measured for the different cooking methods. Temperature was able to speed up all the physical chemical modifications, as protein denaturation, collagen solubilization and browning. D_T values of the considered indices were calculated. Shear force exhibited the highest D_T (108 min at 80 °C for SV) while cooking loss the lowest one (11 min at 280 °C for G), resulting the most sensitive index to temperature change. Ea values were in the order of magnitude of 20-60 $kJmol^{-1}$, with shear force showing the highest value, followed by chroma and coking loss. A dependence of Ea on temperature was found.

Conclusion:

Proportionality of kinetic parameters indicates the possibility of modelling the cooking process. Identification and control of the most sensible quality index can drive the optimization of cooking allowing a better management of the industrial cooking process.

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The exploration of microbial profiles in blue mussels (Mytilus edulis) stored under different modified atmospheres

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Aim:

Modified atmosphere packaging (MAs) has been used to extend the shelf life of live blue mussels. Nonetheless, atmosphere change might impact different spoilage stages as a result of microbial metabolism. This study aimed to investigate the effect of MAs on the microbial community diversity in spoiled blue mussels.

Method:

Blue mussels were stored under different atmospheres $\%CO_2/O_2/N_2$: A40 (30/40/30), B60 (40/60/0), C60 (0/60/40), and D75 (25/75/0). A total of 182 isolates were collected from spoiled mussels at high mussel mortality levels (56 – 100%) and at levels of the total psychrotrophic count > 7 log CFU g^{-1}. The representative colonies were selected based on their morphology. Gram reactions, catalase, oxidase, and salt tolerance were performed to assess biochemical and physical properties. The isolates were identified using matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS) combined with SPe-DE dereplication method. Further, 16S rRNA gene sequencing was performed on isolates with low (<2) spectra confidence scores in MALDI–TOF MS.

Results:

As a result, 182 halotolerants were identified as 47 different strains, including gram-positives and gram-negatives. Among the species*, Latilactobacillus sakei, Shewanella baltica,* and *Psychromonas arctica* were abundant in all MAs. Atmosphere A40 and D75 accumulated more varied microbiota in which other Shewanella species were detected (among them *S. frigidimarina, S. vesiculosa*; *S. ulleungensis*; and *S. polaris*).

Conclusion:

MAs presented a variety of microbial communities, even though biological variation may also occur depending on seasonality. Further investigation needs to be done to characterize the spoilage potential of the identified bacteria isolated from blue mussels.

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Encapsulating quercetin with amorphous-semicrystalline inulin by spray-drying and releasing under in vitro simulated gastrointestinal conditions

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Aim: Encapsulation technology allows the modulation of the polyphenols released in specific digestive tract sites. This research aimed to evaluate the encapsulation of quercetin by spray-drying with either amorphous or crystalline inulin on the encapsulation efficiency (EE), crystallinity index (CI), and quercetin release *in vitro* simulated gastrointestinal conditions.

Method: Quercetin encapsulation was performed applying a Box-Behnken design. The independent variables were inlet air temperature (120-200 °C), quercetin content (0.2-0.5 g), and the amount of preformed crystalline inulin (0-100%). Infeed dispersion was elaborated by mixing non-heated inulin with preformed crystalline inulin and quercetin in ethanol. Preformed crystalline inulin was heated, cooled, and kept on stirring for 48 h at 10 °C. Each experimental infeed run of the design was fed at the spray-dried (Mini B-290). Total and surface quercetin were determined by HPLC, and the CI by WAXS. Both the most amorphous and semicrystalline microparticles (containing 0.35 g Q) were selected to study the quercetin release *in vitro* simulated gastrointestinal conditions applying the INFOGEST protocol.

Results: Inlet air temperature and the amount of preformed crystalline inulin significantly influenced both EE and CI. EE and CI varied between 31-57%, and 0.4-22%, respectively. EE was higher in amorphous microparticles and decreased as the crystallinity increased. According to the experimental design, quercetin amorphous-inulin microparticles (non-heated inulin (100%) at 200ºC; EE: 53.5 ± 1.0%; CI: 0.4 ± 0.2%) and quercetin semicrystalline-inulin microparticles (preformed crystalline inulin (100%) at 120ºC; EE: 31.3 ± 1.8%; IC: 22.4 ± 0.2%) were selected. The release of quercetin from semicrystalline and amorphous microparticles reached 2 mg (4.8%) and 3 mg (7.0%), respectively after gastric digestion. At the end of the intestinal digestion, 7.15 ± 0.16 mg (17.0%) and 11.00 ± 2.79 mg (26.5%) of quercetin were released from amorphous and semicrystalline microparticles respectively. This quercetin release pattern was attributed to surface quercetin (non-encapsulated) and quercetin solubility in each digestion phase.

Conclusion: The differences between semicrystalline and amorphous microparticles slightly affected the release of quercetin under digestive conditions. A low amount of quercetin was released during gastrointestinal digestion, allowing quercetin to reach the colon phase.

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Calcium ions impact properties of potato starch gels and (deep-fried) potato mashes

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Aim:
Ca^{2+}-ions can establish ionic bridges between phosphate groups of potato starch (PS) amylopectin. We here first determine how $CaCl_2$ addition to PS suspensions impacts hydration and therefore alters PS pasting and gel properties. We next evaluate the impact of $CaCl_2$ addition to potato blanching water on the properties of (deep-fried) potato mashes.
Method:
The impact of Ca^{2+}-ions on the viscosity development of PS suspensions (5.0 % dm; 0-41 µmol $CaCl_2$/g PS dm) was evaluated with a Rapid Visco Analyzer as well as their effect on the texture and visco-elastic properties of PS gels (16% dm; 0-11 µmol $CaCl_2$/g PS dm). After $CaCl_2$ addition to blanching water (0-33 µmol $CaCl_2$/g potato dm), the Ca^{2+}-ion distribution in potato tissue was assessed by Laser Ablation Inductively Coupled Plasma Mass Spectrometry. Finally, the texture, visco-elastic properties and proton mobility (with Low field Proton Nuclear Magnetic Resonance (LF-^{1}H- NMR)) of mashes prepared from potatoes that were blanched with or without $CaCl_2$ addition, steam cooked and mashed was studied. The oil content of deep-fried cylindrical mash samples prepared thereof was determined.
Results:
Addition of $CaCl_2$ to PS suspensions (41 µmol $CaCl_2$/g PS dm) reduced their peak viscosity (69%) due to less PS swelling. Furthermore, PS breakdown decreased (85%) and setback values increased (42%). Texture and oscillatory measurements of PS gels and potato mashes showed similar results: $CaCl_2$ addition decreased hardness and visco-elastic moduli. LF-^{1}H-NMR showed that $CaCl_2$ addition lowered the mobility of protons in the starch gel network in potato mashes, indicating an increased interaction between starch and water. This may impact the behavior of mashes during deep-frying as the oil content of deep-fried mash samples (8.1% on as is basis) that were blanched in water with 33 µmol $CaCl_2$/g potato dm was lower compared to the control (9.3% on as is basis).
Conclusion:
Addition of $CaCl_2$ decreased the visco-elastic moduli and hardness of PS gels and potato mashes. When deep-fried, the latter had a decreased oil content probably due to a shift in the water-starch interaction by cross-linking of amylopectin.

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A Simple Mathematical Model on Continuous Ohmic Heating Systems for Strawberry Nectar

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Aim:
Ohmic Heating (OH) is a promising emerging technology used in food processing; it can provide a rapid and consistent heating of food products, ensuring high-quality and microbiologically stable products. The aim of this study is to develop a simple OH mathematical model to treat strawberry nectar. As many physical properties vary with temperature, especially viscosity and conductivity, data for the developed model was obtained from experimental measurements.

Method:
The model was developed on Microsoft Excel® and optimal values calculated with Solver function. Nectar was formulated with 40% strawberry puree and sucrose and citric acid to achieve 12 °Brix and 3.5 pH. The rheological parameters were measured in a viscometer from 4 to 90 °C and conductivity was calculated from conductance data at different temperatures. The density was measured using a pycnometer, and the heat capacity was measured at 20 °C by differential scanning calorimetry. The calculations were made for two different configurations, 32 mm diameter, 220 mm length (DN32) and 42 mm diameter, 290 mm length (DN42), assuming an electrical transformation of 94 % and a final heating temperature of 105 °C, for one and two generators. The assumed initial flow was 400 kg/h and the cell voltage varied from 650 to 4050 V.

Results:
The calculated electrical energy needed to heat the nectar from 20 to 105 °C was 39.94 kW. Considering an equidistribution of power in two generators, it was estimated that the best solution for the DN32 configuration required a first generator with a tension of 2570 V and 41.2 % potency and second with 1630 V and 53.6% potency with an average heating time of 6.68 s, and for the DN42 configuration two cells of 1630 V the first with 78.4 % and the second 41 % potency and an average heating time of 15.18 s.

Conclusion:
The study presents a simple method for modeling a continuous OH process ideal for industrial applications. This method can be used as a tool to forecast budget and industrial line design. This is an efficient way to produce low-cost outputs that can be used for further studies. Further experimental validation of the calculations can be done on the proposed equipment to validate the model.

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HIDING EDIBLE INSECTS IN WHEAT BREAD MATRIX – THE ACCEPTANCE CASE

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Aim: High nutritional value and low production costs make edible insects an excellent and sustainable source of animal protein. Most people in Western countries reject eating edible insects, mainly for cultural reasons. Our previous study confirmed that when the insects are transformed and not visible on the plate, it is easier to get the consumer to try a new product.
Wheat flour bread is one of the most widespread bread type globally, which constitutes an essential part of the human diet. Therefore, choosing the wheat bread as matrix for smuggling the edible insects seems reasonable.
The study aimed to investigate the consumers response (acceptance) towards the addition of powdered insects (*Acheta domesticus*) into the wheat bread.
Method: Breads were baked from wheat flour with the addition of 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 60 and 70% of cricket powder. The sensory analysis of resulting breads was performed based on the consumer assessment of the product's desirability using the scaling method, using a hedonic scale, where 1 point was the lowest and 9 points - was the highest.
Sensory analysis of five sensory attributes (taste, flavour, hardness, chewing, gumminess) and overall assessment was evaluated vs control bread (without edible insects). Twenty-five respondents took part in the survey.
Results: The research showed that adding 30% insect powder to wheat flour is still acceptable to consumers. The greatest influence on the overall rating of the bread was the taste, smell and chewing characteristic.
Conclusion: The addition of edible insects in the form of a powder to wheat flour has a detrimental effect on the sensory characteristics of the product with as little as 20% of the addition. However, it turned out that the taste qualities of bread from such a mix are so attractive that consumers accepted as an acceptable addition up to 30%.
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Water-in-linseed oil Pickering emulsions stabilized with surface-functionalized silica nanoparticles with tocopherol succinate or myristic acid

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Aim: To obtain water-in-linseed oil (W/O) nanoparticle-stabilized Pickering emulsions using surface-functionalized silica nanoparticles with tocopherol succinate or myristic acid as emulsifiers, to be used as stable delivery systems of bioactive compounds.
Method: Silica nanoparticles (SiO_2-NPs) were synthesized according to the Stöber method (ethanol 15 mol/L, tetraethyl orthosilicate (TEOS) 0.15 mol/L, NH_4OH 0.66 mol/L, and H_2O 3.4 mol/L). The SiO_2-NPs were surface modified with 3-aminopropyl triethoxysilane (APTES) to obtain SiO_2/APTES-NPs (Karnati et al., 2019), which were functionalized according to Tudose et al. (2017) with N-ethoxycarbonyl-2-ethoxy-1,2-dihydroquinoline as coupling agent and tocopherol succinate (SiO_2/TS-NPs) or myristic acid (SiO_2/C14-NPs). NPs functionalized with hydrophobic molecules (SiO_2/TS-NPs and SiO_2/C14-NPs) were dispersed in linseed oil (2 and 4%, w/w) with a rotor homogenizer (15,000 rpm, 2 min). W/O emulsions (20:80 W:O) were obtained by emulsification at 15,000 rpm for 5 min. Polyglycerol polyricinoleate (PGPR) was used as control emulsifier for comparative purposes. SiO_2/TS-NPs and SiO_2/C14-NPs were characterized by dynamic light scattering, Fourier-transform infrared spectroscopy (FTIR) and contact angle. Emulsion stability was evaluated over 14 days at 4 °C by droplet size, determined by optical microscopy, and gravitational separation, evaluated by visual observation.
Results: SiO_2/TS-NPs were smaller (127.3 ± 0.7 nm) than SiO_2/C14-NPs (222.6 ± 9.5 nm), but both NPs showed similar contact angles (125.3 ± 2.8° and 123.7 ± 0.2°, respectively). The FTIR spectra showed a favorable modification of NPs with aminopropyl groups (SiO_2/APTES-NPs) and with tocopherol succinate (SiO_2/TS-NPs). Droplet sizes of nanoparticle-stabilized Pickering W/O emulsions at day 14 were 11.90 ± 0.15 µm (2% w/w) and 5.44 ± 0.19 µm (4% w/w) for SiO_2/TS-NPs, and 12.50 ± 0.33 µm (2% w/w) and 5.43 ± 0.35 µm (4% w/w) for SiO_2/C14-NPs; whereas droplet sizes smaller than 3 µm were obtained with both 2% and 4% of PGPR, leading to a lower percentage of water droplets sedimentation in control emulsions. However, neither SiO_2/TS-NPs nor SiO_2/C14-NPs stabilized W/O emulsions showed water separation after 14 days of storage, whereas PGPR-stabilized emulsions showed 20% (2% w/w) and 9.5% (4% w/w) of water separation.
Conclusion: SiO_2/TS-NPs and SiO_2/C14-NPs were suitable to obtain W/O Pickering emulsions, granting a better long-term stability to water separation than PGPR-stabilized emulsions despite the larger droplet size.

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Dairy industry surfaces disinfection using b-PAW

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Aim:

This work studies Plasma Activated Water (PAW) generated by bubbles method (b-PAW) as a novel disinfectant technology against four *Listeria monocytogenes* strains from dairy industry. Different methods of b-PAW generation, contact times between b-PAW and bacteria and b-PAW storage times were investigated. Portions of moulds used for cheese manufacture were chosen as target surfaces.

Method:

b-PAW was generated by an atmospheric cold plasma jet system with dielectric barrier discharge. Different b-PAW generation methods were tested putting in contact water and air plasma gas. Neumatic mufflers and surfaces with several hole settings (number and diameter) were examined. The most biocidal b-PAW configuration was identified after a screening. The bactericial effect of this b-PAW was assessed for three strains of *Listeria monocytogenes* isolated from a dairy industry (CECT911, ULE1264 and ULE1265) and for the mixture of the them. Plactonic inactivation results were confirmed inoculating the same bacteria in cheese mould portions. Four different contact times b-PAW/bacterium (15, 30, 60 min and 24 h) and four different storage times (0, 30, 60 and 90 days) were tested. Nitrates, nitrites, reactive species (OH*, NO* y NO_2*, products after fenol reaction) and HNO_2 were analyzed.

Results:

b-PAW after its generation was demostrated to completely inactivate all bacteria after 30 min of contact (b-PAW/bacteria) and 15 min were enough to achieve 4 log reduction. Furthermore, it was showed that b-PAW after 60 days, is be able to reduce 3 log (15 min of contact b-PAW/bacteria). OH*, NO* and NO_2* (products after fenol reaction) and HNO_2 concentration seem to be significantly reduced after 1 month storage. Moreover, short-life reactive species are thought to come from the instability of nitrites at acid medium. Finally, biocidal activity of b-PAW can be cause of a synergic activity of the identified reactive species and other not identified (like peroxynitrites).

Conclusion:

b-PAW was proven to be an innovative and sustainable food process technology to disinfect dairy industry surfaces. In order to industrial scale up, the development of equipment that generates larger volumes of PAW at a reasonable cost is a decisive factor.

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Detection of mushroom browning using RGB image segmentation approaches combined with hyperspectral image analysis

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Abstract
Aim: Browning of cultivated mushrooms (*Agaricus bisporus*) is one of the most important processes contributing to loss in quality after harvesting. Colour is a primary quality criterion as consumer's preference and demand is for white, unblemished mushrooms. The aim of this study is to develop a rapid tool based on a portable hyperspectral imaging (HSI) camera combined with computer vision and HSI data analysis to detect early signs of browning on the mushroom surface.
Method: Freshly harvested white button mushrooms (n=128) of the same flush were divided into two groups and stored in an incubator at 4 °C with 80% and 50% relative humidity, respectively. Both RGB and hyperspectral images were acquired at the same time on specified days during an 11-day storage period, using a portable HSI camera (Specim IQ, Specim Ltd., Oulu, Finland) under controlled illumination conditions to cover the wavelength range of 400-1000 nm.
Computer vision segmentation strategies, including thresholding on CIE L^* a^* b^* image and fuzzy analysis on K- or C-means clustering, were developed to extract the statistics (e.g., pixel count, pixel location, etc.) of browning and non-browning features in pixel wise on each sample, which were further used as references in a HSI data analysis. Then, the HSI data (X) of each sample were analysed using partial least squares discriminant analysis (PLS-DA) and the browning/non-browning pattern references assigned to arbitrary Y values (i.e., 1 and 0) for the determination of mushroom browning patterns. One dimensional convolutional neural network (1-D CNN) was also developed on the HSI data of mushrooms for discrimination of mushroom storage time.
Results: The strategies of b^* channel image thresholding and fuzzy analysis on RGB image can offer adaptive segmentation of browning and non-browning (white) regions in the images of the objective mushrooms. The developed PLS-DA model achieved > 95% correct identification (CI); and the 1-D CNN model achieved > 97% CI on the determination of mushrooms from their storage time.
Conclusion: The results of this study was the first step in the development of a monitoring tool for the detection of browning in cultivated mushrooms.

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Reduction of par-baked bread additives by process optimization

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Aim:
Par-baking contributes to the extension of the microbiological and physico-chemical shelf-life of bread. However, once fully-baked, retrogradation sets in and reduces quality quickly, resulting as yet in food waste. Typical properties of stale bread are hardening and drying of the crumb, reduction of crumb cohesion and less resilient crumb. In order to bypass the use of chemical additives (*clean label*) or advanced packaging, the influence of par-baking on the physico-chemical properties of bread was studied and compared with six commercially available par-baked breads.
Method:
Additive-free bread buns (AFBB) were produced with varying par-baking conditions, including baking time (4, 6, 8 min), temperature (150, 750, 200°C), steam (200, 400, 600 ml), packaging and storage temperature. The breads were analysed under the conditions par-baked (PB), 1h, 24h and 48h after full-baking. Weight (g), volume (ml), crumb moisture content (%), and texture (crust and crumb hardness, springiness, resilience, cohesiveness and chewiness) were recorded.
Results:
Cohesion of commercial PB breads was significantly lower compared to the AFBB (resp. 0.43 ± 0.03 versus 0.80 ± 0.03). However, 1h after full-baking the values were similar, 0.81 ± 0.01 and 0.79 ± 0.03 (e.g. 200 mL steam). After 24h and 48h cohesion was ± 0.6 for all bread types. Springiness was found to be constant for the commercial breads (± 0.9), whereas a gradual increase in springiness for the AFBB was observed in function of time after full-baking (from 0.8 to 0.95). Moreover, an optimum in springiness was observed for 400 mL steam and frozen storage. Additionally, at 200 mL steam, springiness increased with increasing baking time and temperature. Resilience of commercial bread was signicantly higher after 48h compared to the AFBB, resp. ± 0.4 versus ± 0.2. However at 24h, the values were the same for all types: ± 0.2.
Conclusion:
These results show that optimization of par-baking can prolong the freshness of par-baked bread and limit the use of additives. Additives in PB bread mainly influence crumb springiness and resilience after 48h. After 24h, there is little difference between the commercial breads and AFBB. A combination of par-baking optimization, frozen storage and MAP-packaging can support the market of clean label par-baked bread.

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Understanding the release of proteins from Arthrospira platensis after Pulsed-Electric-Field treatment for sustainable food systems

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Aim: As the world's population grows and climate change threatens the global food supply, sustainable sources of proteins are needed. The cyanobacterium *Arthrospira platensis* is a promising source of edible proteins and high valuable functional substances such as the blue pigment-protein complex phycocyanin. The technology of Pulsed electric field (PEF) was recently studied to permeabilize the cell membrane of *A. platensis*. This work aims to close the knowledge gap regarding optimal process parameters and the underlying mechanisms of the release of water-soluble proteins. This was addressed by investigating the correlation between membrane permeabilization, trichomes decay, and protein release.
Method: The degree of cell permeabilization was directly measured through fluorescence photometry. This novel method allows conclusions about the effects of different treatment conditions, i.e. treatment time, electric field strength, and treatment temperature. An algorithm for image segmentation was developed allowing the observation of trichomes disintegration over 3 hours. During the same time, phycocyanin release was measured by spectrophotometry as a benchmark for water-soluble proteins.
Results: It has been demonstrated that treatment with an electric field strength of 15 kV cm^{-1} or higher is sufficient to permeabilize 100% of the trichomes for the used dye propidium iodide (PI). Nevertheless, significant differences regarding the required treatment time for full permeabilization were observed depending on the treatment conditions. For example, half the time was needed to permeabilize 100% of the cells at 15 kV cm^{-1} and 45°C, compared to the same electric field strength and 30°C. By quantitative digital image analysis, it was demonstrated that cells that were completely permeabilized for PI also completely disintegrated over a time of 180 minutes. This disintegration was brought into a direct temporal correlation to the release of phycocyanin.
Conclusion: PEF was shown to be a promising method for the recovery of water-soluble substances from *A. platensis*. For the first time, the decay of trichomes was directly linked to the release of phycocyanin. This method allows to fill a major knowledge gap and enables the development of new processes for the extraction of sustainable proteins from *A. platensis* which can be used in healthy food applications.

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PAW decontamination for materials used in beverages industry

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Aim:
Plasma activated water (PAW) is used as a novel technology for treatment of forestal material which are employed when manufacturing beverages (mainly wine) especially to tackle biological contamination (*Brettanomyces bruxellensis*) in oak barrels and chemical contamination (2,4,6-tricloroanisol -TCA-) in corks. Oak barrels are currently sanitized by sulphuring, however, there is an European prohibition (Directive 98/8/CE2) that came into effect in 2025. TCA is a molecule commonly known as "the cork disease" and 4% of wordwide wines are affected. There are several methods in order to eliminate TCA, but they require high temperatures and pressures which make it not affordable cost.

Method:
Different treatment times were chosen to generate PAW (1.5 - 3 minutes) applied above 2000 mL of water. Contaminated samples (fragments of oak staves and corks) were immersed in a container with PAW during 3 hours. Nitrates, nitrites, reactive species (OH*, NO* y NO_2*, products after fenol reaction) and HNO_2 of each PAW, before its contact with contaminated samples, were analyzed by selective electrodes, spectrometry and chromatography.

Results:
Regarding phisico-chemical characterization, the pH was below 4 regardless the PAW chosen. Concentrations of OH*, NO*, NO_2* (products after fenol reaction) and HNO_2 were directly proportional to generation time. Furthermore, it is thought that short-life species come from the instability of nitrites at an acid medium. Biocidal capacity could be determined by a synergistic effect of reactives species and TCA elimination may be due to hydroxyl radical (OH*). After selected one PAW (PAW-5, the same one for both applications) it was achived 3.49 log reduction for *B. bruxellensis* and 75.2% TCA reduction. Wine organoleptic properties were no negatively affected after treatments.

Conclusion:
It has been confirmed that PAW is an innovative and sustainable food process technology to decontaminate forestal material used in beverages industry. Moreover, there was applied only one type of PAW for biological and chemical contamination of two different materials which becomes of supreme importance to an industry factory. Finally, in order to scale up to an industrial stage, the

development of equipment that generate larger volumes of PAW at a reasonable cost is a decisive factor.

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TWO-SPOTTED CRICKET (Gryllus bimaculatus) POWDER ADDITION IMPACT ON HYDRATION PROPERTIES OF BLENDS WITH RICE FLOUR

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Aim: Edible insects are a good source of protein and can also be perceived as nutritional enrichment in gluten-free formulations. Among cricket family, except *Acheta domesticus*, also two-spotted cricket (*Gryllus bimaculatus*) called the "African" or "Mediterranean field cricket" is recognized as nutritious raw material with established history of eating.
Gluten-free products are mainly based on starches, which makes them nutritionally inadequate; hence the expected addition of proteins increases the nutritional value and helps create structure and achieve the typical bread texture. Also the most popular gluten-free flour – rice flour contains mainly starch and lack protein and fat.
The main objective of this study was to investigate the water uptake and retention indices in gluten-free flour mixtures composed of rice flour and cricket powder. Four mixtures were prepared to contain 5%, 10%, 15%, and 20% cricket powder, respectively.
Method: Water holding capacity, water absorption capacity, water absorption index, water solubility index and swelling power of mixtures were evaluated.
Results: Cricket powder's water holding capacity (WHC) was higher than rice flour (3.36 g/g d.b. vs 2.29 g/g d.b.). The water absorption index (WAI) of cricket powder was the lowest among the studied samples, while the water absorption capacity (WAC) was the highest, showing different water maintaining behaviour after heating.
Conclusion: The characteristic effect of insect powder on the absorption properties of rice flour means that the additive will modify the rheology of the dough made of such a mixture, which will affect the target volume and texture of the product.
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Germination as green biotechnological process to enhance the nutritional and bioactive profile of oat grains

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Oats (*Avena sativa* L.) have received attention for their high content of phytochemicals and nutritional value. Oats possess antioxidant capacity mainly due to presence of tocopherols, tocotrienols, phytic acid, flavanoids and non flavanoid phenoilc compounds. Oats are known for a unique group of antioxidants reported among cereals known as avenanthramide. The nutritional and bioactive profile is responsible of its health benefits such as hypocholesterolaemic activity. Oats have also recently been considered suitable in the diet of celiac patients. Germination is an efficient and natural strategy that allows the modification of the nutritional value and the nutraceutical properties of seeds, enabling one to tailor the process according to its final use. The use of germination increases the antioxidant and anti-inflammatory profile.

Aim:
This study aimed to compare native oat flour with germinate oat and evaluate the impact of this biotechnological process on different nutritional and quality parameters including proximate composition, content and profile of phenolic compounds, antioxidant activity, anti-inflammatory activity and expected glycemic index (GI).

Method:
Two different oat grain varieties were germinated. Oat seeds were soaked in 100 ppm sodium hypochlorite for 30 min and then washed with tap water until they reached neutral pH. Afterwards, seeds were hydrated in tap water at room temperature for 6 hours. Water was removed and seeds were placed in plastic trays containing sterile tap water and introduced in a germination at >90% air humidity by capillarity. Germination was carried out in darkness at temperatures of 21ºC for 5 days. Nutritional composition, Total phenol content (TPC) and phenolic profile (HPLC-MS/MS), antioxidant activity (ORAC, ABTS, DPPH). reducing power (FRAP) and anti-inflammatory activity were evaluated using methods on extracts and solid samples gaining knowledge of the process and optimize novel industrial applications.

Results:
The germination produced a significant enhancement on TPC increasing 3 times-fold content, from 150 to 320 µmol GA equivalents (GA Eq) g^{-1} d.m. This increment in TPC was observed in the free phenolic and bound fraction regardless of the variety studied. Germination increased 13 times-fold the content in Avenanthramide C, 2f and 2p. Antioxidant activity and reducing power showed same behaviour after the germination, ABTS increased 3 times fold after germination from 650 to 2065

µmol Eq. Trolox·100 g^{-1} in free fraction and 1500 to 2900 µmol Eq. Trolox 100 g^{-1} in bound fraction and FRAP from 380 to 1248 (mmol Fe reducido. 100 g^{-1}) in free and 856 to 2037 in bound fraction. The GI was not modified after the process with a final IG product close to 60.

Conclusion:
Germination is a technological process with a wide interest in the industry for the improvement in the nutritional and functional properties.

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3D-bioprinting: the development of plant-based protein bioinks for the creation of sustainable, cultivated meat structures

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Aim:
One of the most pressing challenges nowadays is to provide sustainable, nutritious and safe food to feed the world. Cellular agriculture gives the possibility to produce animal products such as cultured meat by combining knowledge from biotechnology, tissue engineering and food technology. Cultured meat promises a more efficient and sustainable production compared to conventional meat. Therefore this work aims for the development of a plant-based protein bioink in order to create cultivated meat structures using 3D-bioprinting
Method:
One of the current bottlenecks concerning cultured meat is the production of food-grade, animal-free and affordable scaffolds. Those hereby mimic the natural 3D-cytoarchitecture of meat and allow diffusion of oxygen and culture medium. 3D-bioprinting can be used for scaffold production. However, since the technology is derived from medicine, most of the bioinks used for the process contain animal sources or are not yet food-grade. To replace those, the technofunctional properties of plant proteins are enhanced by applying high intensity ultrasound treatment. Different alginate and plant protein concentrations were investigated with rheological measurements and 3D-printed to develop a suitable ink formulation. Further, the ink was printed in combination with mammalian muscle cells. The printability of the bioink and viability of the cells of the plant protein bioink was further compared to an established bioink containing gelatine.
Results:
The ultrasound treatment led to a reduced particle size, water holding capacity and protein solubility enhancing the printability of the ink. The developed plant protein ink formulations showed desirable rheological properties such as shear thinning and pseudoplastic properties allowing precise printability of cultured meat scaffolds. Furthermore, cell viability and proliferation of the cells were supported. Compared to animal-based inks, the investigated formulation showed promissing results regarding the printability and cell growth.
Conclusion:
Ultrasound treatment of plant proteins enhances the printability of plant-based protein bioink formulations and shows a promising animal-free and food-grade alternative for cultured meat scaffolds, allowing cell attachment and growth. The proposed approach further enables the creation of cultivated meat structures.

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Influence of polyphenols on coffee foam quality

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Aim: Coffee is one of the world's most popular daily consumed beverages. Epidemiological associations between habitual coffee consumption and low incidence of type 2 diabetes are well established. Coffee polyphenols are implicated in several putative protective mechanisms, including anti-inflammatory action and improved insulin sensitivity. Apart from colour, taste and aroma, coffee foam is a very important characteristic that defines the quality of a cup of coffee. Enhancing the sensory appeal of cost effective, instant coffees may improve the inclusion of coffee polyphenols in human diets. The aim of this study is to determine whether polyphenols are associated with the foam quality of instant coffee.

Method: To understand the foaming behaviour of coffee, a control and 42 different instant coffee products were assessed in terms of foam quality. Foam quality experiments were comprised of the determination of foam ability and foam stability of a sample. The relative abundance of 38 phenolic compounds was determined in coffee samples through high resolution LC MS-MS analysis. The relative abundance of each phenolic compound was correlated with foam quality markers.

Results: 21 out of 42 samples were significantly different from control in terms of foam ability. The relative abundance of 26 coffee polyphenols was significantly correlated ($p<0.05$) with at least one foam quality parameter. The strongest positive correlation was observed for 4-vinylguaicol whilst the strongest negative correlation was observed for p-Coumaroyl-quinolactone. The potential foam promoting nature of 4-vinylguaicol may be attributed to its apparent amphiphilic nature, comprising a methylene group non-polar region, and an opposing polar region due to the hydroxyl group. In the case of p-Coumaroyl-quinolactone, the lactonization of quinic acid may significantly increase the non-polar surface area of the compound, and thus act as antifoaming agent.

Conclusion: The knowledge that such coffee polyphenols are associated with foam quality, give insight on the foam stability mechanisms that describe coffee foam. By applying this knowledge to coffee production, it may be feasible to make coffee products which have not only enhanced nutritional value but also are more appealing to the consumers.

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Modification of technological properties of apple bagasse through the application of enzymatic treatments

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Aim:
Large amounts of by-products rich in dietary fiber (DF) and bioactive compounds are wasted in the production of apple juice. These by-products could be added as natural ingredients in foods for human consumption. However, their incorporation into foods could cause changes in their rheological properties, due to their high content of insoluble DF. Therefore, the aim of this study was evaluating enzymatic treatment as a strategy to modify the technological properties of DF from apple bagasse.
Method:
Juice was extracted from apples (*Malus domestica* cv Golden Delicious) to obtain the bagasse. This was treated with *Celluclast* (Novozymes®), varying enzyme concentration (0.5-2% per dry weight) and treatment time (1-6 h), under constant agitation (100 rpm) at 65ºC. Just after treatments, the content of uronic acids (UA) and neutral sugars (NS) were analyzed. Thereafter, the bagasse was freeze-dried, crushed and sieved (<0.3µm) to obtain a DF concentrate. Then, water retention capacity (WRC), oil retention capacity (ORC), swelling capacity (SC) and solubility were evaluated and compared having the untreated bagasse as a reference.
Results:
Increasing the treatment time and enzyme concentration enhanced solubility, NS and UA contents of the DF concentrates. Enzymatic treatments (2% for 6 h) trebled the UA content, doubled that of NS and increased solubility of the bagasse by 35% compared to the untreated bagasse. A similar trend was observed in SC, excepting the bagasse treated by 0.5%, whose SC was similar to that of the untreated bagasse. WRC and ORC decreased by 45% and 40%, respectively, when increasing treatment time and enzyme concentration. Probably, the enzymatic treatment caused modifications in the fiber structure that hindered the hydrophilic and hydrophobic groups. On the other hand, the increases in the content of UA, NS and solubility may be related to a higher content of soluble DF, which has hypocholesterolemic and hypoglycaemic effects, providing a health benefit.
Conclusions:
Obtained results indicate that the enzymatic treatment with *Celluclast* was effective in modifying the technological properties of DF from apple bagasse, which would favour the development of products rich in DF with high-added value while contributing to circular economy.

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Effect of chitin nanowhiskers on chitosan films prepared at different viscosity film forming solutions

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Aim:
Chitosan is a very abundant and interesting biopolymer with view to its use for the development of renewable packaging materials. Compounding with chitin nanowhiskers may be a possible strategy to improve the physico-chemical performance of chitosan films. Little is known about the effect of film forming solution viscosity, which may impair nanowhiskers distribution and chemical interaction, on the properties of the resulting nanocomposite films. The objective of this work was to study the effects of chitosan viscosity and chitin nanowhiskers concentration on the properties of the resulting films.
Method:
Chitin nanowhiskers were prepared from shrimp chitin by acid hydrolysis. Film forming solutions of chitosan (Chitoclear, Siglufjotdour, Iceland) of different viscosities (21·cP, 87 cP and 520 cP) added with increasing concentrations of nanohiskers (0, 0.5, 0.75, 1 and 1.5%, w/w chitosan basis) and plasticized with glycerol were prepared. The films were produced by casting (45ºC/50% RH/24 h) and their structural (SEM), mechanical (tensile test), water vapour permeability and optical properties were studied.
Results:
The films were homogeneous, colourless and transparent, without significant differences in thickness due to the addition of chitin nanowhiskers. When using 21 cP chitosan, the tensile strength was reduced as nanowhiskers concentration increased, whereas the elongation at break decreased. However, the mechanical properties did not show significant differences for the highest viscosities tested (87 cP·s and 520 cP·s). These results may be atttribuited to different factors, such as homogenous dispersion of nanowhiskers and favourable interaction between nanowhisker and biopolymer. Water vapour permeability of films was improved at any nanowhiskers concentration (21 cP chitosan), but no significant differences were observed for 87 cP·and 520 cP·chitosans. This fact may be due to the bad dispersion and aggregation of chitin nanowhiskers into high viscosity film forming solutions, affecting the integrity of polymer matrix, as confirmed by the study of the cross-section of the films.
Conclusion:
Results suggested that nanowhiskers improved some physico-chemical properties of chitosan films at low viscosity film forming solutions. This result indicated that the selection of the viscosity of chitosan and the concentration of chitin nanowhiskers are important factors to improve the technological properties of the films.

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Kinetic modelling of dispersion of baby biscuits in liquid as a quality assessment tool

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Aim:
Baby biscuits can be prepared by adding milk, fruit juices or water. How fast the baby biscuits absorb the liquid and how quickly they get dispersed are important quality criteria. The liquid absorption time of biscuits and the amount of liquid they absorb to reach a porridge-like consistency depends on the composition, process conditions, and physical properties of biscuits. Therefore, it was aimed to develop a method that will explain the effects of changes in the recipe factors on the dispersion of biscuits with a modelling approach.

Method:
Different biscuits (commercially available or baked at the lab) were examined for their liquid absorption properties. The amount of absorbed liquid was measured gravimetrically up to 120 s for at least 9 time points in duplicate. Liquid absorption kinetics was obtained by graphing the volume (mL) of liquid absorbed per g of biscuit versus time (s). The data were modelled by using MATLAB with modified Weibull () and Peleg () equations. The importance of ingredients (flour type, the amount of sugar, fat, and baking agent) on the liquid absorption behaviour was determined. The microstructure of the biscuits was examined with µCT scans and the absorption of a water droplet on the biscuit surface was captured in slow motion by using a camera.

Results:
Initial absorption rate ($1/k_1$ of Peleg or ⍰ of Weibull model) followed the order of refined flour>wholemeal>vegetable pure added biscuit, while the equilibrium absorption (L_{eq} of Weibull or $1/k_2$ of Peleg) followed wholemeal>refined flour>vegetable pure added biscuit. The increasing amount of sugar decreased the equilibrium absorption value. The amount of leavening agents was found to be the utmost important ingredient for the liquid absorption behaviour. The equilibrium absorption value was related to the total porosity of the biscuits while the initial absorption rate was determined by surface characteristics and the distribution of pore diameters.

Conclusion:
The dispersion behaviour of baby biscuits in liquid was explained mathematically for the first time by the parameters of both the Weibull and Peleg models. The estimation of initial liquid absorption rate was proposed to be related to the quality of baby biscuits.

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STUDY OF PHYSICOCHEMICAL AND STRUCTURAL PROPERTIES OF NANOLIPOSOMES ENCAPSULATING GRAPE SEED TANNINS

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Aim: One of the applications of nanotechnology in the food sector are the edible coatings (EC); thin, continuous matrix that forms around a food to provide protection, structure, and functionality. Nanoliposomes that encapsulate grape seed tannins (TLS) have high antioxidant activity and strong binding capacity for large molecules. The objective of this research was to study the physicochemical and structural properties of nanoliposomes that encapsulate grape seed tannins for their subsequent application as an edible coating.
Method: TLS stability was determined by dynamic light scattering (DLS), encapsulation efficiency (EE) by ultracentrifugation, antioxidant activity by inhibition of ABTS and DPPH radicals, and microstructure by transmission electron microscopy (TEM).
Results: The results of mean particle size (MPS), polydispersity index (PDI) and potential (�) for suspended tannins (TS) were 742.7�5.3 [nm]; 0.67�0.03 and -13.5�1.7 [mV], respectively. For TLS they were 259.7�5.1 [nm]; 0.36�0.03 and -21.8�1.5 [mV], respectively. The content of total polyphenols and the antioxidant activity of TLS decreased significantly with respect to TS. This decrease in the physicochemical properties is related to the process of formation of nanoliposomes by ultrasound, this process involves the formation, growth and collapse of microbubbles that reduce the particle size. The SE was 91% results similar to those reported by Sarabandi et al., (2019); Choudhary et al., (2021) and Chen et al., (2021) for nanoliposomes loaded with fish oil, peptides and naringenin, respectively. Regarding the micrographs, the formation of large unilamellar vesicles (LUV) and vesicles are evident. multilamellar (MLV).
Conclusion: Finally, the physicochemical and structural properties of TLS were studied to obtain a scientific basis for future research in the application of these nanostructured active encapsulation systems as edible coatings.

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Simulating Salmonella and Listeria monocytogenes behaviour in dry-fermented sausages as a function of processing factors

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Aim: Dry-fermented sausages (FS) are traditional ready-to-eat raw meat products. As a shelf-stable end products the microbiological safety needs to be ensured during the production process. The aim of the work was to evaluate the fate of *Salmonella* and *L. monocytogenes* as the main pathogens of concern for FS, considering the processing temperature and the resulting acidification and drying curves of three different types of FS, accounting for the inter-batch variability found in a food industry.

Method: Temperature, pH and a_w changes were characterised along the production process of different batches: “chorizo” (2d at 22ºC-82%RH and 12d at 14ºC-60%RH; 14 batches), “fuet” (5d at 14ºC-80%RH and 10d at 17ºC-63%RH; 12 batches) and "espetec” (7d at 13ºC-80%RH and 10d at 13ºC-63%RH; 4 batches). These parameters were introduced as inputs values to the different predictive models available in the scientific literature to simulate growth and/or inactivation and calculate the Log_{10} change along the production process.

Results: The acidification process (pH up to 4.67) associated with the fermentation of “chorizo” prevented *Salmonella* growth, but no reduction was predicted; while *L. monocytogenes* could grow more than 2 Log_{10} according to gamma-concept model associated with the fermentation temperature (22ºC-82%RH). In “fuet”, the combination of processing conditions (<15ºC and <80%RH) and pH drop up to 4.89 (associated with the addition of starter culture) inhibited the growth of both pathogens. For *L. monocytogenes* similar total inactivation extent was predicted between different batches (1 to 1.5 Log_{10} reduction); while higher and wider inactivation range was found for *Salmonella.* Regarding “espetec”, the low acidification (up to 5.37) made the logistic and gamma-concept models predict *Salmonella* grow up at ca 1.2 Log_{10}, while *L. monocytogenes* tended to slightly decrease during the production process.

Conclusion: Among tested predictive models, those based on the gamma concept allow to account for growth sometime occurring during the first steps of the producing projects, besides inactivation. The outputs can be used to support decision making aiming to design safer producing processes conditions.

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Screening of lactic acid bacteria to produce sustainable fermented whey-based drinks

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Aim:
Cheese whey is the watery part obtained after milk curdling in cheese-making. Because it contains high quality proteins, whey is mainly valorized by industrial processed to obtain value-added food ingredients. However, these processes are only applicable to some types of whey, are energy-consuming and only concern large-scale dairy plants. As part of FAIRCHAIN project, we aimed at developing whey-based beverages using fermentation as alternative whey valorization process. This study explores the ability of lactic acid bacteria (LAB) to ferment different types of whey, to obtain the best aroma profiles for the beverages.
Method:
Two types of whey were assessed: a sweet whey from Morbier cheese and an acid one from Comté cheese. 125 LAB strains belonging to 27 species, were selected for their capacity to utilize lactose and their GRAS status. They were evaluated for their ability to ferment both wheys. After fermentation, the products were assessed for their acidification and sensory properties (tastes and sniffing). Sugar content and volatile profile of fermented wheys were evaluated by HPLC and GC-MS respectively.
Results:
Fermentation outcomes differed according to the whey type: 34 strains did not acidify sweet whey, while 91 strains did not acidify the acid one. For a given whey, acidification was species-dependent: *Lactobacillus helveticus* and *Lactobacillus delbrueckii* strains showed the best acidification capacities in both wheys although acidification was higher on sweet whey compared to the acid one. Sensory profile analysis led to different results and were strain-dependent. Regarding sweet whey, 40 strains (12.5%) encompassing 12 species showed a promising aroma profile while only 20 belonging to 7 species were retained for acid whey. Both criteria considered, 26% strains tested on sweet whey showed a good acidification ability and an aroma profile deemed to be acceptable, whereas only 20 strains were retained for Comté acid whey. Noteworthy, 6 strains showed promising results on both wheys.
Conclusion:
This study highlighted the huge diversity of the metabolic profiles of LAB strains when used for fermentation of different whey types. Fermentation by well selected bacteria LAB thus appears as a sustainable and an inexpensive process, to valorize whey.

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Upgrading Horse mackerel discards and chia cake by obtaining a microencapsulated anti-hypertensive food ingredient

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Aim:
Fish processing generates around 20 million tonnes of by-products worldwide that are hardly used. However, there is great potential to use them as a source of high-value molecules of bioactive interest for the food or pharmaceutical industry.
Industrial extraction of vegetable oils generates a large amount of seed cakes, mainly used for animal feed. However, they are a source of molecules with technological and/or functional properties of interest for the food industry. Mucilage, for example, have thickening and texturising properties and can be used as encapsulating matrices for bioactive molecules, protecting them from processing and gastrointestinal digestion. Proteins can also be used for the same purpose.
The first objective of the present work is the valorisation of horse mackerel (*Trachurus trachurus*) by-products by controlled hydrolysis, to obtain a protein hydrolysate with antihypertensive potential. A second objective is the use of mucilage and proteins from underutilised chia seed cakes (*Salvia hispanica L.*) as encapsulating and protective matrices for the hydrolysate.
Methods: Horse mackerel protein derived from filleting was hydrolysed with Esperase. ACE inhibitory activity was analysed by fluorescence before and after microencapsulation of the hydrolysate. Microencapsulation was performed by spray-drying using protein and protein+mucilage as matrices. The colour of the microcapsules was determined with a colorimeter on the CIELAB scale, expressing the results as tone and chromaticity. The solubility of the microcapsules was determined after incubation at different pH values and subsequent protein measurement by the bicinchoninic acid method.
Results: Practically no differences in the colour of the microparticles were observed. Solubility in all cases was similar and increased at higher pH values. All the microcapsules showed ACE-inhibitory activity.
Conclusion: It is possible to obtain a protein hydrolysate with antihypertensive potential from horse mackerel by-products, which can be microencapsulated by spray-drying using protein and/or mucilage derived from chia seed cakes as encapsulating matrices. Microencapsulation preserved potential bioactivity. These microcapsules could have interesting applications as functional ingredients in solid foods given their moderate solubility at slightly acidic or neutral pHs, or in low pH foods.

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Development of soy-yoghurts, containing functional vaginal lactobacilli and their investigation after digestion using postmenopausal donors

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Aim: Recently probiotics have been proposed to improve genital health of women, and microbial strains with beneficial properties can be used to prevent vaginal dysbiosis and genital infections. In particular, members of the *Lactobacillus* genus, which are generally healthy human vaginal microbiota, can be administered also orally, and as probiotics they can reach the genital apparatus for the anatomic proximity once they colonise the gut. Therefore, the addition of an appropriate combination of such *Lactobacillus* strains to food matrices could aid in using food as a dietary strategy to improve the well-being of women. In addition, it is important to underline how probiotic delivery to humans has traditionally been associated with fermented dairy foods mostly of bovine origin, but recently due to several reasons the demand for non-dairy-alternatives is growing. In this context, this work is focused on the development of probiotic soy yoghurts, containing functional vaginal lactobacilli and their deeply investigation on their potential functionality after digestion in post-menopausal female donors.
Method: Encapsulated and unencapsulated probiotic vaginal lactobacilli were then inoculated as adjuncts to produce soy-yoghurts. Also, soy-yoghurts produced without probiotic lactobacilli were included as control. Consequently, the viability of fermentation starter and probiotic cells, encapsulated or not, was checked during the storage at 4 °C. In addition, in order to investigate the effect of the formulated yoghurt, containing the vaginal lactobacilli, encapsulated or not, on the vaginal microbiome of postmenopausal women , the soymilk products were submitted to an *in vitro* simulated digestion and the digest were added into a faecal culture model system using faeces of post-menopausal women as donors.
Results: This approach has given important information on the ability of post-menopausal women microbiome to use the carbohydrates provided in the soy product and if the presence of the vaginal strains affected this; on the metabolism of the vaginal strains and postmenopausal microbiome, by means of SCFA determination and microbiota assessment by means of qPCR determinations of defined microbial groups.
Conclusion: The obtained data could represent a first step for the development of probiotic dairy-free products also in order to promote the woman well-being.

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Does lower salt content affect the shelf life of meat products?

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Aim: Processed meats are recognized as the second most contributing food category to dietary salt intake. Despite consumer concerns about the level of salt intake that are mostly related to high blood pressure and cardiovascular risks, the sodium content in processed meat products remains high. Salt is a desirable compound in such products as it inhibits the growth and survival of undesirable microorganisms and extends the product shelf life. Therefore, the aim of the study was to evaluate the effect of lower salt content in selected meat products on their shelf life and to inform consumers about the reformulation benefits on human health.
Method: The microbiological quality of “špekáčky” sausages, cooked hams and bologna-type sausages produced with a traditional salt content exceeding 2% (2.1%) and reformulated batches with a reduced salt content of 1.7% was determined. The total viable count (TVC), the number of lactic acid bacteria (LAB) and the number of bacteria of the *Enterobacteriaceae* family were evaluated. Microbiological analysis of “špekáčky” sausages was performed on the day of sample delivery (week 0) and then after 1; 2; 3 and 4 weeks of storage. Cooked ham samples as well as batches of bologna-type sausages were analyzed immediately after delivery and after 1 and 2 months of storage at 3±1 °C.
Results: “Špekáčky” samples with 1.7% salt content showed 1 log higher TVC compared to 2.1% batch (P = 0.013), practically throughout the whole storage period. The LAB population remained well below 5 log CFU/g even at the end of the experiment after four weeks of storage. No significant difference was detected between 2.1% and 1.7% salted samples regarding the TVC, LAB and *Enterobacteriaceae* evolution in cooked hams and bologna-type sausages, where the population of bacteria did not exceed 2 log CFU/g during the whole storage period.
Conclusion: Thus, the production of meat products with lower salt content that meet both food safety and quality requirements may become a large-scale production reality. Reducing salt in meat products is seen as one of the most impressive steps to improve population health.

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Optimizing the formation of CO_2 hydrate on a laboratory scale

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Aim:
Gas hydrates are cage structures consisting of water molecules and hydrate formers. In the food sector, CO_2 is used for hydrate formation at 1 to 8 °C and 30 to 80 bar. The binding of water in hydrate structures makes it possible to produce high-quality concentrates while simultaneously not affecting heat-sensitive substances. Furthermore, hydrate technology operates at low energy levels compared to conventional concentration methods such as evaporation or freeze-drying. To further optimize the hydrate technology, the present research highlights the improvement of hydrate formation regarding subcooling and the gassing duration. The data obtained will be used to derive an efficient hydrate formation method to increase yields for industrial applications.

Method:
Hydrate was formed in a CO_2-water system for two hours in a bubble column reactor at a pressure of 37.5 bar. The reactor was either not gassed or gassed for 5, 15, and 120 minutes. Furthermore, the formation of gas hydrate was performed under isothermal conditions and at different cooling rates to assess the influence of subcooling. The mass-based yields of the formed hydrate were determined after each experiment.

Results:
Compared to isothermal conditions, the hydrate yield increased at constant cooling rates. The improvement of hydrate formation can be explained by an increase in the driving force using thermodynamic approaches. Gassing the reactor increased the amount of hydrate formed due to an improved mass transfer compared to the static reactor without gassing. Consequently, raising the gassing duration should steadily improve the yield of all experiments until mass transport limitation occurs. Nevertheless, the highest impact of gassing was observed within a short gassing time of five minutes. At set cooling rates and a gassing duration of five minutes, around 80 to 95 % of the water from the initial solution was converted to hydrate. A further extension of the gassing time thus only slightly increased the hydrate yields in the experiments.

Conclusion:
The results imply that an isothermal mode of operation and operating without gassing is inadvisable. Only the balance of gassing in short periods such as five minutes and constant cooling rates leads to an efficient hydrate formation.

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Microalgae as high-protein ingredients in vegetable soups

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Aim:
Consumer preferences are moving towards healthier and more sustainable diets with lower protein intake from animal origin. Microalgae, used as single-cell ingredients, can be used as sustainable sources of proteins in the formulation of soups. However, their use can entail important sensory and physicochemical changes, which may hamper consumer acceptability. The aim of this work was to develop creamy vegetable soups with high protein content by the addition of microalgae, with minimal changes in physicochemical and sensory properties with regard to the standard products.

Method:
Single-cell ingredients from *Arthrospira platensis* (spirulina), *Tetraselmis chui* and *Chlorella vulgaris* were incorporated into the formulation of standard creamy vegetable soup. Physicochemical properties of soups were determined by colour, moisture content, water activity, pH, syneresis, °Brix and rheological properties (Bostwkick consistency and consistency coefficient). The protein content was determined by the Kjeldahl method. Sensory analysis of the products was performed by a trained panel of 8 members by means of a Quantitative Descriptive Analysis (QDA).

Results:
High protein soups (2.5-3.6%) were obtained with the use of microalgae single-cell ingredients. The effects on physicochemical and sensory properties highly depended on the microalga species. Important colour changes were obtained with *A. platensis* and *T. chui,* while soups with *C. vulgaris* showed minor colour changes. Moisture content, water activity, pH, syneresis, and °Brix of soups did not show significant changes. Microalgae increased Bostwick consistency and decreased consistency coefficient of soups, except *A. platensis*, which had no effect on these rheological parameters. The sensory properties of soups were highly affected by *Tetraselmis chui,* which conferred *fishy* olfactive and flavour attributes.

Conclusion:
Formulation with microalgae single-cell ingredients leaded to high-protein products. Physicochemical and sensory properties were affected by the microalgae, although *A. platensis* and some strains of *C. vulgaris* showed the best potential to be used as sustainable protein ingredients for the formulation of creamy vegetable soups.

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Ensuring the safety of extracted proteins and novel food products

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Aim:
To meet the current protein demands, the EU is 95% dependent on imported soy or cereals. However, these current sources of proteins are becoming unsustainable from an economic as well as an environmental point of view. Biorefineries for the valorisation of macroalgal residual biomass and legume processing by-products to obtain new protein value chains for high-value food and feed applications (ALEHOOP) will attempt to reduce the EU's dependency on protein imports and contribute to the raw material security through the circular bioeconomy.

Method:
ALEHOOP will produce biofunctional and technological proteins from sustainable and under-exploited biomass that do not compete with the traditional food crops for space and resources. The project will develop two new ingredients, one based on legumes and the other based on seaweed (macroalgae). The new proteins will be validated in foods for elderly, sporty and overweight people, vegetarians, and healthy consumers as well as for the animal feed.

Results:
A detailed inventory of the relevant National and European regulations has been prepared to assess the legal requirements from the raw material acquisition, processing, production, and commercialisation. Samples have been assessed for potential pathogens and the presence of heavy metals (Cu, Cd, Pb, Hg, As) have been determined by AAS and ICP-MS. The legume by-products have been analysed for numerous pesticides to determine if they are present within the MRL limits set by the EU. To assess genotoxicity of the extracts, in vitro screening assay using the Ames mutagenesis test (bacterial revertant mutation assay) was performed.

Conclusion:
All samples are within the limits of safety and non-toxicity for animal feed and food additives.

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Rosmarinic extract vs rosmarinic acid for active food packaging system

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Aim: The focus on environmental issues and the challenges related to traditional plastic material has triggered the use of bio-based packaging materials as an alternative to materials produced from non-renewable resources. Moreover, with consumers' growing demands for safe, fresh & nutritional foods, the concerted adoption of so-called smart packaging concepts, i.e. active & intelligent systems is required to ensure shelf-life and premium sensory/nutritional quality of perishable food products. To this regard, biologically active compounds formed in herbs hold promising potential as natural bioactives, as they enhance cross-linking of certain biopolymers, , while their antioxidant, anti-microbial, anti-allergenic functions prolong shelf-life and improve health benefits of food products. Polysaccharides, such as cellulose, starch, chitosan, alginate, etc. are abundant in nature as structural polymers. Many polysaccharides have good film-forming properties and in addition their high accessibility, low cost, biodegradability, and compostability make them desirable candidates for use in more sustainable food packaging systems. The main objective of this work was to design and optimize a sustainable method for incorporation of the selected bioactive compounds from genetic selected and optimized grown Norwegian herbs into natural biopolymer for potential food packaging applications.

Method: Three different concentration of rosmarinic extract (RE) and rosmarinic acid (RA) was added to 2% w/v alginate solution. Mechanical, barrier, antioxidant, and antimicrobial properties of the prepared films were assessed using up-to-date analytical methods. The prepared solution was used to coat strawberries and a short shelf-life study was conducted.

Result: The antioxidant properties of the alginate solution increased significantly with the addition of both RE and RA. At 5 mg addition of RE and RA, the antioxidant activity of the 2% w/v alginate solution increased by 20% and 35%, respectively. There was a slight increase in the mechanical and barrier properties of the alginate films with both RE and RA addition. The coating experiment revealed that the coating in general increased the shelf life of the strawberries. However, the RE and RA coating solution served as a better coating solution in terms of increased shelf life and no significant difference was observed between the RE and RA solution. No antimicrobial properties were observed using the agar disk diffusion study. It could be due to the clogging of the disk by the thick alginate solution.

Conclusion: This study has demonstrated the potential of RE and RA towards enhanced functionality of alginate films for active food packaging applications.

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DIY protein fortification: what foods are suitable for UK older adults to fortify at home?

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Aim:
Protein is a vital macronutrient for combating negative health outcomes associated with malnutrition in older adults, including sarcopenia, functional decline and reduced quality of life. As poor appetite is a major determinant, food fortification is a relevant and flexible approach to assist older adults in reaching recommended protein intakes across the day, even for small eaters. Critically, successful fortification solutions need to be tailored and desirable to consumers for consumption and consequent benefits to be seen.

Method:
Aiming to attain mass appeal and acceptance of a do it yourself (DIY) fortification method in the UK, we have used a mixed methods approach gathering both quantitative and qualitative insights. Data were reanalyzed from a combination of UK datasets (the National Dietary and Nutrition Survey and the Food and You Survey), alongside data purchased from market research consultancy, Kantar. These findings highlight older adults' current sources of protein, typical eating patterns and commonly consumed foods. These insights were complemented by focus groups held with UK older adults and carers in project FORTIPHY.

Results:
Culinary ingredients such as eggs and dairy were identified as key components of older adult’s current diets and were also considered acceptable fortificants. Older adults did not consume, and very few had tried, animal-derived or plant-based protein powders, and were less accepting of an unfamiliar protein source. Opportunities to replace other powders (such as flour) with protein powders, for example in thickening stews and baking cakes, moderated these attitudes. Other meals that were considered as appropriate carriers for protein-fortification will be further discussed.

Conclusion:
Solutions for novel do it yourself (DIY) fortification methods could empower older adults to take a personalised approach to their nutrition and current diet, without requiring a large behavioural change. Importantly, they must promote eating pleasure, cater for personal preferences, be adaptable to eating patterns, and take the specific age-related problems that complicate food intake into account. Without this personalised approach to nutrition, older adults are unlikely to adopt the change.

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Simultaneous parameter estimation in primary stage of freeze drying of bulk blueberries

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Aim
Freeze-drying is one of the best drying alternatives to extend shelf life while preserving bioactive properties of products. Interest in blueberries is due to its high perishability, high content of bioactive compounds and relatively short harvest period. Modelling the process becomes essential to reduce processing time and energy consumption, impacting the economic viability.
The aim of this work was to determine parameters of primary stage of freeze drying of blueberries by using inverse engineering and a single objective optimization procedure.

Method
A theoretical model for heat and mass transfer in a layer of blueberries was developed. The model assumed: (i)blueberries are homogeneous spheres; (ii)shrinkage during drying is negligible; (iii)heat and mass transfer between chamber and spheres occurs across entire external surface; (iv)heat transfer in the frozen and dried layer are in a quasi-steady state and described by algebraic equations; (v)residual water desorption was neglected.
Different batches of blueberries were frozen to -50°C, and then freeze-dried varying shelf temperature (0, 20°C), chamber vacuum (10, 20Pa) and drying period (2 to 12 days).
Parameters to be estimated included heat and mass transfer coefficients and chamber volume. The objective function was defined in order to minimize the difference between predicted and experimental final weight.
A particle swarm optimization algorithm was applied to obtain best parameter values of the model with a swarm of 50 individuals.

Results
External heat transfer coefficient resulted 0.4 $J.s^{-1}.K^{-1}.m^{-2}$. Dried layer heat transfer coefficient resulted 6.6e-04 $J.s^{-1}.K^{-1}.m^{-1}$. External mass transfer coefficient resulted 3.9e+03 $kg.s^{-1}.Pa^{-1}.m^{-2}$. Dried layer mass transfer coefficient resulted 35 $kg.s^{-1}.Pa^{-1}.m^{-1}$.
With the developed model and using the estimated parameters, predicted and measured final weight for different freeze-drying experiments presented a very good correlation (R^2=0.99).

Conclusion
Results of this study allowed modelling blueberry freeze-drying in different conditions. This is useful for decision making at process conditions and to reduce processing time.

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Toolbox for coupling structure modification with physicochemical characteristics and functional properties

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Aim:
Proteins from various sources are widely used in the food industry due to their unique functional performances in food products. However, prior to their use, proteins must be processed into ingredients through industrial processing. Such processing may impact ingredient functional properties. To achieve the rational design of protein ingredients, it is necessary to investigate the relationships among different properties. Hence, this study was devoted to exploring the protein structure, physicochemical properties, and functionality aiming at developing a protein analytical toolbox enabling to elucidate their relationship and food applicability.

Method:
Four commercial pea protein powders, one concentrate (PPC) and three isolates (PPI1, PPI2, PPI3), were investigated. The measurements of protein functionality included solubility, foam property, and emulsion property. Multispectroscopic techniques including Fourier transform infrared, fluorescence, and ultraviolet-visible spectroscopy were performed to evaluate protein structure characteristics. Moreover, we measured denaturation, surface characteristics, particle size, molecular weight distribution, and sulfhydryl group of pea protein dispersions. In order to establish the protein analytical toolbox, chemometric approaches like regression models were employed to couple spectra data and chemical analyses.
Results:
First of all, it was found that the proteins were all denatured in four powders. All proteins showed the typical pH-dependent U-shape solubility curve, but the solubility of PPC was higher than other protein isolates. PPI1 and PPI2 formed more stable emulsions with smaller oil droplet sizes and lower creaming index than PPI3. PPI1 and PPI3 showed similar foaming capacity, but better than PPC and PPI2. These results showed that PPI1 was both a good emulsifier and an effective foam agent. Regarding foam and emulsion functionality, it was clear that these properties could not be explained by solubility alone. Analyses of other molecular characteristics are currently in progress to obtain a complete overview/data of the pea protein powders. This will provide both a reliable toolbox and an understanding of the structure-functional relationship of proteins to help clarify the functional potential of newly developed protein ingredients.
Conclusion:
In conclusion, such a protein toolbox could be extremely useful for the food industry to design desirable protein ingredients.

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Trans-anethol-loaded nanoemulsions and their stability during storage

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Aim

Trans-anethol is an essential oil found naturally in the fennel plant (*Foeniculum vulgare*) and has a sweetening power 13 times greater than sugar. The objective of this work was to emulsify trans-anethol using octenyl succinic anhydride (OSA) modified starch as the emulsifier and evaluate their stability in different conditions during storage, foreseeing their use sugar substitute.

Method:

The emulsion was prepared using a 1:1 mixture of 99.9% pure trans-anethole and sunflower oil as the oil phase; 1.5% w/v OSA was used as the aqueous phase. A pre-emulsion was performed with an Ultra Turrax at 14000 rpm, for 2 minutes. Subsequently, ultrasounds were applied using a Branson Sonifier Model. 450 for 7 minutes at 40% of power. Once the emulsions were obtained, 3 different conditions were defined to study the stability during storage: -20 °C, 4°C and 25 °C. Stability studies included droplet size analysis (Z-average and polydispersity index), zeta-potential measurement, pH, and visual observation for 45 days.

Nanoemulsions were freeze dried (-50°C,vacuum 0.1 mbar, 72 h) and evaluated during this study through scanning electron microscope (SEM), the dried samples were also reconstituted and evaluated through Z-average and zeta-potential in an additional storage study at 4°C and 25 °C.

Results:

Nanoemulsions stored at 4°C and 25°C showed good stability over time, with particle sizes less than 300 nm and PDI below 0.3, also no phase separation was observed over time. On the other hand, the reconstituted samples and the samples that were stored at -20°C presented particle size above 1500 nm, however, no phase separation was present in any of the conditions studied. The SEM images showed a porous surface on all the days that the characterization was carried out.

Conclusion:

The nanoemulsion made from trans-anethol represents a good potential to be used as a sugar replacer not only for its sweetening power but also for its easy storage. This represented a good stability for at least 45 days at room and low temperatures. However, more studies are needed to understand better the behaviour of nanoemulsions under different storage conditions.

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Soluble gas stabilization (SGS) technology as a hurdle against Listeria spp. in Atlantic salmon fillets

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Aim:
The aim of the present study was to investigate the impact of soluble gas stabilization (SGS) technology on the growth of *Listeria innocua* in pre-rigor vacuum-packed fillets of Atlantic salmon (*Salmo salar* L.) during cold storage.

Method:
In this study, *L. innocua (*ATCC 33090) was used as a non-pathogenic surrogate for *L. monocytogenes* due to the similar growth pattern of these species in food matrixes. Pre-rigor salmon fillets (n = 96) were inoculated with *L. innocua* (3.81 ± 0.03 log CFU g^{-1}) and divided into two groups, pre-treated either in 100% CO_2 (SGS) or air (Control). After 18.5 h at 4 °C, the samples were re-packaged in vacuum and given two groups (SGS-VP and VP). The storage trial was conducted by splitting each group into two sub-groups that were stored at 4 and 8 °C, respectively. The growth of *L. innocua* on the samples was quantified using Brilliance™ listeria agar (BLA), whereas the growth kinetics were predicted using the ComBase online tool.

Results:
SGS-technology significantly affected the growth kinetic parameters of *L. innocua* in the samples stored at 8 C. The estimated maximum growth rate was significantly lower in SGS-VP than in VP samples (μ_{max} = 0.28 ± 0.05 day^{-1} and μ_{max} = 0.49 ± 0.12 day^{-1}). Furthermore, the CO_2 treatment resulted in a significantly longer lag phase (8.4 ± 2.4 days in SGS-VP versus 5.7 ± 1.5 days in VP). *L. innocua* was completely inhibited in SGS-VP at 4 C, while the VP samples have a maximum growth rate of 0.17 ± 0.09 day^{-1} with a lag phase of 10.8 ± 4.3 days.

Conclusion:
The persistence of *L. monocytogenes* in the salmon processing chain is a major food safety concern in ready-to-eat food. The above results inferred that the combined effect of dissolved CO_2, packaging and cold storage could effectively inhibit the growth of *L. innocua* in pre-rigor vacuum-packed salmon fillets. Thus, SGS-technology could be a promising approach in controlling the growth of *Listeria* spp., in a hurdle technology approach.

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Raw materials assessment and by-products production in the Irish brewing and distilling sector

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Aim:
To evaluate major raw material inputs, supply and by-products production in the Irish brewing and distilling sector.
Method:
Scoping review of literature on production data and processing inputs for the Irish brewing and distilling sector. Then a survey was carried out to determine the current state of major input materials and by-products production in the sector.
Results:
The Irish brewing and distilling sector is the 7th largest exporter of beer and the 8th largest producer of spirits in Europe, with estimated outputs of 800 million litres of beer and 190 million bottles of spirits annually. Growth of the sector has been consistent since 2014, with an average growth rate of 4% per annum. Individually, the brewing sector had a 22% increase in the number of micro-breweries since 2014 while the distilling sector witnessed an increase from four to thirty-eight in the number of distilleries between 2010 and 2020.
Estimated annual inputs and outputs for the sector were approximately 268,000 t of grain, 1,928 t of yeast, 2,442 t of hop, 2 billion HL of water, 200,000 t of spent grain and 10 L of pot ale per LPA. Current management practices for the by-products from survey data are as follows: 53% of the by-products is being utilised for livestock feed, 23% is disposed as effluent, 12% goes to land spread, and the remaining 12% is used for fertiliser/compost.
Conclusion:
The study gave an insight into current inputs and outputs of the Irish brewing and distilling sector including trends in its by-products management practices. With the volume of inputs and outputs circulating within the sector, innovations and new initiatives needs to be developed for a more sustainable process and to build a circular economy.

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High-moisture Mozzarella cheese freezing: physico-chemical and sensory modifications during processing and shelf-life.

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Aim: High-moisture Mozzarella is one of the most exported Italian cheeses worldwide, but affected by short shelf-life. The feasability of high moisture cheese freezing and frozen storage can be valuable, as freezing can be a solution to decrease product waste, extend market reach, and increase convenience; netherless, its effect on quality has to be estimated. The aim of this project was to characterize the physico-chemical, structural and sensory changes of high-moisture Mozzarella related to freezing and frozen storage.
Method: In a first experiment, different air blast freezing/thawing methods (i.e. presence or absence of brine during freezing/thawing, freezing and thawing rates) were tested on Mozzarella quality characteristics (rheology, texture, color, expressible serum, sensory properties). In a second experiment, Mozzarella cheeses were characterized during a 4-months frozen storage in terms of rheology, texture, color, water status by expressible serum and low field ^{1}H NMR, proteolysis, microstructure and sensory properties.
Results: Different freezing and thawing rates, modulated as a function of air temperature and velocity, did not cause significant modifications of Mozzarella characteristics, as the freezing time was sufficiently short. On the contrary, the presence of brine during freezing and thawing processes caused an absorption of water of Mozzarella cheese, that was found to be more viscous-like and moist than the fresh one. Thus, freezing in the presence of brine was considered a less suitable method to freeze Mozzarella. Frozen storage of Mozzarella slowed down but did not stop proteolytic reactions that showed a higher rate after thawing; Sensory analysis indicated that oxidative reactions occurred. Frozen-stored cheeses showed a modification of water status from a molecular and mesoscopic point of view, possibly due to casein degradation and conformational changes, that caused protein's dehydration.
Conclusion: Frozen Mozzarella showed quality changes that were more related to the frozen storage than to the freezing process itself. Priorly to cheese freezing, milk quality and cheese composition should be controlled in order to limit the presence of proteolytic and lipolytic enzymes in the cheese and to prolong the frozen storage. A shorter shelf life period should be proposed for frozen-thawed cheese than the fresh one.

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Designing Continuous Flow Microwave System for Milk Pasteurization: A Computational Study with Experimental Validation

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Aim:
Milk pasteurization is still carried out with conventional heat transfer approaches where heat exchanges are used. Microwave (MW) heating might be a novel solution, but the possible non-uniformity in temperature distribution is a significant problem even though a volumetric heating effect is expected. The aim of this study was develop a mathematical model to determine the temperature change of milk during MW heating, validated this model with experimental data and then modify it for industrial scale processes to obtain a temperature uniformity.
Method:
For this purpose, first viscosity and dielectric properties (and electrical conductivity) of milk sample were experimentally measured, and the rest of the thermophysical properties were determined using milk composition and empirical equations. The mathematical was developed using Comsol multi-physics (V5.6), and experimental studies were carried out in a lab-scale system under static conditions. For MW heating, the milk sample was placed in a PTFE cylindrical tube (5 cm in diameter and 16 cm in length), and fibre optic probes were used for temperature measurement, and this data was used in the further model validation studies.
Results:
The model validation was carried out with the experimental data obtained at 350 W power for 3 min processing. Following the model validation, the validated model was modified for a continuous flow process, and a double-magnetron scale-up system was designed where various pipe orientations (axial rotation and helical pipe structures) were used to obtain a uniform temperature distribution at the end of the process. The outlet temperature of the milk sample was planned to be over 70 °C.
Conclusion:
A computational mathematical model to determine the temperature change of milk samples during MW heating was developed. The validated model was further modified for designing a scale-up MW system for continuous flow processing, and this system was present for an efficient processing as a novel innovation approach.

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Monodisperse bubble formation and coalescence tuned with liquid phase properties

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Aim: During large-scale production of edible foams, both the use of raw materials and the macroscopic properties of the foam need to be optimized. For this, it is crucial to understand the adsorption dynamics of the surfactants used as foaming agents, and the interplay between surfactant adsorption and bubble formation at relevant time scales, which are typically (sub)milliseconds.

Method: The microfluidic partitioned-Edge-based Droplet GEneration (p-EDGE) device has an array of pores that are protruding into a much deeper collection channel where they produce monodisperse bubbles spontaneously, simultaneously, and steadily. A crucial feature of these pores is their extreme shallowness, causing bubble formation to be controlled by the Laplace pressure and the dynamic adsorption of surfactants. In this study, the p-EDGE device is used to characterize the dynamic adsorption of *whey protein isolate* and its role on the formation and stabilization of monodisperse bubbles. We study the effects of liquid phase properties, which are the continuous phase velocity and viscosity, as well as protein concentration.

Results: In the p-EDGE device, bubble formation shows two regimes based on the applied pressure, divided by the Laplace pressure of the bare meniscus. At low applied pressure, pre-adsorption of proteins is required to decrease the Laplace pressure below the applied pressure. Monodisperse bubbles are formed initially at the pores (with diameter), with a coefficient of variation mostly below 5%. The bubble formation frequency mainly increases with increasing protein concentration. At high applied pressure, bubble formation immediately occurs upon applying pressure. Monodisperse bubbles form continuously at a frequency that mainly decreases with increasing viscosity. In general, increases with viscosity (), following a scaling of . Additionally, bubble coalescence co-exists with bubble formation at high applied pressure, resulting in a larger bubble size (). The bubble coalescence can be effectively suppressed by raising protein concentration and viscosity within certain boundaries, yet ultimately this is at the cost of higher polydispersity of the bubbles.

Conclusion: Our insights into the formation dynamics of bubbles at time scales down to tens of microseconds provide guidelines for controlling bubble formation and stabilization (against coalescence) in practical applications.

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In vitro digestion of chlorophyllin-loaded W1/O/W2 emulsions with different lipid phase compositions into whole milk

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Aim:
Water-in-oil-in-water ($W_1/O/W_2$) emulsions offer great potential for the delivery of hydrophilic bioactive compounds, such as chlorophyllin (CHL), into water-based food products, yet their application remains limited due to their colloidal instability. In this study, the impact of lipid phase composition on the formation, colloidal stability, *in vitro* lipid digestibility and bioaccessibility of CHL-loaded $W_1/O/W_2$ emulsions with gelled lipid phase and into whole milk was assessed.

Method:
The colloidal stability of the CHL-loaded $W_1/O/W_2$ emulsions was studied by measuring changes in droplet size ($D_{3,2}$; µm) and microstructure. The *in vitro* lipid digestibility was assessed in terms of free fatty acids (FFAs) release (%) and CHL bioaccessibility (%).

Results:
The successful formation of CHL-loaded $W_1/O/W_2$ emulsions with gelled lipid phase and subsequent colloidal stability during *in vitro* gastrointestinal digestion depended on the lipid phase composition. A blend of medium-chain triglyceride (MCT) oil with glyceryl stearate (GS) at 5% was efficient in forming $W_1/O/W_2$ emulsions with an average droplet size of 4.30 ± 0.63 µm, which were stable upon gastrointestinal conditions. Instead, using hydrogenated palm oil (HPO) as a lipid phase led to phase separation. The lipolysis extent during *in vitro* gastrointestinal digestion of CHL-loaded $W_1/O/W_2$ emulsions was governed by the lipid phase composition rather than the physical state, since the FFAs release end-point was higher (≥ 100%) for $W_1/O/W_2$ emulsions formulated with MCT (liquid) or MCT-GS compared to HPO (33.40 ± 0.52%). Even when incorporated into whole milk, their colloidal stability and lipolysis extent were still dependent on the lipid phase composition. The colloidal stability and lipolysis extent were not altered when the $W_1/O/W_2$ emulsion (MCT-GS) was co-digested with whole milk, whereas the incorporation of the $W_1/O/W_2$ emulsion (HPO) into whole milk resulted in enhanced colloidal stability and lipolysis extent (57.71 ± 3.06%). The CHL bioaccessibility of $W_1/O/W_2$ emulsions before and after co-digested with whole milk was linked with the lipolysis extent.

Conclusion:
This work evidences that the colloidal stability and *in vitro* lipid digestibility of CHL-loaded $W_1/O/W_2$ emulsions before and after incorporated into whole milk are not only influenced by the lipid phase physical state, but also its composition.

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Potential of Debaryomyces hansenii SP6L12 to produce cricket powder-based innovative breads

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Aim:
The use of insect in foods formulation with functional and nutritional characteristics is still limited due to consumer disapproval and their limitations as functional ingredients due to their chitin content. Therefore, the aim of this research was to use *Debaryomyces hansenii* strain, which has great technological potential for the agri-food industry, to obtain a cricket powder-based hydrolysate to be used as ingredient for innovative bread production.
Method:
The cricket-based hydrolysate was obtained by mixing commercial cricket powder with sterilized water at a ratio of 1:3 (w/v) and inoculated with *D. hansenii* SP6L12 at about 6 log CFU/mL. The sample was incubated at 25 °C for 72 h with agitation. Following, the hydrolysate obtained was added to the bakery dough at two different concentrations of 15 and 25%. The hydrolysate-based doughs and baked products, were compared with control samples containing the two different concentrations of cricket powder, obtained in the same way but without inoculation, and a second kind of control, obtained only with wheat flour.
Results:
Microbiological analyses highlighted the reduced increase in cellular load of *D. hansenii* during the 72h of fermentation. However, this strain in the mixture reduced the chitin content by 3.6 %. Compared with the non-hydrolysed sample, *Debaryomyces*-based hydrolysate was characterized by a lower protein content. The control doughs and the doughs obtained with 15 and 25% hydrolysate were characterized before and after fermentation by *S. cerevisiae*, and the content of the different protein fractions was lower for all samples after rising, but a higher reduction was evident for the sample containing *Debaryomyces hansenii,* which also showed a peculiar profile in volatile molecules. Finally, bread samples were subjected to texture and sensory analysis showing few differences between the samples.
Conclusion:
The obtained data showed that *D. hansenii* SP6L12 was able to affect the cricket powder hydrolysate thanks to its specific proteolytic activity as well as to the different production of volatile molecules. These aspects highlighted the good application opportunities of the obtained hydrolysate as ingredient for bread making. However, it would be interesting to investigate the technological potential of other high lipolytic and proteolytic strains.

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Macauba (Acrocomia aculeata) side streams: A sustainable source for innovative protein and fiber ingredients

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Aim:
Macauba palm (*Acrocomia aculeata*) is a perennial and fructiferous palm tree native to Latin America currently considered a promising alternative for vegetable oil production. With oil productivity similar to palm oil (*Elaeis guineensis*), Macauba palm can grow in drier biomes, thus reducing the risk of rainforest clearance. Both Macauba kernel and pulp render economically attractive oils. After oil extraction, the kernel meal (MKM) offers a protein concentration between 30-50%, whereas the pulp meal (MPM) has a dietary fiber content of 40-50%, both currently underutilized. Therefore, the present work aimed to recover Macauba kernel proteins and pulp dietary fibers to produce food ingredients to leverage the sustainable use of Macauba fruits.
Method:
Our approach comprised a comprehensive characterization of the MKM proteins and the MPM cell wall polysaccharides (CWP). Then integrated process solutions for the recovery of Macauba proteins and fibers were developed. In the case of MKM, oil extraction was optimized and sieve fractionation (SF) was used to produce protein concentrates. For MPM, leaching with aqueous ethanol was used to produce a dietary fiber concentrate.
Results:
Optimized oil extraction, comprising cold pressing, milling, and hexane extraction, followed by SF yielded a protein concentrate with ≥ 65 % protein content, with improved gelling and emulsion stabilization properties compared to MKM.
The CWP from MPM presented similar content of pectic substances, hemicelluloses, cellulose and lignin, with water and oil binding capacities of 1.4-8.8 mL/g and 1.1-8.2 mL/g, respectively. The water-soluble CWP presented shear-thinning behavior, whereas the hemicelluloses and cellulose-lignin CWP showed shear-thickening properties. Thus, the dietary fiber concentrate exhibited versatile functionality, like high foaming activity (685%) and emulsifying capacity (650 mL of oil/g) with high application potential in food products such as condiments, dressings, and angel cakes.
Conclusion:
The downstream fractionation of Macauba side streams resulted in sustainable and functional protein- and dietary fiber concentrates. Altogether, the exploitation of Macauba oil and the conversion of side streams from oil processing into functional ingredients can promote the sustainable use of Macauba fruits, and fuel the development of a value chain for the sustainable production of food ingredients.

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How do plant proteins and flavours interact?

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Aim:
When designing novel foods with high contents of alternative proteins, it is essential to make them attractive for consumers. Therefore, flavours can be added to improve the flavour perception of these novel plant-based foods. However, flavours strongly bind to plant proteins. The binding results in fewer aroma compounds in the headspace, which directly affects flavour perception of these foods. In this presentation, we will show the binding of flavour compounds from different classes to both plant proteins and whey protein as a reference. Furthermore, a model will be developed to predict flavour binding.

Method:
The binding of series with increasing chain length (C4, C6, C8 and C10) of esters, ketones and aldehydes to dispersions with concentrations of 0.5., 1, 2, 3 and 5% wt/wt of pea, soy, faba bean, chickpea and whey protein isolates was analyzed. Binding was measured as a reduction in relative headspace concentrations with APCI-TOF-MS.

Results:
An increase in protein concentration increased the binding of the flavour compounds. Binding also increased with increasing chain length, which is directly related to the octanol-water partition coefficient of the flavour compounds. These results confirm that the binding is mostly of hydrophobic nature. Aldehydes bound more than esters and ketones, which was explained by the additional chemical interactions between proteins and aldehydes. The obtained headspace concentrations were used to fit predictive flavour partitioning models for each protein isolate. For the esters and ketones, assuming solely hydrophobic interactions gave partitioning predictions that were able to predict 90-95 % of the experimental data.

Conclusion:
The obtained models for common plant-based proteins and whey will allow the prediction of flavour partitioning when only the octanol-water partition coefficient of the flavour is known and the chemical class of the flavour to set the chemical interaction parameter. These results are relevant when designing flavoured products with high protein concentrations, such as meat or dairy replacers.

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Effects of microwave radiation on the bioactive properties in selected vegetable species

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Abstract 1

Microwave processes are mainly used to induce thermal changes in the food, which depend on the processing time, the microwave power and the amount of processed food. Thermal changes are associated with modifications of bioactive properties in food.

The aim of the study was to examine the effect of microwave radiation on the total antioxidant capacity (TAC) and contents of polyphenol compounds in celery, carrot, broccoli, cauliflower, red and yellow peppers.

The TAC was analysedboth in fresh and microwave treated vegetables. The heating was conducted in a microwave oven for 15 min. with a rated power of 800 W and a frequency of 2450 MHz. In methanol and ethanol homogenates were evaluated the antioxidant potential by DPPH, ABTS and FRAP and polyphenol content by F-C method.

Microwave radiation caused a significant ($p \leq 0.05$) changes in bioactive properties. In carrots and cauliflower, the TAC was reduced to a lower extent than in red peppers, yellow peppers, broccoli and celery. The highest (15-20%) reduction in TAC was observed in the red peppers, celery or broccoli, containing more than 90% water. This finding indicated that the vegetables with a lower water content characterized by lower deprivation of TAC than the vegetables with a higher water content. This phenomenon is probably interrelated with a high heat capacity of vegetables with a high water content. At the same time, microwave treatment increased the total content of polyphenes in celery, carrots, broccoli and cauliflower.

During the microwave treatment, carrots and cauliflower retain the highest level of TAC as well as the highest polyphenol content.

Our results indicate that the use of a microwave oven for thermal processing may increase the release of polypheonols from the vegetable cell matrix. This suggests that consuming microwave-processed plant foods can provide health benefits to our health.

Keywords: antioxidant activity, polyphenols, vegetable extraction, microwave treatment

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A review on machine learning techniques in controlled environment food production systems

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Aim: Controlled environments can produce a large amount of environmental and crop growth-related data. Mushroom cultivation, for instance, is a very technical process and represents a special case of controlled environment food production system. The aim of this work was to identify the state-of-the-art machine learning (ML) techniques that have been used in controlled environment food production systems and analyse them based on the performed application in order to better contextualise their potential use in mushroom production environments.

Method: The literature review on the application of ML techniques in controlled environment food production consisted of two steps: (a) collection of related research studies from scientific databases and (b) thorough review and evaluation of each study. During the first step, a keyword-based search for peer-reviewed journal articles and conference papers was carried out, using keywords as [“machine/deep learning-controlled environment agriculture”] among others. The second step included the detailed analysis of the selected papers, considering the following criteria: ML technique employed, type of the controlled environment, environmental variables examined, output variable (e.g., yield, quality) and performance indicators (coefficient of determination Root, mean squared error, mean absolute error).

Results: In total, 37 papers referring to ML techniques in controlled environment food production applications were thoroughly reviewed and analysed. The analysis revealed that the vast majority focused on the prediction and control of the environmental parameters such as air temperature and relative humidity. A wide variety of ML models including traditional models e.g., regression models, random forest (RF), support vector machines (SVM) and other more complex architectures of ANN, long short-term memory (LSTM) and convolutional neural networks (CNN) have been applied to predict environmental parameters. The use of deep learning (DL) for solving more complex problems in controlled environment food production systems (e.g., correlation of climatic variables with yield) is gaining momentum.

Conclusion: The results of this survey can be used as a guidance for the deployment DL techniques on mushroom production, due to their significant advantages with respect to data analysis (e.g., learning capacity, performance and flexibility among others) of large datasets that can be generated in multi-domain mushroom production environments.

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Gentiana Lutea microencapsulation in alginate microbeads using air assisted extrusion: process parameters effects on bioavalability

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Aim:
Microencapsulation of Gentiana lutea root extract (GE) using a coating of alginate-pectine was designed to mask the bitter taste of secoiridoids in the mouth and to allow a targeted delivery in the intestine. It is well-known that bitter compounds are effective in modulation of appetite through the activation of bitter receptors in the gastrointestinal tract.
Extrusion of size-controlled droplets using air assisted microfluidic device allowed to encapsulate GE through ionotropic cross-linking gelation into a calcium chloride bath. Pressurized air as a continuous phase enables to overcome some post-processing problems like droplet gelation, oil separation and cleaning compared to the traditional liquid-liquid immiscible fluid configuration.
This study aimed at evaluating the effect of the experimental parameters as the airflow rate and GE loading content (2.5, 5, 7.5 and 10 % w/w) on the encapsulation efficiency release behavior and bioaccessibility of microencapsulated bitter secoiridoids.

Method:
The co-flow microfluidic device comprising two concentric capillaries in which the GA polymeric solution and the air flowed was printed with a 3D printer. Extrusion nozzle of 700 µm diameter allowed to convey the air flow, thus focusing the flow of dispersed phase. The gelation bath was made up of $CaCl_2{\cdot}2H_2O$ in the concentration 0.5 M.
The INFOGEST procedure was adapted to simulate the *in vitro* digestion of GE released from alginate-pectin loaded microparticles.
The total amount of secoiridoids of the pure extract and that released from microparticles, corresponding to the concentration of secoiridoids in *digestas*, was performed using high-performance liquid chromatography.
Results:

Load microparticles with GE considering a total loading content of 10 % w/w is undesirable as the increase in the loading (from 2.5 % w/w to 10%w/w) did not improve the encapsulation efficiency. The *in vitro* release study confirmed the encapsulant polymer conferred efficient protection during gastrointestinal digestion of microparticles given that maximum amount of secoiridoids was released in the simulated digestion intestinal fluid.
Conclusions:
This study showed that a microfluidic air-assisted extrusion process allows to enhance bioavailability of GE. The results bring new perspectives for the design of loaded microparticles using a clean production process.

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Antioxidant activity of fruits of selected grapevines grown in Poland

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Abstract 2

The assessment of the content of bioactive substances with a pro-health effect, especially antioxidant, is of increasing importance for consumers who use natural food raw materials. The antioxidant properties and the content of selected polyphenolic components in the fruit of five hybrid grapevines grown in Poland - Michigan, Alwood, Minnesota, V68021 and Beta were characterized. The highest average antioxidant activity (AA), measured by DPPH method, was observed in grape skin which ranged from 3.31 mg to 4.34 mg of Trolox equivalent (TE), respectively for Alwood and Beta variety. The highest mean AA of the skins as measured by the ABTS method which ranged from 2.36 mg to 6.60 mg TE/g f.m., was observed in grape skin, respectively for the Alwood and Beta variety. The mean reducing activity in the grape skin which ranged from 2.33 mg to 4.08 mg $FeSO4^{-2}$/g f.m., was observed respectively for the Beta and Alwood cultivars. The highest average total content of polyphenolic compounds (TPC) was observed in the grape skin which ranged from 2.58 mg to 16.33 mg gallic acid equivalent (GAE)/g f.m. for Beta and Alwood, respectively. It was shown that AA and TPC depend mainly on the grapevine fruit fraction and, to a lesser extent, on the variety of the tested hybrid grapes. For most of the grapes tested, there were significant differences in the total anthocyanin content between peel, pulp and juice. The skins of Alwood and Beta varieties were characterized by a particularly high content of flavonoids and anthocyanins. Analysis with the use of LC-MS-PDA-Q method, showed that among polyphenolic compounds in grape fruit, anthocyanins, flavonols and flavan-3-ol fractions dominate, respectively, with the highest content it is found in the peel, in the pulp and in the juice. The conducted research shows that non-commercial varieties of hybrid grapevines can be a highly valuable food raw material.

Keywords: grape hybrids; antioxidants; polyphenols; flavonoids; anthocyanins.

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Application of an app-based intelligent packaging system for the shelf life prediction of ready-to-eat salad

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Aim:
Intelligent packaging is a useful tool for monitoring food products along perishable supply chains. Time-Temperature-Indicators (TTIs) can control the temperature conditions along the entire chain. Combined with mathematical models, they deliver information about real-time remaining shelf life of a product. For the practical application a simple digitalized read-out system is important to determine the TTI color and product specific information. The aim of this pilot study was the implementation of a novel smartphone application for the TTI read-out and the real-time shelf life prediction in a ready-to-eat salad (RTE) supply chain.
Method:
A microbial shelf life model of RTE was established under laboratory conditions. Another model was developed for TTI discoloration kinetics and integrated in a novel programmed app. In the pilot study 200 samples of RTE (lettuce, carrots, corn) were labeled with TTIs immediately after production. Samples were transported to the laboratory under real chain conditions including transshipment points and the retailer. During transport and storage, TTI discoloration was measured with the app and a common spectrophotometer. Growth of total viable count (TVC), sensory quality and safety parameters (*Listeria* spp., *Bacillus cereus)* were parallelly analyzed. Finally, the individual remaining shelf life predictions by the app could be evaluated.
Results:
Color measurements with the smartphone and spectrophotometer in different color spaces (RGB, LAB) show high correlations (R^2=0.94). Temperature variations on the pallet during transport could be reflected by the app. Shelf life of carrots as the limiting component was calculated for 2, 7 and 10°C as 11.4, 5.6 and 5.2 days, respectively. The determination of remaining shelf lives by the app was generally possible, resulting in slightly shorter shelf lives with variations of 1-3 days.
Conclusion:
Results show that TTI color measurements with a smartphone were successful under practical conditions. Digitalized TTI systems are a promising application for real-time shelf life prediction of RTE. The implementation of a smartphone for the read-out at every step of the chain enables to optimize processes, logistics and storage. Additional information about quality and temperature conditions can support all stakeholders including consumers to reduce food waste and increase resource efficiency along the chain.

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Impact of fiber-enriched wheat flour on the technological quality of wheat bread doughs

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Aim
Water is one of the most important ingredients of wheat bread, besides flour, yeast and salt. It plays an essential role in different mechanisms during each step of production and storage by interacting with various other components. Fibers are commonly known to have a high water retention capacity. Fiber-enriched wheat bread might have potential to redistribute bound water during preservation in order to delay the process of retrogradation and consequently the staling mechanism. Preventing this phenomenon leads to longer shelf life of wheat bread and less food waste. The aim of this research was to investigate the incorporation of fiber components on the water absorption and technological quality of wheat bread doughs.

Method
The impact of fiber enrichment on wheat bread dough was investigated with a set of fiber products (cocoa, apple and pea fibers) selected for their higher water retention capacity and varying source material. Wheat flour was enriched with fiber at 1, 5 and 10 % (w/w) and dough properties were subsequently analyzed by the use of a farinograph and an alveograph of Chopin. The effect on pasting properties with a rheometer and starch gelatinization cell was also assessed, as well as the yeast proving rate with a texture analyzer.

Results
Increased fiber percentages caused an increase in water absorption and a decrease in dough quality, noticeable in a decrease in elasticity and strength. Additionally, higher percentages of fiber increased the holding strength and final viscosity for cocoa and apple fiber-enriched flour, as well as the peak viscosity for the latter. The results demonstrated an optimal proving rate for 1% mixtures of the cocoa and apple fiber.

Conclusion
Together, the present findings prove the potential of cocoa and apple fiber enrichment in wheat flour at low percentages for the preparation of bread doughs. Pasting curve data were promising, indicating greater water absorption and gelation, which is beneficial for enhanced water redistribution in the further production process and preservation of wheat bread. Higher concentrations however, are unfavorable for the technological dough quality and are thus not preferable in a practical validation.

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Gastronomic plan to valorize date seeds as a functional ingredient of bread.

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Aim:
Today, industrial food production is inevitably linked to the generation of by-products which represent an additional cost for the producer. A large part of these by-products are used as fertilizers, ingredients in animal and pet feed and other applications which, in many cases, represent an additional cost for the producer. However, there is a paradigm shift as the recovery of agri-food waste is shown to be one of the fundamental pillars of the circular economy.
Date seeds contain a large amount of fibre, fatty acids, proteins, and several compounds with antioxidant properties. In this sense, this work arises from the need to valorise this by-product to develop new functional foods that beneficially affect the consumers.
The aim of this study was to assess the physicochemical and nutritional properties of bread produced by replacing wheat flour with date seed flour.
Method:
The bread was baked modifying the percentage of date seed flour to improve the physicochemical and nutritional properties of the final products. To elucidate the impact of date seed flour on quality changes of the final products, the physicochemical (specific volume, colour, sensory value, texture), and functional (phenolic and fatty acid composition, antioxidant capacity) properties of bread were investigated.
Results:
The physicochemical properties as texture or specific volume were modified due to the presence of date seeds flour. The final products with date seed flour had organoleptic properties comparable to the control bread, only the colour was altered due to the brown of the date seeds. The addition of date seed flour to wheat increased the content of bioactive compounds and fatty acids. Besides, the antioxidant capacity of bread with both flours showed a higher value compared to the control. Consequently, the nutritional value of these products was improved.
Conclusion:
The production of bread with both wheat and date seed flour revealed that this combination is an attractive opportunity to have a functional product rich in bioactive compounds and considered satisfactory by consumers. Besides, this application may facilitate the establishment of a circular economy around the date industry by the re-introduction of by-products into the productive system.

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Rapid and non-destructive monitoring of fish freshness using Fourier transform infrared spectroscopy (FTIR)

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Abstract.
Aim:
Fresh fish is a highly perishable food and failures in the cold chain result in substantial waste. Reliable, low cost and non-destructive tools are highly needed for management and monitoring of fish freshness. The present work aimed the evaluation of FTIR as an example of the mentioned tools. This was correlated with microbiological quality monitoring.
Method:
European sea bass (*Dicentrarchus labrax*), obtained from a local fish company, were classified using the Quality Index Method (QIM) scale. Muscle samples were analysed by micro-FTIR (Thermo Scientific, model iN10) upon receipt and during storage under isothermal conditions (2ºC). In parallel microbiological quality was analysed using classical microbiological methods (plate counts) and quantitative (q)PCR for the bacteria-specific 16S rRNA gene. The FTIR spectra were pre-processed and principal component analysis (PCA) was used to classify fish samples and correlated with microbiological data.
Results:
qPCR for 16S and colony counting indicated a significant increase in the bacterial load. On the obtained FITR spectra (500 to 4000 cm^{-1}), the water in the white muscle was detected at 2500 to 3650 cm^{-1}, while the muscle proteins, lipids and trace elements were detected between 1750–900 cm^{-1}. This wavelength range was selected for collection of spectra because of its high sensitivity to C N, N H and C═O molecular bonds in proteins. Furthermore, the spectral peaks at 1460, 1240 and 1175 cm^{-1} are attributed to fat (C O ester) and the peaks from 1025 to 1140 cm^{-1} are the results of absorbance of amines (C N stretch). Visual inspection of the collected spectra did not show observable changes in the pattern of spectral peaks, but differences were visible between the peak ratios. The use of PCA to analyse the spectral ratios of different samples separated them in accordance with their freshness state and bacterial load, which increased with the time of storage.
Conclusion:
FTIR spectral analysis is a promising, rapid and easy to apply technique for fish freshness monitoring along the cold supply chain. Scaling the technique-up for industrial screening will require further studies to assess a broader range of sample types, species and processing and storage conditions.

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Formulation of astringency solutions for plant-based beverages assisted by multi-sip sensory evaluation and mixture design

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Aim:
The number of products containing plant proteins is constantly growing. However, many plant proteins have undesirable sensory attributes such as beany, hay, bitterness, and astringency. Specially, astringency has been found to be an attribute in plant-based beverages negatively influencing consumer liking, hence the need to reduce it for improving consumer acceptance of those products. Sensory evaluation of astringency remains challenging due to its persistence and cumulative effect during consumption. Therefore, this study aimed to define an adapted approach to evaluate astringency perception in plant-based beverages in order to evaluate impact of innovative masking flavour solutions on astringency perception.

Method:
A multi-sip time intensity sensory approach combined with mixture design of experiment were used to develop astringency masking strategies using three flavouring agents (FA) alone or in combination. A pea-based beverage containing 3% protein was used as food model. A panel (n=12 subjects) evaluated each product by five consecutives sips and four evaluation in time after one sip.

Results:
Results showed that the astringency perception is a complex and dynamic attribute in beverages, which depends on the time but also on the number of sips during evaluation. For example, the more sips were taken during evaluation, the larger was the astringency perception intensity. However, for the same sip, the astringency perception decreased along time. The masking performance evaluation of FAs demonstrated synergic effects between FA1 and FA2, and response surface methodology was then used to predict the optimal flavour formulation for a minimal overall astringency in pea-based beverages.

Conclusion:
Astringency is a sensation that comes from complex mechanisms not yet fully understood and thus adapted sensory evaluations are still very limited. In this study, a multi-sip time intensity sensory approach demonstrated its efficiency to study astringency perception and combined with mixture design of experiment was successfully applied to assist the formulation of masking strategies in plant-based beverages.

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Hyperspectral imaging and deep learning for evaluating adulteration in meats

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Title
Hyperspectral imaging and deep learning for evaluating adulteration meats

Aim
1) Assessing the feasibility of using several rapid and/or non-invasive sensors for meat adulteration evaluation.
   - Utilising deep learning algorithms to develop models by meat adulteration can be qualitatively and quantitatively conducted.

Methods
- Beef and pork were adulterated with chicken, and plant-based proteins in different ratios.
- Optical sensors were used to scan the samples including colour vision, hyperspectral imaging, and spectroscopic.
- Deep learning models were applied to classify samples based on the presence of the adulterant as well as the type of the adulterant.
- The ratio of adulterant was evaluated using deep learning regression models.

Results
- Results indicate that there is a feasibility for using optical sensors couples with deep learning technique to detect animal and plant based adulterants.

Conclusion
- Optical sensors can be effectively used for rapid evaluation of meat adulteration.
- Optical sensors have the possibility for developing online systems for adulteration of meat products.
- Sensor fusain was found to boost the performance of classification and/or regression models.

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IPSUS: Climate smart food innovation using plant and seaweed proteins from upcycled sources

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Aim: Food choices impact human and planetary health. The negative environmental impacts of the food system, increasing food insecurity and the prevalence of unhealthy diets are driving policymakers, scientists, companies and consumers to demand sustainable solutions. Globally, livestock emits 14.5% of GHGs; as meat consumption is projected to double by 2050, transitioning to diets that include more sustainable sources of protein is becoming crucial. Plant-based proteins are currently the fastest growing food trend but are unsustainably dependent on soy. The IPSUS project will exploit inter-disciplinary and eco-innovative approaches to upcycle plant and seaweed proteins from agri-food raw materials otherwise destined to join the ~1.6 billion tonnes of annual global food loss and waste (FLW). The quantity, quality, and upcycling opportunities of six protein-rich FLWs (pumpkin, hazelnut, grape, potato, brewers' spent grain, and seaweeds) across the value chains will be investigated in the UK, Italy, Romania, Turkey, and Morocco to address Net Zero opportunity by linking sustainable protein shift and food waste valorisation.
Method: Novel protein extraction methods will be assessed to identify and optimise the less energy and more sustainable techniques. The nutritional quality and safety of the plant and seaweed sources and upcycled proteins will be assessed, taking bio-accessibility and potential allergenicity into account. Incorporation of upcycled proteins into meat and dairy alternative formulations will be tested at lab-scale, followed by prototype development at pilot-scale by the industrial partners. Product's development will not only be addressed to reach functional and sensory acceptability of the prototypes, but also to promote improved nutritional and cleaner label offerings. Exploration of consumer behaviours, preferences and the enabling regulatory and policy environment will reveal drivers and barriers of the sustainable protein shift via upcycled plant proteins.
Results: IPSUS will expectedly: deliver new insights on FLW upcycling opportunities; develop eco-innovative, cost-efficient protein extraction methods; provide diversified plant protein portfolio; create a greener value chain compared to the plant-based meat and cheese alternatives currently in the market.
Conclusion: The interdisciplinary group of IPSUS will address issues across the food systems to support future-proofing of current plant protein supply and deliver innovative, culturally-acceptable meat and cheese alternatives.

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Effect of heating on textural and temperature sensitivity of casein gels

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Aim:
Heating is applied in the production of different types of cheese as it regulates syneresis and thus the gels moisture content, which in turn affects mechanical properties. However, whether these changes can be ascribed exclusively to syneresis or other additional effects caused by heating is still unclear. In this work, we investigated the effect of heating on the mechanical and textural properties of rennet-induced casein gels.
Method:
To isolate changes in gel properties induced purely by syneresis from other effects due to heating, two series of gels were prepared with a similar range in moisture content. The first series was heated at various temperatures, and the second series was centrifuged at increasing centrifugal force. Changes in composition were determined, and dynamic rheology experiments were executed, and texture profile analysis was performed.
Results:
Temperatures above 40 ℃ caused substantial losses of casein, calcium and phosphorus in the cooking water, and resulted in a more compact gel structure. Heating also led a gel structure with less stringy, more fused structural elements and a more heterogeneous network. This fused and coarse structure led to a more brittle, softer, less firm, less strain hardening gel with a decrease in resilience. In addition, the heated gels became more softening and decreased in flowable upon temperature increase
Conclusion:
Our results thus indicate that the additional effect of casein particle rearrangement induced by heating on texture and structure properties of casein gels even at the same dry matter content, and provide a novel and promising way to fry and bake dairy products with softening the matrix but maintaining its flowability.

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Soybean oil organogelled emulsions as oral delivery systems of hydroxytyrosol and hydroxytyrosol alkyl esters

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Soybean oil organogelled emulsions as oral delivery systems of hydroxytyrosol and hydroxytyrosol alkyl esters

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Aim: To design soybean oil organogelled emulsions (OGEs) with mechanical properties similar to lard, as oral delivery systems of bioactive compounds with different hydrophobicity
Methods: A ternary blend of candelilla wax (2.5% w/w), fully hydrogenated palm oil (3% w/w) and monoacylglycerols (2% w/w) was used to formulate soybean oil OGEs with different water content (50-70% w/w). The following bioactive compounds were added to OGEs to a final concentration of 25.94 mM in all cases: Hydroxytyrosol (HT, hydrophilic compound), HT alkyl esters (HTAE) with medium chain length and intermediate hydrophobicity (HT decanoate, HTC10) and HTAE with long chain length (HT stearate, HTC18; hydrophobic compound). The mechanical properties of OGEs were evaluated and compared with lard. OGEs were subjected to *in vitro* gastrointestinal digestion according to Brodkorb et al. (2019), and the bioaccessibility of HT or HTAE was determined.
Results: The increase in the water content influenced the mechanical properties of OGEs. The lard used as control was similar to OGEs with 55% water in hardness, spreadability, viscosity, and adhesiveness; suggesting that 55% is the ideal amount of water in OGEs to replace lard without changing the mechanical properties. High bioaccessibility values (>84%) were found for the three bioactive compounds incorporated into the OGE matrix (HT, HTC10 and HTC18), despite the differences in the chain length and therefore in hydrophobicity. In the case of HTC10 and HTC18, only a slight desesterification was observed during digestion, forming free HT. The fact that OGEs loaded with HTC10 showed high bioaccessibility values for the esterified compound is particularly remarkable, since medium chain HTAE have been related with the highest antioxidant activity in biological systems.
Conclusion: Soybean oil OGEs with high water content (55%) were designed as fat replacers of lard, improving the fatty acid composition and reducing both fat and calories content. OGEs showed a great potential to be used as fat replacers and delivery system for both hydrophilic and lipophilic bioactive compounds in foods.

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Process for a low molecular mass beta-glucan recovery from oat

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Aim:
Our recent studies on the effects of oat beta-glucans dietary supplementation on inflammation of the large intestine (but without early carcinogenesis symptoms) have shown that low molecular weight of oat beta-glucan down-regulated expression of many genes of pro-inflammatory proteins, especially chemokines as well as large intestine content of these proteins (article in preparation).
It should be underlined that during gastrointestinal disorders, especially inflammatory bowel diseases or cancer of these organs, multi-component, unpurified preparations obtained from grinding of oat grains like oat porridge or fiber cannot be used as a food additive. These preparations contain many active ingredients, among others fraction of insoluble fiber irritating the intestinal mucosa as well as proteins that may additionally cause hypersensitivity and intolerance. The aim of the study was to established the process of obtaining low molar mass during on stage extraction process.
Method:
Oat bran concentrate of 15% beta-glucan content was used as a raw material. Alkaline extraction were performed at pH 9,0-9,5 using 0,1 M NaOH at 80ºC for 1 h. Before the extraction stage milled bran concentrate was deffated with 50% EtOH solution. Thermostable α-amylase and amyloglucosidase enzymatic preparation, and papain were used for consecutive residue removal. Three levels of low pH = 4.5, 3.5 and 3.0 were also tested for effective protein precipitation after extraction. The mean molar mass determination was performed by intrinsic viscosity measurement. The viscosity of 0.5% (w/v) solution of β-glucan samples in Ostwald capillary viscosimeter was determined while the measurement was proceeded in 30 °C.
Results:
The starch hydrolysis and liquefaction significantly facilitate the proteinaceous matter removal while papain usage showed an intensive impact on final low β-glucan molar mass fraction recovery.
Conclusion:
Beta-glucan recovery process can provide difficulties due to high viscosity of the medium. Huge part of the viscosity occurring comes from proteins present in bran and extracted. Joint enzymatic activity of starch and protein hydrolases can both liquefy and remove proteins from resulting beta-glucan solution.
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Wheat flour substitution by fava bean flour for whole wheat bread

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Aim
The consumption of too much red meat and milk and too little fruit, vegetables, pulses, nuts and whole grain products is a common problem according to the Global Nutrition Report. With an average intake of only 5.3 g/day, the very low consumption of pulses in Germany is particularly striking. The incorporation of legumes in popular cereal based foods like pasta or baked goods is widely used as it is a possible opportunity to increase the consumption of legumes.
The aim of this work was therefore to analyse the physical properties of a whole wheat bread enriched with fava bean flour.
Method

10 %, 15 %, 20 % and 25 % of whole wheat flour (WWF) was replaced by fava bean flour (FBF) in a standard bread recipe. The physical and baking properties of the recipe variations were then investigated.

Results
The water absorption and dough stability time decreased while the dough development time increased with increasing concentrations of FBF. The stickiness and cohesiveness of the WWF doughs increased significantly with increasing concentrations of FBF. The breads made from the composite flours showed no significant differences in terms of their baking loss. Compared to the reference bread (100 % WWF), the specific volume of the formulations with 10 %, 15 % and 20 % FBF increased. The specific volume of the recipe with 25 % fava bean flour was significantly lower than that of the recipes with 10 % and 15 % FBF. The colour saturation of the crust increased with increasing concentration of FBF. A significant increase in crumb hardness and adhesiveness were observed with increasing concentrations of FBF. The breads with high substitution rates showed significantly lower crumb moisture contents.
Conclusion
To overcome the quality deficits with high substitution rates, the combination of hydrated fava bean flakes with flour as substitution of whole wheat flour in combination with higher amounts of water during the dough preparation is currently evaluated. Nutritional analysis of the resulting breads are performed currently. The promising results will be presented at the conference.

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Probability of germination of Botrytis cinerea using an acid-based model system of strawberry.

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Aim:
Botrytis cinerea is the main fungi responsible for strawberry post-harvest decay. Understanding the factors affecting its germination is crucial to control its growth and reduce the amount of fruit waste generated during pre- and post-harvest stages. The aim of this study was to evaluate and model the effects of storage temperature and water activity (a_w) on *B. cinerea* germination in strawberry, simulating real-life scenarios of product quality and storage over shelf-life.
Method:
The effects of storage temperature (5, 10, 15, 20 and 25ºC) and a_w (0.920 to 0.998) on *B. cinerea* germination were evaluated in a strawberry model medium (pH = 3.7) based on Potato Dextrose Agar, modified using acids naturally present in the fruit (citric, tartaric, malic, shikimic and fumaric). Glycerol was used to adjust the a_w of the medium to values set at the experimental design. *B. cinerea* conidia (10^5 conidia/mL) were inoculated in cylinders placed into Petri dish plates containing the modified model medium. Inoculated plates were stored at different temperatures and conidia germination was monitored under microscope (x100) for up to 30 days.
Results:
B. cinerea germination was significantly affected by a_w at all temperatures tested. An asymmetric model was fitted to the percentage of germinated spores (P_t) as a function of time under the evaluated conditions to estimate the maximum percentage of viable spores ($P_{\max}$, %) and the germination time where $P_t = P_{max}/2$ (τ, days). P_{max} varied from 0.45 (T=5°C, a_w=0.932) to 1.0 (multiple conditions). Log(τ) decreased linearly by increasing a_w at a given temperature. The τ values increased by decreasing storage temperatures from 15 to 5°C, whereas increasing temperatures from 15 to 25°C did not significantly affect its values at a fixed a_w. Overall, the τ values ranged from 0.4 days (T=25°C; a_w=0.998) to 10.2 days (T=5°C, a_w=0.932).
Conclusion:
The *B. cinerea* germination in strawberry can be delayed by lowering storage temperatures, while fruits with higher a_w favour its germination during shelf-life. The models developed in this study can be deployed to manage strawberry storage conditions to enhance strawberry shelf-life and reduce post-harvest waste.

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Effect of raw materials and processing parameters on the digestibility of sourdough bread

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Aim: The study of digestibility of leavened baked goods has recently been entered into the context of human health. Specifically, the proteins hydrolysis and the starch hydrolysis during baked goods making, the usage of nutrients, and the gastrointestinal manifestation after intake, hold a strong relationship with the digestion process. Furthermore, long fermented sourdough and its microbial composition affects the digestibility of leavened backed goods. This work aimed at assessing the *in vitro* bread digestibility, as nutritional marker, of different experimental bread. In particular, the activity focused on the identification and investigation of the main drivers affecting the sourdough bread digestibility.

Method: Forty-six breads, were the result of a multiple combination of raw materials and technological parameters. In order to cover a wide range of factors, flours, fungal proteases, lactic acid bacteria (LAB) cytoplasmic extracts, type of sourdough (fresh, liquid or dried), pools of starter culture (LAB and yeast) and time and temperature of sourdough fermentation were used for making breads. A first screening on the evaluation of acidic parameters, total free amino acids (TFAA) value, *in vitro* protein digestibility (IVPD) and predicted glycemic Index (pGI) was carried out. The evaluation of the TFAA and IVPD mainly allowed an in-depth investigation of six-breads on peptides (Tricine-SDS-PAGE, RP-HPLC), ammino acids profile and protein quality indexes (Chemical Score, Essential Amino Acids Index, Biological Value, Nutritional Index).

Results: The findings showed a greater digestibility from the use of longer fermented sourdough in breads produced from whole wheat, spelt and rye flours. In addition, the use of LAB strains selected for their high peptidase activity, the addition of fungal proteases and fermentation of sourdough at 37°C yielded breads with improved digestibility and quality of protein nutritional indexes.

Conclusion: The identification of the six specific conditions among flours, enzymes, LAB strains, and the fermentation temperature of sourdough provided an assessment of the factors that mainly influence the digestibility of sourdough bread and could be involved in technological processes.

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Combination of green and gentle technologies for the development of innovative hop-based powder ingredients

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Aim:
Plant extracts represent a modern strategy to replace synthetic additives and satisfy the consumers' demand for sustainable, innovative, functional, and clean label products. Hops (*Humulus Lupulus L.*) are a rich source of diverse secondary metabolites (e.g. bitter acids and polyphenols) interesting for both sensory and bioactivity properties. Hops extracts (HE) present a low stability during processing and storage, being sensitive to environmental stresses (e.g. high temperature, oxygen, water, light) causing biological value and functionality loss.
Aim of this study was, thus, to select and combine green and gentle extraction methods and microencapsulation to produce and stabilize hops extracts thereby their use as natural additives/ingredients in food and nutraceutical formulations could be promoted.

Method:
Different extraction technologies (high hydrostatic pressure, high power ultrasounds, dynamic maceration) were used to obtain HE (cv. Herkules) that were analyzed for their bioactives and flavor compounds pattern. Based on the extracts' composition and process efficiency, the one obtained using ethanol (50 % v/v) and ultrasounds (100 Watt, 50 kHz; time 30 min; T: 25 °C) was selected. After ethanol removal, a dispersion in a 0.02 % w/w Tween 20 solution was made, mixed with (+12 %) maltodextrin (MD), Arabic gum (GA), or their combination (1:1 ratio) and freeze-dried. The encapsulated powders HE (eEHs) were evaluated for: moisture (Mc), water activity (a_w), solubility, flowability, moisture sorption isotherms (WSI), color, bitter acids and, polyphenol content, load yield (LD) and encapsulation efficiency (EE). The chemical stability of the differently encapsulated HE was evaluated (50 °C, up to 35 days).

Results:
Extraction methods affected significantly the HE composition and their quality properties and bioactivity. Coating materials influenced the Mc, a_w, and color of the eEHs while did not affect their solubility. All eEXs showed sigmoidal WSI with those containing AG showing the highest higher equilibrium moisture content. Despite the lowest LD, MD determined the highest EE and consequent protection of phenolic compounds and bitter acids over storage.

Conclusion: Ultrasound extraction and freeze-drying microencapsulation with maltodextrins can be effectively exploited by food industries to produce powder hop extracts rich in bioactive and techno-functional compounds and at increased stability.

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Modelling the potential exposure of C. difficile from retail foods in an Irish community setting

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Aim:
Clostridioides difficile is an obligate anaerobe globally recognised as the leading cause of hospital-acquired infectious diarrhoea and the most prevalent cause of antibiotic-associated diarrhoea. In recent years, the epidemiology of *C. difficile* infection has evolved from a traditional nosocomial disease to transcend its known risk factors with an increased incidence in community-associated cases (CA-CDI). A hypothesised association between *C. difficile* and food has suggested that food may be a possible vehicle for human exposure and infection. *C. difficile* has been recovered from a variety of Irish retail foods at an overall study prevalence of 3.75%; with meat products (0.91%), salad products (6%), and dairy products (6.67%) included in this scope (Marcos et al., 2019). These findings allow to evaluate the potential of the food pathway to contribute to the total exposure of *C. difficile* and subsequently develop CA-CDI. This was achieved by the application of an existing agent-based model adjusted to the specific Irish scenario.

Method:
This model employed a hospital-based *C. difficile* transmission framework reported by Kwon et al., 2016 that was translated to an Irish community setting for one year, simulating the probability of contaminated foods as reported by Marcos et al., 2019. The exposure scenarios for each food were detailed using consumption data from the National Adults Nutrition Survey (NANS) (IUNA, 2008-2010) and using Bord Bia, Meat and Livestock Review(2019) data on the yearly consumption of named foods. The reported total outpatient antimicrobial use for Ireland in 2019 as reported by the HPSC was assumed at 21 DDD/1000 inhabitants/day and simulated in the community as a risk factor for human susceptibility to colonisation in the community setting due to the treatment's recognised ability to disrupt an individual's gut microbiota and enhance the opportunity for *C. difficile* to colonise and infect.

Results:
The retail foods were risk ranked based on the quantitative outputs on *C. difficile* exposure/colonisation incidence of the respective exposure scenarios.

Conclusion:

Given the estimated low rates of *C. difficile* prevalence in Irish retail foods, the food safety risks in the community setting for the specified food types are low. Future work will assess the effect of cold-chain and storage conditions on *C. difficile* spore viability in retail foods.

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Influence of a data-rich fiber extract on a dry-cured sausages snack model system

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Influence of a date-rich fiber extract upon a dry-cured sausage snacks model system

COVID-19 pandemic brings a lot of changes in consumer perception of foods. Environmental-friendly technologies, km 0 foods, and coproducts valorisation (CV)are some of the most important concerns for the meat industry. Thus, dates (*Phoenix dactylifera*) CV can be a good solution to develop a give new options for healthy meat products. Dry-cured sausages (DCS) are a good option for snack size. Dates valorisation is an opportunity to obtain Intermediate Food Products (IFP) that can be used as novel ingredients.

Aim: To use a sustainable date *(Larga* cv) IFP in a DCS snack model system. Also, to evaluate its influence upon industrial and physicochemical properties during processing.

Method: The IFP was obtained applying eco-efficient technologies. The DCS (16-18 mm diameter) was made using an industrial formula (pork: 60% lean meat, 40% backfat), 4.5% paprika, IFP (0% control-C and 3%), 0.2% spices, and curing agents. Parameters under study were weight loss-WL, width, and length (expressed as %). Physicochemical parameters were colour parameters (CIELAB), pH, and reflectance spectra (360-740nm). Processing conditions were temperature (16-18ºC); relative humidity (80-85%) and time (4 days). The experimental design was measurements 4daysX2 concentrationsX3batchesX3samplesX3measuremets. ANOVA and Tukey´s tests were applied.

Results: All parameters were affected by the addition of IFP ($p<0.05$). Both reach the required commercial WL (>30%), exactly, C: 41.56±1.66%; 3%: 36.78%± 1.12. For width and length, the reductions were higher ($p<0.05$) in C samples 21.97± 0.99% and 6.01% ± 0.66 respectively; 3%: 19,24± 0.56% and 6.80±0.45%. pH in both DCS decreased during processing. Samples with IFP showed lower pH values of 5.38±0.11. CIELAB parameters were affected by processing time. Thus, IFP decreased L*, a*, and b* coordinates. In both DCS, reflectance spectra showed isosbestic points from 360-560 nm (0 days), and in IFT samples, reflectance was lower from 570-740 nm. At 4 days no isobestic points were detected and samples had lower values for all wavelengths.

Conclusion: The use of Larga-IFP is suitable as a new ingredient for DCS and could be commercialized. Colour parameter and reflectance spectra decrease with the additions of IFP.

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Green Options to Substitute Nitrate in Cured Meat Products

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Aim:
Nitrites and nitrates are precursors of N-nitrosamines that might be involved in the risk associated with colorectal cancer. Nitrite has several technological functions, namely the formation of the colour in cured meat products, being difficult its replacement. This work aims to use *Thymus citriodorus* and *Salvia elegans* as natural replacers of nitrate in cured meat sausage (CMS) with a starter, *S. equorum*, evaluating its impact on the product colour.

Method:
Three batches of the following formulas of CMS were produced: C1- Control without nitrate nor starter; C2- Control with starter *S. equorum* without nitrate; F1- 150 mg KNO_3/kg; F2- 150 mg KNO_3/kg with starter; F3- Sage10.6%; F4- Sage10.6% with starter; F5- Thyme10.6%; F6- Thyme10.6% with the starter. Analysis was performed on days 0 and 60 (final product and end of shelf-life). Microbial analysis was performed according to ISO Standards: Lactic Acid Bacteria (LAB), Coagulase Negative Staphylococci (CNS), and *Enterobacteriaceae*. A_w and pH were evaluated. The colour using L*a*b* colour space was measured with a Konica Minolta CR-400/410 (Konica Minolta, Japan) illuminant D65. Residual nitrate and nitrite were determined.

Results:
Staphylococci counts in the product conditions with the starter were approximately 7 Log cfu/g for both days 0 and 60. Regarding colour, on day 0, no significant differences in L* value were observed, but on day 60, values ranged from 46.86 (F6) to 51.16 (F2), being these two extremes statistically different. On day 0, excepting the Sage formula, all products inoculated presented higher a* values. F2 (a*=13.16) and F6 (a*=13.19) products were significantly redder. On day 60, the same impact on colour was observed. Control samples presented b* values significantly higher than F3 at day 0. No statistical differences were observed for the b* value at day 60.
Conclusion:
It has been challenging to achieve the typical redness of CMS with green nitrite options. The CMS formulated with Thyme and inoculated with *S. equorum* seems to be a good strategy for replacing nitrate since it presented a colour similar to that of products with synthetic nitrate.

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How preservatives affect exopolysaccharide formation of starter cultures in food matrices: Lauric arginate (LAE)

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Aim: It is known that environmental stress conditions such as cold temperatures or ionic strength can promote microbial exopolysaccharide (EPS) production, which due to their functional properties represent an interesting alternative to conventional hydrocolloids for the food industry. However, the influence of preservatives on the intentional EPS formation by starter cultures in food matrices has not yet been investigated.
Methods: The influence of lauric arginate (0-300 µg/mL LAE) on the growth behavior and EPS production of heteropolysaccharide (HePS)-forming *Lactobacillus plantarum* 1.1308 and homopolysaccharide (HoPS)-forming *Lactobacillus sakei* 1.411 (inoculation level: 10^4 CFU/mL) were studied in modified MRS broth in the absence or presence of 2% BSA to simulate protein interactions that may occur in meat or plant protein-containing products (pH 6), and samples were stored under optimal (30°C, 48 hours) and cold conditions (5±1°C, 14 days). Microbial growth kinetics were studied by plate counts, EPS formed in-situ were quantified at different growth phases by HPLC, and protein-preservative interactions were examined by turbidity and microelectrophoretic measurements. The results were compared to the non-EPS-forming strain *L. sakei* 1.2037.
Results: *L. plantarum* proved to be less sensitive to LAE than *L. sakei*, with minimum inhibitory concentrations determined to be 60 and 20 µg/mL, respectively. The differences were even more pronounced *($p < 0.05$)* during cold storage, with *L. plantarum* remaining nearly constant at all LAE concentrations tested, whereas a decrease in cell numbers was observed for both *L. sakei* strains at ≥ 100 µg/mL. The highest amounts of EPS in absence of LAE were produced during the exponential growth phase (e.g. 994.509 ± 56.709 mg/L for *L. sakei* 1.411). In samples with sublethal LAE concentrations, remarkable HoPS production occurred during the stationary phase, while HePS formation was inhibited. Electrostatic complex formation between BSA and LAE reduced the antimicrobial efficacy of LAE and affected EPS formation.
Conclusion: The study provides first insights into the influence of preservatives on in-situ EPS formation by starter cultures, impacting the structuring and texturing of food. In addition to the preservative, both the starter culture used and the type of EPS formed are important, as are the process conditions selected.

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Sequential batches strategy for the enhancement of protein recovery from salmon frames by proteolysis

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Aim:
The aim was to test a new operational strategy consisting in sequential batches where the aqueous phase containing the soluble peptides is withdrawn and the remaining solid phase is submitted to a second batch. The hypothesis is sustained in the fact that peptides inhibitis the protease action, thus, the protein extraction should increase when they are withdrawn.
Method:
The strategy was tested for the hydrolysis of salmon frame proteins by 13 AU subtilisin per kg at 55°C and pH 6.5 (native) during 2 h in a regular batch. Two sequential batches were operated during 1 h each at the same conditions. After 1 h the reaction mixture was centrifugued and the different phases weighted and analyzed for nitrogen content. The solid phase was hydrolyzed in a second batch during 1 h at the same operating conditions.
Results:
The nitrogen extraction was 26.6% ± 0.6 after 2 h of hydrolysis in a regular batch operation. Two sequential batches were operated during 1 h each with the same total protease dose (13 AU/kg) distributed as 75/25, 50/50 and 25/75 percentage in the first/second batch. The nitrogen extraction resulted in 42.9% ± 3.9, 45.9% ± 1.7 and 48.7% ± 0.1 for each protease dose distribution, respectively. These results showed that an increase in nitrogen extraction can be achieved without increasing operation time and protease dose. The sequential batches were also tested without the addition of protease in the second batch. The nitrogen extraction was 43.4% ± 1.5, 43.4% ± 3.3 and 35.3% ± 0.3 for protease dose of 75%, 50% and 25% (respect to 13AU/kg) added to the first batch and without addition in the second batch, respectively. The adsorption of subtilisin was inferred from results as an explanation for the hydrolysis reaction observed in the second batch.
Conclusion:
The nitrogen extraction was significantly increased with the sequential batches strategy without increasing the operating time and protease dose compared to a one batch operation. A higher nitrogen extraction was obtained even without addition of protease in the second batch. The sequential batches is a promising strategy to enhance the efficiency of the enzymatic hydrolysis of byproduct proteins.

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Enhancing the functionality of iron-fortified Hibiscus sabdariffa beverage: the potential role of liposomes

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Aim:
To address iron deficiency (ID), there have been concerted efforts to increase dietary iron intakes through the fortification of staple/commonly consumed foods. Nevertheless, ID remains the most widespread nutritional deficiency globally, disproportionately affecting low- and middle-income countries, these countries have the added challenge of reduced iron bioavailability due to dependence on largely plant-based diets. Furthermore, iron-fortification often imparts unwanted sensory changes on food, affecting consumer acceptance. Therefore, a liposomal encapsulation system was developed to deliver iron through a commonly consumed beverage in sub-Saharan Africa, the *Hibiscus sabdariffa* (hibiscus) beverage.
Method:
Using the thin film hydration method, soy lecithin-based liposomes loaded with ferrous sulphate or ferrous sulphate together with disodium EDTA, a chelating agent to prevent iron-polyphenol complexes, were characterized, and compared. Cholesterol was added to stabilize the membrane of the liposomes in molar ratios 1:0, 1:0.25, 1:0.5. 1:1 (soy lecithin: cholesterol). A transmission electron microscope (TEM) was used to determine the morphology of the particles. Iron encapsulation efficiencies (EE) were also determined using UV–Vis spectrophotometry. Iron retention in the liposomes, stored in milli-q water at 4?C were analysed weekly for 4 weeks.
Results
Liposomes made with 1:0.25 soy lecithin: cholesterol molar ratio had the desired morphology; homogenous, spherical-shaped liposomes, and particle sizes well below the targeted 4 – 15 ?m range for aqueous beverages. The liposome loaded with iron alone had a high EE of 94.7 ? 2.6% while the liposomes with both iron and disodium EDTA had an EE of 61.1 ? 3.1%, suggesting that disodium EDTA was competing with iron during encapsulation. During storage, there was no significant iron leakage from any of the liposome samples however, after 14 days, the supernatant of the stored liposomes became turbid.
Conclusion:
The high iron encapsulation efficiency suggests that this liposomal encapsulation system is a viable iron delivery technique, however, encapsulation of the iron and disodium EDTA separately may improve iron encapsulation. Next, the process will be tested in an acidic environment, followed by test in the hibiscus beverage.

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Taste components in plant-based cheese alternatives

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Aim:
Dairy products are thought to be one of the highest contributors to the UK's greenhouse gas emissions after meat products and despite this, cheese is still highly consumed in the UK. Recently, there has been an increase in the number of vegans in the UK which has resulted in greater demand for dairy-free cheese alternatives. Cheese quality is influenced greatly by its sensory properties however, plant-based cheese alternatives currently on the market are coconut oil based, contain negligible amounts of protein thus lacking the desirable organoleptic properties of dairy cheese. The fermentation and ripening of cheese is essential to produce its desirable taste, flavour and texture and this includes free amino acids, such as glutamic acid, and small peptides, such ɣ -glutamyl peptides, responsible for the umami (or savouriness) and kokumi (or mouthfullness) taste characteristics of cheese, respectively. This study aimed to develop a plant-based mould ripened camembert alternative, using cashews and soy as raw materials while enhancing the formation of compounds contributing to the umami and kokumi taste.
Method:
In this preliminary work, cashews and a combination of cashews and soy beans (50:50 w/w) (to increase the protein content) together with coconut milk, oats, *Penicillium candidum* and a direct set mesophilic culture of lactic acid bacteria were used to prepare the plant-based cheese. The samples were left to ripen at 12 ºC for 24 days. Free amino acids and ɣ -glutamyl peptides were analysed by LC-QQQ. Physical properties (hardness, springiness and chewiness) and pH were also measure.
Results:
Addition of soy beans contributed to the increase in the levels of compounds responsible for the umami and kokumi taste characteristics of plant-based cheese, particularly aspartic acid, ɣ -glutamyl-phe and ɣ -glutamyl-tyr. Results seem to indicate that *Penicillium candidum* was involved in their formation during ripening.
Conclusion:
This study reports for the first time the identification and characterization of compounds associated with umami and kokumi taste sensations in plant-based cheeses and it presents an opportunity for further development of these plant-based cheese alternatives, to increase consumer acceptance while creating sustainable products for a growing demand for these types of products.

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Use of faba flour to develop a more sustainable and nutritious sliced bread

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Aim: Nitrogen-fixing legume crops such as the faba bean (*Vicia faba*) are naturally high in protein, micronutrients and fibre. They enhance soil conditions, promote biodiversity, lower energy costs and grown locally in the UK they have a very low environmental impact. Fortification of bakery products with UK grown fava bean flour has the potential to provide significant nutritional and environmental benefits across society, at an affordable price, but little is known about how such a fortification might influence the processing of bakery products, the formation of process contaminants such as acrylamide and the texture and flavour of the final products. The aim is to develop and characterise dough formulations with inclusion of faba flour.

Method: In this preliminary work, the British standard sliced loaf was prepared using the Chorleywood process, with 0, 5%, 15% of 25% of the strong white bread flour replaced with either roasted or unroasted faba flour. Physical properties (density, volume, weight loss during baking, crust and crumb colour, cell crumb structure, moisture content, water activity) and chemical properties (free sugars, free amino acids, and acrylamide) were analysed. In addition to measuring physical and chemical properties, a trained sensory panel assessed the sensory characteristics of the developed breads.

Results: The relationships between physical, chemical and sensory parameters will be discussed in detail. Addition of faba flour, particularly at 50% inclusion reduced volume and increased density, and the higher protein content tended to increase colour, aroma and acrylamide formation as a result of increased Maillard activity, moreso when the pre-roasted four was added. The major sensory changes were in texture and in the development of a mouldy chickpea aroma and a bitter taste in the bread with 15% inclusion of faba flour, but the 5% inclusion breads had a sensory profile very close to the control.

Conclusion: There is scope for 5% incorporation of faba flour into standard loaves and the potential to develop more artisan loaves at high rates of inclusion.

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Evaluation of the mechanical properties towards the design of 3D printed food

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Aim:
Post-processing of 3D printed food materials improves properties such as stiffness, shape retention, flavor or color. Printing designs with different internal structures influences the texture properties. In 3D printing, the evaluation of infill patterns is important to reduce the amount of material used and texture. The aim of this project was to analyze the design of infill patterns and their effect on the mechanical properties of printed structures.

Method:
Rectangle-shaped figures were printed at 25 °C with a printable food formulation using a 3D Food Printer (Foodini, Natural Machines, Spain) with a nozzle diameter of 1.5 mm. Samples were baked at 150 °C for 1 hour. The mechanical characterization of the post-processed samples was determined using a Perten TVT6700 Texture Analyzer (Perkin Elmer, USA) equipped with a 3-point bending rig (Break RIG Set 675045) and a 10-kg load cell. The measurements were done at room temperature in a single cycle test mode using the cross-head speed of 2.5 mm·s-1 before the analysis, 2 mm·s-1 during analysis, and 10 mm·s-1 after the analysis. The distance between the two supports was 20,40 and 60 mm and the probe was set at 10 mm from the samples. Time, applied load, and displacement travelled by the probe during the test were registered and video recordings were taken to capture the entire bending process.

Results:
The inner porous geometry of the printed and post-processed samples had a relevant effect on the observed values when comparing them. When changing the geometry, the maximum load increased from 25 N to 40 N and the maximum displacement reached decreased from 1.71 mm to 1.05 mm at the moment of fracture for the postprocessed structures. This changes reflected on the mechanichal properties of stiffness and flexibility of the structures.

Conclusion:
The porosity proved to modulate the texture of final postprocessed product, reducing or increasing the stifness. Additionally it indicated that some patterns might be more vulnerable to suffer deformations than others during the post-processing. The results acquired from this study can fill knowledge gaps regarding the mechanical properties on post-processing for the design of 3D printed foods.

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Development of a mathematical model for the drying process of Spanish cured ham

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Aim
Build a 3D multi-physical finite element-based model that would estimate proteolysis, water activity and salt and water content distributions during the stage drying Spanish-cured ham process. This tool will be part of a digital twin of the meat industry.
Method
The 3D model built using Comsol® Multiphysics software demonstrated very good prediction of in-ham salt and water content distributions, water activity distribution, proteolysis index, and ham weight loss.
Results
The accuracy of the model was evaluated by comparing all the predicted values at the end of the salting and post-salting stages with experimental values measured over the same period of time in samples extracted from "Jamón De Teruel" DOP
Conclusion
A valuable tool has been developed to help Spanish Ham Industry to optimize the process of drying cured Ham.

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A novel strategy to enhance bioaccessible lipids and antioxidants in hetero/mixotrophic Chlorella as functional ingredient

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Microalgae are a promising source of polyunsaturated fatty acids as well as bioactive antioxidant compounds such as carotenoids, phenolics and tocopherols. There is a continuous need to increase the yields of such compounds from algae biomass. However, the accumulation of these biomolecules is often promoted by conflicting growth conditions. In this study, we developed a phased bioprocessing strategy to simultaneously enhance the lipid and antioxidant amounts by tailoring nitrogen content in the cultivation medium and applying light stress. This approach increased the overall contents of total fatty acids, carotenoids, phenolics, and α-tocopherol in *Chlorella vulgaris* by 2.2-, 2.2-, 1.5-, and 2.1-fold, respectively. In addition, the bioaccessibility of the lipids and bioactives from the obtained biomass improved after pulsed electric field treatment (up to + 11.6%) and high-pressure homogenization (+42.8-86.3%). This work represents a step towards the generation of more efficient algae biorefineries, thus expanding the alternative resources available for essential nutrients.

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Effect of frozen storage time and thawing rate on thaw-rigor and quality of salmon fillets

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Aim:
Norwegian farmed salmon production now exceeds 1 million tons of which most is exported as fresh on ice. Fresh fish quality degrades throughout the shelf life, but this can be halted by freezing. The drastically increased shelf life as frozen can be utilized for transport and distribution; a solution particularly suited for distant markets, thus eliminating the need for air-freight, and reducing cost and carbon footprint.
Raw material freshness is key for frozen product quality and also rapid freezing after slaughter – pre rigor. Stress level is important for rigor development but there is a lack of data available regarding the effects of stress and handling on thaw rigor and liquid loss for farmed Atlantic salmon. Hence the main objective of this study was to investigate the influence of stress, storage time and thawing regimes on the rigor development, and other physical traits (color and texture), on vacuum packaged salmon fillets frozen pre-rigor.
Method:
Atlantic salmon (4.16 ± 0.70 kg), were stunned, killed by a blow to the head. bled, gutted and filleted (1.5 to 2 hours after bleeding), prior to being tagged and photographed for fillet length, vacuum packed, frozen in dry ice and stored at – 30 °C.
Five groups of salmon fillets were included: Control (non-frozen – stored on ice/0 °C), and four groups stored frozen, at -30 °C, of which two were stored for one month and two for four months, and of these one group was thawed rapidly in water and the other, slowly in air. In the thawed samples drip loss and length was measued, and finally also pH, instrumental color and texture.
Results:
The liquid loss is low (<1%), and weakly correlated to contraction. No differences in color were detected between frozen thawed and fresh fillets after one moth. After four months only a slight decrease in redness was detected as compared to fresh. Freezing gave an overall decreased hardness, while breaking force were generally comparable to the fresh fillet.
Conclusion:
Vacuum packaged, pre rigor frozen salmon fillets possess quality traits that are comparable to vacuum packaged salmon fillets stored chilled for seven days.

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GABA-enriched synbiotic fermented milks: physicochemical, biological, structural, and sensory attributes

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GABA-enriched synbiotic fermented milks: physicochemical, biological, structural, and sensory attributes

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Abstract

Aim: The main objective of the current study was to examine the gamma-aminobutyric acid (GABA) -producing efficiency and biological activity (phenolic content, antioxidant activity and antihypertensive effects) of synbiotic fermented milks by using *Lacticaseibacillus paracasei* (*L. paracasei*) as probiotic bacteria, and galactofructose, inulin, SPI, and spirulina as prebiotic supplements at the level of 1% w/w. (Introduction text - align left, 10 point, Times New Roman, single line spacing)

Method: The pH changes, the viability of probiotics, structure, tribology, and sensory aspects of the produced fermented milks were also investigated.

Results: The highest GABA production (99.63 µg/mL) and glutamic acid consumption (98.39 µg/mL) were found in spirulina-supplemented fermented milks co-cultured with starter culture bacteria and probiotic strain (YSP), followed by the galactofructose-supplemented fermented milk (YGF). However, YSP exhibited the lowest viability of *L. paracasei* and highest pH drop. The biological activity of YSP, in terms of total phenolics, antioxidant potential, angiotensin-converting enzyme inhibitory activity, and degree of hydrolysis was significantly higher than the other studied fermented milks. The lubricity of the YSP sample was also distinct from other samples, with a higher friction coefficient at low sliding velocities (up to 50 mm/s), and lower values at higher sliding velocities (50-200 mm/s). Panellist attributed the best appearance and mouthfeel to YSP, while the taste, texture, and overall acceptance of other fermented milks were preferred due to the spirulina's off-flavour.

Conclusion: In conclusion, the use of spirulina and galactofructose in probiotic fermented milks considerably enhanced the production of probiotic metabolites and the biological activity of the

produced fermented milks, and therefore could be a promising strategy for the development of fermented functional dairy products.

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Freeze-drying processes applied to melon rinds to attain a value-added food ingredient

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Aim:
Several studies pointed out melon rinds as rich sources of bioactive compounds with relevant antioxidant activity. Being considered a non-edible part with no economic value, fruit industries discharge large amounts of these residues to the environment. If these wastes are conveniently processed and transformed, novel food ingredients with potential health benefits may arise.
The objective was to transform melon rinds by freeze-drying to attain dried small bits that can be used as additives to enrich diverse food matrixes. An ozone pre-treatment was applied seeking decontamination and retention of quality characteristics. The impact of these processes was assessed in bioactive compounds (vitamin C, total phenolics and chlorophylls), antioxidant activity, and melon peel microflora (mesophylls, yeasts and moulds) during 7 weeks of storage of the dried materials at room temperature.

Method:
Melon rinds (*Cucumis melo* L. var. *reticulatus*) were cut in small cubes. Before freeze-drying (-50 °C, 1.5-2 bar, 80-90 h) and storage (7 weeks in the dark at room temperature), part of the samples was exposed to a gaseous ozone pre-treatment (15 °C, 152±71 ppm, 30 min).
Vitamin C, total phenolics, chlorophylls and antioxidant activity were analysed by HPLC and spectrophotometric methods in raw peel and throughout storage. Mesophylls, yeasts and moulds were also enumerated.

Results:
Vitamin C, total phenolics, chlorophylls, and antioxidant activity decreased during storage in both non-ozonized and ozonized dried samples. However, pre-ozonized samples retained better the bioactive compounds analyzed throughout the storage: almost 85% of total phenolics and chlorophylls were preserved, and 66% of vitamin C.
In terms of microflora inactivation, the effects of ozone and freeze-drying were not significant. However, a decrease of ~1 log-cycle was observed at the end of storage for the groups of microorganisms considered. Studies with undesirable target microorganisms are required to attain a safe product.

Conclusion:
Freeze-drying with an ozone pre-treatment can be considered a potential process to transform melon peel into an edible form. When the small cubes of melon rinds were freeze-dried, they became lighter and softer. They can be incorporated into different products (*e.g.*, cakes, breads, yogurts), enriching their nutritional profile and creating a value-added food ingredient.

Environmental impact assessment of an Italian tomato processing industry with considering improvement scenarios

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Environmental impact assessment of an Italian tomato processing industry with considering improvement scenarios

Elham Eslami, Gianpiero Pataro, Giovanna Ferrari

Aim:
Agro-food is one of the most environmentally damaging sectors which has significant environmental impacts on air pollutants, natural resource reduction, waste generation, and land degradation. Since tomato is the world's top vegetable for processing, among all food manufacturers, tomato processing industry is one of the most important ones all over the world. In particular, Italy occupied the second position in the world and the first position in the Europe for tomato processing. Since this industry consumes a large amount of natural resources in production line and consequently generates environmental burdens, the application of life cycle assessment can be very practical to identify opportunities for improvement.
In his study, in the frame of the European project AccelWater (Project ID: 958266), a Life Cycle Assesment (LCA) of an Italian company producing peeled tomato and tomato sauce was performed to identify the hotspots and potential for improvements to reduce environmental load and make tomato processing industry more sustainable.

Method:
The system boundaries considered as gate-to-gate approach in tomato processing industry covered the industrial life-cycle stages from delivering fresh tomato to the company up to final products in the company' warehouse. The functional units was a bottle of tomato sauce (540 gr) and a can of peeled tomato (500 gr). Foreground data were collected from the tomato processing facility which is located in south of Italy, and the source of background data was the Ecoinvent, EU & DK input and output database, industry data, and USLCI databases. To analyse the data, SimaPro software was used according to the reference standard for LCA (ISO 14040-14044), and impact categories were assessed by the Recipe midpoint and endpoint methods.
Results:
Results revealed that that a can of peeled tomato generates higher environmental impacts in comparison to a bottle of tomato sauce, which mainly attributed to packaging materials. In terms of improvement scenarios in tomato processing stage, there are some potentials, including conventional conservation measures and the application of new technologies, such as pulsed electric field, to decrease the environmental impacts.
Conclusion:

The findings revealed that following a “from gate to gate” approach, there are several chances for packaging to decrease environmental impacts. It may be accomplished by using materials with minor environmental impacts during manufacture for packaging. However, the combination of conventional conservation action with non-thermal technology in production line can decrease environmental impacts in tomato processing industry.

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Multicriteria assessment tool to support design of food products integrating environmental, nutritional and sensorial dimensions

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Aim:
Food companies need to better include the environmental performance in their food product design process. However, improving the environmental performance can reduce the product performance on other important quality dimensions. Therefore, our goal was to develop a multicriteria assessment tool able to simultaneously assess food product performance on several quality dimensions, including environment. This tool could help food designers developing more sustainable products without neglecting other quality dimensions.

Method:
Pizza was selected as a study model because pizzas are widely consumed worldwide and because it exists a wide variety of different pizzas recipes. Four main steps were followed for the multicriteria assessment tool development:
(1) Identifying the main quality criteria that pizza companies include when defining their product specifications and the associated indicators (semi-structured telephone interviews);
(2) Developing a multicriteria assessment tool (based on DEXi software) to integrate the indicators mentioned by the pizza companies;
(3) Calibrating the tool. This was done by assessing the performance of a large number (n=60) of pizzas on the different quantitative indicators mentioned by the companies in order to establish different levels of performance for each of them;
(4) Validating the multicriteria tool on 16 others pizzas to confirm the ability of the tool to discriminate the pizzas.

Results:
Interviews with pizza companies highlighted that sensory and nutritional properties were the main quality dimensions included. The multicriteria tool was therefore developed including three dimensions: environmental, nutritional and sensorial, resulting in integrating 39 indicators. The validation on the 16 pizzas showed that the pizzas were well discriminated using the multicriteria tool, either through an overall score or by comparing each of the dimensions independently. The tool also makes it easy to identify the indicators to improve which provides design axis to explore.

Conclusion:
The tool could help food product designers in several ways: (i) finding the best compromise between several food design options as it integrates environmental, nutritional and sensory performances, (ii) identifying the dimension that needs improvements and/or (iii) positioning the relative performance of a product within its product category. Future research could generalize such an approach to other food products.

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Increase of kokumi γ-glutamyl peptides in porcine hemoglobin hydrolysate using bacterial γ-glutamyltransferase

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Increase of kokumi γ-glutamyl peptides in porcine hemoglobin hydrolysate using bacterial γ-glutamyltransferase

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Abstract
Aim
γ-Glutamyl peptides can exhibit unique kokumi-imparting properties and enhance the basic tastes of foods. Many of them also play an essential role in human health as they have a range of bioactivities. Production of γ-glutamyl peptides from porcine hemoglobin is an effective approach to obtain multifunctional protein ingredients, which in turn promotes the valorization of animal side streams. This work aimed to achieve a relatively high yield of γ-glutamyl peptides from hemoglobin hydrolysate.
Method
γ-Glutamyl peptides can be synthesized by γ-glutamyltransferase (GGT). Since there are few GGT options on the market, this study also examined the possibility of a commercial glutaminase used as a GGT. The GGT identity of glutaminase was confirmed using liquid chromatography with tandem mass spectrometry (LC-MS/MS) analysis and database searching. GGT was added to hemoglobin hydrolysate to generate γ-glutamyl peptides, and the reaction conditions were optimized using different GGTs, substrate concentrations, reaction times and contents of γ-glutamyl donor. A total of eleven γ-glutamyl dipeptides and two γ-glutamyl tripeptides were quantified using LC-MS/MS with parallel reaction monitoring (PRM) technique.
Results
Results showed that Glutaminase SD-C100S (Amano Enzyme, Nagoya, Japan) and Protana® Uboost (Novozymes, Bagsvaerd, Denmark) were or at least contained GGT from *Bacillus amyloliquefaciens* (*Ba*GGT) and *Bacillus licheniformis* (*Bl*GGT), respectively. The two GGTs showed different substrate specificity, with *Ba*GGT generating more γ-glutamyl dipeptides (e.g. γ-Glu-Leu) and *Bl*GGT showing a higher catalytic efficiency in the formation of γ-Glu-Val-Gly. Increasing the hydrolysate concentration in the range of 10-40% and prolonging the reaction time within 12 h tended to facilitate the synthesis of the monitored γ-glutamyl peptides. Moreover, addition of free glutamine significantly ($P < 0.05$) increased the total concentration of γ-glutamyl dipeptides in both GGT-treated hydrolysates.
Conclusion
Through optimizing the conditions of the γ-glutamyl transfer reaction, hemoglobin hydrolysate containing relatively high concentrations of γ-glutamyl peptides has the potential to be used as a promising protein component like kokumi seasoning.

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Lipidomic insights into the textural impact of baking lipases on fine bakery goods

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Aim:
Baking lipases are used as an alternative to traditional emulsifiers in the production of bread to improve dough and product quality. Up to now, there are only few applications in fine bakery goods. This is due to two main factors: First to off-flavours caused by short-chain fatty acids (SCFA) released from butter and second to the lack of knowledge about interactions of lipases with the broad range of lipid classes within fine bakery goods.
Our aim was to analyze the reactions of baking lipases in fine bakery goods both concerning the influence on textural properties and on the molecular level. This combination allows us to identify the exact reactions responsible for possible texture improvement.
Method:
A basic cake recipe was prepared with seven different baking lipases previously selected for their lack of specificity towards SCFA. Their influence on the textural properties was analyzed in comparison to an untreated sample by performing texture profile analyses. Additionally, a previously established UHPLC-Q Exactive-ESI-MS/MS lipidomics method was used to analyze the alteration of lipids caused by the addition of baking lipases. The distribution of lipids in the lipase-treated samples was compared to the distribution of lipids in the untreated sample.
Results:
Of the seven analyzed baking lipases, four lead to significant improvements of the texture. The resulting products were softer and had lower cohesiveness, resulting in cakes with decreased gumminess (up to 69%) and reduced chewiness (up to 73%) compared to the untreated sample. Additionally, the cakes had a lower resilience (up to 66%) while their springiness was not affected.
Based on the lipidomics method, the effect of the baking lipases on more than 130 different lipids in the samples could be recorded. The results hint that both activity and substrate specificity of the lipases influence their impact on the texture.

Conclusion:
Baking lipases can be used to improve the texture of fine bakery goods. Differences in lipase activity and substrate specificity seem to be linked to their functional impact. Further studies are needed to investigate the role of other typical cake ingredients, such as eggs, in this reaction.

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Composition of smoked oily fish on sale in Dublin

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Aim: The objective of this study was to investigate the nutritional composition and the omega-3 fatty acids present in a selection of smoked oily fish available on the Irish market. In addition, the levels of omega-3 fatty acids and macronutrients measured in the samples was compared to the levels declared on the labels of the products. It is important to establish this relationship as many consumers read food product nutritional labels for health and food intake reasons.

Method: Fifty samples of smoked oily fish were purchased from late September 2021 to end January 2022 in supermarket chains in the Dublin area. Samples were minced, vacuum packed and frozen prior to testing. The nutritional information given on the package, date purchased and sell-by date was recorded for each sample. 50g of defrosted sample was subjected to proximate analysis (moisture, protein, fat and salt) using standard procedures. Polyunsaturated fatty acid (PUFAs) content was measured using the FAME (fatty acid methyl ester) method of Brunton *et al*. 2015). Focus was on the content of EPA (eicosapentaenoic), DHA (docosahexaenoic), DPA (docosapentaenoic) and ALA (alpha-linolenic) omega-3 fatty acids.

Results: Analytical results showed that 100g of the smoked oily fish species provided mean omega-3 contents of 1.28 (smoked salmon), 4.97 (smoked mackerel). 0.62 (smoked trout) and 1.96g (smoked herring) and as such are a valuable source of these desirable fatty acids in the human diet. Smoked salmon, herring and especially smoked mackerel are excellent sources of omega-3 fatty acids with a 100g serving supplying well above the minimum recommended daily intake of 0.25-0.50g [European Food Safety Authority (EFSA); British Nutrition Foundation (BNF)].

Conclusion: Mean values for protein, oil, omega-3 and salt contents determined analytically for the four smoked species were similar to the corresponding data means on the nutritional labels. Agreement between individual samples was more variable especially for omega-3 content.

Reference

Brunton, N., Mason, C. & Collins, M.J. 2015. Rapid microwave assisted preparation of fatty acid methyl esters for the analysis of fatty acid profiles in foods. *Journal of Analytical Chemistry*, 70(10), 1218-1224

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Model validation, design, implementation and real-time process control of a continuous flow ohmic heater

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Aim:
The aim of this project is to model the Moderate Electric Field (MEF) process, validate the model, build a continuous flow ohmic heater pilot plant and apply real-time advanced process control.
Introduction:
The most common conventional heating methods for food processing require heat energy to be generated externally and then transferred to food samples by either convection or conduction. These conventional methods require excessive heat processing that leads to the degradation of the outer portion of food substance and nutritional contents. Using conventional methods, the efficiency of heat transfer to the food substance is limited by the rate of heat transfer from an external medium to the food and by the thermal conductivity of the food. This can result in over processed products and poor product quality due to the lengthy processing time required to reach the target temperature and unwanted temperature peaks. Research has shown that Ohmic Heating (OH) is a more energy efficient form of heating compared to conventional methods. OH is a Moderate Electric Field (MEF) processing technique in which the applied electric field is ≤ 1kV/cm, considerably lower than the field strength used in the high voltage Pulsed Electric Fields (PEF) technology.
Results:
The heat generated within the food substance is rapid and volumetric within the food and dissipated directly in the medium with very high efficiency (>90%) by Joule effect, thus eliminating the heat-transfer step from the surroundings to the medium by means of temperature gradients or hot surfaces. The quantitative results demonstrate significant improvements in modelling the OH process with regard to food of varying conductivities, flow rates and initial temperature. In addition, the application of advanced model-based process control including Model Predictive Control (MPC) on the continuous flow ohmic heater pilot plant gives a template that can be replicated in industry for efficient energy consumption.
Conclusion:
Overall, this research demonstrates the advantages of model-based design and validation in the food industry, the advantages of OH compared to conventional methods and the advantages of advanced process control in food engineering.

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Let's get Freekeh! The flavor profiles of Freekeh, a toasted, green Durum wheat Mediterranean product

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Aim:
Freekeh (فريكة) is a traditional Mediterranean product made by toasting green Durum wheat. Using open fire while smoking the grain lowers moisture content, enables threshing and reduces spoilage, while providing a unique smoky flavor. We investigated Freekeh quality by focusing on flavor and aroma attributes.
Method:
We combined analytical and sensory methods. SPME coupled with GC-MS was used to analyze volatile compounds; trimethylsylilation followed by GC-MS was utilized to monitor taste-related compounds e.g. sugars, amino- and organic acids. Sensory descriptive analysis was performed with non-trained subjects.
Results:
Freekeh has a complex aroma profile, dominated by fatty and amino acid degradation compounds (green/mushroom/earthy), Maillard-reaction/Caramelization products (roasted/nutty/toasted/caramel), and phenols (smoky/meaty/spicy). It is also rich in di- and trisaccharides, free amino acids (e.g. alanine, glutamate and glycine) as well as umami-associated 5'-ribonucleotides. Freekeh produced from the common modern line, C9, harvested at earlier stages (75-83, Zadoks scale) had markedly higher contents of several volatile classes. A strong reduction in levels of sugars and amino acids was evident in parallel to grain maturation, due to conversion into corresponding storage forms. Levels of Maillard-reaction products were shown to be significantly associated with those of reducing sugars and amino acids, the latter being a limiting factor. Freekeh generated from alternative Durum or Emmer lines resulted in generally less aromatic products, with the exception of Emmer that had elevated levels of fatty acid-derived aldehydes and alcohols. Alternative Durum lines, however, were richer in levels of free sugars and organic acids. As expected, levels of compounds associated with pyrolysis, such as phenols and pyrazines, increased at prolonged toasting times. Using analytical and sensory data; we selected samples with contrasting properties. These were introduced to Danish chefs that, using a lead-user based approach, designed novel culinary uses for Freekeh, targeted for Scandinavian markets.
Conclusion:
Taken together, our data shows that Freekeh flavor is the result of a complex interaction between the raw material and a unique processing method. We highlight the impact of agrotechnical factors in shaping the final quality of Freekeh. Finally, we propose novel culinary uses for Freekeh, especially for the northern European market.

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Toxicity effects of crude phlorotannins and phloroglucinol in different bioassay models

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Toxicity Effects of Crude Phlorotannins and Phloroglucinol on *Artemia salina, Daphnia magna*, *Lactuca sativa*, and *Chlorella vulgaris*

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Aim:
Phlorotannins are polyphenolic compounds found in brown seaweeds. The numerous biological activities of phlorotannins such as anti-inflammatory, anti-diabetic, antioxidant, neuro-protective properties, and anti-cancer have been reported. Moreover, phlorotannins also possess larvicidal and growth-inhibiting properties for various organisms. However, the toxicity of the phloroglucinol oligomer of phlorotannin is unclear, especially in *Artemia salina, Daphnia magna, Lactuca sativa*, and *Chlorella vulgaris*, which are commonly used in many bioassays. Therefore, the present study aimed to evaluate the toxicity of phlorotannins on *A. salina, D. magna, L. sativa*, and *C. vulgaris*. The survival rates, inhibition rate, and seed germination of these organisms were also evaluated in this study.
Method:
A. salina, *D. magna*, *L. sativa*, and *C. vulgaris* were used as test organisms in the present study. The different concentrations of phlorotannin extract and phloroglucinol were administered to test organisms. The survival rates of *A. salina nauplii* and *D. magna*, seed germination of *L. sativa*, and inhibition rate of *C. vulgaris* were measured every 24 h. The survival rates were evaluated until 72 h, while seed germination and inhibition rate were observed up to 96 h.
Results:
The results of the current study showed that the LC_{50} of phlorotannin after 24 h was 1.32 and 10.67 mg/mL on *D. magna* and *A. salina*, respectively. 53.3% of *L. sativa* germination was inhibited by 1 mg/mL of phlorotannis after 96 h. The seed growth of *L. sativa* was less than 4 mm. The inhibition of seawater and freshwater *C. vulgaris* at 2 mg/mL of phlorotannins was 43.46 and 39.47%, respectively.
Conclusion:
In conclusion, the survival and growth of the test organisms are influenced by phlorotannins. Phlorotannins can be used as eco-friendly herbicides, algaecides and pesticide. The application of phlorotannins in aquaculture is further required.
Keywords: seaweed, phlorotannins, toxicity, survival rates, inhibition rate, and seed germination.

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Investigation on the role of drying air humidity in shaping the conditions of spray drying

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Aim:

The application of dehumidified air as a medium during spray drying has gained recently much interest. It was successfully applied to obtain i.e. honey powder of reduced carrier content or kiwiberry powders without any carrier. It has not yet been established how the reduced humidity of drying air affects the process, nor it has been compared to the conventional spray drying. Spray drying requires carefully selected process parameters, including drying air temperature and humidity, feed rate, atomization speed, feed solution concentration in order to successfully evaporate water. This research aimed to investigate and describe a relationship between the drying air humidity and the process performance of spray drying.

Method:

Feed material: water and maltodextrin solutions. The following parameters were investigated:

• drying air humidity: low (0.1-0.3 $g \cdot m^{-3}$), medium (1.1-1.3 $g \cdot m^{-3}$), high-ambient (9-10 $g \cdot m^{-3}$),

• inlet air temperature: 80-120℃,

• feed rate: 0.16-0.83 $mL \cdot s^{-1}$,

• maltodextrin solutions solid content: 30%.

The drying process was studied based on a comparison of the inlet and outlet air parameters (temperature, relative and absolute humidity), calculation of the moisture extraction rate MER, calculation of specific heat and drying air consumption, powder recovery for maltodextrin solutions. The physical properties of maltodextrin powders were determined: moisture content, water activity, morphology, loose and tapped bulk densities.

Results:

It was observed that the lowest drying air humidity enabled to evaporate water more effectively in regards to water as feed model material. Powder recovery of model maltodextrin powders depended on drying conditions and it varied up to 73%. Maltodextrin model powders characterized with lower moisture content and water activity at lower drying air humidity than their counterparts at high-ambient drying air humidity.

Conclusion:

Reduced humidity of inlet air improved the process conditions and enabled to reduce drying temperature. The optimum spray drying process parameters for a model materials were estimated, indicating the actual role of air humidity in the shaping the process performance.

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Development of sorghum-based food products: Current knowledge and future prospects

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Aim: Sorghum (*Sorghum bicolor* (L.) Moench) ranks fifth in world cereal production. This grain is integrated in human food in Asian and African countries and has been gaining popularity in other regions, such as the USA, due its potential as an ingredient in nutritionally-improved products. Therefore, this study aimed to provide a panorama of scientific studies regarding the development of sorghum-based food products. Method: The review was made by exploring the Elsevier Scopus database using specified keywords for sorghum products as search strings in the topics and titles to select original articles published until 2021. The search resulted in 1639 articles found, 672 of which met the inclusion criteria. Selected papers were used to produce the bibliometric maps using the VOSviewer software. Results: According to the articles analyzed, sorghum flour (SF) is mainly used as an ingredient to produce beverages, sorghum beer being the most developed and evaluated product made with this cereal. Porridge, for many years, used to be one of the main products but now extruded products and bread, mostly gluten-free versions, are now of major interest.The bibliometric maps highlight specifically fermentation and extrusion process as the most frequent terms. Fermentation is a common homemade process in some regions, while extrusion is an industrial process which has interested researchers, both being studied to verify any nutritional gains in the resulting products. Extruded sorghum is becoming more common, resulting in ready-to-eat products like snacks, breakfast cereals and extruded flatbreads but it is also an ingredient in cake, bread and beverage formulations, which presents technological and nutritional advantages when compared with non-extruded sorghum flour. Conclusion: Sorghum grains can be submitted to different types of thermal processing, obtaining products with good physical properties, combining nutritional and functional values for direct consumption by the general population, and consumers with food restrictions or preferences Future research to investigate the sensory properties of sorghum-based products is needed, guaranteeing, in addition to obtaining a nutritionally adequate product, a product with good sensory appeal.

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Potential of sorghum in gluten-containing and gluten-free products: Effects on the thermomechanical properties of dough

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Aim: Based on its planting characteristics, sorghum is considered a sustainable ingredient in food. However, it has remained as one of the most underutilized cereal crops. Sorghum has a high potential to promote human health and, also, food and nutrition security. It also contributes to the dietary treatment of celiac and diabetic patients. Several studies have highlighted the potential of sorghum as an ingredient in products for human consumption, so this work aimed to determine ideal levels of sorghum flour (SF) to be combined with wheat (WF) and rice flour (RF), verifying the effects of the particle size of SF on dough thermomechanical properties, obtaining a better understanding of sorghum potential in both gluten-containing and gluten-free products. Method: BRS305 (brown pericarp with tannins) and BRS373 (bronze pericarp without tannins) hybrid sorghum grains were milled to fine, medium and coarse levels and mixed in different blends (25, 50 and 75%) with WF and RF. The dough was analyzed in the Mixolab® using the Chopin+ protocol. Results: Doughs made with 100% of each SF showed a similar characteristics of 100WF, while for 100RF no similarity was observed. WF blends with BRS373 in finer and medium levels produced no significant impact to dough, while blends with 50% of BRS305 showed a negative impact, presenting lower C3, C4 and C5 values, indicating lower gelatinization and starch retrogradation of these doughs, which can impact the physical characteristics and shelf life of the products. Blended RF with 25 and 50% BRS373 did not change the dough thermomechanical properties, while blending with 75% of BRS373, in all the milling levels, showed high C3 values,. RF presented an interesting curve when mixed with 25% of BRS305 in the finer and medium levels, presenting higher C3, C4 and C5 values. Conclusion: Based on the results , SF shows great potential to improve technological quality of gluten-containing and gluten-free products. Studies to evaluate the water levels of these blends to improve these doughs are still needed, as well as sensory analysis to indicate the impact of the milling levels on the characteristics of final products.

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How to cook sorghum? Results from empirical tests and from a literature review

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Aim: Sorghum can contribute to food and nutrition security for the population in general, and especially for individuals with gluten consumption restrictions, being necessary studies to define processing techniques that enable their consumption, boosting homemade techniques that can encourage the daily consumption of this cereal by the population, introducing this grain as an option to replace commonly consumed cereals such as rice and corn in daily meals . Therefore, this study aimed to to investigate the ideal proportion between water, grain and cooking time , as well as reviewing the literature to verify the process conditions used when wet cooking. Method: Soaked and unsoaked sorghum grains of BRS305 (brown pericarp with tannins) and BRS373 (bronze pericarp without tannins) were submitted to wet cooking using an electric pressure cooker to define the ideal proportion between water, grain and cooking time, The review was made by exploring the Elsevier Scopus database using specified keywords for sorghum cooking as search strings in topics and titles to select original articles published in the last ten years (2011-2021). Results: 15, 30 e 45 minutes were the cooking times used and a water/grain proportion of 3:1 for soaked grains, while for unsoaked grains the time and water needed were higher, defined as 40, 65 and 90 minutes and a proportion of 5:1 of water to grain. The literature indicates shorter cooking time of the pressure-cooking than conventional cooking made in an open pan, showing benefits of pressure-cooking for the nutritional quality of cooked grains. Soaking was cited as a pre-treatment to reduce the anti-nutritional components but some studies indicate this process as being unsuitable for sorghum. Conclusion: This work defined three cooking times that prepare the sorghum for eatingwhile verifying the influence on nutritional quality, to conclude if the soaking process is really necessary, and also to analyze consumer acceptance. The studies reviewed submitted the sorghum to wet cooking to check mainly the changes in composition and nutritional quality, with no sensory evaluation, which are necessary to define the acceptance and the feasibility of including sorghum as a substitute to other common cereals in meals.

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From processing to digestion- polyphenol's interactions and bioaccessibility in model systems

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Aim: Polyphenols are known for their anti-oxidant, anti-inflammatory, and even direct action on cellular activities, therefore often perceived and considered as health-promoting compounds. Their interactions with other molecules are strongly affected by processing technologies and formulations, resulting in an array of effects and outcomes on bioaccessibility.

The goal of this work was to investigate the stability and bioaccessibility of polyphenols, from processing to digestion, as affected by important parameters such as chemical structure, cell-wall material (CWM), processing method and pH.

Method: We used mono- and multi-polyphenol model systems, and investigated polyphenol-CWM, polyphenol-polyphenol interactions and antioxidant capacity (AC) under different types of processing methods and formulations, followed by quantification of bioaccessibility using *in-vitro* digestion methods.

Results: We revealed that high-pressure processing (HPP) affects polyphenol interactions (3-way ANOVA), probably by inducing self-association of hydrophobic polyphenols and increasing their interaction with CWM. In contrast, for hydrophilic polyphenols, HPP can result in de-complexation. CWM mostly induced de-complexation of polyphenols, and the AC of such a system increased by pressure and CWM by up to 53%.

Following, we revealed structure-dependent bioaccessibility of polyphenols, affected by stability under digestive conditions. Moreover, we found that processing was the most affecting parameter on the polyphenol bioaccessibility, while CWM had a minimal impact. Compared to unprocessed polyphenols samples, HPP mildly affected the bioaccessibility, while thermal processing had the largest negative impact, resulting in up to 70% decrease in bioaccessibility of anthocyanins and flavonols, in a pH and structure-dependent manner. Surprisingly, processing affected in advanced digestive stages, even if no influence was observed at the beginning. Further, aglycone-CWM binding was found to be correlated with gastric bioaccessibility (unlike in the case of glycosides), while at the intestinal phase the bioaccessibility was irrespective of the CWM and HPP.

Conclusion: Our results suggest that engineering of food products should not aim only at maximal concentration after processing and shelf-life, but also consider their final bioaccessibility. This work provides many innovative conclusions regarding how processing method and food matrix can influence the interactions and bioaccessibility of polyphenols, and can help in developing healthier products.

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Comparative metabolite profile and antioxidant potential of germinated wheat (Triticum aestivum L.) beverage during preparation

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Aim:

The aim of this study is to explore the metabolite profile and antioxidant potential of germinated wheat beverage during preparation.

Method:

Samples from different preparation stages, raw wheat (RW), germinated wheat (GW), steamed germinated wheat (SGW), and roasted-steamed germinated wheat (RSGW), were collected and their physicochemical characteristics, structural characteristics, bioactive components, amino acids and volatile metabolite profile as well as antioxidant potentials were determined using spectroscopy, Fourier Transform Infrared Spectroscopy (FT-IR), high performance liquid chromatography, and electronic nose.

Results:

RSGW showed the highest levels of bioactive components amounting to 2.46 mg/g of gamma-amino butyric acid, 0.72 mg CE/g of total flavonoid content, 4.66 µM TE/ g of 2,2-diphenyl-1-picrylhydrazyl radical scavenging activity, and 10.20 mM TE/g trolox equivalent antioxidant capacity, respectively. Regarding FT-IR spectrum, similar band position with peaks at 3400, 2900, 1600, 1000, and 550 cm-1 were observed for all samples. Volatile profiling detected the 22 volatiles: 6 alcohols, 2 aldehydes, 4 acids, 1 furan, 1 hydrocarbon, 3 ketones, 1 pyrrole, and 4 sulfur containing compounds in samples at all stages. Principal component analysis revealed that metabolites were responsible for discrimination of each preparation stage showing the highest components of amino acid in SGW and GW and strongest antioxidant potential and greatest abundance of bioactive components and volatiles in RSGW sample.

Conclusion:

The overall results of this study provided the useful information on the metabolites formation and alteration of germinated wheat beverage during different preparation stages.

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Potential of orange juice co-product as a regulator of postprandial glycaemia

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Aim:
Taking the circular economy strategy as an objective, it seems an opportunity to think of the use of the waste of fibre-rich foodstuffs as a natural source of fibre. Despite the physical, chemical and techno-functional properties of fibre from citrus by-products allow it to be proposed as a higher quality alternative to fibre from other sources, further investigation of its physiological impact is a pending task. Glycaemic response has been employed as a criterion for proposing balanced diets. Slow-absorbing sugars are of interest, i.e. foods with a low glycaemic index (GI) and a high glucose retardation index (GRI), whose consumption is particularly indicated for the management of obesity, diabetes and cardiovascular diseases. In this study, the fibre content and the glycaemic response (GI and GRI) of the orange juice co-product (CoP) was determined.

Method:
Total dietary fibre (TDF) and its soluble (SDF) and insoluble (IDF) fractions were analysed by the enzymatic gravimetric method. GI was predicted from the in vitro bio-accessibility of glucose. GRI was determined by the dialysis methodology.

Results:
TDF of CoP was 9,2% of which 32.6% was SDF, a relatively high value as compared to other fruit and vegetable processing by-products. IDF/SDF=1.9 was in the range to obtain the physiological effects associated with both fibre fractions and to be accepted as a high-quality food ingredient. Glucose dialysis studies mimic events occurring in the small intestine and are useful to predict how glucose absorption is modulated. Predicted GI<50 allows CoP to be categorized as a low GI product. The GRI of CoP was 25, a value related to the fibre composition and the structure of the freeze-dried CoP, which could contribute to the longer delay of glucose dialysis.

Conclusion:
As the orange juice coproduct flour is able to decrease the concentration of blood glucose, it may be offered as a natural ingredient that could act as a potential source of functional compounds in the treatment of different diseases, among others those related to glycaemic metabolism. In this way it could be added to formulate nutraceuticals or even to enhance the activity of oral hypoglycaemic drugs.

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Development and characterization of mixture of plant-based beverage

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Aim: Substitutes for cow's milk are plant-based beverages, however, they differ in their chemical composition. To achieve a nutritional value comparable to cow's milk, we should blend two or more raw materials. The aim of the study was to analyze three mixtures of plant-based (cashew nuts, Brazil nuts and soy; cashew nut, hazelnuts, and soy; cashew nuts, Brazil nuts and sunflower seeds) beverages and compare them to cow's milk.
Method: Three vegetable beverage mixtures were prepared in the Vegan Milk Machine®. Analysis of moisture, ash and lipids were performed according to Adolfo Lutz, protein analysis was performed by the Bradford method and carbohydrates were obtained by difference and total energy value by Atwater conversion. Dispersion stability was determined according to the methodology described by Quasem. Mineral composition was determined by ICP OES. Cow's milk were also analyzed to make the comparison. Shelf-life analysis was performed for 12 days with storage at 4 and 25ºC.
Results: The cluster analysis performed using XLSTAT software (Addinsoft Inc.) showed three main clusters, the mixtures, skimmed milk and whole milk, indicating that the mixtures and the milks analyzed were statistically different. It was noticed that the greater the amount of water-soluble cashew extract in the mixture composition, the more stable its dispersion. The mixtures have great amount of minerals besides Calcium (Ca) and Potassium (K) and the mixture with cashew nuts, Brazil nuts and soybeans had a good mineral content overall. All mixtures showed microbiological stability during the 12 days of storage at 4ºC.
Conclusion: Although the mixtures have differences in the chemical and mineral compositions in relation to cow's milk, they are commercialized as their substitutes and need to be further investigated. The market for plant-based beverages is expanding and there is a need to better understand them and how we can improve their characteristics to be a better substitute for cow's milk. Therefore, it is necessary to study these or new mixtures further to improve them, verifying if there is any kind of fortification that can be done, and to analyze possible conservation methods to prolong their shelf life.

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Vegetable by-products as a source of bioactive compounds in beer brewing

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Aim:
Valorisation of by-products from food sources is one of the approaches to build a more sustainable system. The by-products from vegetables contain various bioactive compounds and nutraceuticals. They possess the potential to be used as a functional food ingredient in the food industry. In this study, we explored and evaluated different vegetable by-products as sources of glucosinolates, carotenoids, and polyphenols in brewing beer.

Method:
To valorize the residual components of plant tissues, vegetable by-products were explored as an ingredient in pale beer brewing. 100 L of beer was brewed with vegetable by-products from different food chains. Volatile organic compounds, free amino acid profiles, and bioactive compounds were examined.

Results:
According to the study, vegetable by-products affected the physicochemical parameters as well as amino acid and volatile profiles. Coffee powder and spent coffee grounds gave the beer a higher pH value and acidity percentage. The colour of the ECB value for control beer was affected by different ingredients, but the value for coffee beer reached the highest level. Tomato peels produced a slight increment of lycopene (5.0±0.4 g/mL). Spent ground coffee is a valuable source of chlorogenic acid enriched beer (2.3±0.2 g/mL). The content of total free amino acid in beer samples ranged from 370 to 680 mg/L and the variance was well explained with PCA. Additionally, PLS-DA score plots demonstrated satisfactory differentiation between the untargeted volatile profile and the black cabbage beer sample.

Conclusion:
Researchers and the food industry can use the results of this study to design and develop food applications like beer with functional ingredients to meet market and sustainability needs.

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Almond Okara as functional ingredient for cookies

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Aim:
The term “okara” traditionally defines the water insoluble residue deriving from the production of soymilk, but this by-product is originated by the preparation of all vegetable beverages, including almond milk. Almond milk market is expected to grow at a compound annual growth rate of 15.2% from 2022 to 2030. Therefore, investigating the strategies to valorize these by-products would mitigate the footprint of such growing productions. However, while the soy okara was well studied, the information on almond okara (AO) are scarce, with no references in the scientific literature. In this study the AO was preliminary characterized and used to produce cookies.
Method:
Fresh AO had 75% of moisture content and a water activity of 0.99. Thus, it was lyophilized until a moisture content <5%. The proximate composition and the quality of the lipid fraction were evaluated. The lyophilized AO was used in for the formulation of cookies in concentration of 15, 25 and 35%. The products were then characterized for their physicochemical, textural and sensory properties.
Results:
AO had 11.5% of proteins, 44.5% of lipids, 3.1% of ashes, and 44% of dietary fiber. Due to the lipid content, AO was used to substitute not only the flour but also part of the sunflower oil used in the cookies’ formulation. Moreover, the lipid fraction showed a better quality than the sunflower oil, being less rich in triacylglycerol oligopolymers and oxidized triglycerides. These differences positively impacted the lipid quality of the cookies. The variations in diameter and in thickness recorded after cooking were significantly lower as the concentration of AO increased. This can be related to the progressive reduction of the gluten in the dough. The texture analysis highlighted a higher deformation and work at maximum force in the cookies with the addition of AO compared to the control, confirmed by the results of the sensory analysis which revealed an increase of the hardness and of the chewiness.
Conclusion:
AO is a valuable upcycled ingredient that would be abundant in the next years. AO works well in cookies formulation due to the high lipid content with a good quality feature.

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Effect of kefiran, carrageenan, milk protein addition on the rheological properties of reconstituted kefir powder

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Aim:
The effect of kefiran, carrageenan and milk protein (sodium caseinate and whey protein concentrate) addition on the rheological properties of reconstituted kefir powder products was evaluated.

Method:
Kefir powder was produced by spray-drying a widely applicable, high throughput, efficient and nutritionally favorable drying method employed in the dairy industry. Due to the nature of the drying process and the processed product (powdered kefir), the palatable consumption of the reconstituted powder necessitates comparable rheological and sensory properties to the original unprocessed product though the addition of texture modifiers such as kefiran, carrageenan and milk proteins.
Pasteurized, homogenized bovine semi-skimmed milk was heat-treated (95C for 5 min), inoculated with the starter culture and incubated at 30C until the pH dropped to 4.4. Kefir was then mixed and stored at 4C for 24 h before spray drying under reduced process temperatures. Physicochemical (pH, acidity and color parameters L*, a*, b*) and rheological (apparent viscosity and viscoelastic determined by dynamic analysis and creep-recovery tests) properties of the reconstituted samples were evaluated and compared to the unprocessed product. From the rheological data, elastic modulus, tan δ (dynamic analysis), instantaneous elasticity, retarded elasticity and Newtonian viscosity (creep test), as well as apparent viscosity at low shear rates typically experienved in the oral cavity during consumption were determined. Analysis of Variance was applied to the experimental data, in order to elucidate the effect of texture modifiers on the products' properties, while the Tukey multiple comparison test was used to identify statistically significant differences.

Results:
According to the results, the physicochemical properties of reconstituted kefir powder were affected by texture modifiers. With regards to the rheological properties, increasing kefiran, carrageenan and milk proteins concentration, as well as mixing temperature (4C to 30C) and residence time resulted in increasing apparent viscosity and viscoelastic properties of the reconstituted powder products when compared to kefir.

Conclusion:
In conclusion, rheological properties of reconstituted kefir powder can be improved, to comparable values to the properties of kefir, with kefiran, carrageenan and milk proteins addition.

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Spray-dried kefir powder and reconstitution properties as affected by storage temperature and thermoprotectant carrier addition

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Aim:
The present work aimed in evaluating the effect of storage temperature and carrier addition (kefiran and trehalose) on the properties of spray dried kefir powder products.

Method:
Extending the self-life of kefir, making it available to a broader consumer base and improving its keeping and transportation costs can be partly met by the development of dried powder kefir products. Spray-drying is a widely applicable, high throughput, efficient and nutritionally favorable drying method. The temperatures employed though, during drying, can be detrimental to the microorganism survival if no thermo-protectant carriers are used. The beneficial to human health kefir microbiota when subjected to low temperature stress periods can improve its viability through effectively producing protective substances. Furthermore, the presence of microenacpsualtion and/or thermoprotective substances such as kefiran and trehalose, respectively, can significantly favour microbial viability.
Kefir samples were prepared using homogenized and pasteurized semi-skimmed milk and commercial starter cultures. Following fermentation (30?C until pH 4.4), a probiotic culture was added to kefir and five different samples were prepared. One control without carrier addition or any other treatment, two with different low temperature storage periods (4?C for 24 h and 72 h, respectively), one sample with kefiran addition (2% w/v) and one sample with trehalose (1% w/v). The samples were subsequently spray-dryied at reduced process temperatures.
Moisture content, particle size distribution via laser diffraction, particle porous structure by confocal laser microscopy, as well as bulk density, tapped density, flowability, cohesiveness, water solubility index and insoluble matter content of powder samples were determined. Particle size distribution and morphology was also evaluated at the reconstituted samples. Measurements of the degree of oxidation and antioxidant activity after reconstitution were also performed. Microbiological viability of lactic acid bacteria and probiotics was evaluated.

Results:
According to the results, trehalose proved to favour the functional and reconstitution properties of kefir powders. Kefiran addition and temperature stress conditions also affected, but to a lesser degree, the above mentioned properties.
Conclusion:
Low temperature stress conditions of kefir and the addition of thermoprotectant carriers (trehalose, kefiran) can improve kefir microflora survival and the reconstituted product properties.

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Determination of the potential health benefits of seaweed-derived oligosaccharides and polyphenols: Generation and characterisation strategies

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Aim:
Inflammatory Bowel Disease (IBD) is a significant problem globally with 6 million sufferers reported in 2021. It is also a substantial cost to global healthcare systems and in the United States; costs associated with treatment of the disease were reported as $41,150 per patient in 2020. The aim of the Algae4IBD project is to develop algal-based remedies/functional foods to prevent or treat IBD and enhance the lives of sufferers. Our work is focused on identifying the prebiotic and antimicrobial activities of water and enzymatically generated extracts from different seaweeds and microalgae.
Methods:
Water and enzymatically treated extracts containing oligosaccharides and polyphenolics were generated from Irish red, brown and green seaweeds harvested from the west coast of Ireland in December 2021 (Donegal, Ireland). These extracts were stabilised using freeze-drying and screened for their ability to promote the growth of prebiotic strains, specifically *Bifidobacterium longum* subsp. *infantis, Bifidobacterium longum* subsp. *suis, Lactococcus lactis*, and *Bifidobacterium animalis* subsp. *animalis.* In addition, the antimicrobial activity of generated extracts was assessed using the well diffusion antimicrobial assay and microbial growth curve absorbance assays. Pathogenic strains assessed included *Escherichia coli, Cronobacter sakazakii* and *Listeria innocua*.
Results:
Results indicated that selected oligosaccharide and polyphenolic extracts generated from Irish seaweeds stimulated the growth of prebiotic strains including *L. lactis* and *B. longum* subsp. *suis* when included in the growth media (DSMZ media 92 and 52 respectively). Furthermore, extracts from selected algae inhibited gram-negative pathogens.
Conclusion:
Results demonstrate that water and enzymatically generated extracts from Irish seaweeds have potential for use as both prebiotic and antimicrobial ingredients. Next steps include inclusion of generated extracts in suitable food carriers for IBD sufferers both young and old.

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Assisting decision-making in resource recovery from food waste

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4e: Techniques to enhance energy efficiency & minimize environmental impact

Assisting decision-making in resource recovery from food waste

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Aim:

The production of volatile fatty acids (VFA) from food waste and side streams constitutes an excellent opportunity for resource recovery within a circular economy framework. However, its development is still hindered by technological constraints as predicting the VFA yields by different wastes. Furthermore, the validation of a better life-cycle environmental and economic performance than the current waste treatments is needed to unlock its deployment. This work aims at overpassing those development risks and boosting the resource recovery into added value products as are the VFA.

Method:

The framework is implemented as a computer-aided design tool, which is comprised by five different modules: (i) a library of substrates including their characterization and appropriate kinetic parameter selection; (ii) an integral kinetic and stoichiometric model which solves the constraints regarding the disintegration mechanisms and the acidogenic stoichiometry variability in the mono(co)fermentation; (iii) a life cycle inventory (LCI) module which upscales and transforms the model outcomes into LCI inputs and outputs; (iv) an environmental and economic evaluation module which transforms the LCI items into environmental impacts and capital and operational costs; (v) an interpretation module which converts the outputs of module into decision-support indicators.

Results:

Through the insights provided by the computer-aided design tool practitioners can screen the potential of waste streams to be integrated into the carboxylate platform and establish relationships with other stakeholders. For instance, food industry actors can assess the potential of their waste streams to be valorized as VFA and compare that route to the actual waste treatment. Process developers can explore the operational conditions when designing processes, assisting the experimental validation at lab and pilot scale. Final users can identify the proper co-substrates formulation for a required VFA composition. Thus, this tool can solve supply chain problems, e.g., screening a portfolio of wastes and providers to obtain a suitable VFA mixture that it is further transformed into polymer material with specific properties.

Conclusion:

This work proves that computer-aided design tools can help to assist the decision making at different stakeholders' levels, identifying technical bottlenecks, and proposing innovative solutions prior to expensive lab research and piloting.

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Functional properties of African oil bean (Pentaclethra macrophylla) and melon (Citrullus colocynthis) seed protein isolates

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Aim: There is growing interest in the use of under-utilised seeds such as African oil bean (AOB) and melon seeds as food ingredients. However there is limited data available regarding the functional properties of proteins from such sources. Therefore the objective of this study was to investigate the functional properties of protein isolates produced from AOB and melon seeds in order to enable their utilisation as food ingredients.

Method: AOB and melon protein isolates were produced from ground, defatted seeds by ultrasonication (50°C, 15 µm, 60 min, pH 11) followed by precipitation at the isoelectric point (pH 4.5) and freeze drying. The water holding capacity, oil adsorption capacity, foaming capacity, foam stability, least gelation concentration, emulsifying activity index, emulsion stability index, surface hydrophobicity index, amino acid profile and FTIR spectra of the isolates were determined in triplicate.

Results: AOB and melon seed isolates had good foaming and emulsifying properties. The foaming capacity and stability of the isolates were >200 % v/v and >90% v/v respectively. The protein isolates had a hydrophobic/hydrophilic ratio of 2.2 and 2.1 for AOB and melon seed protein isolates respectively. The relatively high hydrophobicity of AOB and melon protein isolates likely contributed to their foaming capacity. Melon seed isolate exhibited the highest emulsion stability (108.1% at 1% w/v). Emulsion stability in AOB emulsions was lower (78 at 1% w/v) but increased to 100.8% when 5% w/v was added. It was also noted that melon protein isolates did not gel as ultrasonication conditions resulted in protein denaturation. This was supported by FTIR analysis which indicated a reduction of the β-strand and β- sheets.

Conclusions: The physicochemical and structural properties of AOB and melon seeds proteins, as well as extraction conditions largely determined their functional properties. Overall AOB and melon seed protein isolates have desirable functional properties and can potentially be used as food ingredients in various food applications such as the production of mayonnaise, salad dressings, and foams to impart body, smoothness, and lightness to foods.

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Trained Panel Descriptive Analysis of Dairy Products from Different Feeding Regimes and Lactation Stages.

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Aim:
Grass-feeding is typical of temperate climates with abundant rainfall and fertile soils in countries including Ireland and New Zealand. However total mixed ration (TMR) feeding is more common in other climates such as in the United States. Grass-fed dairy products have different nutritional profiles with some key compositional differences compared to products from TMR feeding. Stage of lactation may also influence milk composition. These compositional differences may lead to a sensory difference between dairy products from different feeding regimes and lactation stages. The aim of this research is to determine if a trained panel differentiates whole milk powder (WMP), butter and cheese produced from milk from different feeding regimes and lactation stages.
Methods:
Early Mid and Late lactation samples of WMP, butter and Cheddar cheese were produced in Teagasc Moorepark in Fermoy Co. Cork specifically for this task. Cows were fed a diet of grass, total mixed ration, or partial mixed ration.
A panel consisting of 15 members were trained using the Sensory Spectrum method and a 15-point scale. Panellists were trained using sensory attributes generated from existing lexicons for WMP, butter and Cheddar cheese. The panel then narrowed down these attributes and generated a lexicon to encompass WMP, butter and Cheddar cheese. Panel performance was monitored using the Panel Performance Analysis on Redjade software. Panel training and lexicon generation is complete. The next stage involves descriptive analysis of the WMP, butter and Cheddar cheese samples by the trained panel.
Results:
The lexicon generated included the following terms: Fruity, Nutty, Sweet Aromatic, Cooked Cheese, Brothy, Milk Fat/ Lactone, Barny/ Cowy, Butyric, Grassy, Umami, Salt, Sour, Sweet, Bitter, Cream, Butter and Mouthcoating. These are the attributes of interest when the trained panel conduct descriptive analysis of WMP, Butter and Cheddar cheese samples.
Conclusion:
Descriptive analysis of WMP, butter and Cheddar cheese samples by the trained panel will take place in Summer/ Autumn 2022 and will be the focus of this presentation.

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Effect of cattle grazing botanically diverse pasture on the sensory quality of beef

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Aim: Effect of cattle grazing botanically diverse pasture on the sensory quality of beef
Introduction:
There is growing interest in biodiverse and sustainable pasture-based feeding systems for ruminants to improve the nutritional profile of beef (Leroy et al., 2018). Pasture feeding leads to increased levels of desirable polyunsaturated fatty acids and natural antioxidants such as vitamin E available for uptake into muscle. In addition, pasture feeding can result in meat with a lower intramuscular fat content, which may have an impact on consumer acceptability (tenderness, flavour and liking) of the beef. Therefore, the aim of this study was to determine the effect of cattle grazing botanically diverse pasture on the sensory quality of beef.

Method:
Sixty Hereford x Holstein Friesian yearling steers were randomly allocated to one of three different pasture treatments (n = 20 per treatment); a monoculture (perennial ryegrass (PRG) (*Lolium perenne*)), a two-species pasture (perennial ryegrass and white clover (PRG+WC) (*Trifolium pratense*)) and a multi-species pasture ((MS) consisting of perennial ryegrass, timothy (*Phleum pratense*), white clover, red clover (*Trifolium repens*), chicory (*Cichorium intybus*) and plantain (*Plantago lanceolata*)). Following slaughter and postmortem ageing of the muscle (*M. longissimus thoracis)*, samples were frozen at -18°C prior to sensory analysis at Teagasc Food Research Centre, Ashtown. A trained sensory panel consisting of 9 panellists scored the samples for a number of sensory attributes using a 100mm linear scale. Statistical analysis involved a MIXED-model analysis of variance (ANOVA) followed by Tukey's multiple-comparison test.

Results:
No significant effect of dietary treatment ($P < 0.05$) was observed for any texture attributes (initial tenderness, juiciness, chewiness and overall tenderness) or for any flavour attributes (beefiness, sweetness, sourness, livery, metallic, grassy, fatty/greasy and off-flavour) in the beef from animals grazing different botanically diverse pasture treatments.

Conclusion:
Grazing animals on botanically diverse pasture has no significant negative impact on the overall sensory quality of beef.

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CAPSICUM OLEORESIN-LOADED MICROPARTICLES: FORMULATION, TOXICOLOGICAL STUDY AND IN VITRO DIGESTIBILITY

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Aim: Capsicum oleoresin is a source of capsaicin, which has many health-promoting benefits such as anti-obesity, thermogenesis, and reducer appetizer. However, studies have shown capsaicin to have toxic effects.The main aim of this work was to formulate microparticles of *Capsicum* oleoresin and evaluate their toxicity,,*in vitro* digestibility and controlled release of capsaicin.
Methods: Arabic gum (GA), OSA-modified corn starch (EMCAP), modified malt (MALT), and their ratio 1:1 combination (GA: EMCAP; EMCAP: MALT; MALT: GA) were used as wall materials to formulate six different oil-in-water emulsions containing 15% solids (5% capsicum oleoresin and 95% wall material). These formulations were homogenized and spray dried. The encapsulation efficiency of each formulation was determined by Ultra Performance Liquid Chromatography (UPLC). The formulated microparticles, individual microparticle components, and capsicum oleoresin were tested for cytotoxicity on human intestinal cells (Caco-2) and human liver hepatocellular cells (HepG2). Furthermore, the INFOGEST static *in vitro* simulation assessed the digestion of microparticles using UPLC to obtain % capsaicin release.
Results: EMCAP: MALT, MALT: GA and GA presented highest encapsulation efficiency of capsaicin reaching values of approximately 90%. *In vitro* cytotoxicity studies of all treatments with five concentrations ranging from 5 - 100µg/mL showed no significant cytotoxicity after exposure times of 4 hours on Caco-2 and 72 hours on HepG2. MALT: GA formulation presented the best controlled release. Results showed that MALT: GA microparticles started with 7.41% cumulative release in the oral phase after 2 min of digestion, reaching after 2 hours in the simulated gastric fluid a release of 17.67%, followed by 53.53% of capsaicin cumulative release after 4 hours in intestinal fluid. This result indicated that MALT: GA was able to concentrate release in the intestinal phase (53.53%), probably due to the low solubility of particles and synergy between wall materials.
Conclusion: In conclusion, the MALT: GA microparticles have the potential for the oral delivery of capsaicin.

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Toxicity Assessment of Catechin on Aquatic Organism and Terrestrial Plant

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Toxicity Assessment of Catechin on Aquatic Organism and Terrestrial Plant
Dicky Harwanto [2,3], Bertoka Fajar Surya Perwira Negara [1,2] , Gabriel Tirtawijaya [2], Maria Dyah Nur Meinita 2[,4] and Jae-Suk Choi [1,2,*]

Aim:
Catechins have been widely researched and applied as health functional ingredients in various foods and diets. However, its effect on the environment is still rarely studied. The current research aimed to evaluate the toxic effects of crude catechin and catechin hydrate on invertebrate larvae, plants, and microalgae.

Method:
Crude catechin and catechin hydrate were tested on *Daphnia magna* neonates, *Artemia salina* nauplii, *Lactuca sativa* seeds, and *Chlorella vulgaris* with several concentrations. The survival rates of *D. magna* and *A. salina* were observed every 24 hours for up to 3 days. Evaluation of the inhibitory effect of *L. sativa* included observation of germination rate and root length which were recorded every 24 hours for 4 days. The inhibitory effect on *C. vulgaris* was carried out in both fresh and seawater. The cell density of *C. vulgaris* was recorded every 24 h for 4 days and the yield inhibition was calculated after 96 h.

Results:
The results showed that the lethal concentrations at 24 h of *D. magna* and *A. salina* those were exposed to crude catechin were 1,174 and 1,895 µg/mL, while those exposed to catechin hydrate were 54 and 153 µg/mL, respectively. Seed of *L. sativa* exposed to 10 mg/mL crude catechin and catechin hydrate experienced 21 and 67% inhibition of germination, with 80 and 92% inhibition of root growth; while, those exposed to the lowest concentrations experienced an increase in root growth of 10 and 13%, respectively. The yield inhibition of freshwater *C. vulgaris* exposed to 2.0 mg/mL crude catechin was 34%, and to 1.0 mg/mL catechin hydrate was 35%; and those of seawater *C. vulgaris* were 35 and 36%, respectively. In contrast, the cell densities of both C*. vulgaris* were increased 2 to 8% when exposed to lower concentrations.

Conclusion:
Catechins have proven to be very useful as functional foods. This study showed that crude catechin and catechin hydrate were also not harmful to the environment. Terrestrial plant and microalgae growth were still good after exposure to catechins, even increased at certain concentrations.
Keywords: algae, eco-friendly, germination, larvae, survival, toxicity.

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Development of innovative added-value baked products based on substitution of wheat flour with seaweed powder

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Aim:
Baked products (e.g., breads, biscuits, cakes), are the base of daily diet in developed countries. In this context, our purpose was to increase consumption of seafood at the European level through the use of aquatic sources in baked products. Specifically, we target to increase the seafood consumption in younger ages which are the consumer group with the least preference to seafood. Therefore, the main goal was the development of a new added value baked product, by direct integration of seaweed powder in the recipe of a brioche type bread, which is the most preferable in younger ages.

Method:
Dry sugar kelp seaweed powder was used as a wheat flour replacement in percentages of 1 and 5% of the total flour content in the commercial brioche recipe. Four different products were developed: two with 1% seaweed (one according to the recipe and one without salt) and two with 5% seaweed (with and without salt). The produced brioche breads were tested according to their sensory characteristics to reveal how consumers would perceive the appearance, aroma, taste and texture of these novel food products. Moreover, a color measurement based on the CIELAB color system and an optical observation using light reflectance with a stereo microscopy were conducted. Finally, the products were subjected to a hardness measurement in order to calculate their tensile modulus. All the aforementioned methods were performed in comparison with a commercial brioche as the control sample.

Results:
The sensory evaluation revealed that the product with 1% seaweed and no salt had the highest score while the product with 5% seaweed was the least liked. The color measurement showed that the increase of the seaweed content led to larger color differences from the control brioche. Finally, increasing the seaweed content led to a more compact and stiffer product with smaller porous, based on the optical observation and mechanical measurement.

Conclusion:
The partial substitution of wheat flour with seaweed powder led to the development of brioche type baked products with similar to the reference product characteristics and high consumer acceptance. This fact fortells a potential new trend in bakery products.

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Development of sausages using edible insects as a source of alternative protein

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Development of sausages using edible insects as a source of alternative protein

Aim:
Insects have been promoted as human food and animal feed given their high feed conversion to protein with regard to livestock. To study the potentials of insects to turn the food systems to a more sustainable production, edible insects need to be integrated into the regular diets to be applied as an alternative protein source. Under the framework of the SUSINCHAIN project, the present study is focused on the development of an insect-based sausage as a meat substitute.

Method:
A sausage formulation was designed to be sensory appealing for consumers and aiming to reach 13% w/w insect protein in the final product. Formulation contained dehydrated insect powders at a concentration of 20,67% w/w, vegetable oil, flavourings, binding agents, water and stabilizers. The insect species applied were *Acheta domesticus* and *Alphitobius diaperinus* due to their optimal balance between taste and texture impact on the sausages. The insect-based sausages were produced using the standard process for Frankfurt-type sausages. Microbiological, physico-chemical and sensory characteristics were evaluated. The initial aerobic bacterial count and also the presence of *Salmonella Typhimurium*, coliformii and *Listeria monocytogenes* was analysed. The thermal cooking effect in the count reduction or survival was also studied. The physico-chemical parameters evaluated were cooking loss, moisture and proximate analyses, texture analyses (TPA, Cutting Force) and color analysis. Consumer tests were carried out for the sensory assessment of the insect-based sausages using an intensity and acceptability 9-point scale for different sample attributes.

Results:
Microbiological analyses showed that pasteurized (packed and non-cooked) sausages and cooked sausages were safe for consumption. Sensory analyses showed that consumers had a high acceptability for the insect-based sausages, especially for its flavour and taste. Texture analyses showed and appropriate hardness, springiness and cutting force values for an optimal mastication and mouthfeel.

Conclusion:
The results of the study demonstrate that insect-based sausages can be a source of alternative protein in commercial foods and, therefore, a contribution to the transition of food systems in Europe towards a more sustainable food chain.

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Effect of osmotic dehydration and edible coatings on the shelf-life and quality of fresh-cut potatoes

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Aim:
Fresh-cut fruit and vegetables consumption has increased significantly in recent years with potato being among the most popular products in this category. However, fresh-cut potatoes are prone to browning after cutting, resulting in short shelf-life and quality degradation. The aim of this study was the development of innovative fresh-cut potato products with superior sensory characteristics and extended shelf-life using mild treatment methods, including osmotic dehydration and applying edible coating technology.
Method:
For osmotic dehydration, fresh-cut potatoes were immersed into concentrated solutions of various osmotic agents (glycose, glycerol, glycose: glycerol and glycerol: maltodextrin) at a constant ratio of 1:5, at two different temperatures, 25°C and 45°C. The drying kinetics for each sample were determined. The osmotic dehydrated products developed were evaluated regarding their water loss, color, total acidity, total soluble solids and polyphenol oxidase (PPO) activity. For edible coating, the recovery of polysaccharides from potatoes' peels was optimized using microwave/ ultrasound assisted extraction (MAE/ UAE) and their combination, in the context of circular economy. The extraction parameters including MAE and UAE power, the solid: liquid ratio and the extraction time, were optimized using the response surface methodology (RSM) and central composite design (CCD). The recovered polysaccharides from potatoes' peels at optimum conditions in combination with the use of pectin and chitosan were studied for the development of edible coatings. Rosemary essential oil and ascorbic acid were selected as antimicrobial and antioxidant agents for the inhibition of microbial spoilage and enzymatic browning and were incorporated in edible coatings in encapsulated of free form. The effect of different edible coatings was investigated on the quality and shelf-life of potatoes during 7 days of storage at 4°C. Color, weight loss, texture, PPO activity and microbiological stability were determined periodically.
Conclusion:
The results showed that both of these technologies are suitable for the extension of fresh-cut potatoes shelf-life and for the inhibition of enzymatic browning of the developed products.
Acknowledgements:
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Development of bioactive feed extrudates containing encapsulated phytogenic compounds

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Aim:
The use of natural antimicrobial agents in animal diets, consist a very promising approach towards the replacement of synthetic feed additives, such as antibiotics and preservatives. The present research, focuses on the development of feed products enriched with natural bioactive compounds from medicinal plants and herbs, through extrusion processing. More specifically, a blend of oregano, rosemary, chamomile and hypericum essential oils (EOB), was investigated and further incorporated into the conventional feed, in free and encapsulated form.
Method:
Two different methods were employed for the encapsulation of EOB, namely electrohydrodynamic process and spray drying, in the aqueous biopolymeric matrice of whey protein isolate (WPI) and pullulan (pul). Both techniques composed microstructures with different morphology, bioefficacy, and controlled release. The extrusion was performed in a co-rotating double screw extruder (180◦C, 200rpm). Prior to extrusion,three bioactive premixes of certain specifications were prepared and compared to the conventional one (corn flour based), before and after the extrusion process. Bioactivity was evaluated by the total phenolic content (TPC) of the samples, determined by the Folin–Ciocalteu method. A full morphological and structural characterization was carried out. The extruded structures were observed using scanning electron microscopy (SEM). Textural, thermal, and payload release analysis were performed. Simple mathematical models were developed in order to correlate structural properties, with premix characteristics, bioactivity, and release rate of EOB, in the extruded samples. The extrusion efficiency was calculated by the quantification of EOB in the final extruded products, towards the total EOB of the sample before extrusion.
Results:
Comparative results showed that the samples containing the encapsulated agents, succeeded more gradient release rates, and much higher extrusion efficiency, since the EOB loss in the final product was very low. More specifically, the sample containing the spray dried microparticles was considered as optimum, according to the structural profile and morphological chararacteristics.
Conclusion:
The present study, demonstrates the feasibility of developing naturally bioactive feed pellets, containing spray dried microparticles of the EOB studied, through extrusion processing. The aforementioned results, contribute to the effort towards the elimination of synthetic feed supplements, through an innovative approach.

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Combined Effect of Plasma Functionalized Water, In-package Cold-Plasma, and Green Chemicals towards poultry related pathogens

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Aim:
Residues from fresh poultry meat processing in the post slaughter poultry chain provide ideal nutrients promoting the prevalence of pathogens, which can lead to cross-contaminations and biofilm formation and growth in process environments. Cold plasma is an emerging non-thermal intervention technology which can be flexibly applied in gaseous or liquid mediated form. This study investigated the individual and combined effects of Plasma Functionalized Water (PFW), In-package Cold Plasma (CP), and an active chitosan coating encapsulating plant essential oils for control of poultry related pathogens.
Method:
The treatment effects were compared using an optimised chicken juice model in liquid or solidified form. Both liquid and solid sterilised chicken juice models were prepared from the exudate of frozen chicken breast. The chicken juice model was characterised in terms of fat and protein contents, ash, moisture, and pH. The bactericidal effect of PFW was assessed and optimized against *S.* Typhimurium suspended in the liquid chicken juice model. The antimicrobial efficacy of the active chitosan edible coating integrated with essential oils (lemongrass, oregano, and thyme) were considered separately and in combination with in-package CP (3, 5, & 10 min) using the artificially inoculated solid chicken juice model.
Results:
Within 15 sec of PFW treatment, a 9.26 $\log_{10\ \mathrm{CFU/ml}}$ reduction of *S.* Typhimurium was reached in the liquid chicken model. Using the solid chicken model, a 3 min in-package CP treatment provided a reduction of 1.178 $\log_{10\ \mathrm{CFU/ml}}$, whereas a chitosan coating (plasma treated for 3 min) provided a 1.589 $\log_{10\ \mathrm{CFU/ml}}$ reduction. Combining lemongrass or thyme EO within the chitosan coating reduced numbers by 2.03 $\log_{10\ \mathrm{CFU/ml}}$. Applying PFW as a washing step resulted in a1.86 $\log_{10\ \mathrm{CFU/ml}}$ reduction. Combining the optimum treatments reduced pathogen levels by approximately 5 log cycles.
Conclusion:
PFW, in-package CP, and plasma functionalized chitosan are effective, scalable, and sustainable approaches that can be applied at individual or sequential process stages to rapidly control poultry-related pathogens that may be present in suspension, attached in biofilms to abiotic surfaces or on the surface of poultry meat, where the mode of delivery can be adjusted to several commonly used intervention points.

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Modelling the Radio Frequency inactivation of Salmonella Typhimurium in Skimmed and Whole Milk Powder

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Aim:
Radio frequency (RF) heating is a novel technology particularly suited for processing low moisture foods where pathogenic bacteria such as the foodborne pathogen *Salmonella* can survive during prolonged storage and lead to numerous outbreaks and product recalls. This study focuses on modelling the inactivation kinetics of *Salmonella* Typhimurium in skimmed and whole milk powder by RF.
Method:
Salmonella cells were introduced in the milk powder to a cell density of 10^6–10^7 CFU/g by wet inoculation. Using a 50 Ω, 27.12MHz RF set-up, 2.5 kg of milk powder was first heated to 55°C at a power of 1 kW and then heated further using a power of 200 W. The process temperature was monitored using optic fiber sensors. Additionally, IR imaging was used after each treatment to determine heating uniformity. A log-linear inactivation model containing a Bigelow-type temperature dependency and including tailing was used to describe the RF inactivation kinetics. Solubility and colour measurement analyses were performed for the most severe treatment (95ºC).
Results:
A 4-log reduction of *Salmonella* was achieved at end temperatures of 95ºC in skimmed milk powder and at 92ºC in whole milk powder. It took approximately 2.4 hours for skimmed and 1.4 hours for whole milk powder to reach 95ºC. *Salmonella* in whole milk powder showed a higher inactivation rate k_{max}, z-value and also, residual population N_{res} in comparison to skimmed milk powder. In both products an increasing sublethal injury was observed with higher temperature treatments. Treatments at 95ºC had an adverse effect on solubility and colour in comparison to the untreated powder.
Conclusion:
Radio Frequency at 27.12 MHz was successfully used for the inactivation of *Salmonella* Typhimurium in both skimmed and whole milk powder. Overall, the model demonstrated that *S*. Typhimurium had a higher k_{max} and N_{res} in whole milk powder as compared to skimmed milk powder.

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Characterization of the gelling properties of protein from bovine co-product using the response surface methodology

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Aim:
Dehydrated beef proteins are a co-product of edible meat from the fat rendering process that are underutilized in human food. The valorization of these bovine co-products would increase protein resources of good nutritional quality. Giving value to such co-products would reduce the amount of waste and therefore it would contribute to a more sustainable and profitable meat industry.
Method:
In this study, three beef co-products were first characterized with regard to their composition. Second, the response surface methodology was used to characterize and optimize protein solubility and gelling properties by modulating pH (4 to 7), protein concentration (5% to 20%) and ionic strength (0 to 0.4M NaCl). The responses of gelling characteristics as a function of the three factors were adjusted to second-order polynomial models.
Results:
These products mostly consisted of proteins (ExtraBeef80: 83.71%±1.17; K85: 61.75%±1.07; K85G: 62.32%±0.00), with molecular weights ranging from 10 to 300 kDa, corresponding to sarcoplasmic, myofibrillar and connective tissue (collagen) proteins in the soluble fraction.
Protein concentration was the most significant factor for almost all the characteristics measured. However, basic pH significantly decreased water loss of ExtraBeef80 gels, and high ionic strength positively affected deformation at the rupture of K85 and ExtraBeef80 gels, and the water loss of ExtraBeef80 gels. Optimum conditions have been determined for each characteristic, in order to get closer to the performances of commercially available beef gelatins.
Conclusion:
This information of the composition and gelling properties of proteins co-products can be useful in guiding the development of functional ingredients suitable for specific uses.

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Moderate Electric Fields (MEF) application during the extraction of oleuropein from olive leaves

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Abstract:
Aim:
Green Food Processing concept based on the design and development of more sustainable processes, can contribute with the reduction of energy and the increase in value of wastes and by-products. In this sense, technologies such as Moderate Electric Fields (MEF) can respond to this challenge by the intensification of processes. Thus, in extraction/infusion of interesting compounds, MEF can permit the use of low temperatures or the use of no-organic solvents, enhancing the yield and the product quality. In this study, the feasibility of using MEF to improve the phenolic extraction from olive leaves was approached.
Method:
Extraction kinetics of olive leaves with distilled water were carried out at 50ºC with and without application of MEF (13 V/cm) at different frequencies (300, 600, 900 and 1200 Hz). The olive leave-solvent mass ratio (OSR) was also studied (1, 5, 10, 15% w/v). The extraction was monitored by taking samples at pre-set times. Samples were filtered and the absorbance at 280 nm measured and compared with an oleuropein calibration curve previously determined. The extraction kinetics were mathematically described by Naik's model.
Results:
The experimental results showed a significant influence of MEF application in the extraction operation, being kinetics faster and yield greater in MEF assisted experiments than in the conventional extraction. Electric frequency resulted as an important parameter to be considered. The fastest extraction and the greatest yield was observed in experiments carried out at 600 Hz. The oleuropein extraction ratio was lower above and below of this frequency value. Moreover, it was observed a maximum yield after 20-30 min of extraction. After that, the oleuropein content remained constant or even slightly decreased being this fact attributed to degradation reactions. The increase of OSR decreased extraction capacity but, in turn, limited the degradation of oleuropein.
Conclusion:
MEF application can intensify the oleuropein extraction from olive leaves. The results indicated the existence of a frequency optimum around 600 Hz which provide the faster extraction of oleuropein. As expected, the increase in the OSR decreased the extraction yield per dried mass of olive leave but prevented the later degradation of the oleuropein.

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DEVELOPMENT OF CHOCOLATES WITH FUNCTIONAL INGREDIENTS AS KEY DRIVERS FOR HEALTH BENEFITS

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DEVELOPMENT OF CHOCOLATES WITH FUNCTIONAL INGREDIENTS AS KEY DRIVERS FOR HEALTH BENEFITS
Chocolate is consumed by people of all ages in all segments of society throughout the world. The popularity of this food is mainly associated with its potential to arouse sensory pleasure and positive emotions. Increasing awareness of the link between healthy eating and well-being is reflected in the current views of the general consumers. Consumers perceive functional foods as a member of the specific food category to which they belong. Also, in developed economies, a key trend at the moment is confectionery products that deliver functional benefits for health and well-being, such as functional chocolate.
The production of newly developed digestive, antioxidant, energetic, defense, cardiovascular and relax chocolates is a promising solution that meets nutritional requirements of specific target population while maintaining the sensory characteristics of a traditional chocolate. The aim of this study is to add at different concentrations, ranged between (0,05-2%), functional ingredients such as Q10, melatonin, gingko biloba, omega-3 fatty acids, probiotics and propolis to sugar free dark chocolate to evaluate their impact in the consumer acceptance, nutritional composition and stability. For the chocolate formulation, all the ingredients were added to the tempering process and the amount needed was calculated to meet nutritional claims and deliver functional benefits for one portion of chocolate (10g) per day.

The final formulations are evaluated with respect of sensorial traits (appearance, texture, mouthfeel, flavor and general acceptability), shelf-life and nutrition profile. The results reflect the impact of functional ingredients in confectionary products to deliver functional benefits for health. Besides, the ingredients do not change the organoleptical properties and does not impact negatively in the commercial shelf-life.

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Biofortified cowpea beans cultivars: Centesimal Composition

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Abstract
Aim:The purpose of this work is to evaluate de centesimal composition of biofortified cowpea (*Vigna unguiculata*) cultivar in order to produce akara flours for akara preparation.
Introduction: Cowpea (*Vigna unguiculata* L.Walp) is from African origin, introduced in Brazil in the second half of the 16th century by Portuguese settlers in Bahia State. Belongs to Dicotyledoneae plants, Fabales order, Fabaceae family, genus *Vigna*, subgenus *Vigna*, species *Vigna unguiculata* (L.) Walp (Freire Filho, 1988). Cowpea has several popular names and the most used in Brazil are macassa and "feijão-caupi", in the Northeast region; The cowpea beans are preferably used to prepare akara, a typical food from Bahia state, known throughout Brazil (Freire Filho, 1983). Food of plant origin with high levels of protein are an option to compose the diet. Additionally, the protein nutritional value of cowpea is twice that of other cereals, proving to be an adequate option in several preparations (Akinyele e Akinlosotu, 1987).

Method:
The samples of three biofortified cultivars of cowpea (BRS Xiquexique, BRS Tumucumaque and BRS Aracê) cultivated at Embrapa - Meio – Norte. Teresina, Piauí, Brazil and a commercial as a control. The centesimal composition were carried out according to AOAC (2005). The analyses were carried out in triplicates.

Results:
The results of centesimal composition of the biofortified cltivars sand the control revealed that BRS Aracê presented the higher content of moiture (11.21±0.12), proteins (25.14±1.23), lipidis (1.40±0.03), ash (3.3±0.05 fiber (27.45±1.24) and carboidrates (31,5) g.100g^{-1} followed by BRS Tumucumaque cultivar: moisture (11.58±0.09), proteins (23.86±0.32), lipids (1.40±0.03), ash (3.33±0.06), fiber (25.58±079) and carboidrates by difference (34.28) g.100 g^{-1}. The Xiquexique cultivar revealed good contents of protein, ash and lipids.

Conclusion:
As all biofortified cultivars presented high values maily for protein, lipids and ashes, they can be used in the akara formulations improving the nutritional quality of many food preparations.

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Real-Time Monitoring of Foodborne Microbiological Risks in the Food-Chain

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Aim:
Quantitative Microbial Risk Assessment (QMRA) is the fundamental framework for characterizing the nature and likelihood of harm resulting from human exposure to foodborne hazards. Usually, QMRA models take into account the associated variability and uncertainty for the parameters of the model. QMRA studies for specific food-hazard combinations can take advantage of the technological advancements in monitoring tools and devices for environmental parameters and turn into a food business operators' decision making tool based on the concept of Real-time product-specific QMRA (RT-QMRA).
Method:
A general QMRA model for verotoxigenic *Escherichia coli* in beef patties was developed for the EU region. The model predicts the overall probability of illness associated with consumption of beef patties in the EU by taking into account the variability and uncertainty of all factors assessing risk. The model was further rerun by substituting the probability distributions for time and temperature during storage and cooking with time-temperature profiles simulating real-time monitoring of 100 beef patty batches in the food chain. The risk for each batch was assessed and ranked in relation to the overall risk in the EU. For each batch, the overall uncertainty in the risk estimate was quantified using the probability distributions for the unknown risk factors (i.e., initial prevalence, concentration etc.) used in the general model.
Results:
The RT-QMRA model showed that each batch presents a different level of risk at a certain point of the food chain. The latter information on the real-time product-specific risk can be used for effective food safety management.

Conclusion:
The ongoing development of sensors and on-line monitoring devices for QMRA-relevant environmental parameters enable the utilization of a "real-time" decision making tool. The RT-QMRA approach described herein enables the progressive (re)evaluation of consumer risk for a specific lot/product under surveillance. Furthermore, since the consumer risk is updated based on the elapsed stages of the food-chain, the need or the extent for corrective measures to achieve the accepted level of risk (compared to traditional QMRA) can be decided. Based on the above, the importance of the RT-QMRA approach as an interactive decision making tool for the food industry is highlighted.

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Evaluation of Moderate Electric Field (MEF) for pasteurization of pork sausages in a conductive casing

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Aim:
Electro-heating methods such as moderate electric fields (MEF) reduce heating time significantly and allows elevation of food temperatures to target levels much faster than conventional heating methods. However, the extent to which a product has to be treated to achieve appropriate microbial destruction and heat induced physical and chemical changes depend on the time and target temperature. The purpose of this study was to investigate the impacts of cook on the physical and chemical changes occurring during MEF pasteurizing of pork sausages.
Method:
Pork sausages of 57 g ± 0.9 g (3.2 cm diameter and 9 cm length) were pasteurized in conventional water bath at 80 °C to a target temperature of 72 °C at the core followed by a holding time of 2 min prior to MEF treatment to determine the minimum and maximum cook values. The maximum cook value achieved (1.84±0.36 min) was then reduced by 80%, 60% and 40% and applied in MEF treatment. For MEF treatment method, a voltage input of 300 V at 1200 Hz was used to pasteurise pork sausages in 183 ml saline solution of 0.5% salt concentration (w/w) in a MEF chamber having 20 cm gap between electrodes.
Results:
The experimental results revealed that in addition to significantly reducing the overall treatment time, MEF resulted also in better quality attributes of treated samples compared to conventional method. Minimum cook value which was 40% of the maximum value was sufficient to deliver appropriate destruction of the targeted microorganism at significantly lower energy. Analysis of instrumental texture and color indicated that there was no significant difference between samples pasteurized at the above value compared to a control one.
Conclusion:
MEF has shown the potential of using electric field for rapid and uniform heating at minimized energy consumption compared to conventional method. The lower the cook value the shorter the cooking time which may result in a lower energy consumption. However, product should be microbiologically safe (above the target F0) at the target temperature. Further study on the sensorial properties and nutritional values are required to demonstrate the application of MEF for other products.

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Incorporation of natural antioxidants as ingredients in aquatic biomass powders

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Introduction
Globally, about one third of the food produced for human consumption is wasted every year. Fish and seafood constitute the commodity group with the second largest food losses and waste at 35%. Marine resources are rich in valuable bioactive compounds that can be used as novel ingredients in foods, nutraceuticals, pharmaceuticals and cosmetics. Due to the high content of unsaturated fats, marine biomass is highly susceptible to lipid oxidation. The incorporation of antioxidants from natural sources not only is expected to extend the product stability but also to gain significant attention due to public concerns related to the long-term intake of synthetic antioxidants.

Methods
Fish side-streams (filleting leftovers and microwave-assisted vacuum-dried protein hydrolysates-FPH from the bottom fraction after enzymatic hydrolysis) were used for the development of fish-based powders. Characterization and sorption isotherms of powders were conducted. Rosemary antioxidants, rich in carnosol/carnosic acid, were used to protect the developed biomass from lipid oxidation. The maximum concentration of rosemary extract used, was equal to 150 mg of carnasol/carnosic acid per kg of lipids being consistent to the EFSA regulations. The efficiency of antioxidants on powders was determined in terms of lipid oxidation, total volatile basic nitrogen compounds (TVBN), colour and sensory characteristics of the products. Samples with and without antioxidants were stored at selected relative humidity (RH=11-53%) and temperature (20-50ºC) conditions.

Results
FPH were characterized by the highest water sorption capacity at all the storage conditions due to more hygroscopic compounds compared to filleting side-streams which were rich in fats and proteins. Increasing %RH resulted in more intense colour changes with storage. Additionally, for FPH, caking and formulation of a sticky paste was observed for RH>35%. The addition of rosemary in powders inhibited primary and secondary oxidation ($k_{without,antiox}$=0.85 d^{-1}, $k_{with,antiox}$=0.25 d^{-1} at 20ºC and 22% RH) and protein degradation, resulting in an increase in up to 4-fold of the estimated shelf-life and blocking the production of rancid off-flavors.

Conclusion
Fish industry side-streams are rich oil and protein sources suitable for further valorization as food ingredients. The incorporation of natural antioxidants from rosemary significantly protected quality degradation of the developed fish powders and its sensorial characteristics.

Acknowledgment
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Antimicrobial activities of polysaccharide-rich extracts from the Irish seaweed Alaria esculenta against foodborne pathogens

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Aim:
Due to the rapid global spread of antimicrobial resistance in recent decades, interest has grown towards alternative antimicrobial compounds such as those isolated from natural sources. Among these, macroalgae (seaweeds) have emerged as a potential bioreservoir of antimicrobial compounds, eg. polysaccharides, with interesting biological properties produced by these organisms. The aim of this study was to evaluate the antimicrobial activity of extracts rich in polysaccharides produced from the brown macroalga *Alaria esculenta* against the foodborne pathogen *E. coli*.

Methods:
A. esculenta was analysed for its potential to produce polysaccharides and the biomass was extracted by ultrasound (US), microwave (MW), or ultrasound-microwave-assisted (UM) extraction methods. Protein, total phenolic content (TPC) and total soluble sugars (TSS) of the extracts were determined via LECO, Folin-Ciocalteu reagent and phenol-sulfuric acid method, respectively. Analysis of antimicrobial activity of *A. esculenta* extracts was carried out via minimum inhibitory concentration (MIC) assays and growth curves following broth microdilution methods. Extracts were analysed against *E.coli* using gentamycin antibiotic as a control.

Results:
The extracts evaluated contained low and similar levels of TPC (ranging from 1.27 to 1.64 mg gallic acid equivalents (GAE)/100 mg dried extract (DE) macroalgae) and protein (ranging from 4.64 to 9.93 mg/100 mg DE). The main differences in composition were appreciated in their contents of TSS, being 18.84, 19.14 and 32.68 mg glucose equivalents (GE)/100 mg DE. Antimicrobial activity was observed against *E.coli,* with MIC of 6.25 mg/ml in extracts prepared by US (TSS=32.68 mg GE/100 mg DE; TPC=1.27 mg GAE/100 mg DE), while the worst performing extracts with an MIC of 12.5 mg/ml were achieved by those extracts generated by MW (TSS=18.84 mg GE/100 mg DE; TPC=1.5 mg GAE/100 mg DE).

Conclusion:
This study indicates the potential of macroalgal polysaccharides extracted using innovative

technologies as alternative antimicrobial agents against *E. coli* to combat pathogen resistance towards conventional antibiotics. Further work is necessary characterizing the chemical features of these polysaccharides responsible for this different antimicrobial activities appreciated in this study.

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Kelp on the menu: reduction of the high iodine content in brown seaweeds

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Title: Kelp on the menu: reduction of the high iodine content in brown seaweeds

Presentation type: Oral or Poster

Sub-Theme: 2.6 Designing and producing foods to meet future challenges

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Aim:
Kelp as food is interesting from both nutritional and sustainable views. However, the two commercial cultivated kelp species; sugar kelp and winged kelp contain over 500 mg kg^{-1} iodine in dry weight (dw). Even though iodine is an essential trace element, intakes at these levels can have health consequences. This study aims to optimize a current blanching setup of the two kelp species by exploring different conditions to maximize iodine reduction.
Method:
Standard blanching conditions were set as a reference inspired by a current industrial setup: whole seaweed at 80 ˚C for 120 seconds, using fresh water for blanching and cooling, at a ratio of 50 g wet seaweed per liter of water and not reusing the water. In each of the experiments, we replaced one of the standard variables to evaluate its effect. For iodine, the samples were prepared in TMAH and analyzed on a Triple Quadrupole ICP-MS (ICPQQQ).
Results:
Blanching at standard conditions reduced the iodine concentration from 750 to 90 mg kg^{-1} dw and from 5000 to 350 mg kg^{-1} dw for winged- and sugar kelp, respectively. Lowering the temperature to 45 ˚C can lead to a noteworthy reduction of iodine, if the blanching time is increased to two minutes. The kelp to water ratio had a significant impact on the reduction, meaning a smaller ratio, the more iodine retained. Reusing blanching water ten times leads to a saturation of the water, meaning less iodine reduction. Cutting the kelp to increase the surface or changing the blanching water to seawater did not impact the reduction.

Conclusion:

In conclusion, it was possible to optimize the current industrially applied blanching method. The industry can decrease the temperature, if they increase the blanching time. Moreover, to reduce iodine, it is not needed to cut the kelp. To save fresh water, seawater can be used as well as reusing the blanching water up to five times.

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Assessment of MEF processing potentiality in vegetable based dressing sauce

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Aim: The consists in the application of an electric potential gradient ranging from 1 to 1000 V/cm (at frequency in the range of Hz to kHz) on a food item placed between two electrodes, with a consequent dissipation of large part of electrical energy into heat within the food item. In terms of energy efficiency, Moderate Electric Field (MEF) processing has been recognized to be a potential sustainable heating method for the food industry (MEFPROC, SUSFOOD2). In this scenario, this work was aimed to assess MEF processing as a sustainable method in industrial production of “pesto” a basil-based dressing, a class of products which are often over-processed. Particularly, assessment was done on MEF employed for two different operations: fresh leaves blanching, and pesto heating.

Method: A custom MEF system, fed by a power generator delivering up to 3000 W (from 40 Hz to 1200 Hz), was used. For assessing MEF performances in blanching, fresh leaves were picked up from a plant of basil (*Ocimum basilicum*) acquired at local market. Blanching solutions were water/sodium chloride, at three different sodium chloride composition (0.5%, 1% and 2%, in mass). Control blanching was done using a heater with an on/off controller. MEF blanching tests, at frequency of 50Hz and 1000Hz. For assessing of pesto heating, samples at different salinities and ratio water/oil were considered. Set point temperatures were 80°C, 90°C, and 100°C.

Results: For basil blanching, MEF processing did not improved the process energy efficiency, given most of the energy losses due to water evaporation. In any case, MEF processing showed to be competitive in terms of process start-up, on/off heating. For pesto heating, the salt content as well as the ratio between water and oil in the sample formulation played a crucial role in determining the thermo-electrical behavior of the basil-based sauce samples, at same time these parameter affect the sensory of the final product. An optimal set (salinity 1.63%) was found, at which the MEF processing results particularly efficient

Conclusion:
MEF processing has been showed being applicable along the unit operations chain in pesto production, with a clear contribution in terms of energy efficiency, especially in pesto heating.

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Development of healthy and personalized food solutions for 3D printing from fish by-products and microalgae

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Aim

This work addresses the potential of 3D printing as a useful and novel technology to valorize fish filleting by-products employing food hydrocolloids. The main objective was to improve the technological and nutritional characteristics of a 3D printing matrix, based on hake, with the addition of two species of microalgae, *Tetraselmis* chuii (approved for human consumption) *and Isochrysis galbana* (not approved yet, but with good sensory and nutritional properties) in order to offer personalized healthy food solutions to consumers with chewing and/or swallowing problems.

Methods

The two species of microalgae were cultured in 10 L carboys with seawater enriched with a commercial nutrient solution. When cultures reached early stationary state, cells were harvested by ultrafiltration through a 300 kDa Pall membranes. Microalgae and hake by-products were nutritionally characterized. The printable matrices were prepared from raw hake, with the addition of different concentrations of hydrocolloid food additives and 1 or 5 % of fresh microalgae biomass. Impact of microalgae addition on the fatty acids profile, Atherogenic (IA) and Thrombogenic (IT) Health Lipid Indices, aminoacids (AA) score, ratios of digestible essential aa (EAAs), the protein efficiency ratios (PER), the ratio of branched-chain AAs to aromatic AAs (Fisher´s ratio) was determined. Also, color, texture, antioxidant capacity and sensorial properties of the different printed matrices were compared.

Results

The incorporation of food hydrocolloids (1% sodium alginate and 1% calcium sulphate) allowed the 3D printing of a fish matrix with 75% of fish that maintained the printed shape even after microwave cooking. The addition of microalgae biomass demonstrated to improve the texture, sensory perception and nutritional value of the final 3D printed product. Microalgae protein presented some limiting AA but addition of 5% of microalga increased concentration of Mg, Mn and Cr (*I. galbana*) and Mg, Ca and P (*T. chuii*).

Conclusions

3D printing is a promise technology to valorize fish by-products and develop healthy personalized food for people with chewing or swallowing problems. *T. chuii* and *I. galbana* biomass can be used as healthy ingredients to improve sensorial and nutritional value of printable fish matrices.

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Influence of chewing on in vitro and vivo starch digestion of brown rice and chickpeas

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Aim:

Oral processing behaviour may contribute to individual differences in glycaemic response to foods, especially in plant tissue where chewing duration can modulate the fraction of starch released from the cellular matrix. The aim of this study was to assess the impact of chewing time of two starch-based foods varying in cellular integrity after cooking (brown rice and chickpea) on bolus properties, *in vitro* starch digestion and blood glucose response in healthy subjects.

Method:

Natural chewing time and chewing frequency of both foods were determined in healthy adults (n=80). Chewing time differed considerably between consumers (brown rice: 13–83 s/bite; chickpea: 13–70 s/bite) with a consistent chewing frequency (1.4 chews/s) independent of food type. Natural short and long chewing times were determined by median split (brown rice: 23 and 41 s/bite; chickpea: 20 and 37 s/bite). Expectorated boluses were collected and subjected to *in vitro* starch digestion. Salivary amylase activity and bolus properties were determined. In an 8-day cross-over trial participants (n=24) consumed two carbohydrates-identical test lunches (brown rice: 233g; chickpea: 323g) with either long or short chewing time in duplicate while glycaemic response was monitored using a continuous glucose monitoring device (CGM).

Results:

Longer chewing resulted in significantly ($p<0.05$) more and smaller bolus fragments, higher saliva uptake into the bolus and higher *in vitro* degree of starch hydrolysis (DHS) than shorter chewing for both foods (brown rice: $DHS_{23s}=84\pm4\%$ and $DHS_{41s}=90\pm6\%$; chickpea: $DHS_{20s}=27\pm3\%$ and $DHS_{37s}=34\pm5\%$, $p<0.001$). Salivary amylase activity was correlated with degree of starch hydrolysis only for brown rice during early stages of *in vitro* digestion. No significant effect of chewing time on glycaemic response (glucose AUC) ($p>0.05$) was found for both foods. Glucose AUC and degree of starch hydrolysis were higher for brown rice than for chickpea regardless of chewing time. No significant correlations between bolus particle size and glucose AUC or DHS ($p>0.05$) were observed.

Conclusion:

We conclude that chewing time of brown rice and chickpea impacts bolus properties and *in vitro* starch hydrolysis as expected but does not affect glycaemic response.

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Protein extraction from red and green seaweeds using enzymatic pre-treatment and subsequent bioactive peptide characterisation.

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Aim:

Seaweeds can contain up to 47% protein on a dry weight basis. However, due to the rigid seaweed cell wall, which is composed of various interlinked polysaccharides depending on species, the extraction of proteins from this resource is not straightforward. The primary aim of this work was to determine the efficacy of using enzymatic treatment as a strategy to release small proteins and peptides from the red and green seaweeds *Porphyra* sp. and *Ulva lactuca*. A secondary aim was to determine potential health benefits of generated protein hydrolysates using in vitro bioassays for heart health, inflammation and pain prevention as well as in silico methods to determine other bioactivities of characterised peptides.

Methods:

Proteins were extracted from both seaweed species independently in triplicate using different enzyme combinations including (1) Bromelain at an enzyme to substrate ratio of 1:100 w/w or (2) A hydrolysis where the enzyme Viscozyme® and Bromelain were used sequentially at their optimum pH, temperature, and enzyme: substrate ratios and rotation conditions. The release of proteins from generated hydrolysates was determined by comparing the proximate protein, ash and lipid composition of hydrolysates v's untreated seaweeds. Bioactive peptides were enriched from generated hydrolysates using 10-kDa molecular weight cut off filtration. Generated permeates were subsequently frozen, freeze-dried and screened for potential heart health benefits using the Angiotensin-I-converting enzyme (ACE-1; EC3.4.15.1) inhibition assay and for potential to prevent pain and obesity using the Monoaceylglycerol lipase (MAGL: EC3.1.1.23) inhibition assay.

Results:

Treatment of the red seaweed *Porphyra* sp. with the enzyme bromelain resulted in extraction of 18% of available protein from the seaweed biomass. Proteins and peptides generated were characterised using SDS-PAGE analysis and mass spectrometry. ACE-1 inhibition was observed for both Bromelain and Sequential hydrolysates generated from *Porphyra* sp. in the 10-kDa permeate fraction.

Conclusion:

Results demonstrate that enzymatically generated hydrolysates from *Porphyra* sp. have potential for use as heart health ingredients. Next steps include characterisation of active fractions using mass spectrometry and development of food products containing selected hydrolysates.

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Influence of seed germination on phenolic content of lupine flour

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Aim:
Lupine plant is well adapted to Mediterranean climate and is considered to be a low-income crop due to its low fertilizing and water needs. Extraction of protein from lupine seeds represents not only an alternative but also a challenge due to the presence of the so-called anti-technological (ATF) and anti-nutritional factors (ANF) preventing the processing and further use of lupine protein isolates. Among other compounds, such as fats, tannins, saponins and alkaloids, polyphenols represent an ANF due to its high ability to associate with proteins during its isolation and reducing the further digestibility of isolated protein. This works explores how the previous germination of lupine seeds affect the polyphenol content in the flour.
Method:
Lupine seeds (var. Tremosilla) were germinated in darkness at room temperature 24 ± 2 ºC for 3 and 6 days, coinciding with the beginning of sprouting and sprouts of 2 to 3 and 6 to 7 cm, respectively. Afterwards, germinated seeds were freeze-dried for 48 h to reach a final moisture content of 7 kg water/100 kg seeds. Freeze-dried germinated seeds and seeds were milled to obtain a flour with similar particle size. Polyphenol extraction using flour from non-germinated (LF) and germinated lupine seeds (GLF) were extracted in acid-methanol (HCl 0.2M). Finally, phenolic content was determined using Total Phenolic Content (TPC) method.
Results:
GLF presented a higher phenolic content than standard LF thus, in the case of germinated seeds during 6 days, the phenolic content was 119 % higher than in LF (3.47 ± 0.18 and 1.58 ± 0.07 mg GAE/g dry matter, respectively). GLF for 3 days reached intermediate values of phenolic content of 1.9 ± 0.09 mg GAE/g dry matter, which represents an increase of 20 % compared to LF.
Conclusion:
Despite the results reported in previous literature, previous germination of lupine seeds did not reduce the phenolic content of the flour. Further works should elucidate the impact of germination not only on the phenolic content of the flour but also on the protein isolate, as well as to identify how individual phenolic compounds are altered by germination.

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Enrichment Of Model-Cheeses With Blackcurrant Or Cornelian Cherry Increases The Total Amount Of Polyphenols

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Aim: Improving Benefits of Cheese Consumption with Polyphenol Rich Berries

Blackcurrant (BC) and Cornelian Cherry (CC) are rich in polyphenols which have bioactive properties for human health. Dairy products only have minor amounts of polyphenolic compounds, and these molecules have beneficial bioactive properties, therefore, increasing the amount of polyphenols in cheese improve nutritional value. BB and CC are used in many food products, but, to the best of our knowledge, has yet to be used in cheese. The aim of the present study was to produce fresh model cheeses from pasteurized cow milk, fortified with BC and CC, in order to increase the total amount of phenolic compounds, without negatively affecting their physicochemical properties, sensory and microbial characteristics.

Method: Testing Enriched Cheese for Bioactivity and Viability

We produced model cheeses by pasteurized whole cow milk added with commercial microbial starter and rennet, and enriched with different concentrations of BC or CC (0.3 – 0.6 % wt/milk volume). Cheeses were analyzed after 4 weeks of ripening. BC and CC were purchased from a certified organic and a conventional producer respectively and were added to the curdle as either freeze-dried or not. The concentration of total polyphenols in the cheeses was measured as the Gallic Acid equivalent (GAE) using the Folin-Ciocalteu reaction. Experimental cheeses were evaluated for their sensory characteristics by means of a blind untrained panel; the microbial community was examined by plate counts of lactic acid bacteria and coliforms.

Results: Total Polyphenols increased in Enriched Cheese without changing Sensory or Microbial Characteristics

The GAE value was higher in cheeses with BC and CC. Addition of BC and CC did not significantly change sensorial score, except for their appearance. The microbial community in the cheeses did not differ significantly for either lactic acid bacteria or coliforms when enriched.

Conclusion: Enriched Cheese Has Potential as a Functional Food

Overall, the addition of BC or CC shows potential as phenolic supplements for dairy products, increasing the bioactive potential without affecting fermentation or sensory value.

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Mediterranean Diet: the role of phenolic compounds from Mediterranean plant foods

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Aim: Today's global food system is one of the main drivers of climate change and biodiversity loss, while causing public health issues and failing to meet SDG2. Yet, some sustainable food cultures, of which the Mediterranean Diet (MD) is a paradigm, have been noted as being nutritionally balanced and respectful of nature at the same time. The wide range of Mediterranean fruits, herbs, and vegetables encompass a wide variety of bioactive compounds, particularly phenolic compounds, which are plant secondary metabolites including small molecules to large polymers. The evidence-based role of these metabolites in adding value to the MD will be discussed.

Method: A literature review was performed in key databases aiming at mapping relevant knowledge on i) health benefits of common herbs and seasonings used in Mediterranean cuisine and their phenolics, and ii) common extraction procedures used for these compounds, as well as some of their industrial applications. The PRISMA-ScR (Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews) approach was followed.

Results: All sub-classes of phenolic compounds share a broad range of biological activities in vitro and many effects are also proved in vivo (e.g., plant sterols and stanols lower cholesterol levels in the blood and are the object of legal health claims). In the present work, the role of polyphenols from Mediterranean plant foods with respect to human and planetary health is discussed.

Conclusion: The commercial interest in polyphenols is increasing, as nutraceuticals and as part of true Mediterranean foods, and therefore a strategy for the sustainable exploitation of Mediterranean plants is essential. The reuse of bioactive phenolics (recovered from food waste) as food supplements or cosmetics is a desirable trend. Nevertheless, with respect to diet, it is noteworthy that the linkage of food habits with cultural landscapes is a cornerstone of the MD and the awareness-raising about seasonality, endemism and other natural constraints. This may facilitate the preservation of plant species at risk as well as the commercial valuation of local cultivars (e.g., by the use of IP quality schemes, such as GI).

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Assessing the use of wild Beta vulgaris in reinforcing nutritional features of bakers' wheat flour

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Aim: Diet-related health issues are a major cause of mortality and morbidity worldwide. Wheat, a staple food in the Mediterranean became a key ingredient for food industries and white wheat flour is now traded and consumed worldwide. In order to fill its nutrient deficiencies, many countries adopted flour fortification strategies' recommendations. In the present study, we examined the impact of replacing a % of white flour with wild and cultivated Beta vulgaris on the bread's nutritional quality, technological features, and consumer preference. Environmental impact questions at a local level and at a food systems global level are also discussed.

Method: Mainstream and fortified flours were analyzed for mineral composition (K, Fe, Ca, Mg, Zn) by flame emission or atomic absorption spectrophotometry and the corresponding dough's rheological properties were evaluated mainly by ISO or AACC methods. Hedonic studies for bread were performed in Tunisia with 100 volunteers from different places, socioeconomic statuses, ages, and educational levels.

Results: The impact of blending chard in wheat refined flour was assessed by comparing the nutritional quality, technological parameters, and consumer preference. As expected, the mainstream refined flour was depleted of minerals and chard addition may complement such deficiencies. Wild chard was found to be richer in all mineral elements than cultivated plants in the studied region being, for example, sixfold richer in potassium. The nutritional quality of wheat bread significantly improved by blending chard powder with refined flour, notably with respect to microelements, without significant changes in the dough's rheological properties or in the bread's texture.

Conclusion: Our results are encouraging with respect to this bread fortification strategy.

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LIQUID INFANT FORMULA BASED ON O/W EMULSIONS FORMULATED WITH BUTTERMILK AND PROCESSED BY HIGH-PRESSURE HOMOGENIZATION

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Nowadays there is a growing interest in the development of infant formula milks (IFs) that mimic breast milk, which is rich in triglycerides stabilized by the milk fat globule membrane (MFGM). MFGM is mainly composed of phospholipids, transmembrane proteins, and cholesterol. In the last decade, technological advances have allowed the incorporation of MFGM concentrates into certain FIs. This interest arises from verifying its bioactive properties related to the neurodevelopment and health of the infant, which could explain some of the differences observed between infants fed with breast milk or with IFs.
The objective of this study was to analyze the effects of the homogenization system (ultra-high pressure, UHPH vs conventional, CH) applied in the preparation of an O/W emulsion, used as a lipid phase in the preparation of a UHT liquid IF. The oil phase of the emulsion was formulated using a mixture of chia and sunflower vegetable oils rich in fatty acids of type ω-3 and ω-6, and buttermilk rich in MFGM as the emulsifying agent. The pre-emulsion was obtained using a rotor-stator system (15,000 rpm, 5 min) and then treated by UHPH at 200 MPa or by CH at 30 MPa, obtaining the corresponding emulsions, which were added to a milk base to obtain the FIs, which were thermally treated using a UHT treatment. The emulsions and UHT FIs were characterized at the physicochemical level in terms of rheology, particle size distribution, as well as physical and oxidative stability. The UHPH treatment presented a greater capacity to reduce the size of the particles, compared to the CH. However, when mixing these emulsions with the IF milk base, the particle sizes were very similar due to the presence of lipoprotein aggregates due to the inclusion of whey protein in the formulation. The analyses of the rheological behavior and the physical and oxidative stability showed that the FI containing the UHPH emulsion was physically and chemically more stable than its counterpart with the CH emulsion. The results achieved in the present study confirm the benefit of the UHPH technology in the production of IFs rich in fatty acids type ω-3 and ω-6, and MFGM, providing the infant with the nutritional and functional benefits from the bioactive compounds, with a high physical and oxidative stability of the lipids.

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How to ensure the printability of a food matrix ? From formulation to consumer appreciation

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Aim:
3D food printing allows the development of personalized, appealing and healthy foods through different shapes, textures, nutritional compositions and tastes. This work presents a pluridisciplinary approach by understanding the impact of fruit/vegetable purees on the rheological properties and printability of printing material, determining the optimal printing parameters of a gelatinized wheat flour dough, determining printability criteria independent of the formulation and evaluating consumer appreciation for printed and baked products.

Method:
First, to understand how the introduction of fruit (apple and mango puree) or vegetable (broccoli puree) impacts the rheological properties and printability of gelatinized flour dough, two experimental designs were conducted to distinguish the modifications induced by the properties of the serum and those of plant particles. Second, two experimental designs were realised to determine optimal printing parameters and then to test these parameters on different formulations and different printing shapes (cylinder, star and pyramid). Finally, an experimental design on the impact of the water content and the heating time (during thermo-mechanical treatment) was set up for soy and rye flour to ensure their printability and thus diversify the printable materials. Six recipes were printed (wheat, rye and soy flour with and without 20% apple puree), baked (175°C, 17 min), and evaluated by a 4 trained panelists and by 56 consumers.

Results:
The main printability criteria used are the tan δ, the consistency ($Pa.s^{n-1}$) and the firmness (N) for the dough and the dimensions (image analysis) for the printed model. All printed recipes of cylinder and pyramid shapes had a good printing quality but for the star shape, poorer printing quality was obtained with broccoli puree. Different sensory perceptions were observed for products made from different flours. Using a back-engineering approach, we determined that consumers preferred wheat flour products with 7% of apple puree.

Conclusion:
The printing quality depends on the percentage of puree, the process parameters of the thermo-mechanical treatment, the printing parameters and the shape of the model. Physicochemical properties of purees and rheological properties of the printing material can explain printing quality. These results also show the complexity of combining printability, nutritional composition and consumer acceptance.

Nous avons souhaité comprendre comment l'introduction de purées de fruits ou de légumes impacte les propriétés rhéologiques, la capacité à être imprimer et la qualité d'impression de matrices imprimables à base de farine de blé. Deux plans d'expériences ont été menés pour faire la part des choses entre les modifications induites par les propriétés du sérum (brix, teneur en sucre, pH pouvant impacter la gélatinisation de l'amidon et la fonctionnalisation des protéines) et celles induites par la présence des particules végétales issues des fruits et légumes (teneur en insolubles, rigidité, distribution de taille de particules). Ces deux plans d'expériences nous permettent également de définir un critère objectif de l'imprimabilité des matrices étudiées.

i) understand how the introduction of fruit or vegetable impacts the rheological properties and printability, ii) determine the optimal printing parameters of a control dough (with 20% of apple puree) and use these parameters to study printing quality of formulations with different percentage of fruit or vegetable puree and printed with different shapes, iii)

In order to test these optimal parameters on doughs with different percentages and types of fruit/vegetable puree, different shapes (cylinder, star and pyramid) were printed and subsequently analyzed by image analysis. The doughs tested had 30% of wheat flour and a variable percentage of puree (20% or 45% of apple puree, 20% or 45% of mango puree and 45% or 70% of broccoli puree). Two experimental designs were conducted to distinguish between the modifications induced by the properties of the serum (brix, sugar content, pH which can impact starch gelatinization and proteins functionalization) and those induced by the presence of plant particles from fruits and vegetables (insoluble content, stiffness, particle size distribution). These two experimental designs also allow us to define an objective criterion of the printability of the studied matrices.

The main objectives of this work were i) determine the optimal printing parameters of a control dough (composed by wheat flour, water and 20% of apple pure) and ii) use these optimal parameters to study the printing quality of formulations presenting different proportions of fruit/vegetable purees.

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Omnibus modeling of Listeria monocytogenes growth rates as an emerging tool for shelf life prediction

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Aim:
Listeria monocytogenes is a pathogen of particular concern for refrigerated foods. Predicting and extending the shelf life for such foods can have a high economic impact.
Traditional two-step modelling of growth or inactivation is done sequentially. First-order models are fit to individual growth experiments, where the factors of interest are held constant. The estimated growth rates from these models are then used to fit a second-order model, which models how growth rates respond to changes in these factors. By contrast, omnibus modeling – here using a mixed-effects nonlinear regression approach - uses all experimental data to fit a combined model in a single step. This allows rapid estimation of growth and shelf life, with no loss of information.
The aim of this work is to demonstrate the effectiveness of omnibus modeling for predicting *L monocytogenes* growth under conditions where multiple factors vary. This can include temperature, acetic acid, pH, water activity, strain and food matrix.
Method:
Growth data for *L monoctyogenes* in broth or food were taken from previously published experiments. In the first, the effect on growth in response to changes in pH, water activity, and acetic acid was compared across three matrices. The second study compared the growth of several different strains of *L. monoctyogenes* in broth at 4℃ and 7℃. In both cases, the estimates for the omnibus model were compared with both traditional modelling and Combase predictions.
Results:
Preliminary results suggest broad agreement between the different modelling approaches. More consistent estimates for growth are shown by the omnibus approach. The variation between more categorical factors like strain and matrix can be quantified and compared.
Conclusion:
The omnibus approach allows predictive models to made from large pools of data. Experiments where primary modelling was not possible due to incomplete growth can still inform the final results. The uncertainties of the predictive modelling estimate are also more consistent. The scalability and complexity of the modelling approach makes it well placed to capture value from emerging or next generation technologies.

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Microencapsulation of probiotic cells enhances their survival under conditions simulating the human gastrointestinal system

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Aim: The present study examined the survival of 2 probiotic strains (*Lacticaseibacillus casei* Shirota and *Lacticaseibacillus rhamnosus* GG), grown on different media and microencapsulated in a whey protein isolate (WPI)-gum arabic (GA) complex coacervate matrix, under stress conditions simulating the human gastrointestinal system (GIS).
Method: The strains were grown in MRS broth (containing 2% glucose) and Tryptic Soya Broth (TSB) (containing 1% glucose). Then, cells were microencapsulated in the WPI/GA coacervate or tested as free cells. The cells survival was estimated under conditions simulating the human GIS, i.e., exposure to i) Phosphate Buffer Saline (PBS) buffer pH=2.5, ii) PBS pH=8.0 with 0.5% bile salts, and iii) sequential combination, by enumeration on MRS agar.
Results: Results showed that the two encapsulated probiotic strains previously grown on MRS and exposed to PBS pH=2.5 (simulating the food passage through the stomach), showed a lower population decline, in comparison to the strains grown on TSB. In detail, the population declined by 2.5-3.0 log CFU/ml, in contrast to the encapsulated cells grown on TSB, that exhibited a higher reduction of 3.5-4.0 log CFU/ml (initial population in all cases was 9.0 log CFU/ml). The population of the encapsulated cells grown on MRS and exposed to PBS pH=8.0 and 0.5% bile salts (simulating the food passage through the small intestine), showed an 0.50 log CFU/ml reduction, whereas the encapsulated cells population grown on TSB exhibited a higher decline (1.5 log CFU/ml). At the sequential combination (exposure to pH=2.5 and then to pH=8 with 0.5% bile salts), the encapsulated cells population was reduced by 2.5-3.0 log CFU/ml when grown on MRS and by 3.5-4.0 log CFU/ml, when grown on TSB. Free cells grown on MRS had a higher survival in contrast to the cells grown on TSB, however all treatments led to a population decline of 3.0-5.0 log CFU/ml.
Conclusion: It can be concluded that the microencapsulation can protect the probiotic cells against GIS stress conditions and allow them to maintain at high population levels.
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Chitosan/LCNF/Gallic-acid films for active food packaging

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Aim:

Study the reinforcing effect of lignocellulosic nanofibers (LCNF) isolated from raspberry pruning residue (RPR) and the active properties of gallic acid as additives into chitosan-glycerol film matrices.

Method:

Lignocellulose nanofibers were isolated from RPR using a semi-mechanical process followed by high-pressure homogenization. Films were performed by the solvent casting method. Chitosan was fixed at 0.75% (w/w) in film solution. The remaining components were added based on chitosan dry weight (c.d.w). Concentrations of 20 and 5 % (c.d.w.) for glycerol and LCNF, respectively, were fixed based on previous studies. Gallic-acid (GA) was added at 1%, 5%, 10% and 20 % (c.d.w.). Films were dried at 50% relative humidity and 25°C for 3 days. Mechanical properties were evaluated in terms of Young Modulus (YM), Tensile Strength (TS) and Elongation percentage (E) following the standard ASTM D638. Percentage transparency and UV-Blocking capacity were measured at 600 and 280 nm, respectively. Water vapor permeability (WVP) of films was studied according to the ASTM E96/E96M-10 standard. Finally, antioxidant power of the films was determined by DPPH assay.

Results:

The elongation percentage was improved when adding 10% and 20% GA, reaching 7.5% and 7.9%, respectively. The optical properties were enhanced with the incorporation of GA into the film matrix. An inversely proportional relationship between percentage transparency and GA content was observed, reaching a minimum transparency of 24,10% for 10% GA films. Furthermore, UV-blocking capacity was higher with the addition of GA, showing the best results for 20% GA content, reaching values of 99.18%. Finally, the antioxidant power of the films was largely enhanced with the addition of GA, reaching values of 8,32 % DPPH inhibition per mg of film for 20% GA samples.

Conclusion:

The combination of gallic acid as an active component, and LCNF as a bulking/reinforcing agent in chitosan-glycerol matrices improved the mechanical, optical and antioxidant properties of the films, which could be a desirable combination for their inclusion in the food packaging.

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Phenolic compound profiles and antioxidant concentrations in Lettuce grown under AI developed LED light recipes

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Aim: Development of different LED light recipes can reduce nitrate content and increase phytochemical concentrations within antioxidant effects using AI, big data and IoT.

Lettuce (*Latuga sative*) is one of the major leafy vegetables consumed worldwide. It has also important role in human nutrition by containing wide range of bio-active compounds such as vitamins, minerals, and antioxidants. Among many factors affecting plant growth, light is considered one the main environmental factors, since it regulates growth, photosynthetic activity and accumulation of metabolites. Therefore, different custom-made wavelengths/spectrum recipes could regulate concentration of nutritionally important phytochemicals.

Method: Growth under different light recipes and phytochemical analysis
Lettuce (*Lactuca sativa L*. cv. Butterhead) was grown under different LED lighting conditions based on the light recipes combining red (R), blue (B), infrared (FR), with and without green (G) at different intensity and spectrum. PlantEye phenotyping scanner was used to collect big-data representing growth conditions. All datasets were analysed using different AI algorithms for optimising the best growth conditions. Nitrate and chlorophyll concentrations were measured by spectrophotometric method. Total polyphenols and flavonoids were analysed by established methods. Profiling of phenolic compound was conducted by spectrometric analysis (HPLC-MS, GC-MS, ICP-MS). All analysis was also conducted for control treatment to be compared to the AI developed light recipes.

Result: Combination of R, B, G and FR lights has significant effect on plant nutrients
Statistical analysis showed significant interaction between total phenolic content and light combinations. Nitrate content has significantly reduced under RBFR and RBGFR light recipes compared to control, whereas total phenolic content and antioxidant activity has increased under both RBFR and RBGFR lights compared to control. The biomass (fresh and dry weights) of the plants under the light recipes calculated based on AI algorithms (RBGFR 4:1:1:1 100-300µmol) were two times higher than the controlled growth conditions (RB 4:1 200µmol).

Conclusion: Enhanced nutritional quality
Findings from our study suggest that proposed light recipes can significantly increase nutritional quality of lettuce grown indoor and can contribute designing optimal condition for high quality crops in greenhouse.

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How oral structure breakdown, food and bolus properties determine juiciness perception of plant-based meat analogues

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Aim:
Juiciness is a positive, pleasant, mouthfeel property of many meats. Plant-based meat analogues (PBMA) are food products that are designed to mimic sensory properties of meats. Many of the current PBMA's lack juiciness which limits their sensory appeal and consumer acceptance, especially by flexitarians. There is a lack of knowledge of the properties that drive juiciness perception. The aim of this study is to understand juiciness perception of meat and PBMA by linking oral structure breakdown, food and bolus properties to sensory properties.

Method:
Beef and PBMA burger patties with different juiciness levels and textural properties were prepared by controlling internal cooking temperature (60, 70, 80 and 90°C). Patties were characterized for cooking loss, composition, serum release, serum composition, and texture properties (Texture Profile Analysis). Sensory properties of patties were evaluated by 100 consumers: sensory juiciness was determined using rank-rating tests and texture and flavor perception was quantified using Rate-All-That-Apply (RATA) profiling. Bolus properties were characterized by saliva uptake, bolus particle size, bolus texture properties (penetration test), serum release of bolus and serum composition. Food and bolus properties of beef and PBMA patties differing in juiciness were linked to sensory properties and juiciness perception by multivariate statical data analysis.

Results:
The data collection and analysis are ongoing and will be completed by September.

Conclusion:
This study will reveal the food and bolus properties that drive juiciness perception in beef and plant-based meat analogue patties, and the role of oral break down, food and bolus properties in PBMA's sensory perception will be clarified.

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Pulsed electric fields impacts the stability and bioaccessibility of phenolic compounds in carrot purees

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Aim: Carrot is a good source of antioxidants, including phenolic compounds (PC), whose consumption has protective effects against cardiovascular diseases. However, natural barriers and interactions with carbohydrates prevent their release from the food matrix during digestion, which make them poorly bioaccessible. Pulsed electric fields (PEF) modify the cell membrane permeability, which could enhance PC bioaccessibility. However, processing may impact the retention of PC in the final food products, in turn influencing their health-promoting properties. Therefore, developing strategies to obtain products with enhanced PC bioaccessibility and content during storage is critical. The aim of this work was to evaluate the effect of PEF on the stability and bioaccessibility of PC in carrot purees.

Method: Purees were produced by blending carrot pieces with water [1:1 (w/w)] and adding olive oil [5% (w/w)]. Two batches were obtained: one was subjected to PEF (0.61 kJ/kg) and other remained untreated (NT). Then, one fraction of each batch was thermally-treated (70 ºC for 10 min) (T and PEF/T) and other remained unheated as a reference. PC content was evaluated for 21 days at 4 ºC by UPLC/MS-MS, as well as their physicochemical characteristics. In addition, purees were submitted to an *in vitro* digestion to assess PC bioaccessibility just after treatment.

Results: T- and PEF/T-treated purees had the highest PC content (74.6 - 94.7 mg/kg DW). After 21 days, a 34 % reduction in T-treated purees was observed, whereas in PEF/T-treated purees just decreased by 22.7 %. Caffeic acid derivatives were the most sensitive to PEF, probably due to the major exposure of its oxidizable group. PC were probably better kept after heat application by inactivating oxidative enzymes. Besides, total PC bioaccessibility was trebled in PEF- and PEF/T-treated purees (100 %), whereas T-treated purees had similar bioaccessibility as NT (30.7 %). Noteworthy, purees' physicochemical characteristics were not significantly affected. Obtained results suggest that changes in matrix integrity facilitate the accessibility of digestive enzymes and phenolic release during digestion.

Conclusion: PEF/T treatment has demonstrated to be an effective strategy to enhance PC bioaccessibility and stability, which make feasible to obtain a functional product that better keep their health-promoting properties during storage.

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Microencapsulation improves probiotic survival under harsh conditions during model food storage

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Aim: The present work studied the effectiveness of a complex encapsulation system to increase the survival of two probiotic strains under stress conditions during storage of a model-food.
Method: *Lacticaseibacillus casei* Shirota and *Lacticaseibacillus rhamnosus* GG were encapsulated in a whey protein isolate (WPI)-gum arabic (GA) complex coacervate matrix. Then, the encapsulated probiotic cells were added in Tryptic Soya Broth without glucose, which was used as a model-food, to study the survival of the strains under harsh conditions (pH 2.0, 2.5, 3.0, 3.5, 4.0) during storage at 4°C and at 10C for up to 20 days, depending on the case. Free cells of the 2 probiotic strains were used as controls.
Results: Results showed that the encapsulated cells exposed to the low pH (2.0, 2.5) exhibited an immediate population reduction of 3.0 log CFU/ml, in contrast to free cells that showed a 6.0 log CFU/ml decline (initial population was 9.0 log CFU/ml). After 24h of storage at 4°C and at 10°C, the encapsulated cells showed a 0.5 log CFU/ml population reduction, in contrast to free cells that declined by 6.5-7.0 log CFU/ml. At the end of storage at both temperatures, population of the encapsulated cells was 3.0 log CFU/ml, in comparison to free cells that were not detected (<1.0 log CFU/ml). At pH 3.0 and 3.5, both encapsulated and free cells showed an initial population reduction of 3.0 log CFU/ml. After 24h of storage at both temperatures, population of encapsulated cells was maintained at 6.0 log CFU/ml, whereas free cells declined by 2.0-2.5 log CFU/ml. At the end of storage, population of the encapsulated cells was 3.0-3.5 log CFU/ml, while free cells population was 1.0 log CFU/ml lower. At pH 4.0, population of the encapsulated and free cells was maintained at 7.0 and 6.0 log CFU/ml, respectively, throughout storage.
Conclusion: It can be concluded that the WPI/GA coacervate can be efficient in protecting the encapsulated probiotic cells from the examined stress conditions.
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Understanding flavor release and perception of meat analogs in relation to structure and oral breakdown

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Aim
The current knowledge about the influence of the structure, composition and physicochemical properties of plant-based meat analogs (PBMAs) on the eating process, the oral structural breakdown during consumption and its influence on sensory perception is limited. The interaction of the food matrix and its structure, composition and physicochemical properties with *in vivo* flavor release and perception during food oral processing has not been explored yet. This knowledge is crucial to improve the texture and flavor of PBMAs, which are essential sensory attributes for consumer acceptance.
This study aims to determine how changes in texture and juiciness of PBMAs affect oral structural breakdown and consequently influence *in vivo* flavour release and perception. It is hypothesized that a higher level of juiciness leads to higher flavour release and more intensive flavour perception.

Method
Commercially available PBMAs and minced meat are formed into burgers. The juiciness of these burgers is varied by varying the internal temperature of the burgers. Analytical flavour and sensory methods are combined to investigate the effect of juiciness on oral breakdown, flavour release and perception. Rate-All-That-Apply (RATA) is used to obtain descriptive sensory profiles of all samples to confirm differences in juiciness and provide additional sensorial information. To understand how *in vivo* flavor release and perception interact, in nose - Proton Transfer Reaction Mass Spectrometry (PTR-MS) monitors *in vivo* release of volatile organic compounds (VOCs) and is combined with Time-Intensity sensory profiling (TI) to identify the temporal release of the VOCs. The PBMAs' structural properties, composition, dynamic bolus properties and oral processing behavior will be linked to the *in vivo* flavor release and perception to understand the underlying mechanisms.

Results
Results from the RATA confirm significant differences in juiciness for the PBMAs samples. The PTRMS and TI data collection is ongoing and will be finished in August 2022.

Conclusion
This research will reveal the impact of texture and juiciness of PBMAs on *in vivo* flavour release and perception. Understanding the mechanisms contributing to texture and flavour perception of PBMAs will be crucial to develop higher-quality meat analogues.

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Evaluation of the antirotaviral activity of milk extracellular vesicles using a human intestinal model

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Aim:
Rotaviruses are the leading etiologic agents causing severe gastroenteritis and fatal dehydration in infants and young children. Current vaccination is not completely effective, mainly due to economic and logistical difficulties, and low vaccine availability/acceptance. This prompts search for affordable and accessible alternative approaches. Accordingly, food components like milk constituents have been shown to attenuate rotavirus infectivity, but the role for the hitherto less considered milk derived extracellular vesicles (EVs) in this context is unknown. EVs are now central to research in many fields of biology because they constitute an overseen new system of cell-to-cell communication with the potential application within therapeutics. Milk EVs have been found to consist of several components that have exhibited antiviral properties, especially glycoproteins like mucins and lactadherin. The objective of this study was to evaluate the activity of EVs isolated from bovine milk against human rotavirus in Caco-2, a human cell line that differentiates into enterocytes.
Methods:
EVs were isolated from bovine skim milk serum, and more processed fractions, using differential centrifugations followed by size exclusion chromatography. Isolates were characterized, *e.g.,* western blotting was carried out to verify the presence of the specific membrane markers and potential contaminants. The neutralizing activity of EV samples against infection by the human rotavirus strain WA was evaluated using Caco-2 cells and a colorimetric assay read out.
Results:
The success of EV isolation was verified by the presence of the tetraspanins CD9, CD63, and CD38, as well as low or non-significant contents of proteins like casein. Together with other milk fractions, milk EVs turned out to have antirotaviral activity in the applied in vitro assay. Additionally, the effect of several common processing approaches used by the milk on the rotavirus inhibitory activity was evaluated. Treatments like pasteurization and homogenization turned out to reduce the desired effects depending on the extent of the treatment.
Conclusions:
In the end, the effect of milk EVs potentially adds another food-derived tool to fight rotavirus infection. However, the results also stress that it is important to consider the depth of the industrial processing to ensure effective transfer of bioactive food components to human consumers.

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PHYSICAL AND ANTIOXIDANT PROPERTIES OF A YOGURT CONTAINING LIPOSOMAL NANOSUSPENSIONS WITH ENCAPSULATED TANNINS

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PHYSICAL AND ANTIOXIDANT PROPERTIES OF A YOGURT CONTAINING LIPOSOMAL NANOSUSPENSIONS WITH ENCAPSULATED TANNINS
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Aim: The oxidative stability of milk directly impacts the yogurt since lipids are susceptible to oxidation. Incorporating molecules with high antioxidant capacity, such as tannins encapsulated in liposomal nanosuspensions would prevent oxidation reactions. This research aimed to study the physical and antioxidant properties of yogurt made with liposomal nanosuspensions that encapsulate tannins (SLT) to prevent oxidation over time.
Method: A stability study was carried out for six weeks, which contemplated the storage of yogurts made with SLT at different temperatures (-18ºC, 4ºC, and 25ºC). Mean particle size (MPS), polydispersity index (PDI), z potential, total phenol content (TPC), antioxidant activity by reduction of the ABTS radical, peroxide value by iodometric titration, and the rheological parameters with a Discovery Hybrid Rheometer HR2 (TA Instruments, USA) were measured. The linear region of viscoelasticity was established, and temperature ascendant/descendant scans were applied from 5°C to 25°C at a rate of 1°C per minute.
Results: The SLT at -18°C had a size of 800 nm, while at 4 °C and 25°C, the sizes ranged between 200 and 300 [nm]. The MPS increase was attributed to the hydrolysis of phosphatidylcholine esters present in the formulation of the nanosuspensions. Regarding the PDI, for 4ºC and 25ºC, a homogeneous and monodisperse distribution of particles was reported at 0.4. For -18ºC, an aggregation of particles with a value of 0.6 was reported. TPC stored at -18ºC decreased due to prolonged exposure to water, leading to degradation of phenols. The antioxidant activity values were 1.30 [mM Trolox] for 25ºC and 1.70 [mM Trolox] for -18ºC and 4ºC. High temperatures cause hydrolysis of the glycosidic bond of tannins, affecting their antioxidant activity. Stored SLTs had a

significant decrease in peroxide value over time. For all evaluated samples, the storage modulus (G') was greater than the loss modulus (G''), which suggests that the evaluated yogurts show a typical behavior of gelled structures.
Conclusion: Finally, the yogurt made with SLT and stored for 6 weeks at 4°C presented better stability than at -18ºC and 25°C, maintaining its physical and antioxidant properties.

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Pressurized Hot Water Extraction, an Efficient Technique for Extracting Antioxidants from Ghanaian Fruits and Vegetables

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Aim:
In our study, we aimed to investigate the antioxidative effects of underutilized Ghanaian fruit and vegetable extracts obtained using pressurized hot water extraction (PHWE) and conventional (organic solvent) extraction methods.

Method:
Six edible indigenous fruits and vegetables of Ghana, namely: *Chrysophyllum albidum* G. Don, *Chrysophyllum perpulchrum* Mildbr. ex Hutch. & Dalziel*,* *Chrysophyllum subnudum* Baker, *Landolphia dulcis* var. *barteri* (Stapf) Pichon*, Morinda morindoides* (Baker) Milne-Redh. and *Sterculia tragacantha* Lindl were analysed. PHWE (Speed SFE-Helix, Applied Separations, Allentown, PA, USA) and methanolic extracts were obtained from the dried plant material and the antioxidative activity of each extract evaluated *in vitro* using 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging and oxygen radical absorbance capacity (ORAC) assays.

Results:
In both assays, PHWE extracts showed better (or equal) results as compared with methanol. Records from the ORAC assay indicates that the mesocarp of *C. albidum* which demonstrated the highest antioxidative activity of 18.54 ± 0.27 µg/ml among the methanolic extracts, displayed a better result of 16.85 ± 0.10 µg/ml among the PHW extracts comparable with Trolox (IC50 16.87 ± 0.33 µg/ml), the water-soluble analogue of a well-known antioxidant vitamin E. The aril and epicarp of *C. albidum* correspondingly recorded higher significant activities of 35.54 ± 2.97 µg/ml and 44.13 ± 5.28 µg/ml respectively in the PHWE extract against that of methanol (IC50 37.34 ± 6.6 µg/ml and 58.13 ± 3.42 µg/ml). *C. perpulchrum* and leaves of *S. tragacantha* which exhibited no antioxidative properties among the methanolic extracts recorded activities of 110.36 ± 15.97 µg/ml and 107.30 ± 14.83 µg/ml respectively in the PHWE extract.

Conclusion:
A comparative evaluation of the results suggests that PHWE method of extraction could be used as a more efficient and ecologically safer option for extraction of antioxidants from fruits and vegetables. Additionally, our findings provides evidence that the fruit parts of *C. albidum* exhibit better significant antioxidant properties with the green technique of extraction as compared with the conventional. Some degree of radical specificity was shown in the scavenging abilities of potent antioxidative fruit parts and vegetables vis-à-vis the two assays used.
Czech University of Life Sciences Prague (IGA) supported this research.

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Image Analysis for Sediment Quantification in Rehydrated Infant Formula

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Aim:
Current methods for measuring sediment post rehydration of infant formula (IF) powders, rely on manual visual inspection, filtering, or sieving which are subjective. This study developed and evaluated a non-destructive automated platform and measured sediment in a baby bottle.
Method:
An automated platform using a collaborative robot and image analysis was developed to: (i) reconstitute 24 commercial and pilot stage-1 IF powders in a commercially-available baby bottle, using a ‘swirl’ robotic motion; (ii) quantify the amount of sediment in the bottle using an in-house developed vision system; and (iii) monitor the sediment change in four imaging rounds over 15 minutes. The robot rotated the mixtures in front of the camera to inspect the bottle from six different viewpoints. The mixtures were prepared and rated in the same baby bottle to: (i) not disturb the prepared mixture during the measurements; and (ii) closely resemble consumer evaluation. Validation of the image processing technique was conducted using two approaches. Firstly, robot-taken images of one randomly-selected imaging round from each sample were shuffled and rated by one of the authors. Secondly, the differences between target and actual total solids (TS) was compared with the sediment measurements of the image analysis. The actual TS was determined using a microwave moisture analyser (SmartTrac) (one measurement post mixture preparation); the target TS was calculated based on the weight and number of scoops used for mixture preparation. A Pearson correlation was computed using R.
Results:
Sediment height measured by the vision system was correlated (r=0.75) with the difference between the target and actual TS. This relationship may be explained according to the law of conservation of mass; the mixtures should show sediment (or lumps) if the added powder is not rehydrated sufficiently. Furthermore, the human ratings of the robot-taken images were positively correlated (r=0.88) with the vision system ratings.
Conclusion:
The preliminary results indicate that the developed platform has the potential to objectively reconstitute IF powders and measure sediment in a commercially-available baby bottle. Further work will include additional robotic motions. The system is potentially adaptable to other dairy or food powders to provide objective sediment measurements.

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REVALORIZATION OF COCOA BY-PRODUCTS THROUGH ENZYMATIC HYDROLYSIS AND GASTRONOMIC APPLICATIONS

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Cocoa is one of the most consumed foods worldwide with an annual production of around 5,024 million tons, according to the International Cocoa Organization [1]. Only 20% of the fruit is used, the rest is discarded, generating a great environmental impact, since the total residue is around 16 million tons per year [2]. The main by-products are the shell of the fruit and the shell of the cocoa beans. Therefore, rethinking the full use of the fruit in the food industry is a latent need. This research proposes the use of exogenous enzymes as a biotechnological solution to make use of organic compounds contained in these by-products and generate full use of them.

The cocoa shells and the cocoa bean shells were provided by the Mater Initiative Research Center, Lima, Peru. All enzymes were purchased Töufood, Barcelona, Spain. Different enzymes were used, pectinase, cellulase, amylase, xylanase, and β-glucosidase, all of them at a concentration of 2.5%. Enzymatic hydrolysis was carried out during 3 h in a heating bath at 50ºC and a pH range of 4-5.

The hydrolyzed cocoa shells were used to obtain a paste added as a flavoring and texturizing agent in different food matrix, like a drink made with *Saccharomyces bayanus* yeast, a low sugar spread, a miso, and an ice cream. This ingredient allowed us to reduce additives while providing distinctive flavors. Different gastronomic applications were also obtained through enzymatic hydrolysis of the cocoa bean shells, as a clarified cocoa drink, a praline, and a gluten-free flour with a high fiber content and suitable for a gluten free diet. Finally, to determine consumer acceptability, a hedonic test was carried out (n>60), to assess the degree of linking for the different developed products.

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[2] *Z. S. Vásquez, D. P. de Carvalho Neto, G. V. M. Pereira et al. "Biotechnological approaches for cocoa waste management: a review,"* Waste Management (New York, NY), vol. 90, pp. 72–83, 2019.

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Mathematical modeling for furan estimation during thermal sterilization process of jarred carrot

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Aim:
Furan (C4H4O) is a volatile compound produced during the processing of heat-treated foods and drinks and considered carcinogenic by the International Agency for Research on Cancer (IARC, 1995). Many efforts have been performed to understand the behavior of this compound during thermal treatments in different food materials, but special attention has been put on ready-to-eat baby food, which has been reported to contain high values of furan (EFSA, 2011). Therefore, the aim of this research was through a preliminary study to develop a mathematical model able to predict furan formation from temperature-time profiles measured at the surface and cold spot of thermally sterilized food

Method:
The furan formation kinetic was determined in carrots samples put into glass tubes sealed and heated at three constant temperatures: 112, 117, and 123 °C in an oil bath. The determination of furans was carried out by the SPME method using a GC-M. Furan content was fitted to first-order kinetic (1), and constant *k* was analyzed by the Arrhenius model (2). The model used to predict furan content was developed by coupling 1 and 2. The validation of the furan formation model was done through furan formation data obtained from sterilization of carrots in 55x88mm jars in a vertical autoclave (Loveless, model 117, USA) using three and different process temperatures using a target of lethality values-F_0 > 3min.

Results:
The furan content showed to fit the first-order kinetic model with R^2-values >0.980 (0.667<*RMSE*<1.809). The k-values ranged from 0.0282 1/min at 112 °C to 0.0820 1/min at 123 °C, showing an increment of *k* with temperature. The values reported for furan content in processed carrots varied between 8.54 ± 0.33ng/g to 19.46 ± 0.98ng/g showing a dependence on TRT and processing time. The model used to predict the average furan content presented an error between -0.12% to +11.21%, with respect to the value reported experimentally

Conclusions:
As a first approach, the model proposed here allows to have an approximation of furan content at the end of the process, and in the future, can optimize the process through variable retort profiles that minimize furan content.

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Psyllium effect on physic-chemical characteristics of gluten free bread including apple pomace powder

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Aim:
Apple pomace waste is a promising upcycled ingredient in the manufacture of gluten gluten-free breads. In this line of clean-natural labelling, psyllium is a recently widespread ingredient in marketed gluten free bread products. It is presented as a kind of natural and functional ingredient and it might have an impact into quality characteristics such as durability, which is a key aspect of gluten free manufacture. The aim of this work was to assess the effect on quality parameters of psyllium addition in a gluten free bread formulation together with apple pomace powder, by-product from cider manufacture.
Methods:
Commercially available gluten free starches (maize and rice) and flours (rice, buckwheat and chickpea) were enriched with 13.5% apple pomace powder. Psyllium was added to the formulation at 0%, 0.9% and 1.8%. Formulations with no pomace addition were also prepared as controls. Physic-chemical parameters were measured at day 0 and day 3: water content, Aw, specific volume, cell concentration per cm^2 and size, and finally colour (CIELAB parameters) and texture in both, crumb and crust. Possible significant ($p<0.05$) differences due to pomace and psyllium addition were studied by means of non-parametric tests (Kruskal Wallis H and U-Man-Whitney) and Wilcoxon rank test was used as a paired difference test to identify possible time differences. Regression analysis was used to estimate weight of experimental factors on quality parameters.
Results:
Cell concentration was significantly and inversely affected by fiber sources (pomace, psyllium), mainly by psyllium addition (6 times reduction per 1% psyllium increase). In parallel, cell size tended to increase. Colour was affected mainly in the crust, with lighter tones with no APP addition and higher reddish colour when APP was included. Psyllium reduced a* parameter significantly (greenish) in control samples with no APP added (from 11.5±0.48 to 6.7±0.25). Time was the main factor explaining significantly hardening and cohesiveness lose along conservation, but psyllium concentration had a positive effect as it delayed cohesiveness decrease.
Conclusions:
Psyllium addition had an overall relative impact on quality parameters on gluten free breads assayed, conditioned to its interaction with apple pomace.

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Quality of gluten-free breads formulated with apple pomace and psyllium as affected by frozen storage

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Aim:

Low durability is one of the main problem identified for current commercial gluten-free breads. It is necessary to study possible solutions, which include ingredients from sustainable and natural sources as consumers demand. The aim of this work was to characterize the effect of frozen storage on quality parameters of gluten-free bread formulations including upcycled apple pomace and psyllium.

Methods:

Apple pomace (0%, 13%) and psyllium (0%,0.9%,1.8%) were added to bread dough based on starches (maize, rice) and flours (rice, buckwheat, chickpea). Physic-chemical parameters were measured at day 0 and after 30 days of frozen storage (-26ºC): Aw, colour (CIELAB) and texture profile. Significant ($p<0.05$) differences due to pomace or psyllium addition were analyzed by non-parametric tests (Kruskal Wallis H and U-Man-Whitney) and Wilcoxon rank test was used as a paired difference test to identify possible time changes. Regression analysis was used to estimate weight of experimental factors on quality parameters.

Results:

Aw values went from 0.82±0,043 to 0.96±0.01 after 30 days storage. Colour was mainly influenced by apple pomace. However, time of frozen storage had small but significant impact on L* and a* (mainly in the crumb) mean values going from 57.97±12.86 to and 64.69±10.08 and from 8.10 ±3.69 to 5.43±3.49, respectively. Storage at -26ºC had the greatest impact on crumb hardness and cohesiveness; storage time alone could explain the 78-79% of their variability. Pomace and psyllium amount were relevant for texture parameters, as well. Hardness, decreased with increasing psyllium concentrations in those formulations with no pomace added, while it increased with it in pomace containing samples. Similarly, greater chewiness values were registered in 1.8% psyllium breads, compared to 0% and 0.9% in pomace-added samples and no significant changes were described in breads without pomace. Finally, significant differences for resilience between 0% and 13.5% pomace was only found in controls for psyllium.

Conclusions:

Frozen storage of gluten-free bread influenced texture parameters significantly. This study suggests that, responding to new food design tendencies, further studies on interactions between hydrocolloids added to new gluten-free formulations will be needed in order to be able to foresee and standardize quality characteristics.

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Impact of different plant or microbial enzymes on cheese analog production from soy milk

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Aim:
Plant-based food products are increasing in demand worldwide as a consequence of consumers' demands for more sustainable and healthy food products. Among the many food categories targeted, plant-based meat and milk analogues are highlighted as the most common and there are several products already introduced in the market. Although plant-based cheese analogues are sought greatly by consumers their design and development poses several challenges. Formulations must ensure the quality and safety requirements to meet the regulatory requirements and the consumer's expectations. Technological interventions required to obtain the desired final product can alter their composition, physicochemical, structural and sensory properties. For plant-based cheese analogues the induction of a sol-gel transition is crucial to enable a viscoelastic solid with textural characteristics similar to those of conventional cheese. This may be done by several processing routes including the use of enzymes: crosslinking enzymes, proteases. In this context, the aim of this work was to assess the effect of different enzymes on the setting quality of a soy milk cheese analogue.
Method:
Upon soaking, soybeans were blended to disrupt cell structure. The resulting colloidal dispersion was pasteurized and cooled to 30 ºC before submission to different enzyme systems in order to induce a sol-gel transition. The enzymes tested included microbial transglutaminase, melon seed extract and vegetable protease added at reference concentrations and optimum cross-linking/clotting temperature. Vegetable oil was added to the dispersion between 15-17.5% and the resulting mixture was heated at 85-90 ºC for 10 min. The resulting curd was cut, molded and stored under refrigeration. All the soy cheese analogues were studied with respect to their textural properties using a TA.TX.plus texture analyser (Stable Micro Systems,UK) and their rheological properties using a Bholin Gemini rheometer (Malvern Panalytical, UK).
Results:
All three enzymes demonstrated suitable cross-linking or clotting activity for soy cheese analogue manufacture. The resulting curds exhibited a certain extent of oil separation, and differed in firmness, consistency and springiness.
Conclusion:
Soy-based cheese analog can be produced from the clotting activity of different plant-based or microbial proteases. Texture and rheological profiles can be modulated according to the desired characteristics and nutritional profiles.

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Extended raw milk shelf-life and safety by hyperbaric storage at room temperature during 60 days

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Title:
Extended raw milk shelf-life and safety by hyperbaric storage at room temperature during 60 days

Aim of work:

Milk rich nutritional profile, near neutral pH and high-water activity makes milk the perfect environment for the proliferation of several microorganisms, which limits dairy products shelf-life and safety.
Hyperbaric storage (HS) is a new preservation methodology, based on the application of high pressure, between 25-150MPa, that relies in microbial growth inhibition, similar to refrigeration (RF) that can be applied in the preservation of foods at room temperature (RT), thus, not only contributing to possible shelf-life extension, but also reducing considerably the energy requirements in food storage.
In this work the feasibility of HS/RT of raw milk was evaluated in microbiological/physicochemical and nutritional parameters.

Methodology:
Cows raw milk was stored under HS (50-100MPa) at RT (16-22ºC) during 60 days and compared with RF under atmospheric pressure (AP), regarding endogenous microflora and inoculated microorganisms (*Salmonella enterica*, *Escherichia coli* and *Listeria innocua* with ~5Logs initial load) and *Bacillus subtilis* endospores (~5.5Logs initial load), and pH, titratable acidity, lipid oxidation, viscosity and volatiles profile.

Results/Discussion:
After 7 days, milk stored at AP/RF quickly surpassed the acceptable microbiological limit, regarding endogenous microbiota, while at 50MPa a better microbial growth control was achieved for at least 14 days, whereas a significant microbial inactivation occurred under 75-100MPa (~4 log units), to counts below detection limit (<1 log CFU/mL) and a similar behaviour was observed for the inoculated microorganisms, including the highly resistant *B. subtilis* endospores (≥4 log units of inactivation), thus resulting in higher safety and extended shelf-life at least up to 60 days. Additionally, under these HS conditions, the physicochemical parameters remained mostly close to those prior storage even after 60 days, retaining for instance a much closer volatile organic profile with no signs of unpleasant compounds formation.

Conclusion:
These results indicate that HS at RT leads not only to raw milk shelf-life extension but also enhances its safety and quality at least up to 60 days, compared to 7 days at AP/RF, with *quasi* no energetic costs, thus being in addition an environmentally friendlier preservation methodology.

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Antimicrobial properties of nanoprinted PLA-based films with embeded antimicrobials and use in meat preservation

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Antimicrobial properties of nanoprinted PLA-based films with embeded antimicrobials and use in meat preservation

Polylactic acid (PLA) has been used lately as a preferable alternative to plastic film packaging for use in food, since it is biodegradable and relatively easy to produce in large scale. In the present study, the effect of nanoprinting techniques that may prevent cell adhesion and biofilm formation, as well as the addition of natural antimicrobials in/on PLA films has been studied in vitro and meat food samples, in order to design an active and recyclable food packaging.
Nanoprinting is a novel technique that can be applied on different printable surface, such as the PLA films and can create physical obstacles at nanoscale to prevent microbial cell adhesion and microbial growth. In the present study, the formation of nanotubes, nanopillars, nanoneedles of different size were tested in vitro in order to optimize the antimicrobial and/or antifouling activity via nanoprinting. At the same time, natural antimicrobials like polylysin, EDTA-dissodium salts, essential oils, zinc and titanium oxide nanoparticles, tannic acid, plant polyphenols and citrox were embedded into PLA films in order to test comparatively their antibacterial (e.g. against E. coli and S. aureus) and antifungal (e.g. against A. niger and P. expansum) effect.
The results of this research showed that nanoprinting on its own can prevent bacterial and fungal growth, while the addition of some well-established antimicrobials varies greatly and can be lost upon heating or treatment of PLA with organic solvents. Thus, the most effective antimicrobials in vitro were polylysin, zinc and titanium nanoparticles and to some extend EDTA-Na2 or tannic acid. PLA films casted with polylysin (with or without nanoprinting) were also used in packaging of fresh or processed/cured meat in order to verify the effectiveness of the optimal antimicrobial films in a food matrix. The results showed that the technique developed in this study was effective in reducing the growth of Total Plate Count, Yeasts and Enterobacteriaceae, which are major sources of food spoilage in packaged meat.
This work offers new insight into the production of smart, active and biodegradable food packaging, in order to improve food safety, prolong shelf-life and reduce food waste, in an environmentally sustainable manner.

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The effect of eliminating nitrite from a cured pork “salpicão” evaluated by a CATA test

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Aim: To evaluate the influence of eliminating nitrite from the production a traditional dry-cured pork product, "salpicão", through a CATA test with consumers
Method: Pork loins were cut in portions ±350g each. The meat was divided into three groups: (1) 2% of salt, (2) 2% of salt and 150 mg/kg of sodium nitrite, and (3) fermented with *Staphylococcus xylosus.* The salted meat rested (4ºC, 24h) and was marinated in red wine (50% in water) with 1% garlic and 0.5% bay leaf (4ºC, 48h). After filling in collagen casing *salpicão* was smoked (< 35ºC) with beechwood smoke and dried for 30 days (15±2°C, RH 95 to 85%).
A Check all that apply test was used with 104 consumers (66% women) aged 19-66 years. Three samples were presented to each consumer, identified with a random two-letter code. Consumers were asked to check from an attributes list those applied to each sample. The list included: colour - reddish, pinkish, cured, brownish, greenish, orangish, bright, dull, red wine, ale colour, dark red; aroma - *sui generis* and cured. The test included a 9-point hedonic scale. The analysis of CATA results was done by factor analysis. The Cochran test compared the frequencies for each attribute between formulations.
Results: *Salpicão* made with nitrite was more reddish and bright ($p<0.001$). The control was more pinkish, pale and dull ($p<0.001$). The *sui generis* aroma was higher in the *salpicão* prepared with *S. xylosus* than in the control. Still, with differences in the proportion of colour and aroma evaluation, there were no differences ($p=0.089$) in the hedonic evaluation between the three groups.
Conclusion: The absence of nitrite resulted in a salpicão with colour with different tonalities, redder and brighter. The personal evaluation of cured colour and aroma was similar in the three formulations and the hedonic evaluation, indicating that the elimination of nitrite from the salpicão manufacturing, still resulting in a slightly different colour, does not affect the consumer acceptability.
Funding: This research was funded by project oneHcancer NORTE-01-0145-FEDER-000041 and projects UIDB/CVT/00772/2020 and LA/P/0059/2020 funded by the Portuguese Foundation for Science and Technology (FCT).

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Effect of pH on heat-induced gelation properties of plant and whey proteins

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Effect of pH on heat-induced gelation properties of plant and whey proteins

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Aim:
The substitution of dairy proteins with plant proteins is gaining attention due to the environment and sustainable food supply concerns.

Method:
The gelation properties of different plant protein isolates (soy, pea, chickpea and lentil) with whey protein isolates under different pH conditions (pH 3,7) were investigated.

Results:
The results showed that pH has a significant effect on the heat-induced gelation properties of proteins. Plant protein, except Chickpea, showed a higher LGC and lower gel strength than whey protein. Chickpea showed the least LGC, while pea protein showed the highest LGC among plant protein samples. Lentil protein gels showed a most ordered structure like whey protein gels at all test pH levels, while soy and pea protein gels showed aggregates and protein particles by CLSM.

Conclusion:
Overall, the findings of this study suggested that there is a great variation between the gelation properties of plant and dairy proteins, especially under different pH conditions. This work might help select appropriate plant protein alternatives for their target application in plant-based food products.

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Submerged cultivation of Ganoderma lucidum, Monascus purpureus and in vitro comparative study of their bioactivity

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Submerged cultivation of Ganoderma lucidum, Monascus purpureus and in vitro comparative study of their bioactivity
Ganoderma lucidum and Monascus purpureus are two medicinal fungi with significant bioactivity, which includes anticancer, hypocholesterolemic, antimicrobial and antioxidant properties. There are usually cultivated on solid substrates and used as food or food supplements (dry powder of G. lucidum mushroom grown on wood/straw, or red rice powder of M. purpureus grown on rice), however, their cultivation in liquid substrates has the benefit of fast growth under totally controlled fermentation conditions, which could allow the production of bioactive mycelium within a few days. The bioactive substance can either part of the mycelium (intracellular metabolites), or they may be excreted into the fermentation broth.
In the present study, the mycelium of both fungi was grown in liquid synthetic media (like potato dextrose broth with added nutrients) and the bioprocessing conditions were optimized in order to achieve high content of mycelium. The filtered and dried mycelia were isolated from the culture filtrate and both fractions of the fermentation broth were used to study the antimicrobial and antioxidant properties of the two fungi.
The results showed that, bioprocess conditions (such as agitation rate, pH) can significantly affect the size and production of mycelium and exopolysaccharides (which are usually linked to bioactivity). The water extracts of the dried mycelium were tested for their antimicrobial activity in comparison to the culture filtrate of the fermentation broth. Ganoderma lucidum culture filtrate was effective against some food pathogens (E. coli, S. aureus), while culture filtrates of both fungi showed a higher antioxidant activity in vitro.
These results show that both fungi can be cultivated in controlled conditions in order to produce novel antimicrobial and antioxidant substances for use in food and cosmetics preservation.

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Application of almond milk residue in the development of a functional almond cream spread

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Aim:
The consumption of plant food products as a substitute for dairy products has been increasing, both for medical reasons, due to lactose intolerance and allergies to milk proteins, or due to the adoption of lifestyles where alternative or vegetarian/vegan diets are practiced due to concerns about health and sustainability issues. In this context, the main objective of this study was the formulation, production and characterization (microbiological, chemical and biological) of almond residue spread creams with and without incorporation of *B. animalis* subsp. *lactis* BB-12.
Method:
Plant-based spread cream was prepared by mixing almond residue (resulting from almond milk production) with aquafaba, lemon juice, coconut oil and salt. All ingredientes were blended in a Thermomixer (Vorwerk, Portugal) for 3 minutes. Three batches were prepared as follows: to assess impact of heat processing on nutritional/biological qualities of the spread one batch was not pasteurized (NPS). The other two batches were pasteurized at 90 ºC for 10 minutes (PS). One of the pasteurized batches was subsequently inoculated with the probiotic strain *Bifidobacterium animalis* subsp. *lactis* BB12 (PPS). All spreads were stored at 4ºC for up to 14 days. Samples were taken at 0, 7 and 14 d and analysed for microbiological, physicochemical and biological properties.
Results:
Heat processing led to a change in colour of the almond-base cream spreads; pasterurized PS and PPS samples were whiter in colour. Microbial stability was reported over the 14-d storage period and in the case of the PPS spread viable cell numbers of *B. animalis* ssp. *lactis* BB-12 were maintained above the minimum required threshold of 10^7 CFU/g throughout storage. pH values decreased 0.2 units over storage whereas titratable acidity increased slightly. Sugar and protein contents were not affected by pasteurization. The PS cream contained a high concentration of lauric and myristic acids. The capturing capacity of the $ABTS^{\bullet +}$ and DPPH radicals increased relative to what was observed in the raw materials (2-3 fold higher). Regarding the anti-diabetic activity, neither pasteurization nor respective storage affected the potential activity reported for the almond residue.
Conclusion:
Almond milk residue demonstrated suitability for a probiotic alternative cream spread delivering multifunctionality.

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Optimization of an olive oil emulsion for meat products fat replacement

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Aim: To optimize the formulation of an olive oil-based emulsion with legume protein to be used as an animal fat replacer
Methods: A Response Surface Methodology design was used to test: amount of protein (10, 15, 20%), proportion of soy:pea (75:25; 50:50; 25:75) and olive oil (30, 40, 50%). The proteins were hydrated (16h, 4ºC) and emulsified with olive oil with an Ultra-Turrax (15.000 rpm, 3 min). 0.5% of transglutaminase was added followed by incubation (37ºC, 2h) and cooking (90ºC,5 min).
Five experienced panellists evaluated the emulsions. The characteristics evaluated, in a five-point scale of intensity, were the amount of exudate, fat separation, colour, crumbly with finger pressure, flour, soy, pea and olive oil aroma, hardness, floury texture, juiciness, texture similarity to pork fat, flour, soy, pea and olive oil flavour, saltiness and general similarity to pork fat. The texture was measured by compression test in duplicate in cylindrical slices of 20 mm high with a TA.XT. texturometer with a cylindrical probe and 3 kgf cell. Colour measurement (L*a*b*) was performed with a Chroma Meter CR-400 colourimeter.
Results: In the analysis of desirability, we made two approaches. First, the characteristics that are aimed to be low, level of exudate, fat separation, friable texture, aroma and flavour related to the ingredients (flour, soya, pea, olive oil), floury texture and bitter flavour. The lower scores were attributed to the emulsions prepared with more protein. When we use the positive attributes, sensory hardness, juiciness, texture similar to pork fat, and instrumental hardness, the formulations' discrimination becomes clearer. The highest amount of protein and fat resulted in better emulsions. The proportion of soya does not influence the emulsion characteristic; still, there is a tendency to have a more interesting emulsion when using a higher proportion of soya and, consequently, less pea protein.
Conclusion. A stable emulsion with interesting properties was obtained with 20% of total protein and 50&% olive oil. The higher proportion of soya resulted in slightly better emulsions.
Funding: This research was funded by projects UIDB/CVT/00772/2020 and LA/P/0059/2020 funded by the Portuguese Foundation for Science and Technology (FCT).

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3D Printing of A Spinach Pasta Enriched with Chicken Meat

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Aim: Adding chicken meat with high quality protein and spinach rich in vitamins, minerals, fibers and antioxidants is a great alternative to semolina in pasta formulations while seeking for improved sensory, nutritional values and health benefits. This study aimed to develop 3D printable high protein pasta formulations using spinach powder and varying proportions of chicken breast meat (CBM), and investigate the effect of CBM proportions on some quality characteristics of final products.

Method: Four groups of spinach pasta formulations for 3D printing were developed, one was control containing semolina flour, salt, spinach powder in the proportions determined in preliminary experiments. The other three groups were incorporated with 15%, 30% or 45% CBM using the same ingredients as control. 3D printing was performed with a smart 3D food printer (ArtıBoyut, Turkey) based on Fused Deposition Modeling extrusion technology. 3D printer parameters to obtain the best response were 3mm thickness, 100mm length and 10mm width with fill density=100%, print speed=15 mm/sec and nozzle diameter=1.8 mm. 3D printed pastas were cooked in boiling water for 8 min. Volume and weight gain during cooking, instrumental CIE color values , total color difference (*ΔE*), and pH were determined before and after cooking. Sensory analysis was conducted with a 9-point hedonic scale for color, flavor, texture and overall acceptability.

Results: Control, 15% and 30% CBM formulations were easily printed with the targeted dimensions whereas 45% CBM one was not printable. The a* values decreased and b* value increased with CBM addition in uncooked pasta ($p<0.05$). *ΔE* values were 18.47, 13.29 and 8.51 for control, 15% and 30% CBM added samples, respectively. After cooking, volume increased and weight decreased while increasing CBM proportion. CBM addition resulted in higher raw pasta pH ($p<0.05$) while no pH differences were found for the cooked ones ($p>0.05$), whereas addition of CBM in both proportions improved product sensory characteristics.

Conclusion: Nutritionally enriched high protein 3D printed pasta products were successfully developed with the addition of chicken breast meat and a spinach-based powder. These chicken meat-fortified 3D printed pasta products constitute a very promising innovative approach to improve diet and well-being.

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Effects of Cooking Methods on 3D Printed Gluten-Free Chips Enriched with Beef Broth

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Aim: Chips are one of the fast-growing snacks worldwide due to convenience, easy portion control, wide variety, desirable textural and sensory attributes. 3D printing offers appealing opportunities for developing novel customized products such as functional snacks. Some consumers either have gluten intolerance, celiac disease, wheat allergy, or other diet constrains, and for these reasons food manufacturers and researchers are developing innovative gluten-free products with enhanced nutritional value. Beef broth umami peptides could be natural alternatives to monosodium glutamate to enhance flavor of chips as well as nutritional value. The aims of this study were to develop gluten-free product to render 3D printable formulations, and to identify the most suitable cooking method for post-processing.
Method: Gluten-free chips were manufactured by using a previous developed formulation consisting of corn flour (21.73%), buckwheat flour (21.73%), garlic powder (3.26%), onion powder (3.26%), salt (2.17%), beef broth (39.13%), olive oil (5.43%), and shortening (3.26%). A smart Fused Deposition Modelling type 3D food printer (ArtıBoyut, Turkey) was used to obtain pretzel shaped printed chips with fill density=100%, print speed=25 mm/sec and nozzle diameter=1.8 mm. 3D printed chips were cooked in an electric oven, a microwave, or in an air fryer. Instrumental CIE color values, total color difference (*ΔE*), pH and weight loss were determined for the 3D printed gluten-free chips before and after cooking. Sensory evaluation was performed using a 9-point hedonic scale for color, flavor, appearance, texture, and overall acceptability.
Results: Gluten-free pretzel shaped chips were successfully 3D printed. As post-processing technique, microwave cooking rendered lower L* and b* values, and higher a* value in comparison to baking and air frying ($p<0.05$). *ΔE* values (color differences before and after cooking) by microwave, electric oven, and air frying were 46.14, 25.93 and 19.48, respectively. The lowest weight loss in the products upon cooking was observed with air frying (36.31%) followed by oven (37.93%) and microwave cooking (40.67%) ($p<0.05$). 3D printed chips received acceptable scores for each attribute evaluated regardless of the cooking method.
Conclusion: Clean-labelled and gluten-free 3D-printed chips have been successfully developed using three cooking methods. Results of the present study reveals that air frying is overall the best post-processing technique in terms of physicochemical properties and sensory attributes.

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Heat Gelation of Commercial Pea Protein Isolates

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Aim:
To determine the relationship between pea protein isolate composition, protein structure and thermal behaviour to understand commercial pea protein gelation behaviour
Method:

1) Dynamic light scattering to determine protein particle size range
   - Rheology to investigate protein gelation behaviour
   - Size exclusion chromatography to investigate soluble protein composition
   - Sodium dodecyl-sulphate polyacrylamide gel electrophoresis (SDS-PAGE) to investigate size range of soluble protein
   - Circular dichroism to investigate secondary structure of soluble proteins
   - Scanning Electron Microscopes to investigate network structure formed after protein gelation

Results:
Although commercial protein isolates are highly denatured due to the commercial extraction process, the pea protein isolates investigated were shown to be able to go through gelation and form fractal gels. The fractal gels formed had minimal involvement from the soluble protein content due to the low protein solubility and was dominated by hydrophobic interactions. Protein gelation is also heavily dependent on pH, and this was found to be influenced by the commercial extraction process of the protein isolates. When pH values were dropped to acidic pH, the protein solubility of the pea proteins decreased but still formed gels that had comparable gel strength with gels made from higher pH values. Gelation temperature (the temperature at which gelation occurs) is also dependent on the concentration of the protein solution. At high enough concentrations, structural arrest occurs in protein solutions, resulting in a solution with high viscosity, making it behave more solid-like than fluid-like. Pea proteins also showed great potential for production of plant-based meat analogues, even when compared against soy protein isolates which have been reported to exhibit much better gelation strength.
Conclusion:
Although gelation strength of plant protein has always been linked to the soluble protein content, it was found that commercial plant protein sources are still able to form fractal gels. Pea protein isolates, which have been reported to exhibit weak gelation abilities, were found to have storage modulus values that are comparable to gels formed with soy protein isolates.

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Cross-cultural conceptualization of high-end pastry cakes based on visual stimulus

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Aim:
Beyond the physical aspect, the visual assessment defines the intangible values that the vision evokes in each person and influences the purchase intention. This study aimed to analyse, through word association, the emotions, sensations and/or impressions evoked by the visualisation of five high-end pastry cakes in people from different food cultures.

Method:
Photographs of five high-end pastry cakes were used as direct stimuli. A total of 859 participants were recruited, 235 from Spain, 108 from England, 251 form Portugal and 265 from Latin America. Thematic content analysis was performed by grouping words according to their similarity of meaning in categories and dimensions. Categories and dimensions were translated into English and harmonised between countries, and a correspondence analysis was also performed to originate perceptual maps. The evoked words were analysed according to participants' country of residence and according to the type of cake.

Results:
The chi-square test for the terms elicited by the participants shows significant differences ($p<0.05$) for the different categories as a function of the area of residence. For all different cultures, "Sensory properties" was the most highly rated category, as expected for a food product's visual assessment. Spaniards and Portuguese tend to associate the stimuli with a more sentimental part, also valuing the nutritional contribution of the cakes. Latin Americans perceived and associated the stimulus with more emotional terms. Anglo-Saxons have more in mind factors related to culture and tradition and the composition of the cakes.

Conclusion:
Understanding consumers' motivations and perceptions when choosing and eating food products are essential when launching new products. Sensory and hedonic properties are the most evoked also in cakes.

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Folic acid-loaded Hydroxypropyl methylcellulose micro and nanoparticles produced by electrospray

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Aim: Folic acid (FA) is an essential micronutrient not synthesized by the human body (recommended daily intake (RDI) of 420 µg for adults). FA food fortification is challenging because FA is very sensitive to degradation during processing and storage. Additionally, despite being a hydrosoluble vitamin, it is of difficult solubilization in aqueous solutions. Therefore, this work aimed to evaluate the effect of solution formulation on the production of micro and nanostructures that could protect FA from external factors. This work aimed to evaluate the effect of solution formulation on the production of micro and nanostructures that could protect FA from external factors.

Method: Electrohydrodynamic processing (EHDP) was used as an encapsulation technology and hydroxypropyl methylcellulose (HPMC) was used as encapsulation matrix. EHDP was optimized using a design-of-experiments (DOE) to determine the relationship between particles production parameters and particle morphology (SEM). The optimized system (6% HPMC with 2% Span-20) was characterized by XRD, FTIR, DSC, and TGA. For FA encapsulation two different formulations were tested: a) dissolved FA (pH=12) and b) dispersed FA (pH=7). In-vitro gastrointestinal digestion was performed, and FA was quantified by uHPLC. Photostability tests were also conducted.

Results: The DOE showed that flow rate influences the particles aspect ratio and particles diameter. After FA addition, FTIR results show that there is an interaction between HPMC and FA observed at 1608 cm^{-1}. Produced particles with dispersed FA (dispersed at pH=7) are more resistant to photodegradation at UV-light than soluble FA (pH=12). 10 mg of produced particles can deliver the adult's FA RDI.

Conclusion: It was possible to conclude that EHDP produce stable FA particles and we foresee their use in food fortification and pharmaceutical application.

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Extraction of Pectin From Apple Pomace Using Environmentally Friendly Processes For Circular Economy Initiative

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Aim:
The world currently faces a crisis, with energy production and packaging manufacturing inextricably tied to the availability of oil. Oil is a finite resource, subject to supply chain issues and increasing prices. Recent EU bans of Russian oil imports demonstrate that vital technologies (such as the safe packaging and storage of food), rely heavily on an unreliable means of production. The next generation of biomaterials focuses on utilizing existing waste streams as a source of sustainable materials. Pectin is a cheap, widely available polysaccharide. Pectin can be extracted from waste *apple pomace* (A.P.), making it an ideal material for the *circular economy* initiative. This work details environmentally friendly production of pectin from waste streams for use in sustainable, edible, packaging materials.
Method:
Waste A.P. was sourced from industrial partner (*The Apple Farm,* Tipperary), and frozen at - 20 °C for storage. A.P. was thawed at room temperature, and dried at 60 °C for 12 hrs. The dried A.P. was then ground using a Buchi B-400 mixer. Ground A.P. was then sieved below 355 µm by Analysette 3 Spartan apparatus, operating by vertical vibration. Pectin extraction from sieved A.P. was optimized by controlling a number of parameters (solvent temperature, pH, extraction time, precipitation time, and solid:liquid ratio). After centrifugation and filtration, pectin was isolated via precipitation in EtOH. The precipitate was analysed to determine the quality of the pectin produced.
Results:
Organic acid extractions achieved similar, or greater, pectin yields when compared to harsh mineral acids, such as HCL. Green, environmentally friendly extraction techniques were achieved through shortened precipitation times, reduced energy consumption, and the use of organic acids. Optimisation of these processes allowed for the production of high quality "hairy" pectin, ideal for incorporation into the food packaging sector.
Conclusion:
Sustainability and achieving a more circular economy are becoming major areas of research within the food industry. This work displays pectin's significant potential to be utilized in the food packaging sector, by environmentally friendly means. Organic acid extractions of pectin have not only matched current industrial standards, but have also surpassed them.

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Targeted and semi-untargeted UHPLC-qTOF-MS determination of polyphenols in five indegenous fruits of South Africa

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Aim: Targeted and semi-untargeted UHPLC-qTOF-MS determination of polyphenols in five indigenous fruits of South Africa

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Introduction
The use of indigenous fruits for food and nutrition security has been documented to be underexplored. This work quantified the phenolic compounds inherent in the pulp of five indigenous fruits: Kei apple (*Dovyalis caffra*), simple spined num-num (*Carissa edulis*), Natal apricot (*Dovyalis longispina*), wild medlar (*Vangueria infausta*), and marula (*Sclerocarya birrea*), cultivated across Mpumalanga Province of South Africa.

Method
A targeted and semi-untargeted approach using the Ultra-High Performance Liquid Chromatography-Quadrupole Time-of-Flight Mass Spectrometry (UHPLC-qTOF-MS) was used in the tentative identification and quantification of polyphenols in the pulp of the five indigenous fruits. The total polyphenols, flavonoids, antioxidant activities and anthocyanin content of the indigenous fruit pulp were also determined.

Results
The targeted UHPLC-qTOF-MS analysis showed the presence of catechin (0.54 – 106.55 mg/L) across all fruit pulp; chlorogenic acid (1.02 – 134.26 mg/L) in Kei apple, simple spined num-num, wild medlar and marula; gallic acid (0.76 – 10.99 mg/L) in simple spinned num-num, wild medlar and marula; neochlorogenic acid (18.90 – 134.26 mg/L) in Kei apple and simple spined num-num; epicatechin (0.99 – 73.42 mg/L) in simple spined num-num, natal apricot and marula; and rutin (1.05 – 8.08 mg/L) in Kei apple, simple spined num-num and Natal apricot. The semi/untargeted UHPLC analysis showed the presence of over 50 compounds belonging to the hydroxycinnamic, hydroxybenzoic, phenolic acids, tannins and flavonoid groups across all five indigenous fruit pulp.

Conclusion

Identification of polyphenols in the pulp of the indigenous fruits indicate that upon processing of the indigenous fruits, the fruits could serve as a good source of antioxidants. Processing of such fruits into consumer acceptable products with determined polyphenolic concentration is therefore encouraged in order to enhance the absorption and utilization of the antioxidant ingredients.

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Impact of scanning rates on crystallization and melting profiles of hempseed (Cannabis Sativa L.) oils

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Aim:
This study investigated the influence of different scanning rates (i.e. 1,2 and 5°C/min) on crystallization and melting profiles of hempseed oils. Samples were originated from '*Henola*' cultivar from Poland, supplied by five different suppliers; amongst them two were reported been harvested during production year 2019 (Group A) and other three has been harvested during 2020 (Group B).

Method:
Differential scanning Calorimetry (DSC) has been opted for the crystallization and melting curves analysis. GC-FID was employed for determining fatty acids composition, and HPLC analysis used for tocopherols quantification.

Results:
Crystallization curves obtained from scanning rate 1 and 2°C/min depicted a single peak, where peak temperature was lowest for group A samples in both cases. However, for melting curves, scanning rate 5°C/min showed consistent repeatability, such as the major peak appeared in between -31 to -33°C along with three other minor peaks residing in the same pattern for all samples, thus can play vital role for the authenticity assessment. Contrarily, 1 and 2 °C/min scanning rate profile showed differences amidst different supplier's, concerning intensity of peak height, peak temperature and enthalpy, which might contribute for the study of differences in varieties from same cultivar. Monounsaturated fatty acid (MUFA) content were positively correlated with crystallization peak temperature (0.83 for 1°C/min and 0.78 for 2°C/min), whilst Polyunsaturated fatty acids (PUFA) were negatively correlated (-0.81 for 1°C/min and -0.73 for 2°C/min. For melting curves from 1 and 5 °C/min scanning rates, MUFA content was positively correlated with peak temperatures (evidently with the major peak), and negatively with peak height and enthalpy and PUFA showed opposite characteristics accordingly. Higher content of total tocopherols in group A seems to have contributed for lower peak temperatures in crystallization curves at scanning rate 1 and 2°C/min as significant negative correlation has been found as -0.73 and -0.59 respectively.

Conclusion:
Therefore, Principle Component Analysis (PCA) for crystallization and melting curves and fatty acids prevailed that, for scanning rate 2 and 5°C/min, principle 1 and 2 can explain and differentiate between group A and B, briefly the freshness of the seeds.

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Mechanistic understanding of food protein fibrils: laying the groundwork towards their usage as techno-functional enhancers

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Aim: Identifying the mechanism underlying the formation of curly protein fibrils. This specific protein morphology is primarily reported in the food protein context and has the potential to contribute to the sustainable exploitation of food proteins towards enhanced techno-functional properties (gelling, foaming and emulsification) on an industrial scale. Understanding the precise mechanism behind their formation will enable future research to more specifically study and steer fibril formation of food proteins, a task that remains challenging.
Method: The aggregation core regions that drive the formation of hen egg white ovalbumin fibrils, formed in three different conditions, were identified via mass spectrometry. These regions were further characterized via synthetic peptide analysis and their seeding efficiency on monomeric ovalbumin was assessed. Subsequently, truncated ovalbumin mutants were produced to analyse the influence of aggregation core regions on the morphology of ovalbumin fibrils. Finally, a meta-analysis was performed on previously reported curly-fibril forming proteins to validate the ovalbumin results and identify common features.
Results: We found that the curly fibril-forming protein ovalbumin contains multiple aggregation prone regions (APRs) which form straight fibrils when isolated as peptides, or when excised from the full-length protein through trypsin hydrolysis. In the context of the intact full-length protein however, the regions separating the APRs facilitate curly fibril formation. The meta-analysis of previously reported curly-fibril forming proteins revealed that long, hydrophobic inter-APR regions are commonly associated with curly fibril formation, in line with our ovalbumin results. Moreover, we found that curly fibrils typically lack a lag phase in their aggregation kinetics, and curly fibrils therefore form in a nucleation-independent manner.
Conclusion: Up until now, proteins forming curly fibrils had not been considered as a distinct type of fibril, as shown by the lack of a fixed terminology. However, we show here that proteins that form predominantly short, curly-type fibrils share several distinguishing characteristics, including (1) nucleation-independent aggregation kinetics and (2) significantly longer and more hydrophobic inter-APR regions than those in proteins forming straight fibrils. These novel insights will contribute to the understanding and eventual directed exploitation of food protein fibrils for enhancing foodstuff characteristics in a more sustainable manner.

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Ethanol extraction of phospholipids in herring roe – optimization and co-extraction of unwanted compounds

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Aim:
Norwegian spring-spawning herring (*Clupea harengus*) represents one of the larges fish stocks in the world with total landings to Norwegian processors in 2020 and 2021 of 416,000 and 490,000 tons, respectively. Fishing season is October-February and coincides with the gonad maturation and spawning season in February-March. Mature roe is collected in February and marketed for use in different roe products. However, there is a hughe potential for improved valorization of unmature roe. Herring roe contains high levels of phospholipids and n-3 PUFA making it an interesting raw material for production of lipid extracts targeting the health food and nutraceutical market.
Method:
A 2-factorial central composite design and response surface methodology was used to optimize the ethanol extraction process variables, temperature and water content in the ethanol phase. Spray dried roe was contacted with aqueous ethanol under standardized conditions for 5 minutes followed by filtration. Comparison of direct extraction of wet roe and spray dried roe was performed using the optimized conditions.
Results:
Water content in the solvent phase played a major role influencing total extract and phospholipids yield, and co-extraction of salt and protein. No significant effect of temperature was observed. Best single step phospholipids yield (82%) was obtained using 11.3% water content in the ethanol phase. Increased swelling of roe and retention of solvent in the filter cake can explain the reduced yield compared to chloroform-methanol extraction. Comparison of dewatering of the roe before or as part of the extraction process, revealed 25% higher yield and significant advantages of the former procedure. The developed protocol gives an extract with 65-70% phospholipids and 31% n-3 PUFA. Co-extraction of salt and protein followed a close to linear and exponential relationship, respectively, to water content in the ethanol phase. Persistent organic pollutants (POPs) and arsenic were extracted quantitatively, however, heavy metals (Cd, Pb, Hg) only partly.
Conclusion:
Effective extraction of spray dried herring roe can be performed using aqueous ethanol giving an extract with high levels of phospholipids and n-3 PUFA. The method co-extracts some salt and protein, however, gives a level of POPs and heavy metals well below regulatory levels.

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Production of fish sauce based on herring (Clupea harengus) and blue whiting (Micromesistius poutassou)

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Aim:
The project "Mapping of optimal pelagic raw material for the production of fermented fish sauce" aims to promote efficient utilization and increase value creation of side stream materials from pelagic fisheries by developing a fermented fish sauce for consumption. With a raw material base of over 1.5 million tons of fish per year, the pelagic sector is a significant player in the Norwegian fishing industry. The pelagic consumer industry has focused on sustainable production through processing and automation. With such processing, valuable residual raw material will be created. To expand opportunities for the use of residual raw material from pelagic fish, Norwegian pelagic consumer companies have chosen to investigate the possibility of commercial production of fish sauce in Norway. Fish sauce is a traditional consumer product in Southeast Asia, where about one million tons are produced each year. A successful project is well placed to contribute to an industry based on economically sustainable production of Norwegian fish sauce.

Method:
Based on a factorial design, side streams from herring (*Clupea harengus*) and blue whiting (*Micromesistius poutassou*) were added different levels of salt and fermented at two temperature levels for 13 months to assess their potential as fish sauce. Chemical composition, protein recovery, sensory properties and colors of the resulting products were analyzed.

Results:
Significant differences in yield, color and sensory attributes between the fish sauces were found. In general, products based on herring had higher intensities of total smell and were perceived as more fermented compared with that of blue whiting. The fermentation process was long, even at elevated temperatures, and efforts must be met to ensure shorter fermentation, such as addition of proteases and bacteria's to speed up the autolysis process.

Conclusion:
Both herring and blue whiting were considered as candidate species for production of fish sauce and produced products of different sensory properties. However, the fermentation process was long and with high personnel and production costs in Norway, it is important to reduce production time and costs to ensure economically viable fish sauce production.

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Assessment of engineered subtilisin proteases in the hydrolysis of Atlantic salmon residuals

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Aim:
Enzymatic hydrolysis is a preferred method for utilizing marine residuals (e.g., heads and backbones after filleting), where commercial proteases constitute a significant processing cost. The alkaline subtilisin proteases from *Bacilli* are often applied despite their pH-optimum being higher than the pH of marine residuals. A drawback with enzymatic hydrolysis is the formation of unpalatable tastes. In particular, alkaline subtilisin proteases have been found to cause bitter taste. Development of new subtilisins should therefore be designed to reduce processing costs, while maintain high protein yields and reduced bitterness. In general, alkaline *Bacilli* subtilisins are great model enzymes for mutational studies. The aim of this study was to provide engineered alkaline subtilisins to facilitate higher efficiency at lower pH-levels, which ultimately will allow reduced enzyme costs at equivalent production yields.
Methods:
To identify which subtilisin to target for mutagenesis, enzymatic hydrolyses of salmon residuals were performed using recombinant native subtilisins from *Bacillus amyloliquefaciens* (BAM) and *Bacillus licheniformis,* compared to Alcalase™. The hydrolyses were conducted at equal activity-to-substrate-ratio and sensory attributes of the hydrolysates were assessed. Studies have suggested that deamidation of amino acids at the surface of subtilisins allow a shift to lower pH. Enzymatic hydrolysis of salmon residuals at pH=8.0 and pH=6.5 were conducted with native and mutant subtilisins, based on equal activity-to-substrate levels at pH=8.0. Process yield at both pH-levels was calculated.
Results:
A trend of reduced bitter taste of hydrolysates based on the recombinant subtilisins relative to Alcalase™ was observed, suggesting that both *Bacilli* subtilisins were suitable candidates for pH-engineering. Biochemical assessment showed that certain surface-bound mutations in BAM subtilisin indicated a shifted pH-range towards lower pH levels. In hydrolysis experiments, these mutants gave slightly higher yields of solubilized protein at pH 6.5 compared to the native enzyme.
Conclusion:
Mutagenesis may be a useful strategy to optimize pH-optimum of subtilisins, thereby contributing to process cost savings. Still, the product yields at pH=6.5 remained lower than at pH=8.0, suggesting a higher potential for further shifting the enzymatic pH optimum. The study however demonstrates effective methods for assessing the potential for new proteases in enzymatic hydrolysis of marine residuals.

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Automized Optimization of Food Formulations using Machine Learning

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Aim:

Whether in the areas of research, development, or production - the creation and optimization of formulated products represents a major challenge for science and industry in the food sector. Thereby, different raw materials are combined in such a way that predefined properties are achieved. During this process, applied experimental campaigns not only require expert knowledge, but, depending on the complexity, also cause a high consumption of resources and costs. In the present work, a fully automized micro-fluidic laboratory driven by optimization algorithms was designed and a protein aggregation process was optimized with it.

Method:

A mixture of whey protein isolate and mono- and bivalent salt solutions was chosen as the formulation to be optimized. The interaction of these components results in the formation of aggregates, which influence the rheological and optical properties of the mixture. A millifluidic robotic platform was developed to study the influence of recipe composition on these two properties. Designed as a continuous flow system, this system enabled fully automated dosing and mixing of the components. Furthermore, a system-adapted capillary viscometer and a turbidity sensor were integrated. To subsequently obtain a formulation according to predefined viscosity and turbidity properties, the optimization algorithm TS-EMO was linked to the platform. Based on the measured values for viscosity and turbidity as a function of the sample composition, the algorithm provided a suggestion for the dosage of the next sample.

Results:

By means of a closed-loop system between the robotic platform (sample analysis) and the algorithm (sample suggestion), a number of 90 experiments could be performed within 48 hours, resulting in a Pareto front formed by a set of optimal recipes. Results illustrate that both congruent and competing objectives can be handled by the algorithm. The experimental program has been initialized and refined according to the evolution of the pareto front without human intervention. It is thus a successful demonstration of an actively learning, self-driving food recipe formulation process.

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Conclusion:

Further developed and applied to formulations of higher complexity, the methodology described here can lead to faster, more sustainable, and cost-saving product development of future food products.

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The effect of faba bean starch concentrate addition on pea protein isolate based meat analogues

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Aim:
Texturized plant protein products with fibrous structures can be produced with high moisture extrusion (HME). Commonly plant-based ingredients with high protein content, like protein isolates and concentrates, are used in these types of products. However, the production of these protein ingredients require more energy the higher the protein content is. It also produces side-streams/by-products with high content of carbohydrates. Some studies have shown that the addition of carbohydrates in HME can be favourable for fibre formation. Therefore, the aim was to study the effect of content of faba bean starch concentrate (FBSC) and extrusion parameters on the fibre formation and properties of the extrudate basing on pea protein isolate (PPI) in HME. FBSC is a by-product of faba bean protein concentrate production and contains approx. 40% starch.

Method:
A mixture of PPI and FBSC were extruded with HME using a long cooling die. The effect of three independent variables including PPI:FBSC ratio (90:10, 70:30, 50:50), water content of feed (55%, 57.5%, 60%) and temperature of long cooling die (40 °C, 60 °C, 80 °C) on the mechanical, physico-chemical, and structural properties of the extrudates were investigated. Additionally, fibrous structures obtained were studied using protein solubility analysis.

Results:
The results showed that water content of feed and the ratio of PPI:FBSC affected the most the properties of the extrudates, while temperature of long cooling die had a smaller effect. Increasing content of FBSC and water content of feed produced softer extrudates. The formation of clear fibrous structure was achieved with FBSC addition of 10% and 30%.

Conclusion:
Adding FBSC with PPI, up to a certain point, resulted in fibrous structures in extrudates. Utilizing less refined legume fractions or side streams from protein ingredient production lowers the energy consumption when considering the whole chain from plant raw material to extruded product.

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Thiamin, riboflavin, and folate retention in faba bean and lupine extrudates

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Aim:
High moisture extrusion can be used to produce fibrous plant protein structures from legume ingredients. However, the knowledge of the nutritional quality of legume-based extrudates is scarce. The aim of this study was to investigate the retention of thiamin, riboflavin, and folate in extrudates produced from faba bean and lupine ingredients using high moisture extrusion. The effect of extrusion parameters on vitamin contents of extrudates was studied as well.

Method:
High moisture extrudates were made of faba bean and lupine ingredient mixtures with different ratio of flour, protein concentrate, and protein isolate. In extrusion varying feed water content, screw speed, and temperature of the long cooling die were used. To study vitamin stability in extrusion, the vitamin contents were analysed from ingredient mixtures and respective extrudates. Thiamin and riboflavin were extracted using acid hydrolysis and enzymatic treatment. Determination of these vitamins was conducted by a UHPLC-FL method. Folate was analysed by a UHPLC-PDA-FL method after tri-enzyme extraction and affinity chromatographic purification.

Results:
In the eight faba bean ingredient mixtures, thiamin contents ranged 3.1–4.9 µg/g dry matter (dm). Corresponding values for the two lupine ingredient mixtures were 3.3 and 3.8 µg/g dm. The thiamin contents decreased up to 32% in extrusion. Riboflavin contents of ingredient mixtures were slightly higher in faba bean samples (2.3–6.1 µg/g dm) than in lupine samples (1.6 and 1.8 µg/g dm). Faba bean and lupine extrudates had no major difference in riboflavin contents compared to the respective ingredient mixtures. Folate contents of faba bean ingredient mixtures ranged 355–900 ng/g dm and folate losses in extrusion were 42–67%. Despite the losses, notable amounts of folate were still left in some faba bean extrudates. Folate content of lupine ingredient mixtures (910–960 ng/g dm) remained in extrusion. In general, extrusion parameters did not affect the retention of vitamins.

Conclusion:
Thiamin and riboflavin were relatively stable in extrusion of faba bean and lupine ingredient mixtures, whereas retention of folate varied depending on legume species. This study showed that extrudates made of faba bean and lupine ingredients are promising source of thiamin, riboflavin, and folate.

Posters – SOYA Nominees

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Oral lubrication performance of food - a new textural manipulation to enhance satiety

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Aim: Enhancing satiety in food to reduce energy intake has been acknowledged as a promising strategy to address obesity. Often textural interventions have been used to generate satiety, specifically in short-term and preload study design.[1] In our recent study[2,3], by using a novel approach, we have showed that non-calorific hydrogels differing in their lubricating properties can influence appetite sensations for a short-time period. Based on this, we aimed to investigate further the effect of oral lubricity of pre-loads in combination with macronutrients and calorie/energy load expressed through protein beverages on appetite, subsequent food intake, salivary biomarkers and change in friction coefficient of the human saliva.
Method: Whey protein and casein-based beverages varying in their degree of salivary lubricity in the boundary regime (low, medium, high lubricity of saliva after protein ingestion and control - water), measured instrumentally, were used as pre-loads. Healthy volunteers (n=37) participated in an acute, single-blinded, randomized, counterbalanced, within-subject designed cross-over trial.
Results: Hunger decreased and fullness increased immediately and 30 min after consumption in the medium and high lubricating protein beverages compared to control ($p<0.05$), however, no effect on food intake was observed. The protein retention in human saliva was higher in medium and low lubricating ($p>0.05$) as compared to high lubricating conditions ($p<0.05$) immediately after drinking the protein beverages.
Conclusions: This is the first study to demonstrate that combining oral lubricity with macronutrients and energy load can trigger appetite suppression, and the effect of lubricity as a textural intervention lasts longer when it is combined with macronutrients/energy load as opposed to non-calorific foods. Irrespective of the presence/absence of the macronutrients/energy load, lubricity appears to have no effect on subsequent food intake. Considering the subtle difference of oral lubricity between the conditions in the actual study, future studies should increase the degree of lubricity difference to assess its effect, on food intake and gut peptides. In summary, lubricity offers a promise as a textural manipulation for food developers to influence appetite regulation in order to achieve weight-management and tackle obesity.

Acknowledgement
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New insights into the thermodynamics and kinetics of triacylglycerols crystallization

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Aim:
Understanding the transition from a liquid state to an organized crystalline state of triacylglycerols (TAGs) has great significance when designing lipid-based materials. Several models have been proposed for TAGs organization in liquid state and are still up for debate. This organization is the starting state, from which the molecules self-assemble and form the initial stable nucleus, which then grows to form the solid crystal. The current research aims to explore the isotropic liquid state while focusing on its impact on nucleation and crystal formation.
Methods:
Molecular dynamic (MD) simulations in combination with X-ray diffraction and scattering were used for the characterization of specific inter and intra-molecular organizations in the isotropic liquid state. Kinetic and stochastic models were used to analyze the thermal characteristics of the liquid-solid transition, using differential scanning calorimetry (DSC). The effect of such transition on the resulting crystal structure was analyzed by polarized light microscopy (PLM).
Results:
The MD simulations showed the existence of four different conformations of TAGs at isotropic liquid state, which followed the abundancy order: trident > chair > propeller > tuning-fork (Tf). It was shown that these conformations are changing constantly, with a high conversion rate which is positively correlated with temperature. The DSC and the PLM results showed that higher crystallization temperature leads to organized crystals with higher melting temperature and enthalpy but lower nucleation rate. Based on the negative dependency of the nucleation rates and the induction times on temperature, it was suggested that the limiting factor for nucleation is the conversion from the Tf conformation to any other conformation. While, based on the positive dependency of the melting temperatures and enthalpies on crystallization temperature, and the organized morphologies obtained at higher temperatures, it was suggested that the limiting factor during crystal growth is the conversion to the Tf conformation from another conformation.
Conclusion:
The findings in the current study establish the relation between the nucleation and crystal growth kinetics to the molecular conformations in the isotropic liquid state. Such findings provide a scientific foundation for a rational design of lipid-based food products, allowing better control over food sensory attributes.

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Innovative pulsed electric fields assisted flow cytometry for rapid microbial detection

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Innovative pulsed electric fields assisted flow cytometry for rapid microbial detection
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Aim
Inadequate hygiene practices can lead to microbial contamination of food, resulting in food safety issues including food spoilage or foodborne illness outbreaks. Conventional plating is still the gold standard for detection, but it is time-consuming, labor-intensive, and detects only viable and cultivable cells. Hence, this study aimed to propose a novel rapid flow cytometry (FCM) detection method with the assistance of pulsed electric fields (PEFs) to minimize or prevent microbial contamination.

Methods
For proof-of-concept of the PEFs-assisted FCM approach, three non-permeable non-toxic fluorescent dyes, namely EvaGreen, GelGreen, and GelRed, were added to an E. coli model solution and either pre-treated with irreversible electroporation (E: 20 kV/cm; Wspec: 150 kJ/kg) to channel the dyes into the bacterial cells and incubated (27 min at RT) or solely set (27 min at RT) and analyzed with FCM. To further assess if PEFs can accelerate the detection, PEFs-treated samples were stained and immediately analyzed by FCM without incubation. As reference for all experiments, conventional FCM with the common cell membrane permeable dyes SYBR® Green and Propidium iodide was conducted. To evaluate the efficiency of the novel method, a total cell count analysis was performed.

Results

PEF-assisted FCM using each non-toxic dye resulted in a highly significantly increased fluorescence signal intensity ($p \leq 0.0002$) compared to conventional FCM analysis of E. coli cells after 27 min of incubation and was able to significantly accelerate ($p < 0.05$) the method. This approach also showed comparable fluorescence intensities with common dyes without incubation compared to the conventional method with 27 min of incubation.

Conclusion

The proposed rapid PEFs-assisted FCM detection allows the use of non-toxic dyes instead of conventional toxic dyes to avoid contamination of the system and potential risk to human health. This was the first study using PEFs prior FCM detection to channel non-toxic dyes into bacterial cells. It is emphasized that this emerging method shows potential for helping to increase food safety. Hence, the PEF-assisted FCM approach could be used for total cell count analysis as a first indicator of microbial contamination.

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Leveraging heterotrophic microalgae eco-efficiency through novel nanosecond pulsed electric fields for more sustainable food production

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Aim:
In previous work, nanosecond pulsed electric fields (nsPEF) were shown to trigger biological responses in photoautotrophic microalgae while further research is required to transfer this knowledge to heterotrophically grown species. A significantly higher concentrations overcomes the high production cost of current light-dependent microorganisms yielding highly-nutritious concentrated biomass in short time. The aim of this work was to establish nsPEF treatment for heterotrophically cultivated *Auxenochlorella protothecoides* and *Chlorella vulgaris* leveraging bioconversion efficiency.
Method:
Placket Burman's screening design was used to study the effect of pulse width, -repetition frequency, -number, and electric field strength on microalgae dry weight. Cryopreservation, substrate administration, and shacking conditions were tested to set up a reliable, axenic and optimized microalgae laboratory-scale cultivation. Glycerol, methanol, and DMSO were investigated for microalgae post-freezing recovery maximization. Re-feeding scheme of N/C sources and working volume were evaluated to optimize microalgae growth.
Results:
The screening study (P=0.0002, R^2 =0.8) showed the significant effect of microalgae species (P=0.00002) and electric field strength (P=0.00167) on the percentage of biomass difference compared to the pumped control. The study maximization determined an increase of 22.77%; 95% confidence interval CI[15.39%, 26.46%] for *C. vulgaris* by applying two treatments (15 kV/cm, 5 Hz, 100 ns pulses) each five minutes apart. *Auxenochlorella protothecoides* did not show significant biomass increase under the investigated conditions. Methanol and DMSO were the best cryoprotectants for both microalgae species with a recovery ratio 95%-CI[1.79, 2.083] and [2.03, 2.32] respectively, while both worked significantly better than glycerol 95%-CI[1.02, 1.32] (P<0.0001). BBM medium with 20 g/L glucose and 6.7 g/L yeast extract (YE) resulted in higher final biomass (4.54±0.2 g/L; P<0.02) compared to 2 (4±0.1 g/L) or 3 (3.94±0.07 g/L) refeeding steps (10 g/L glucose, 3.35 g/L YE fed at 0, 36 and 60 hours). Flask working volume reduced from standard 2/5 to 1/5 produced doubled biomass concentration (4.37±0.15 vs 8.73±0.32 g/L; P=0.000).
Conclusion:
This work lays the foundation for improved microalgae eco-efficiency and, therefore, affordability of this potentially more sustainable food alternative. It develops further knowledge on using experimental design for screening several combined factors in PEF-research and opens the door to scrutinize transferability to multiple organisms.

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Effects of ultrasound on off-flavour-related aroma compounds in a pea protein-based yoghurt alternative

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Aim:
The intake of plant proteins is recommended for a healthy diet. However, their incorporation into conventional foods may be challenging due to techno-functional and sensorial limitations. This study aimed at developing a plant protein-based yoghurt alternative, consisting of 4.65 % pea protein isolate, 3 % rice syrup, and 2.5 % rapeseed oil fermented by lactic acid bacteria. Ultrasound (US) treatment was used as an alternative to conventional high-pressure homogenisation (HPH). Off-flavour reducing potential, texture characteristics and quality parameters were determined.

Method:
Aroma analyses by Head Space-Gas Chromatography-Mass Spectrometry were combined with the analyses of texture characteristics and quality parameters, including rheology, syneresis, pH, and colourimetry.

Results:
Aroma analysis showed that the US treatment significantly reduced the concentrations of the legume off-flavours hexanal, 2-pentylfuran, and 2-methylpropanal. The concentrations of the yoghurt aromas diacetyl and acetoin were significantly increased. These effects were attributed to the cavitational forces of US: It was assumed that an increased availability of substrate increased the fermentation rate and the yoghurt aromas.

Further, conformational changes due to US may have altered hydrophobic patches on the surface of the proteins. This might have resulted in the detaching of the hydrophobic, reversibly bound off-flavour-related aromas. The cavitational forces of the US treatment promoted aldol reactions and Schiff base formations contributing to the reduction of off-flavour-related aromas. The kind of homogenisation system affects off-flavour reduction. The US treatment was an open system allowing detached aromas to evaporate, whereas HPH was a closed system. No significant differences on texture characteristics by US were detected compared to HPH. Lighter colour was detected in HPH yoghurts, which might indicate higher particle size reduction compared to US.

Conclusion:
This study showed the potential of US as an alternative homogenisation treatment for the off-flavour reduction of pea protein-based yoghurt. US might be a promising tool to increase consumer acceptance for plant protein-based products as a more sustainable alternative to animal proteins. Additional sensory analysis is recommended to investigate effects of US on consumer acceptance since flavour perception is a multisensorial mechanism

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Modeling of perceived sweetness in biscuits to evaluate reformulation performance in sugar reduction studies

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Aim:

Sugar has an important role in flavor perception and quality characteristics of bakery products. Due to the relationship between high sugar consumption and diseases such as diabetes and obesity, the food industry is under pressure to reduce sugar. However, because of the aforementioned effects of sugar, diminishing sugar levels is a challenge. This study aims to understand the effect of the amount of sugar in biscuits on the perception of sweetness and model the perceived sweetness based on sensory analysis, to create a new tool to explain the perception of sweetness in biscuits to be used in sugar reduction studies.

Method:

Biscuits with different sugar ratios (6-39%) were baked by using refined wheat flour, whole grain flour (%50 of the flour), protein (whey and pea, %2), by changing sugar granule size (powdered or crystal) and distribution, by reducing fat (45%) and by adding flavoring substances (ethylvanillin, furaneol, phenylacetaldehyde). The biscuits were evaluated by a panel for their sweetness on a line scale in duplicate. Then, the sugar ratio-sweetness perception data were fitted to the modified Weibull function.

Result:

Usage of whole-grain flour, adding pea or whey protein, and adding ethyl vanillin, furaneol, or phenylacetaldehyde increased the intensity of perceived sweetness at the same sugar concentration ($p<0.05$). Reducing fat, increasing sugar granule size, or uneven sugar distribution in the structure did not cause any change in sweetness perception ($p>0.05$). The modified Weibull model) well fitted to perceived sweetness (S) vs sugar concentration (C) and gave an 'S-shape curve'. With that model, lower asymptotic value of sweetness (S_i), upper asymptotic value (S_e), and sugar concentration required to reach 63% of S_e-S_i (b) are predicted while a determines the shape of the curve. Therefore, it could be used for sugar reduction purposes to understand the sweetness perception-sugar ratio once the curve had been obtained.

Conclusion:

Whole grain flour, pea protein, whey protein, and flavorings are promising ingredients for sugar reduction in biscuits. The modified Weibull model which was used for the first time for the evaluation of sensory data predicted well the sweetness perception of biscuits having a certain sugar concentration.

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Study of the protein quality and digestibility of plant-based burger analogues compared to meat ones

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Aim:

Nowadays there is a growing concern of consumers for concepts as food security, safety, and sustainability. Consequently, the attention on meat-analogues and the variety of products offered on the market is increasing. Therefore, authors considered relevant the implementation of a study aimed at characterizing their actual protein quality.

Method:

The study was conducted on three different types of burgers: i) commercial analogues (N=2 soy-based, N=2 pea-based) – selected starting from a previous work (Cutroneo et al., Front. Nutr., 2022); ii) control burgers (N=2 beef-based) – to perform a comparison with meat; iii) experimental analogues (N=2 soy-based, N=2 pea-based) – formulated to resemble meat in nutritional values and appearance. To the aim, the proximal composition (dry matter, ash, protein, fats, carbohydrates), protein profile identification (SDS-page) and protein integrity (AA profile, degree of hydrolysis, racemization degree) were investigated. Analysis were conducted on raw and cooked products to investigate also the effect of cooking. Lastly, the protein digestibility was investigated following the INFOGEST static *in vitro* gastro-intestinal digestion procedure, determining the soluble protein content and degree of hydrolysis.

Results:

Results showed a major protein and fat content in beef burgers, while analogues showed a major content in carbohydrates. The essential AA profile showed a lack in lysine for almost all burgers compared to AA scoring pattern of FAO/WHO (children and adults). All burgers showed a good protein integrity, having low degree of hydrolysis and racemization degree, that resulted comparable between all samples. The analogues showed a better, even if comparable, digestibility compared to meat controls. As can be noticed, also beef burgers had a lack in lysine and there is a comparable digestibility of samples. This can be due to the quality of meat with which burgers are made. Therefore, the work will proceed studying different product categories usually made by qualitatively better cuts, as steaks.

Conclusion:

This study allowed the authors not only to estimate the protein quality and digestibility of these new products, but also to compare this results with the relative animal references. The experimental analogues permitted a comparison with analogues having a known recipe, allowing a better understanding of data obtained.

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Future cheeses produced by extrusion of renneted curds

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Aim:
The possibility to structure milk curds by extrusion, in order to create cheeses with customized properties in terms of texture and meltability has not been studied. Hence, the aim of this study was to investigate the shearing process of renneted curds in an twin-screw extruder, and understand the effect of the extrusion parameters on cheese composition, structure and texture.
Method:
A lab twin-screw extruder with a cylindrical cooling die was used for the shearing process. Four parameters at two levels were selected: heating temperature (T_h, 80 or 90 °C), screw speed (SP, 50 or 150 rpm), barrel length (L, half or full) and cooling temperature (T_c, 10 or 30°C). Residence time (RT) and specific mechanical energy (SME) were calculated. Exit temperature (T_{exit}) of the extrudates was measured at the exit of the cooling die. The effect of controllable parameters (T_h, SP, L and T_c) on measured and calculated parameters (SME, T_{exit} and RT) and curd properties (water content and distribution, textural properties – elasticity and melt strength, and microstructure by X-ray micro-computed tomography) were evaluated.
Results:
Extruded curd products with a variety of properties were obtained, which were significantly influenced by controllable extrusion parameters T_h and T_c. A higher T_h enhanced curd elasticity and reduced melt strength while a higher T_c induced lower water content (42.8–48.6%) and melt strength. The measured and calculated parameters could comprehensively summarize the effect of multiple controllable parameters and their interactions. Easily separated, longer and finer fibers were formed at lower SME 23–27 $kJ \cdot kg^{-1}$, higher T_{exit} 50–54 °C and shorter RT 55–60 s, conditions that were reached at T_h of 90 °C, SP of 150 rpm and full-L of the extruder. Microstructure of the parallel protein fibers separated by fat particles was clearly observed.
Conclusion:
The relation between controllable extrusion parameters, characteristics of the extrusion process and properties of the curd provided new insigths that can be further explored to produce structured cheese products with customized properties.

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Mathematical models for predicting spoilage of non-refrigerated food products due to thermophilic spore-forming bacteria

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Aim:
Thermophilic and thermotolerant spore-forming bacteria are related to spoilage of a wide range of non-refrigerated food products, including milk and dairy products. Due to the fact that the minimum temperature for growth of thermophilic bacilli is quite high, these products are currently considered as microbiologically stable. However, their stability is based on the current distribution and storage conditions, which is already marginal in temperate regions such as Mediterranean. Hence, a projected temperature increase of 2 ℃ is expected to allow growth of thermophilic and thermotolerant bacilli to spoilage level and subsequently increase the incidence of non-compliance. Hence, the aim of this study was to assess the temperature increase on the major contaminants of non-refrigerated food products and re-evaluate their microbiological stability.
Method:
Therefore, models for *Anoxybacillus flavithermus, Bacillus coagulans, Bacillus licheniformis, Bacillus amyloliquefaciens, Bacillus sporothermodurans* and *Paenibacillus polymyxa* growth as a function of temperature were developed. In these models, cardinal temperature values, along with the maximum specific growth rates of the above-mentioned bacteria were estimated individually, by studying the temperature range between 15 and 70 ℃. The models were validated in canned or UHT milk, as representatives of non-refrigerated dairy food products and in a plant-based milk alternative, depending on the studied microorganism.
Results:
The obtained results evidence that regarding thermotolerant bacteria a “zero tolerance approach” should be applied in raw materials, while for non-refrigerated food products, in which thermophilic bacteria are present, distribution should be performed by insulated trucks in order reduce the risk of spoilage.
Conclusion:
This study is of a great importance since it provides useful predictive tools for the assessment of the effect of climate change on the microbiological stability of non-refrigerated food products, under different temperature scenarios.

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Design of oat fermentation processes to improve texture and quality of 100% oat bread

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Aim:
Oat is an ideal raw material to obtain innovative plant-based food products due to its nutritional quality, providing proteins, unsaturated fatty acids, vitamins, minerals, phenolics, and fibre. In fact, β-glucan cholesterol-lowering properties have been approved by EFSA. Oat is tolerated by celiac patients, but, on the negative side, gluten absence makes oat baking properties challenging and several process adjustments are required to obtain high quality bread. The main aim of this research has been to study how tailored fermentation by dextran producing lactic acid bacteria can help to obtain improved quality of 100% oat bread.
Method:
Several dextran-producing lactic acid bacteria strains (LAB) have been screened for their dextran production and fermentation performance in oat whole grain flour. The development of acidity, relative viscosity, β-glucan content and amino acids profile after fermentation at 30°C have led to the selection of *Weissella confusa* VIII40 and *Leuconostoc citreum* 5B8 as the best dextran producers in oat sourdoughs. Sucrose as 10% of dry weight replacing flour has been added to promote dextransucrase activity. β-Glucan content has been measured via β-Glucan Assay kit from Megazyme and its molecular distribution is investigated by Size-Exclusion Chromatography (SEC). Dextran quantification has been performed with HPAEC-PAD (High performance anion exchange chromatography with pulsed amperometric detection). Baking tests and bread quality measurements (texture profile analysis) have been conducted.
Results:
Both sourdoughs reached pH ca.4 and moderate acidity. Dextran content reached approximately 2 to 4% of dry weight depending on the strain used, showing good production based on the theoretical maximum (5% of d.w.). β-Glucan content did not change significantly after fermentation staying ca. 4 g /100 g of fermented oat flour. Baking tests have shown that 100% oat breads containing the selected sourdoughs are softer and have higher volume compared to control bread.
Conclusion:
The addition of sourdoughs fermented by *W. confusa* VIII40 and *L. citreum* 5B8 improved the quality of 100% oat breads without reducing the β-glucan content. This bioprocess showed high potential to deliver oat bread with improved technological and nutritional properties.

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How food processing can alter the texturizing potential of fruit and vegetable cell wall material

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Aim:
From a sustainability and health viewpoint, an opportunity exists to valorize in human food products the high amount of waste- or side-streams generated during the processing of fruits and vegetables in food industry, which can be rich in cell wall polymers. The current work aims to deliver fundamental insights into the potential use of cell wall material (CWM) as texturizing agent in food products and the potential of functionalization (i.e., optimizing this texturizing potential) by high-pressure homogenization (HPH). These insights are needed to elucidate this matter given the complexity when different botanical origins and CWM compositions are considered. The main emphasis of this work is on the residues which are obtained after pectin extraction from the CWM.
Method:
The texturizing properties and the potential of functionalization by HPH of partially pectin-depleted CWM was first evaluated for apple, carrot, onion, pumpkin and tomato. Second, the role of the residual pectin content and method of pectin extraction on the texturizing properties and functionalization by HPH was further addressed for tomato. The microstructural properties, viscoelastic properties and water binding capacity (WBC) of the CWM were determined in model systems (i.e., suspensions of the CWM in deionized water).
Results:
The storage modulus (G') of the suspensions and the WBC of the partially pectin-depleted CWM was highly differing among the matrices studied, being related to their specific microstructural attributes and composition. Also the potential of HPH to functionalize the CWM was different, while a decrease in the G' by HPH was observed for apple and carrot and no effect for onion, an increase was observed for pumpkin and tomato. Nevertheless, work on the tomato CWM showed that partial pectin depletion combined with harsh extraction conditions or extensive pectin depletion was needed to facilitate the microstructural alterations during HPH needed to obtain an improved texturizing potential.
Conclusion:
The results indicate that in the context of an optimal use of the CWM of fruits and vegetables as texturizing agent, a thorough food engineering approach is essential involving both the intrinsic microstructural attributes and possible preceding composition altering steps when considering targeted mechanical treatments such as HPH.

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Dunaliella Salina-based nanoemulsions to increase the retinol and β-carotene bioavailability in rats after oral administration

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Aim: *Dunaliella Salina* is an abundant and sustainable source of β-carotene that can be converted into retinol in the intestinal mucosa. However, that compound is easily degraded, so there is a need of finding systems to protect it and increase its absorption. Therefore, the aim of this work was to study the bioavailability of retinol and β-carotene in rats after the oral administration of β-carotene-loaded nanoemulsions formulated using alga *Dunaliella Salina* and natural emulsifiers (soybean lecithin or whey protein isolate).
Method: Carotenoids were extracted from the microalgae and incorporated into the oil phase. Then, nanoemulsions were prepared following a homogenization process and 5 cycles of microfluidization. Rats were fed with the nanoemulsions formulated with the emulsifiers using a multiple-dose administration. Rats were sacrificed and blood, tissues and digesta were collected. β-carotene and its metabolized retinol from the tissues of the digestive tract (duodenum, jejunum ileum and colon), as well as liver and blood were quantified by UPLC. Digesta samples were also observed by optical fluorescence microscopy to evaluate the stability of nanoemulsions throughout the gastrointestinal tract of the rats.
Results: Using whey protein as emulsifier, higher β-carotene concentration was detected in the jejunum and ileum of rats in comparison to the use of soybean lecithin, meaning that the bioactive compound was better absorbed using the protein-based nanoemulsion. Moreover, retinol concentration in the duodenum tissue (≈239 ng/g), liver (≈3254 ng/g) and blood (≈473 ng/mL) were also the highest when whey protein isolate was the emulsifier. The coalescence phenomenon that soybean lecithin nanoemulsion presented in the stomach and small intestine of rats could have reduced the digestibility and absorption of β-carotene. Conversely, although whey protein isolate nanoemulsion showed aggregation in the stomach, small particle sizes were observed in the intestine due to droplet redispersion, which favoured lipid digestibility.
Conclusion: Whey protein isolate increased the bioavailability of retinol in plasma and liver more efficiently than soybean lecithin due to the higher absorption that β-carotene presented when enclosed in the protein-based nanoemulsion rather than in the lecithin.

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Improving lubrication and functionality of plant proteins by microgelation for optimal sensory and fat-replacement applications.

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Aim:
To design novel ultra-lubricating plant protein microgels utilising native alternative plant proteins which are typically limited in food application due to off-mouthfeel and poor functionality. The lubrication and functionality of these microgels are compared to that of native protein and an oil-in-water emulsion.
Method:
Potato protein microgels at 5 and 10 wt% protein, pea protein microgel at 15 wt% protein, and combined protein microgel at 12.5 wt% were prepared at pH 7.0 by thermally crosslinking the proteins at 80 ^{o}C for 30 minutes to form gels, followed by homogenisation into volume fractions 10 – 70. An array of characterisation techniques combining oral tribology using 3D biomimetic tongue surface, rheology, dynamic light scattering (DLS), atomic force microscopy (AFM) and quartz crystal microbalance with dissipation (QCM-D) were used to characterise these newly designed microgels and their surface properties comparing to that of native protein.
Results:
DLS, AFM and rheology revealed that microgels were sub-micron sized ranging in diameter from 85 to 232 nm with low polydispersity (≤ 0.25) with moduli's of 0.35 to 6.5 kPa. These particles spread on AFM surfaces acting similar to oil like mechanisms. Strikingly when compared to native proteins of same protein concentration, up to two orders of magnitude reduction in friction was achieved with friction even lower than that of an oil emulsion obtained. QCM-D and mathematical modelling revealed a mechanism to which microgels allow better flow between particles in contrast to aggregated-like behaviour from native proteins suggesting reasons for high lubricity. Particle sizes were also found to be stable for over a month displaying excellent solubility.
Conclusion:
We demonstrate for the first time microgelation applied to plant proteins allow not only exceptional lubricity compared to native proteins and an alternative to dairy proteins but also a potential application as a fat replacer. The optimised lubricity and functionality through microgelation is a process which enhances new prospects for more pleasurable foods using plant proteins in healthier, high protein, vegan and sustainable food.

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Isolation of casein for Stable Isotope Ratio Analysis of butter, cheese, and milk powder

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Aim:
Stable Isotope Ratio Analysis (SIRA) can provide independent analytical evidence to authenticate geographical origin and production background claims in dairy products. Dairy products differ in composition making inter- and intra-product comparisions, based on isotope analysis, difficult. Therefore, isolating a high purity constituent, common to all products, could eliminate the contribution of compositional differences to variation in the stable isotope values between products. The aim of the study was to develop methods for the isolation of a casein fraction of high purity from cheese, whole milk powder (WMP) and butter, enabling subsequent intra- and inter-product SIRA comparisons without the confounding effect of product composition.
Method:
Three published methods for isolation of protein (from cheese, milk, and butter) were adapted to yield high purity protein (casein) fractions from commercial cheddar cheese, WMP and butter samples. The casein fractions isolated underwent elemental analysis (H, C and N), protein determination, and SIRA of H, C, N, O, and S. Two-way analysis of variance and Tukey post-hoc comparisons tested differences between methods.
Results:
Optimised casein isolation methods were identified based on the C/N ratio and protein content (%) of the casein fraction isolated. Optimum solvent lipid extraction (petroleum spirit:diethyl ether (2:1)) and casein precipitation steps were identified for isolation of cheddar cheese casein. An additional solvent lipid extraction (heptane:isopropanol (3:2)) step was necessary for WMP and butter casein isolation. $\delta^{13}C$ and $\delta^{2}H$ values were used to validate the methods.
Conclusion:
Casein of high purity, for subsequent SIRA, can be isolated from cheddar cheese, WMP and butter following modifications of previously published methods. This enables meaningful inter- and intra-product comparisons of the effects of geographical origin, animal production system or processing on stable isotope composition, providing evidence to support authenticity claims.

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Bacillus subtilis endospores inactivation under hyperbaric-storage –a novel nonthermal strategy to inactivate spores at room-temperature?

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Aim of the work:
A previous work revealed the possibility of inactivating *Bacillus subtilis* endospores by hyperbaric-storage (HS) at 50-100MPa in carrot juice, as the endospore behaviour may depend upon nutrient-availability while under HS. Considering that the inactivation of spores require intense thermal treatment (sterilization), and given the aforesaid, it is important to study the behaviour of endospores at different pH values under HS conditions, using *B. subtilis* endospores as case-study, being a surrogate of the pathogenic *Bacillus cereus* and the food spoiler *Bacillus stearothermophilus.*

Methodology:
The combined effect of pH and nutrient-availability on *B. subtilis* endospores response under HS (25, 50, 75 and 150MPa for 30 days at 18-23ºC) was accessed. For so, *B. subtilis* endospores were inoculated in a nutrient-free McIlvaine buffer and nutrient-rich Brain Heart Infusion broth (BHI-broth, the richest culture media for *B. subtilis*) at three different pH values (4.50, 6.00 and 7.50). After each storage condition, samples were plated in appropriated culture media for quantification and phase-contrast microscopy images were collected to observe ungerminated/germinated spores' state.

Results/Discussion:
The results showed an undeniable influence of pH and nutrient availability on spores while under HS. At pH 4.50, neither endospore development nor inactivation occurred (possibly due to the protonation of the germinant receptors), except at 150MPa, where a maximum reduction of 2 log-units was observed. Increasing the pH to 6.00 and 7.50 resulted in higher inactivation levels, which were proportional to the pressure increase, with the presence of nutrients enhancing the sporicidal effect of HS, which were more pronounced at pH 7.50, being observed approximately 5 log-units of spore reductions to below detection limits at 150MPa, while at pH 6.00, spore inactivation also occurred, yet at lower levels. Phase-contrast images revealed that the spores do not form vegetative-cells before inactivation.

Conclusion:
These results hint the possibility of inactivating *B. subtilis* spores during HS-RT up to at least 5-logs, suggesting that this may be a tool for safer food storage, with the additional advantage of destroying bacterial spores with *quasi* no energetic costs. Albeit, mechanistic insights are to be studied to understand how inactivation takes place and can be optimized for possible industrial application.

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Ultrasound-assisted extraction and polymer-based encapsulation of phycoerythrin from Phorphyridium purpureum

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Aim:

Phycoerythrin (PE), a red color phycobiliprotein, is employed to prepare biomarkers, food colorants, therapeutics, medicines, and health-promoting products. This study comprises two primary objectives, including 1) ultrasound-assisted extraction (UAE) of PE from freeze-dried biomass of *Phorphyridium purpureum (P.p)* in the aqueous phase; 2) encapsulation of a heat-sensitive compound (PE) with improved stability and functional properties.

Method:

Initially, four UAE strategies and a control method were investigated for the extraction. Based on the recovery of crude extracts and their concentrations of phycoerythrin (PE), crude extracts were subjected to cytotoxicity analysis against A549 human lung carcinoma and Caco-2 human colorectal adenocarcinoma cells using Alamar blue assay. Further, these PE extracts were encapsulated using 5% inulin as the coating material (core-shell ratio of 1:3.3) using a nano-spray dryer (inlet temperature: 80 °C; gas flow 100 l/min; chamber pressure 31 hPa; spray rate 80%, pump 50%; vibration frequency 120 kHz). Physicochemical properties of the encapsulated extract were estimated, comprising the color, yield, and scanning electron microscopy (SEM) for size and morphology analyses.

Results:

PE concentration in the extracts was improved from 0.1 mg/ 100 g in the control sample compared with 0.55 mg/100 g of extract in the UAE-treated samples. Inulin with a 5% concentration level resulted in higher retention of red color (a* + value), with 3.01 ± 1.08 µm particle size and 83.82 ± 2.49% yield. SEM micrographs of encapsulated freeze-dried PE extract confirmed its spherical shape. Additionally, cytotoxicity results indicated the effects of PE extract on A549 and Caco-2 cell lines studied under different concentration gradients (from 200 µg/ml to 1.5625 µg/ml) and cells post incubated for six days at 37 °C in 5% CO_2. An IC_{50} of 157.6 µg/ml and 124.6 µg/ml for control and UAE samples in A549, while an IC_{50} of 199.7 µg/ml and 149.0 µg/ml were found for control and UAE samples in Caco-2 cells. Two-way ANOVA demonstrated a significant difference in viability between the highest and lowest concentration ($P<0.0001$).

Conclusion:

UAE is more effective for the recovery of PE than the control extraction method. The obtained extract proved its potential as an anticancer agent. Moreover, inulin has shown to be a suitable carrier for preparing encapsulates, focusing on the stability improvement of bioactive compounds.

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Split-stream processing of asparagus side-streams improves the flavour of dried asparagus food ingredients

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Aim: White asparagus (*A. officinalis*) is a popular vegetable consumed worldwide and its cooked spears are appreciated for their distinct flavour profile. During asparagus harvesting, around one-third of the total material is usually discarded. This significant waste stream partially consists of the stem bases which are cut off to produce spears of equal length (Pegiou et al., 2020). These stem parts are, however, still rich in flavour compounds (Pegiou et al., 2021) and valorisation of these materials to aroma-rich natural food ingredients (e.g., dried powders for soups) could reduce the amount of agricultural waste. Split-stream processing of the asparagus side-streams is a novel approach to produce spray-dried powder from concentrated juice and asparagus fibre (Siccama et al., 2021).
Method: Newly-processed asparagus ingredients generated by the split-stream processing and a conventionally dried asparagus powder were compared by evaluating their flavour profile in an instant-soup formulation. Professional sensory panel, untargeted metabolomics and multivariate regression analyses (Random Forest) supplied information about important sensory-relevant compounds.
Results: The essential role of previously-reported key asparagus odorants was confirmed. Seven new volatile compounds are proposed to also positively contribute to key asparagus flavour notes, some of which were more abundant in the spray-dried powder. The spray-dried powder scored significantly higher on asparagus odour and taste attributes compared to the commercial powder. The fibre had a negative impact both on the taste (e.g. 'cardboard' and 'off-taste') and mouthfeel of the soups and could also be linked to deviations in the metabolite profile.
Conclusion: Performing untargeted metabolomics and sensory evaluation of the soup formulations and integrating the data using Random Forest approaches proved the split-stream process to be effective for the production of asparagus ingredients, which were richer in flavours than the conventionally hot air-dried asparagus powder. This research demonstrates the feasibility of upcycling asparagus side-streams into flavour-rich ingredients with good sensorial properties for food formulations.

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Capillary suspensions for oil structuring with agri-food residues micronized via high-pressure homogenization in oil

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Abstract

Oleogels have been proposed as novel systems for replacing unhealthy saturated fats in food preparations with vegetable oils while enhancing their nutritional value without penalizing taste and mouthfeel. This work aimed at structuring sunflower oil through the formation of capillary suspensions using wheat middlings (WM) as a structuring solid fraction. The use of WM enables also to reduce the caloric content of the oil, while sustainably valorizing an agri-food residue (AFR) of the wheat milling process, hence contributing to implementing the circular economy across the food chain. High-pressure homogenization (HPH), which is an emerging, purely mechanical cell disruption technology, was used as a wet milling technique directly applied on WM-in-oil-dispersion, at 80 MPa and 25 °C for 20 passes. The HPH treatment enabled the reduction of the WM particle size by one order of magnitude, causing, at the same time, WM fiber activation and the release of high value-added intracellular compounds (such as phenolic compounds with high antioxidant activity) into the sunflower oil. The addition under high-shear mixing (HSM) of a secondary immiscible fluid (i.e. water) in a continuous phase (i.e. oil) of HPH-treated particle suspension drastically altered the rheological behavior, evaluated by using a rotational rheometer equipped with a concentric cylinder, and the strength of these suspensions due to the formation of a sample-spanning particulate 3D network. This phenomenon can be attributed to the capillary bridge forces of the two fluids acting on the fibrous solid particles, which cause the transition from liquid to gel-like state. The WM-in-oil-dispersion at 30 wt% of particle fraction treated by HPH with the addition of 50 wt% of water exhibited a high apparent viscosity and apparent yield stress (about 300 Pa). Remarkably, the antioxidant compounds released in the oil contributed to slowing down the oil oxidation phenomena. In conclusion, the obtained oleogels are very promising materials for the formulation of healthier and more sustainable food products in replacement of solid fats, enabling to reduce the overall caloric content while adding the benefits related to the dietary fiber content, as well as exploit the recovery of valuable bioactive compounds still present in the AFRs.

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Contactless characterization of potato drying by using air-coupled ultrasound

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Aim:
The food industry is requesting novel technologies for non-invasive food control in the context of Industry 4.0 and the Smart processing purposes. Thus, the recent development of highly energy air-coupled ultrasound transducers allows the characterization of different food products as a non-invasive and real-time. Therefore, the aim of this study was to determine the feasibility of the air-coupled ultrasound technique to monitoring the drying of potato slices as a rapid, non-destructive and non-invasive technique.
Method:
Potato slices (5 mm thickness) were dried in a convection oven at 60ºC at different times (0, 15, 90, 180, 300 and 420 min). At each drying time, ultrasonic measurements were carried out using through-transmission mode (250 kHz) and, subsequently, the viscoelastic properties of the samples were evaluated by the stress-relaxation test. Finally, the moisture content and density were determined. The ultrasonic velocity (m/s) and the variation of the transmission coefficient with frequency (ΔTC_f, dB/MHz) were obtained after the ultrasonic signal analysis.
Results:
During the potato moisture reduction, the ultrasonic velocity and the ΔTC_f increased significantly ($p<0.05$) from 509 m/s (fresh sample) to 673 m/s (420 min dried) and from -205 dB/MHz (fresh sample) to -55 dB/MHz (420 min dried), respectively. Therefore, a reduction of the potato slices attenuation was computed by the ΔTC_f. Finally, the Elastic Young`s modulus were satisfactorily related with the ultrasonic velocity (R^2= 0.93) and the ΔTC_f (R^2= 0.82). While the density was linearly related with the ΔTC_f (R^2= 0.91).
Conclusion:
The viability of the air-coupled ultrasound to characterize the viscoelastic properties of potato slices during drying has been showed in this study. The ultrasonic parameters studied showed a direct relationship with moisture loss and textural properties that allowed potato snacks to be classified at different drying times. Therefore, this study presented a potential application of air-coupled ultrasound technique that could translate as an improvement in potato dried snack production, as well as being considered an additional step forward in green technology.

Keynote Presentations

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Innovative and Novel Sustainable Food Processing and Challenges

Prof. Ferruh Erdogdu[1]
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Innovative and Novel Sustainable Food Processing and Challenges

Food industry has been under pressure to increase the quality of food products with their safety, and achieving this thorough sustainable processes has been the significant concern. Sustainability in food processing is based on applying non-polluting and economically efficient processes and conserving energy. Additional concern is the process safety. Besides this, food industry has been challenged by (recently) increased food safety issues (e.g. recent *Salmonella* outbreaks in peanut butter, whole shell eggs, dry onions, etc.).
Even though conventional thermal processing (canning and aseptic processing) has been the major pillar of the food industry with its high energy consumptions, innovating this conventional approach with novel thermal and non-thermal technologies has now become the significant focus for sustainable processes. Reducing the energy requirement via the decrease of process time is also considered to lead to more efficient processes with increased quality and safety. This consideration coincides with the challenges of environmental-friendly food processing under the umbrella of the European Green Deal and indicates the novelty requirement in the conventional process lines with increased quality without compromising the safety.
The objective of this presentation is therefore to present the novel innovative approaches (of microwave, radio frequency, infrared, pulsed electric field, etc.) with their challenges to replace the conventional processing for a sustainability in the view of process design in industrial scale. While process design and optimization are the required background for industrial process sustainability, improved food safety and quality assurance through sustainable processes will further require virtualization (mathematical modeling based simulation) approach supported with artificial intelligence and machine learning applications (in addition to the use of IoT and big data). These are expected to be the key components of designing sustainable processes. With the introduction of Industry 4.0, combining the digitalization with virtualization will be more significant for improved smarter sustainable food processes.
Keywords: Innovative processing, sustainability, process design and optimization

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Precision food safety -using DNA sequences to inform risk assessment

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Precision food safety -using DNA sequences to inform risk assessment -

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Abstract- Foodborne disease surveillance is now at a critical juncture. Whilst remaining firmly embedded in the principles of risk analysis; including assessment; management and communication, technological developments have opened up new opportunities for food safety, in its pursuit of the protection of public health and brand reputation.

Microbiological food safety has traditionally been monitored using culture-based protocols designed to detect; characterise and identify the target foodborne pathogen. Bacterial pathogens have been mainly studied at the species level without any consideration being given to the microbiological context, from which the bacterium was originally recovered. Technological advances in high-throughput DNA sequencing in the early 2000's have made available accurate sub-typing protocols that can be deployed to track foodborne pathogens across the food chain whilst describing the associated microbial communities, from which they have arisen. These advances have rapidly changed the approach to foodborne disease surveillance and the assessment of risk to human health. This paradigm shift hearlds the era of *precision food safety*.

In this presentation, examples demonstrating the application of DNA sequencing in the context of microbiological food safety will be presented. These will describe strategies used to accurately identify bacteria and genotypes of importance to human health during an outbreak along with a study to describe the resistome contained in metagenomic data of relavance to food safety.

Keywords - whole genome sequencing; food safety; risk assessment

[216/300 words]

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The role of digital tools in quality food design and sustainability

Assoc. Prof. Francesco Marra[1]
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What are digital tools and how can they be used in designing quality food? How can the use of these tools contribute to the sustainability of the food processing industry?
These are (some) questions that we will try to answer in this talk.
Under the large umbrella of digital tools for the design of food products are included software and applications, coupled with any online or offline resource that can be used with computers, mobile devices or other digital devices, and in which it is possible to incorporate data, data analysis and data prediction. Some of these tools are known and established as methodology (mechanistic modeling, statistical analysis, machine learning tools) and are often applied in research, both at industrial and academic level. The benefit of using digital tools resides in the possibility to accelerate the exploration of different scenarios, then shortening the time-to-market of a new food product. Being based on computation, they can virtually provide answers to complex problems in a short time, exploring scenarios with a very limited cost and – potentially – without any limit. So, in a world running toward sustainable food transition, the use of these tools can open new roads to established food companies but also to start-ups.
Another unpayable benefit coming from digital tools is the contribution to transfer knowledge.
Technological data available on food properties, from ingredients to final products, are often scattered or uncomplete. In such a scenario, a pure statistical approach could lead to relations among data which are misleading. Digital tools can be used in such cases to guide the interpretation of data relationships and help the transfer of knowledge from product developers and process/system designers.
Finally, a visionary perspective on the use of unconventional digital tools (though for other purposes than food design) for the understanding of consumers' perception and needs is presented and discussed.

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Consumer inferences from production and processing characteristics: A barrier to a more sustainable food production?

Prof. Klaus G. Grunert[1]
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Consumer inferences from production and processing characteristics: A possible barrier to a more sustainable food production?

Klaus G. Grunert

Consumer perceptions of the way in which a food product has been produced can lead to inferences about the quality of the product, like its healthiness, its sustainability and its taste, and can thus both facilitate or delay the adoption of new food products. In particular, many consumers use degree of processing as a cue to infer healthiness, which may be a barrier to the adoption of products like meat substitutes or upcycled food products, which often have a high degree of processing. On the other hand, many consumers do buy and consume food products with a high degree of processing, showing that these products have other benefits to consumers that compensate for possible negative inferences. The adoption of new and more sustainable food products is therefore related to how consumers handle perceived trade-offs between different quality dimensions. As consumer food choices are often made quickly and with limited deliberation, the positioning of new products and the framing of the communication about them will be important for their adoption. Transparency and communication about food processing may at least partially mitigate barriers due to negative inferences from high degrees of processing. Clean labels may be an element in such communication, but should be embedded in a broader strategy for framing communication about food production.

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"shaping the production of sustainable, healthier foods for the future"

Dr. Albert Mcquaid[1]
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EFFoST 2022 Abstract (Albert McQuaid)

Abstract: Every Innovation begins with an idea that captures the potential for a better future. Food waste is one of the greatest sources of inefficiency in our food system. The magnitude of the food waste crisis underscores the need to continue to strive for Future where unrivalled collaboration and innovation across industries delivers Climate Positive & nutritionally balanced food system that enables us to driving people towards healthy nutritious food choices.

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Defining what type of industry will provide sustainable and healthy future foods
Prof. Wayne MARTINDALE[1]
[1]*University of Lincoln, , United Kingdom*

Defining what industry will provide sustainable and healthy future foods

Industry (definition)- a group of manufacturers or businesses that produce a particular kind of goods or services

The research presented will show how the sustainability and responsible sourcing requirements of food and beverage supply chains can be reported. We have developed geospatial models that build-in well-established population modelling and Life Cycle Assessment methods to create digital twins of production and consumption. Current developments in our laboratory utilise remote sensing and Earth Observation to assess the impact of land use change on food consumption at global and local population scales. This is important because the capability to determine where resource flows in food supply chains will go and what they will do are of great importance if international frameworks such as the UN Sustainable Development Goals are to be met. This includes nutritional outcomes where it is impossible to develop any notion of sustainability without knowing where resources are, where they are going and what they are utilised for. Our methods project the value of the ecosystem service and health outcomes using of science-based targets and algorithms that measure how resources move around the food and beverage system. These are dependent on acquisition of timely and accessible data and the approach has been tested to assess the production of insect larvae in feed systems and the production of foods in hostile environments which are reported in our articles and presentations.

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The role of sensory, consumer and community research in designing foods for healthy sustainable diets

Prof. Lisa Methven[1]
[1]*University Of Reading, Reading, United Kingdom*

Title:
The role of sensory, consumer and community research in designing foods for healthy sustainable diets

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Abstract:
Redesigning foods and food systems for the health of people and planet requires the participation of everyone. Diets considered poor for human and planetary health have developed over decades, and can be perpetuated within communities for many reasons, including finance and resources. Focus on redesigning diets considers multiple food types, including the reduction of high saturated fat, salt and sugar (HFSS) foods and the shift towards plant-based diets.
Often the primary aim in redesigning foods is to ensure the final products have the sensory appeal of the foods that they are intended to replace. This can be a highly challenging objective.
Reducing saturated fat, salt and sugar within a food product whilst maintaining texture, taste and palatability is not easy, although we can argue has been achieved in many products and in particular beverages. How much more can we achieve by this "mimicking" strategy, and will it be enough? Have we sufficiently considered any long-term pitfalls such as the environmental and financial sustainability of alternative ingredients, as well as fundamental relationships between sensory cues, metabolite delivery and satiety?
Replacing meat and dairy products with plant-based alternatives continues to be a rapid growth area for research and product development. Here we have multiple approaches, usually tailored to different consumer groups. Meat analogues that have the texture, flavour and juiciness of meat may attract meat-eaters wishing to reduce their meat consumption but repel vegetarians. When we consider insects as food, the "yuk" factor can hit the meat eater as much as the vegetarian. So where should we put out effort, into mimicking animal-based products, or designing completely new products?
At the heart of what we do, we must work with consumers and communities. Often foods designed to impact dietary change attract more advantaged people and can leave behind disadvantaged communities. To achieve health and sustainability goals we need to redesign foods and food systems for everyone. This talk aims to address how sensory and consumer research can achieve this.

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Microalgae based production of single-cell protein

Prof. Maria Barbosa[1]
[1]*Wageningen University, , Netherlands*

Microalgae based production of single-cell protein
Maria J. Barbosa
Microalgal Biotechnology, AlgaePARC, Wageningen University

Microalgae express high protein levels and can be produced in contained cultivation systems with low water requirements and complete fertilizer use. The production potential is 22-44 tons of protein per hectare per year although the current production scale is small. Techno-economic analyses have shown good potential for scale-up and cost reduction. Large-scale production of microalgae in the post-fossil era will rely on the capture of carbon dioxide from the air or sugars from crops. Microalgal amino acid composition matches well with requirements for food and feed, which, combined with novel biomass pre-treatment steps, will guarantee high-quality microalgal protein. Several developments have been realized including the production and commercialization of a few microalgae strains as a source of functional ingredients, and meat replacers, among others. For a broadening of the microalgae species available as single-cell protein, to allow full exploitation of microalgae as single-cell protein, novel food approval is required.

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How can the wastewater treatment sector contribute for the sustainability of the agro-food industries?

Dr. Catarina L. Amorim[1]
[1]*Universidade Católica Portuguesa, CBQF - Centro de Biotecnologia e Química Fina, Escola Superior de Biotecnologia, Porto, Portugal*

How can the wastewater treatment sector contribute for the sustainability of the agro-food industries?

Catarina L. Amorim (1)

(1) *Universidade Católica Portuguesa, CBQF - Centro de Biotecnologia e Química Fina – Laboratório Associado, Escola Superior de Biotecnologia, Porto, Portugal*

Over the last decades, the agro-food industry has largely intensified its production to cover the growing needs of society. The economic model based on the take-make-dispose paradigm is no longer viable due to its unsustainability. In this context, the agro-food industry has been paying attention to cross-cutting technologies to incorporate sustainability into its processes.

The water footprint is a key issue for the agro-food industry. Huge amounts of water are needed, and consequently huge amounts of wastewater are produced. Wastewater treatment processes are necessary for the preservation of water and its environmental quality. Nowadays, the implementation of greener wastewater treatment technologies, that allow for the reduction, reuse and recovery of materials is an asset. The granular sludge technology is an example of a such innovative process, robust to deal with fluctuations in wastewater composition and able to offer opportunities for more value-added processes.

In this presentation, recent data and results will be shown to illustrate how the granular sludge technology can help in the transition to achieve sustainilibity in the agro-food industry, especially related to its water footprint.

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Latest developments in food authenticity: an overview

Professor Paul Brereton

[1]*Queen's University Belfast, Belfast, United Kingdom*

Latest developments in food authenticity: an overview
Paul Brereton, Queen's University Belfast

Over recent years there has been a greater awareness of food fraud and the need to demonstrate the authenticity of the food we eat. As a result, there are several ongoing international activities taking place around the globe including attempts at standardisation in a number of areas such terms and definitions, methods of analyses and traceability. In addition, new technologies such as blockchain, remote sensing, non-targeted analysis, online/in field detection and digitilisation offer potential significant improvements in food fraud mitigation. "Big data" early warning systems based on incident information, econometric analysis, Artificial Intelligence/Machine Learning provide the potential to better anticipate food fraud risks and help the food industry better focus mitigation actions.
An overview of some of the key international developments will be given as well as an assessment of the current impediments to progress in terms of ensuring the authenticity of our food.

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Sustainable food systems: Role of food packaging

Dr. Begonya Marcos Muntal[1]
[1]*IRTA (Institute of Agrifood Research and Technology), Finca Camps i Armet s/n,, Spain*

Title: Sustainable food systems: Role of food packaging
Food packaging plays an instrumental role in preserving food quality and safety and reducing food waste. However, the increasing growth in short lifespan applications that are not designed for reuse or recycling, has let to inefficient and lineal production and consumption patterns. As a result, there has been an increase in plastic residue generation and a leakage into the environment due to packaging waste mismanagement.
Packaging sustainability has become a global trend, with consumers becoming increasingly concerned about the impact of packaging contamination in the environment. However, the debate is lacking common understanding within the scientific community, opening the door to emotional responses, rather than informed decisions. Uninformed decisions may contribute to greenwashing practices within the industry and leave policymakers vulnerable to uninformed policy. Consumer training based on scientific facts and clear on-pack information can contribute to improve the sustainable buying and recycling behaviour.
Packaging innovation should focus in addressing the main challenges to obtaining sustainable food systems, that is to minimise the environmental footprint of packed food. Sustainable packaging solutions must address food waste and loss reduction while assuring food quality and safety. The key challenges for sustainable food packaging are to reduce the carbon dioxide emissions, to reduce waste generation and accumulation, and to prevent overconsumption of raw materials. Advances and measures in food packaging to effectively implement circular food systems will be discussed.

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Alternative proteins

Mr. Hadrien Delemazure[1]
[1]*Clextral, , France*

16/09/2022

Bio

Hadrien DELEMAZURE hold a Master degree of Food Engineering from AgroParisTech Massy. Over the last 12 years, he has worked for Clextral as a Process engineer. He has extensive experience into extrusion processing and in R&D program to sustain company growth into alternative protein market.

Abstract =

Pioneer in the field, Clextral has more than 30 years of experience in protein extrusion processing
HME technology allows transformation of plant protein from plant based sources into meat-like texture products presenting wide range of attributes in terms of fibration, surface appearance, color, texture, flavor, or product size.
These fibrated proteins are the base ingredient for "Alternative protein products". Well balanced in nutrients, recipes include vegetable proteins from plants such as soybean, pea, lentil, chickpea, fava bean, mung bean, sunflower, lupine, wheat gluten ….Novel protein products are either used as ingredients for vegetarian or vegan dishes, or prepared into ready-to-eat meals.
HME: high moisture extrusion

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Metabolomics – how it can contribute to developments to underpin a healthy, sustainable diet.

Prof. Lorraine Brennan[1]
[1]*UCD, UCD Institute of Food and Health, Ireland*

Metabolomics – how it can contribute to developments to underpin a healthy, sustainable diet.

Lorraine Brennan
UCD Institute of Food and Health, UCD School of Agriculture and Food Science, Belfield, Dublin 4, Ireland.

Metabolomics is the study of small molecules called metabolites. Application of metabolomics in Food and Nutrition research are far reaching and include for example (1) Applications to identify dietary biomarkers for single foods or for dietary patterns (2) Applications to dietary intervention studies to help understand metabolic alterations following certain diets and (3) Detailed compositional analysis of foods. Combining metabolomic analyses with classical biological screening can lead to the identification of bioactives and combinations of bioactives with biological impacts. Examples from using green solvents to obtain bioactives from waste streams will be highlighted. Furthermore, using metabolomics to help understand the response to foods can help tailor recommendations to the individual. Examples of how metabolic phenotyping can be used to underpin developments towards Precision Nutrition will be discussed.

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Understanding the individual in the food system, a science of consumers or citizens?

Prof. Monique Raats[1]
[1]*University Of Surrey, Guildford, United Kingdom*

Food serves many functions and has multiple meanings including consumption, transfer and identity. Cultural background and personal factors (e.g. motivation, preferences and habits) are reflected in food choices and dependent on the wider context of food provisioning (e.g. production, distribution, selling, waste management). The human and social sciences together with the humanities offer a knowledge base to understand and inform policy. Public and stakeholder involvement in science and policy has gained a significant traction in the past 20 years, during the period of "participatory turn" in the processes of developing policies and setting trajectories of science and innovation. Responsible Research and Innovation is a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society) Von (Schomberg, 2013). Public and stakeholder engagement are considered to be requirements both in terms of enhancing democratic legitimacy and improving impact of research and innovation. This presentation will reflect on how the individual is considered in food policy development and the building of knowledge systems connecting science with wider society and in particular policy. Sugar reduction and the concept of processed foods will be used as illustrations. An example infrastructure COMFOCUS that is being developed in the interdisciplinary field of food consumer science will function as an example. The scope for harnessing social learning models – communitarianism – e.g. through community-level engagement and deliberation to decide which versions of the future we, as society, would like to pursue, and then citizens can enact system change – i.e. impacting what, where and when we eat will be discussed as a way forward.

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Robots of the future – Collaborative Robotics & 3D Printing for Food Quality & Design.

Dr. Norah O'Shea[1]
[1]*Teagasc, , Ireland*

Robots of the future – Collaborative Robotics & 3D Printing for Food Quality & Design

Norah O'Shea

Food Chemistry & Technology Department, Teagasc Food Research Centre, Moorepark, Co. Cork

The role of automation in food processing has received additional attention during the Covid-19 pandemic and the current energy crisis. Process automation in the form of robotics and sensors for manufacturing has changed from a "like to have" to a "requirement". The use of robotics in food processing offers many advantages, such as speed, movement accuracy, and the ability to perform hazardous or repetitive tasks, e.g. lifting heavy weights, working with dangerous chemicals or activities requiring precision. Traditionally, industrial robots have been used for "pick and place" applications, for example, packaging and distribution. With the introduction of collaborative robotics (cobots), the use cases have increased, as cobots can safely work alongside humans. Cobots are now being integrated into processing lines to carry out tasks that operators previously could not complete. They have the added benefit of end-of-arm tooling that can be retrofitted with additional sensors for determining difficult-to-measure process parameters, e.g. gel strength during cheese manufacture, where human intervention is not possible. A case study will be presented discussing the application of cobots in sample preparation for dairy powder reconstitution. An additional case study will demonstrate the potential of 3D printing for developing dairy snacks as a green food-processing tool of the future. The cost of process sensors has reduced with development, making them more accessible for food processors and extending their application. In a world of digital transformation, Industrial Internet of Things (IIoT) is a system for collecting, storing, sorting and visualising data from different processing parameters, including robotic sources, and presenting the information in a user-friendly format. This system can visualise interconnected equipment and process data, offering insights into plant operations for process optimisation and energy savings.

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Consumer interest in healthy sustainable diets and the role of tools supporting food choice

Prof. Wim Verbeke[1], Ms. Fien Minnens[1], Ms. Hélène Van der Stricht[1], Prof. Yung Hung Christine[1]
[1]*Ghent University, Department of Agricultural Economics, , België*

This contribution will focus on the consumer perspective and discuss the role of health and sustainability as possible drivers of food choice while accounting for diversity in terms of personal characteristics, attitudes, interests and motivations. Findings from selected consumer studies will be shared. These range from the mapping of consumer perceptions and attitudes, over the perceived importance of health and sustainability relative to other food product attributes, to purchase intentions and behaviour. This will also cover willingness-to-pay for foods with a health and sustainability benefit or related claim. Empirical findings will illustrate that the concepts of health and sustainability match each other for a large majority of consumers, although only about one third might be strongly interested in both concepts while making food choices. The role of consumers' personal motivation versus their ability to make healthy and sustainable food choices, and the potential of a positioning that is based on health and sustainability combined, will be discussed. Since favourable attitudes towards health and sustainability do not systematically translate into according behaviours and food choices, the related citizen-attitude-to-consumer-behaviour gap will be discussed, providing insight into why individual consumers may not consistently act in line with their attitude as a citizen. Last but not least, the potential of technologies and/or tools to help consumers make informed decisions about sustainable healthy foods will be illustrated with the case of an online tool that provides consumers with personalised health risk-benefit information about seafood consumption. Finally, implications and challenges for food policy and communication will be presented.

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Food design challenges: balancing sustainability, nutrition and circularity

Dr Milena Corredig[1]
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Our food system is based on old paradigms of production, processing and distribution. New more sustainable sources of food are needed, but only if more robust, resilient value chains and less resource intensive processing practices can be established, together with less wasteful circular systems. However, all of this requires not only a fit within the planetary boundaries, but within the definition of heathy, nutritious and affordable diets. Our ability to control raw material quality will need to be more important than ever, and will require machine learning tools to cope with high inherent variability of the refined fractions. Food structure design will become also critical as formulations will need to be resilient and adjustable, to ensure the correct balance between circularity, sustainability and nutrition. This work will highlight and provide examples for some of the research challenges we face today, from control of quality by design of raw materials across the entire supply chain, to the utilization of less refined ingredients and the implications from the technological, nutritional and labeling perspective, to new formulations whereby the attention is not only to the nutritional components but also their functionality during digestion. These challenges will be in focus in the next decade, and for some of them, we have yet to find clever solutions. More then ever, we need a multidisciplinary approach to de-risk industrial development, communicate quality to consumers and establish their trust in the new food system.

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The Internet of Things for Food

Dr. Sjaak Wolfert[1]
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The Internet of Things for Food
The domain of agri-food is increasingly being digitized through the introduction of all kind of smart devices and software: the Internet of Things (IoT). I distinguish 4 application areas in which IoT and the digital transformation is expected to bring big changes and where data will play an increasingly larger role:

1) Digital data is becoming more important for decision-making for actors at any level of the agri-food supply chain: from farmers, through logistic providers to consumers.
   1. The same data is essential for food integrity, providing assurance to consumers and other stakeholders about safety, authenticity and quality of food.
   2. Public decision-making for societal challenges such as food security, climate change, healthy food and nutrition could also tap into these data instead of using separate censuses and statistics which are usually lagging behind.
   3. Finally, this digitization is driven by fast developments in science and technology (S&T), such as Artificial Intelligence, Internet of Things, Blockchain, etc. At the same time, advancements in data science also heavily rely on the data that is being generated by the application of data-driven research; simply put: no big data analytics without big data.

Now it could be expected that this is purely a technological development. However, I will show how the organisational development is equally important, coining an integrated, multi-disciplinary approach. The heart of this approach is formed by use cases in which digital solutions are designed, tested & implemented and evaluated in a real-life environment, following a cyclic, iterative development path. It is supported by (i) data science and information management, (ii) business modelling, governance & ethics and (iii) ecosystem development. The approach will be demonstrated by an existing example from the wine sector.

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The potential of protein hydrolysates to support immune health

Prof. Christine Loscher[1]
[1]*Dcu, , Ireland*

The potential of protein hydrolysates to support immune health
Prof Christine Loscher DCU.

The development of functional “value-added” ingredients is a key priority for the expansion of the Irish Agri-Food sector. An important application area for Functional Foods that has emerged over the last decade is the area of Immune Health. Furthermore, the recent global COVID-19 pandemic has now put immune health in the spotlight raising public awareness and opening an opportunity for food companies to develop immune-modulatory ingredients. These include improving viral immunity, improving gut health in the elderly and optimising the immune system in children.
This talk will present some recent data from the Food for Health Ireland consortium demonstrating the ability of novel milk-derived protein hydrolysates to modulate key immune responses involved in allergy and inflammation and provide evidence for their use as functional food ingredients to support immune health in infants and adults.

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Spectral imaging in Food Safety: background, opportunities and limitations

Prof. Aoife Gowen[1]
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Spectral imaging in Food Safety: background, opportunities and limitations

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Spectral imaging expands the technique of spectroscopy through acquisition of spatially contiguous spectra over a sample surface. This technique enables investigation of the spatial distribution of bio-chemical components on or within a sample. Recently, spectral imaging has been applied to the identification of bacteria in a variety of contexts [1]. Although this technique presents considerable opportunities for rapid, inline characterisation, many challenges still exist, including optimisation of sample reproducibility, sample presentation and data analysis. These challenges are illustrated here through the presentation of three case studies, where spectral imaging was applied to a range of systems. In the first case study portable spectral imaging in the visible wavelength range (443 – 726 nm) was used to assess effects of UV decontamination on the quality of vacuum packaged chicken and to predict bacterial spoilage [2]. Mean spectra obtained from the hyperspectral images were analyzed, and predictive models for were developed by using partial least squares regression. The developed models were then applied to pixel spectra from samples in the validation set to inspect spatial variations during storage. In the second case study microscopic Fourier transform infrared (FTIR) imaging, macroscopic visible-near infrared (VNIR), and shortwave infrared (SWIR) spectral imaging were compared for the identification of bacteria on stainless steel. In this study, the robustness of models built from mean and pixel spectra was compared and the results highlight the importance of independent model validation when dealing with samples of high biological variability [3]. In the third case study spectral imaging modalities are compared for the investigation of bacterial biofilms grown on metallic substrates. Once again the high level of biological variability posed challenges in obtaining reproducible samples for spectroscopic measurement.

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Personalised food-based dietary guidelines to support transition to a more sustainable healthy diet.

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Personalised food-based dietary guidelines to support transition to a more sustainable healthy diet.
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Improved nutrition could be one of the most cost-effective approaches to address many of the societal, environmental and economic challenges currently facing the globe, reflected in the UN Sustainable Development Goals (1). While innovation to drive sustainable methods in food production is urgently needed, the development and supply of attractive, affordable foods that deliver appropriate nutrition to promote growth, development and life-long health and wellness is a societal priority. Reflected in the widely debated 2019 EAT-Lancet Commission (2019) report, the link between diet, health and the environment is incontrovertible and there are widespread calls to substitute plant-based foods for animal-based foods (2). Like others, Ireland must develop food-based dietary guidelines that define a sustainable healthy diet. This will call for significant change in eating patterns which will mean changing consumer perceptions and behaviours. At the same time, any changes must be sensitive to diverse nutrient needs of vulnerable groups, like young women, children and older adults.

Personalised nutrition accounts for individual needs, allowing interventions to target advice based on individual nutrient requirements, food preferences and socioeconomic circumstances. Taking a personalised approach means that dietary advice can incorporate health and sustainability targets along with what is accessible, affordable and acceptable for consumers. An evidence-based personalised approach that meets health and sustainability targets considering what is accessible, affordable and acceptable to the consumer is required when reforming national dietary guidelines. However, we have no evidence to suggest that the majority of the public will embrace such diets or that they will be effective in achieving environmental and personal health benefits. As part of SuHeGuide project, we have developed a system of decision trees to personalise dietary advice to meet health and sustainability targets within a framework that maximises acceptability and effectiveness of the diet. Initial testing shows that the decision tree networks deliver a lower environmental impact diet compared to standard healthy eating guidelines; however, evidence showing dietary change ireal-world context is necessary before we attempt to refine Ireland's existing food-based dietary guidelines

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The Evolution of Food Fraud Vulnerabilities: Beyond Melamine to Infinity

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Presentation title: The Evolution of Food Fraud Vulnerabilities: Beyond Melamine to Infinity
Presentation summary: Collectively, the global food supply chain stressors are creating new market dynamics that have led to an evolution in the food fraud vulnerabilities. This presentation will begin by focusing on the market changes and the future scenarios that are constantly evolving. The food fraud vulnerability assessments must continue to evolve by considering old but also the new system factors. Fortunately, the core food fraud initial screening and broad incident review methods still apply – as long as they are looking at new and evolving vulnerabilities. That holistic and all-encompassing prevention focus foundation was started ten-years ago when the Global Food Safety Initiative (GFSI) created at Food Fraud Think Tank to understand 'what' food fraud is. The work expanded to from 'the what' to 'the how' to address the problem. Over the years – and particularly through publications in EEFoST journals – the focus expanded to 'how much is enough.' The global food supply chain has been massively stressed from COVID related supply and consumer shopping stressors, ripple effects of many factors are contributing to global shortages and inflation, and events such as Ukraine-Russia are creating what some are calling the biggest impacts since World War II.

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From mice to mouse: Developments in toxicological and allergenicity risk assessments

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From mice to mouse: Developments in toxicological and allergenicity risk assessments
Rhodri Evans, PhD, Exponent International Ltd
As food production and processing practices continue to develop and evolve in order to meet increasing demand for nutritious, sustainable and safe food, whether through production of novel proteins through targeted fermentation, or development and use of novel food ingredients or food additives, there is also an increasing desire from multiple stakeholders to revisit and possibly replace "traditional" chemical risk assessment models. This is driven from both an increased animal welfare perspective, which is central to the goals of both consumers and food businesses alike, and also a recognition that the use of rapidly developing *in vitro* and *in silico* assessment approaches can allow a more cost effective, and faster identification of potential hazards.
The presentation will address ongoing developments in chemical risk assessment approaches that can assist with evaluation of the safety of (new) food ingredients as well as potential hazards associated with new and / or emerging contaminants. For example the use of *in silico* methods such as (Q)SAR (in combination with non-targeted analysis) and proteomic analysis can help identify potential hazards to human health. It will also examine the application of *in vitro* methods and other approaches (including collation and assessment of analytical data) to assist with ensuring the presence of contaminants or potentially allergenic material is managed effectively in the food chain to protect sensitive consumers.

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Development of process analytical technology (PAT) tools for enhanced quality and safety in food processing

Prof. Colm O'DONNELL[1]
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Development of process analytical technology (PAT) tools for enhanced quality and safety in food processing

Process Analytical Technology (PAT) is a framework for innovative process manufacturing and quality assurance. The PAT concept is to design, analyse, and control manufacturing processes through the measurement of identified critical control parameters which govern product variability. The PAT initiative aims to move from a paradigm of *'testing quality in'* to *'building quality in by design'.*
Recent significant advances in process sensors and in model-based monitoring and control methodologies, have led to enormous opportunities for improved competitiveness in food processing through the adoption of PAT tools. Improvements in process efficiency, reduced product variability, enhanced traceability, process understanding, and decreased risk of contamination are some of the benefits arising from the introduction of a PAT strategy in food processing.
However, to date adoption of PAT tools in the food industry has been limited, mainly due to challenges associated with development and validation of calibration models, instrument variability, data management systems, sanitary design and compatibility with processing environments.
This presentation reviews established and emerging PAT tools with potential application in the food processing industry. Specific drivers for adopting PAT in the food industry are also reviewed. In particular, recent technical advances in spectral technologies, chemometric modelling and data fusion approaches which will facilitate increased adoption of a PAT approach and transition to Industry 4.0 in food processing applications are outlined. Through case studies from both dairy and meat processing, the challenges and benefits of adopting a PAT strategy in the food industry are demonstrated. In particular, opportunities for improved understanding of critical product and process parameters, and improved competitiveness from adopting a PAT approach in food processing are highlighted.

Plenary Presentations

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Future of healthy, environmentally sustainable and desirable diets: guidelines, industry and consumers

Prof. Jennie Macdiarmid[1]
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Poor diets, poverty and climate change are some of the global challenges facing us today. Healthy and sustainable diets can play an important part in addressing these issues. In 2010, the FAO published a comprehensive definition of sustainable diets and many countries revised their dietary guidelines to incorporate environmental sustainability. One dominant, but often contentious, recommendation is reducing consumption of animal products since the production of livestock has a much greater environmental impact than production of plant-based commodities. In 2019, the FAO and WHO published a joint report 'Sustainable, Healthy Diets - Guiding Principles' grouping the guidance into health, environmental impacts and sociocultural aspects (e.g. affordability, access and desirability). In much of early research, the sociocultural aspects were overlooked with health and environment the focus, which was reflected in some of the example diets. However, research consistently shows sociocultural aspects, including price, pleasure and social norms, are primary drivers of decision making among consumers, while health is a bigger driver than environment. To tackle global warming and limit climate change diets must change and this means reducing consumption of meat and dairy and a shift to more plant-based diets. The challenge is putting this into practice. The recent rapid increase in availability of processed plant-based alternatives to meat (e.g. burgers, sausage rolls, ready meals) could help with the transition to plant-based diets by addressing some of the barriers consumers have expressed, such as not knowing what to eat, the perception of the difficultly and time it takes to make plant-based meals. However, many of the processed plant-based convenience foods are high in fat, salt and sugar and use commodities that can have negative impact on the environment. Going forward sociocultural aspects must be integrated in sustainable healthy diets but this must be alongside health and environment.

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Bringing molecular methods to bear on food safety

Prof. Colin Hill[1]
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Bringing molecular methods to bear on food safety

Colin Hill, University College Cork, Cork, Ireland

Molecular biology and food microbiology have not always been comfortable bedfellows but that needs to change, and quickly. We all understand the role of molecular biology in unravelling virulence mechanism of microbial pathogens, or in dissecting the host response. The role of molecular methods in pathogen detection and in molecular epidemiology has also been widely appreciated and accepted. However, the idea of genetically manipulating food-related organisms destined for the supermarket shelves has been more controversial. There are many GM plants grown worldwide, and many ingredients derived from these find their way into our diet, but this has not always resonated with consumers. What about manipulating bacteria used in the production of fermented foods, or using genetically modified bacteria to produce food ingredients. Is this an idea whose time has arrived? I will present some examples from our own laboratory where we have used molecular techniques to produce improved food ingredients and additives to improve food safety and animal welfare.

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'Better Living through Sensory'; Using Sensory Cues to Moderate Eating Behaviour, Food Intake and Health

Prof. Ciarán Forde[1]
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'Better Living through Sensory'; Using Sensory Cues to Moderate Eating Behaviour, Food Intake and Health

Ciarán G. Forde

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Food choice and energy intake are much influenced more by sensory and cognitive aspects of eating than the nutritive properties of the food being consumed, yet chronic disease and ill-health are the result of prolonged exposure to diets with poor nutritive properties and high energy-density. The role of dietary patterns in the development of diet-related conditions is undisputed, but this knowledge is of little value if we do not understand the reasons why people continue to choose and consume unhealthy foods. Today we know much more about what a food does to the body once consumed, than we do about why a food is chosen and eaten, or why it can be easy overconsume certain foods and not others.

The sensory properties of foods play an important role in shaping 'what', 'how much' and 'why' we eat, and the dietary patterns that influence health and well-being across the lifespan. Not all calories are created equal and food texture, taste and aroma are influential before and during meals to direct food choice, inform portion selection and drive our eating behaviours. Our research has demonstrated the joint impact of eating at a faster rate and consuming higher energy dense foods in promoting greater intake, and we have extended this to explore the sensory and eating rate properties of (ultra)processed foods. By including 'sensory' ratings in population dietary epidemiology studies, we have pioneered the development of 'Sensory Epidemiology' to make novel connections between the sensory properties of habitual diets and the intake patterns that influence body composition and health. Sensory Scientists are uniquely positioned at the cross-roads of food science, nutrition and consumer behaviour to understand how food perception can be used to influence the transition to healthier and more sustainable diets. The sensory properties of foods offer opportunities to moderate the flow of energy and nutrients through our diets, yet are currently an under-utilized tool in public health nutrition. Addressing the serious public health challenges posed by the modern food environment will require changes in food formulation and intake behaviour. Using a foods sensory properties makes it possible to support healthier eating behaviours and can inform the development of successful dietary strategies that keep food enjoyment and satisfaction at the heart of healthy eating.

819

Food Vision 2030: its development, conclusions and implementation in a fast changing world

Tom Arnold[1]

1

Commented [DC1]: @Emma Slattery insert Tom Arnold Affiliation here

Abstract: The presentation will trace the process through which the stakeholder -led strategy was developed, following on from the four earlier such processes dating back to 2000. Food Vision 2030 has continuities with the earlier strategies but in adopting a 'food systems' approach to its development, introduced a number of important innovations. Food Vision's central objective is that Ireland should become an international leader in Sustainable Food Systems over the coming decade. With the Irish Government's approval of the Strategy in August 2021, its implementation must take account of international and domestic events subsequent to its approval. In February 2022, the Russian invasion of Ukraine has had major consequences for the global food economy. In July 2022, the Government set challenging targets for emissions reduction by the agricultural sector as part of the national Climate Action Plan. The presentation will also link Food Vision's central objective on leadership in Sustainable Food Systems to developments in the global food economy and to the follow-up to the 2021 Food Systems Summit.

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Consumer attitude toward innovative and sustainable food processing

Prof. Diana Bánáti[1]

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Complex environmental, societal and economic problems, population growth, ageing, food-related health issues, climate change, pandemics, war are all threats to the food system. Consumers being more and more health- and environment-conscious, expect ’natural’, minimally processed, safe and nutritious foods with long shelf-life.

Innovative, novel food technologies are crucial for the sustainable production of safe and nutritious food, they are important for food security and to build a more resilient food system. Novel food technologies are as worthy of consumers’ attention, as much as they are understood and appreciated. Consumers’ perception and acceptance are influenced by many factors. Cultural background, neophobia, the perceived naturalness of a given technology and trust in the industry are all important factors. Highly processed foods are perceived as lacking naturalness.

People are conservative by nature regarding culturally defined dietary behaviour, thus concerning unfamiliar, novel foods and novel food technologies. Although, some novel foods became accepted (e.g. plant-based meat alternatives, exotic fruits, sushi), this would not substantially change consumers’ diet, but would rather increase food variety.

While technological progress is perceived positively in general, the food sector is different as some novel food technologies encounter strong resistance by consumers. Innovative technologies capable of transforming our food system and our foodstuffs are often rejected by consumers, despite their positive perception by food experts.

Consumer fear is built on the ruins of failed science communication. The examples are numerous, from irradiation, via GMOs, to nanotechnology. The lack of evidence-based information, the unlimited amount of uncontrolled information widely available, the easiness of having access to interesting and often misleading information, would influence consumers’ perception. Misleading and unclear terms, such as ’natural’, ’superfood’, ’ultra-processed’ would further amplify the confusion. Interest-driven food marketing can trigger the phenomena.

It is our role and responsibility to explain food innovations for consumers. We need to understand the factors influencing consumers’ perception of innovative, novel technologies at an early stage of their development and introduction in order to trigger better attitude towards and higher acceptance of such technologies.

Special Session Presentations

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Predictive modelling tools to evaluate the effects of climate change on food safety (PROTECT)

Prof. Enda Cummins[1], Ms Rhea Sanjiv Chhaya[1], Ms Styliani Roufou[2], Ms Lydia Katsini[3], Mr Rodney Feliciano[4], Ms Ourania Misiou[5], Ms Maria Ioanna Malliaroudaki[6], Ms Paola Guzmán Luna[7], Mr Gopaiah Talari[8,1]

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Predictive modelling tools to evaluate the effects of climate change on food safety (PROTECT)

Special Session Description:

Climate change and food safety have become interdependent worldwide research priorities. In order to meet the EU challenge of doubling food production by 2050 (to meet population demands) while dealing with the impact of climate change on food safety, investment in research to address this issue is required. The overarching aim of this Innovative Training Network (ITN) is to provide high-level training in Predictive mOdelling Tools to evaluate the Effects of Climate change on food safeTy (PROTECT) to a new generation of high achieving early-stage researchers. PROTECT provides them with the transferable skills necessary for thriving careers in a burgeoning area that underpins innovative technological development across a range of diverse disciplines. This goal is achieved by a unique combination of "hands-on" research training, non-academic placements, summer schools and workshops on research-related and transferable skills facilitated by the academic and non-academic composition of the consortium. PROTECT brings together intersectoral and multidisciplinary expertise from 11 European Countries (7 third level educational institutions, 6 industry partners, 1 United Nations agency). The consortium shares technical and training expertise to train 8 highly skilled ESRs in advanced modelling tools to investigate the impact of climate change on food safety, considering food as unsafe if it is injurious to health (due to pathogenic bacteria or mycotoxins) or unfit for human consumption (due to spoilage bacteria). PROTECT uses this new knowledge to create a science-based decision support tool and to develop policy guidance through a white paper. The consortium supports specialist job creation in an area central to human and environmental health while ensuring continued growth and public confidence in Europe's agri-food sector. This work is supported by the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement [No. 813329].

Chair: Prof Enda Cummins
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Presenter 1: Rhea Sanjiv Chhaya
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1: Quantifying human exposure to Aflatoxin M1 through raw milk under climate change scenarios

Abstract:
Climate change may impact the production of mycotoxins in food and feedstuffs. Following the consumption of contaminated feed, mycotoxins may carry over into animal products, including milk from dairy cows. Aflatoxin B_1, produced by *Aspergillus flavus* and *Aspergillus parasiticus*, is a Group 1 carcinogenic mycotoxin linked to liver cancer in humans. Its metabolite, aflatoxin M_1, has been found in milk due to biotransformation occurring in livestock after consuming contaminated feed. A feed to fork probabilistic exposure assessment was developed to assess the risk from aflatoxin-contaminated milk under different climate scenarios.
Data from scientific literature was collected to model each stage, including pre-harvest and post-harvest stages of the cereal crop and subsequent potential transfer of the mycotoxin from farm to consumers via dairy milk. The exposure assessment integrates predictive mycology models to assess the potential exposure to aflatoxin M_1 from raw milk. Changes in temperature and relative humidity are variables used to assess the effect of climate change on aflatoxin M_1 in milk. The exposure model assessed the increase in initial spore count of *Aspergillus flavus* in soil based on temperature and previous cropping history, the effect of fungicide application on mycelium inhibition and the effect of temperature and relative humidity on the growth of *Aspergillus flavus* and subsequent production of aflatoxin B_1 on maize destined for animal feed.
The exposure assessment results are compared with the current scenario to assess the impact climate change may have on potential aflatoxin contamination in raw milk. A sensitivity analysis has been carried out to understand the impact of each variable on human exposure estimates.
The information generated by the model will be useful for policy-makers and risk managers to better assess the potential risk of aflatoxin B_1 contamination in feed and subsequent potential human exposure through milk under various climate change scenarios.

Keywords:
Mycotoxins, Climate Change, Risk Assessment, Dairy Industry

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2: Assessing the impact of climatic factors on the quality and safety of raw milk

Abstract:
The quantity and quality of milk are associated with seasons, animal diet, health, and breed. This work evaluates the impact of several environmental factors on the variability of milk production traits that account for quality and microbiological state.
The case study selected consists of 289 dairy farms in Spain. Raw milk data were analysed for five years (2014-2019). The farms had two different feeding systems, (1) with an unknown component ratio (HAND) and (2) with a known ratio (TMR). Data-driven techniques were utilised to correlate milk variables with climatic factors to assess the impact of the environment on the dairy industry. Principal Component Analysis (PCA), applied to investigate variability and possible correlations among variables, showed potential relationships between fat, protein and dry lean among content, somatic cell and total bacteria counts. Partial Least Squares (PLS) regression models were developed by capturing the main covariance between the two datasets.
The PCA and PLS models characterised the impact of environmental factors on milk quality well. In addition to temperature, the importance of precipitation, radiation, and wind speed was illustrated. Low fat, protein and dry lean values are associated with high precipitation, radiation, and minimum environmental temperature. PLS models performed poorly in explaining the total bacteria counts for the overall data, although they were improved when trained on yearly data sets ($R^2 > 0.84$). These models highlighted the importance of precipitation, radiation, vapour pressure and minimum temperature in the microbial population for most years (VIP scores > 40%). Milk quality was influenced by different variables in the two feeding systems. The HAND system was affected by wind speed and relative humidity, apart from precipitation and radiation.
This work demonstrates the impact of climate on milk production while including the effect of animal diet, highlighting the potential climate change impact on the dairy industry.

Keywords:
Predictive Microbiology, Modelling Tool, Dairy Products, Climate Change

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3: Predicting milk contamination under climate change scenarios

Abstract:
This work aims to predict microbial food safety risks due to climate change for dairy. This is realized by utilizing models describing the effect of climatic factors on the contamination of raw milk, i.e., total bacterial counts, as well as future projections from climate models accounting for different scenarios. The impact modelling methodology is followed. This requires the use of an impact model that, when initialised with future projections trajectories, evaluates the risk due to climate change. In this study, microbial contamination of raw cow milk is considered. The impact model was developed and validated based on a 5-year data set from 121 Maltese dairy farms using data-driven modelling. The projections used to initialise the impact model are generated through a multi-model ensemble of CMIP6 climate models. These are first screened based on grid quality, and then bias-corrected based on observations using the delta method. Finally, the multi-model ensemble is computed using a weighted average and is used to predict microbial contamination under climate change scenarios. The developed model predicts raw milk contamination using temperature, precipitation, wind speed, and humidity as predictors. 11 climate models are selected based on data quality and applicability. The weights of the multi-model ensemble are estimated based on the climate sensitivity of each model. The impact model predicts the raw milk contamination for Malta

under different climate change scenarios with an average 10% relative error. Thus, it allows the assessment of food safety issues that arise under climate change. Milk contamination is predicted to become a food safety issue under all climate change scenarios. The approach presented can be applicable to other case studies, referring to different regions and/or products, given the necessary data. The results from climate change impact assessments such as this one are valuable for policy-making and adaptation planning.
Keywords:
Predictive Microbiology, Modelling Tool, Dairy Products, Climate Change

Presenter 4: Rodney Feliciano
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4: Multi-criteria framework to evaluate safety and environmental impacts: Application to a large dairy farm

Abstract:
The dairy supply chain is susceptible to climate change which may pose additional threats through the increase in microbial hazards and disruptions to daily operations. Pressure may increase on the current dairy farming operations and food safety programs may need to be reviewed to guarantee the microbial safety of raw milk. Greenhouse gas emissions and other relevant environmental impacts should be considered to make sure that the possible solutions do not bring new problems to solve. This research aims to present and evaluate food safety mitigation strategies that can potentially draw together human health safety and environmental impact.
The research identified a selection of food safety mitigation strategies to be applied at the dairy farm level under hot weather conditions. These were evaluated first in terms of food safety using literature data and microbial risk assessment models. Environmental impacts were evaluated using Life Cycle Assessment (LCA) with milk production as Functional Unit. The cost of implementing the mitigation strategies was assessed using literature and dairy farm inputs. Several multi-criteria frameworks (TOPSIS distance-based technique, PROMETHEE outranking technique) were set up to evaluate and rank the mitigation strategies.
Five mitigation strategies were suggested. None of them outperformed the others on the three criteria (food safety, environmental impact and cost of implementation). Nevertheless, multi-criteria frameworks allowed for the ranking of the best compromise solution. Moreover, multi-criteria techniques enabled to take into account the priority of the stakeholders through assigning a weight to each criterion, in a transparent manner.
This study presented different methodologies to evaluate food safety mitigation strategies while minimizing environmental impacts. That was demonstrated with a large dairy farm operating under

hot weather conditions. The approach can be implemented by food safety managers to address the intensification of climate change impacts and aid in the decision-making process in controlling these effects.
Keywords:
Food Safety, Dairy Industry, Climate Change, Risk Assessment, Life Cycle Assessment

Presenter 5: Ourania Misiou
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5: Mathematical models for predicting spoilage of non-refrigerated food products due to thermophilic spore-forming bacteria

Abstract:
Thermophilic and thermotolerant spore-forming bacteria are related to spoilage of a wide range of non-refrigerated food products, including milk and dairy products. Due to the fact that the minimum temperature for growth of thermophilic bacilli is quite high, these products are currently considered as microbiologically stable. However, their stability is based on the current distribution and storage conditions, which is already marginal in temperate regions such as Mediterranean. Hence, a projected temperature increase of 2℃ is expected to allow growth of thermophilic and thermotolerant bacilli to spoilage level and subsequently increase the incidence of non-compliance. Hence, the aim of this study was to assess the temperature increase on the major contaminants of non-refrigerated food products and re-evaluate their microbiological stability. Therefore, models for *Anoxybacillus flavithermus*, *Bacillus coagulans*, *Bacillus licheniformis*, *Bacillus amyloliquefaciens*, *Bacillus sporothermodurans* and *Paenibacillus polymyxa* growth as a function of temperature were developed. In these models, cardinal temperature values, along with the maximum specific growth rates of the above-mentioned bacteria were estimated individually, by studying the temperature range between 15 and 70 ℃. The models were validated in canned or UHT milk, as representatives of non-refrigerated dairy food products and in a plant-based milk alternative, depending on the studied microorganism. The obtained results evidence that regarding thermotolerant bacteria a "zero tolerance approach" should be applied in raw materials, while for non-refrigerated food products, in which thermophilic bacteria are present, distribution should be performed by insulated trucks in order reduce the risk of spoilage. This study is of a great importance since it provides useful predictive tools for the assessment of the effect of climate change on the microbiological stability of non-refrigerated food products, under different temperature scenarios.
Keywords:
Thermophilic Bacteria, Thermotolerant Bacteria, Cardinal Mode, Growth Kinetics, Climate Change, Non-Refrigerated Food Products

Presenter 6: Maria Ioanna Malliaroudaki

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6: Towards resource sustainability: Modelling fouling and cleaning in milk pasteurisation processes

Abstract:
During the thermal treatment of milk, a fouling layer develops on the processing equipment. This fouling layer has an adverse effect on the energy performance of milk pasteurisation processes. Fouling acts as a thermal insulator and thus, heating energy needs to be supplied at an increasing rate during fouling growth to ensure sufficient pasteurisation. Cleaning is required for fouling removal which demands significant amounts of resources including energy, water, and chemicals. Contributing towards net-zero carbon by 2050, the aim of this study is to model fouling and cleaning in milk pasteurisation to minimise energy and integrated resources.
The developed model integrated chemical engineering process design, first principle, and empirical modelling approaches. A simplified geometry that represents a plate heat exchanger was used, and kinetic models for fouling and cleaning were applied. Sensitivity analysis was performed to identify

the model parameters that most affect the model output. The model was then used to identify processing conditions that can minimise the energy and water use of the pasteurisation process.
The fouling and cleaning model was able to predict the dynamic behaviour of key parameters associated with heat transfer. According to model outputs, moving from conventional to more sustainable processing conditions can save up to 70% of the energy use and 65% of the water use related to fouling and cleaning. However, selecting optimal processing conditions may pose a risk of ineffective pasteurisation and/or cleaning due to uncertainty under real processing conditions. To understand how parameter uncertainty propagates to the output of the model, uncertainty analysis was performed and results were visualised through carbon footprint heatmaps.
The uncertainty output allowed the incorporation of a safety margin to the theoretically optimal processing conditions so that sufficient pasteurisation and cleaning is successfully performed for every process. The model has the potential to improve sustainability in milk processing and at the same time prevent any risk related with ineffective pasteurisation or cleaning.
Keywords:
Dairy Industry, Energy Models, Decision-Making, Net-Zero, Carbon Footprint

Presenter 7: Paola Guzmán Luna
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7: Climate change challenges in the transition to an environmentally sustainable European dairy sector by 2050

Abstract:
The EU dairy sector is transitioning towards environmentally sustainable production by 2050. This transition may be challenged by future climate change as biophysical impacts and potential adaptation strategies to cope with them might alter the environmental performance of dairy value chains, modifying the primary and secondary data of the Life Cycle Inventory (LCI). This research aims to support the dairy sector by developing a toolbox to estimate the biophysical impacts of climate change and their effect on the LCI under climate change scenarios.
The Food and Agriculture Biomass Input-Output table (FABIO) is used to identify the main agricultural biomass producing countries that supply the largest EU dairy producers. The Representative Concentration Pathways (RCP) are the climate change scenarios used. A risk assessment approach is followed due to the paucity of projections on the intensity of biophysical impacts on dairy value chains by 2050, in which Geographical Information Systems, literature review, and mathematical modelling are used. A mind-map identifies the LCI data affected by the quantified biophysical impacts. Sub-scenarios on these data are created as they are modified by non-climate factors (i.e. energy transition). Finally, the inventory is ready to be transferred to the impact assessment stage.

Dairy farms in the Mediterranean need to increase their resource consumption to face climate change in the Business-As-Usual scenario. Fertilizer application doubles to compensate the crop yield reduction caused by climate variability. This increased application, along with other factors, has resulted in 30% rise in the carbon footprint of raw milk in this region. However, if regulations are considered, an increase in fertilizers is not conceivable, and hence, it will have repercussions on the land footprint to provide the same amount of crop will be affected.
The proposed tools are needed to support the dairy sector in continuing to improve its environmental sustainability.

Keywords:
Dairy Industry, Life Cycle Assessment, Life Cycle Inventory, Climate Change

Presenter 8: Gopaiah Talari
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Prof. Enda Cummins
University College Dublin, School of Biosystems and Food Engineering, Dublin, Ireland.

8: Microbial risk ranking is “a web-based decision support system” tool

Abstract:
WHO estimates that more than 23 million people fall ill from eating contaminated food in the European region every year, resulting in 4,654 deaths and more than 400,000 DALYs. Reducing these numbers has proven challenging because of the complex European food supply chain system and thousands of firms that provide consumers with hundreds of billions of euros worth of food each year. This system is constantly in flux due to changing consumption patterns, the development of new products, and increasingly globalised food supply chains.
In a food safety system, decisions about food-borne risks from various products must be made to minimise foodborne illness, reduce risks, and maximise benefits while also considering the cost of illness. The microbial risk ranking model, a web-based decision-support tool, was developed to rank the most hazardous pathogen and food combinations to translate an academic understanding of the factors affecting the growth or inactivation of a pathogen in a specific food throughout the farm to fork scenario to estimate the final risk. It incorporates the disease-causing pathogen and properties of food, the influence of temperature change on pathogen growth and concentration at each stage of the supply chain, consumption patterns and the size and vulnerabilities of the populations affected, and economic factors to calculate the disease burden. The tool was intended to make the techniques of food safety risk assessment more accessible to non-experts in this field to assist in understanding the process of microbial food safety risk assessment. The tool helps teach the principles of risk assessment concerning food safety and highlights factors contributing to food safety risk. The tool can be used by risk managers and others without extensive experience in microbial risk assessment or modelling and as a simple and quick means to develop the first estimate of relative risk.

Keywords:

Decision Support System, Risk Ranking Model, Food-borne Illness, Food Safety

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Global Harmonization Initiative - available, sustainable, healthy food for the future through networking sound science

Dr Nicola Stanley[1], Mr John Points[2], Prof. Nadiya Boyko[3], Dr. Eniola Oni[4], Prof. Diána Bánáti[5], Dr. Filiz Hazal[6], Dr. Hilde Wijngaard[7]
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Global Harmonization Initiative - available, sustainable, healthy food for the future through networking sound science

Special Session Description:
The Global Harmonization Initiative (GHI) is a non-profit, impartial organisation consisting of a network of individual scientists from across industry and academia; all working together to harmonise global food safety regulations and legislation based on sound science. GHI was founded in 2004 as a joint activity between the Institute of Food Technologists (IFT) International Division and the European Federation of Food Science and Technology (EFFoST). Our overall mission is to achieve consensus on the science that underlies food regulations and legislation to ensure the global availability of safe and wholesome food products for all consumers. With around 1400 individual members and 20 working groups GHI is working to reduce world hunger and foodborne disease by: minimising the amount of food that is destroyed due to unnecessary trade barriers, limiting the potential for foodborne illness outbreaks which are of increased risk as international food supply chains become more interconnected, and aiding in the development, adoption and application of new technologies to ensure improvement in the safety and quality of the food supply. You may already be aware of some of our activities such as: the GHI whistleblower food safety incident report site, the GHI Halal certifier's page and our GHI webinar series. More information is available at: www.globalharmonization.net. For today's special session, we have put together a series of presentations showcasing examples of the science and technology activities that our members are involved with that are in support of the 36th EFFoST International Conference theme of sustainable, healthy food for the future.

Chairs: Nicola Stanley[1], Hilde Wijngaard[2]
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[2]The Hague University of Applied Sciences, Delft, the Netherlands

Presenter 1: John, Points
Food Safety Consultant, John Points Consulting Ltd., Newbury, United Kingdom
1: The Complexity of Regulations for Human Milk
Abstract:
There is no more natural and sustainable food than a mother's milk to her own baby. Throughout history there have been cultures with a tradition of wet-nurses; women who breastfeed others' babies because the mother is unwilling or unable to do so. In Middle-Ages Europe it was against the social norm for any upper class mother to breastfeed her own baby. Wet-nursing declined in the 20th Century with the advent of infant formula milk and – more latterly – public education in the nutritional benefit of a mother breastfeeding her own baby particularly in its youngest days. The related practice of milk sharing ("co-feeding") continued on a small, informal scale with mothers donating their excess expressed milk to local friends or family. This has continued below the regulatory radar in many countries. But platforms such as Facebook Marketplace have lit the regulatory fuse. Mothers are now selling their expressed milk direct to other mothers online. Ethical and safety regulations are struggling to catch up. This presentation describes a UK business model with the altruistic aim of running a private sector milk bank for the mutual benefit of donors and recipients, giving both the confidence that the process is handled systematically, safely and securely. There were no specific regulatory requirements. Neither food safety management systems nor hospital milkbank regulations were sufficient in our view to underpin safety; an elective bespoke system was therefore developed in-house. The key elements of that system are described. Regulators now face a choice. They can either ban or permit such businesses. If the latter, then there is an urgent need for a sector-specific international regulatory framework based on the principles described.
Keywords:
Breastmilk banks, regulatory gaps, HACCP, online marketplaces, health screening

Presenter 2: Nadiya, Boyko
Uzhhorod National University, Uzhhorod, Ukraine
2: Healthy nutrition based on food-omics data and meeting 3P (predictive, preventive and personalized) medicine expectations
Abstract:
The supply of safe, healthy and sustainable food is a priority and there are many innovative methodologies and tools available to detect the safety and nutritional quality of food at different stages of the supply chain from farm to fork. Given the huge variety of food products, environmental conditions, different regional-geographical specificity, and individual nutrition requirements, the use of prognostic models, IT tools, and unique databases are the only instruments that are appropriate for the complex and appropriate characterisation of food quality. High-performance thin-layer chromatography (HPTLC), mass spectrometry (MS), high-performance liquid chromatography (HPLC), and Raman spectroscopy are widely recognised as gold standards for the analytical estimation of food micro-macro elemental composition. For characterisation of biologically active compounds, newly applied 'omics' technologies are becoming more widely used and rapidly becoming the recommended methods to detect biological properties of foods as characterised by the food-omics techniques - MALDI, RNA/DNA-based assays, ELISA and all the sequencing-based approaches. Indeed, the proteomics assay is fast becoming the most convenient method for assessing protein quality, however, it is also the most expensive. It allows detection not only of food protein quality but also the food functionality as a major determinant affecting our personal health. Using these and other methods, most molecular mechanisms by which the human microbiome influences human health and regulates the immune balance of the host were recently detected and mechanisms of such regulation revealed and clinically proved. The diet-microbiome interplay is currently the basis for personalised nutrition where the microbiota composition is the key factor affecting responsiveness to food consumption. Healthy, nutritional food products are designed to consider the 3P-Medicine expectations; however, in addition to this already high level of complexity other factors also need to be considered such as product attractiveness, recognition, taste and price.
Keywords:
Food-omics, 3P medicine, proteomics, human microbiome, immune balance

Presenter 3: Eniola, Oni
Department of Microbiology, Federal University of Agriculture, Abeokuta, Nigeria
3: Aflatoxin assessment in blood serum of rural households consuming mouldy grains in Ogun State, Nigeria
Abstract:
In Nigeria, 20-30% of maize produced yearly is lost in storage due to mould infestation, aflatoxin contamination, and damaging postharvest practices used by rural farmers. Moulds are common food contaminants of diverse agricultural produce such as grains and nuts. Long term consumption of aflatoxins from mouldy foods by rural households, often because of their poverty level, is an important public health concern as a result of several possible health effects and subsequent deaths. Blood serum samples were taken from residents living in two different rural areas in Ogun-State, Nigeria, where farmers typically use the open-air drying method for their maize. Information on respondents' socio-demographic characteristics was collected from the rural dwellers using an interviewer-led self-completion questionnaire. A 24hour dietary recall was recorded for each member of each household using a self-completion questionnaire. Eighty-six blood samples (43 adults and 43 children) were obtained and analysed for aflatoxin levels using High Performance Liquid Chromatography (HPLC). Dietary recall (24hour) of the two villages studied in this work revealed that 70% and 85% of the sample populations consume maize as their main staple food component. Aflatoxin in the serum samples examined was detected to be higher in the village with the higher consumption of maize (especially for children) with the concentration of 65.10 ng/ml and 44.77 ng/ml in the two villages respectively. Aflatoxins in serum of the population sampled in both villages could be traced to the difference in their maize consumption pattern. Hence, consumption of mouldy maize should be discouraged among rural households and the use of environmentally friendly, locally fabricated solar dryers should be encouraged. During this presentation, the efficacy of the constructed modern solar dryers (in terms of duration of drying and cost) will also be extensively discussed.
Keywords:
Aflatoxin contamination, blood serum, maize, solar dryer, rural households

Presenter 4: Diána, Bánáti
Faculty of Engineering, Institute of Food Engineering; University of Szeged, Szeged, Hungary
4: Edible insects for human consumption
Abstract:
There is a growing need for alternative proteins and edible insects are a potential solution. There are more than 2,000 recorded species of edible insects around the globe. According to the history of entomophagy, the Chinese began eating insects more than 3,000 years ago and edible insects have for a long time been part of the human diet in several countries. Those insect species eaten worldwide are comparable to other animal foods in terms of nutritional value. Insect farming has environmental and economic advantages and is considered as sustainable. However, consumer acceptance can be a barrier in the market introduction of insects as food sources. Europeans have reservations about eating insects as it is not part of their culture and many consider it disgusting or a sign of poverty. There are indications that consumer attitudes in some developed countries are changing, but cultural barriers remain in many others. To increase consumer acceptance, scientists are looking for alternative solutions to improve processing, to isolate proteins and lipids from insects to be used as food ingredients and to increase the shelf-life of insect products. Insects are classified as “novel food” in the European Union (EU), they need to undergo an authorisation procedure, which includes a safety assessment in a case-by-case approach. Based on such a risk assessment the frozen, dried and powdered form of four insects have already been authorised to be placed on the market in the EU. We will examine the pros and cons of the introduction of insects in the human diet and discuss the cultural, environmental, technological, nutritional and safety aspects of insect production and human consumption.

Keywords:
Edible insects, novel food, sustainability, food safety, consumer acceptance

Presenter 5: Filiz, Hazal
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Department of Food Engineering, Engineering Faculty, University of Gaziantep, Gaziantep, Turkey
5: Food Waste Recovery: Microwave Assisted Extraction
Abstract:
One-third of the food produced throughout the world for human consumption is wasted or is simply lost somewhere in the complexities of the supply chain. With increasing world population and human consumption, food waste and loss are becoming a major hindrance to the global security and sustainability of food. Decreasing food waste is critical not only for protecting the environment but also in preserving natural resources. Waste streams from agriculture and food processing operations are generally rich in nutrients that can potentially be converted into valuable bioproducts such as bioactive compounds, biofuels, biochemicals and enzymes. Conventionally these wastes are handled by landfilling, incineration or use in fertilizer production, all of which have their demerits particularly the high costs involved. The researchers and experts in the food industry have therefore been seeking low-cost and green technologies including solvents with considerable dissolving capacity for the valorisation of biomass and biowaste. In this sense, reutilizing and reducing these wastes through the application of advanced methods, such as microwave-assisted solvent extraction, has created much interest. Microwave energy generated through this process provides an effective extraction by rapidly heating the solvent and/or sample to high temperatures. Compared to traditional extraction methods, microwave-assisted solvent extraction is an environmentally friendly technique with a short extraction time, limited solvent usage, lower energy use, and higher extraction efficiency. During this talk, we give an overview of by-products from food waste and their uses in the food industry and discuss studies that have examined the application of microwave-assisted extraction techniques for the valorisation of high-added value compounds from food wastes.
Keywords:
Food waste, microwave assisted extraction, by-products, recovery, valorisation

Presenter 6: Hilde, Wijngaard
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6: Challenges in valorising food waste for small and medium-sized enterprises
Abstract:
Waste streams from agriculture and food manufacturing are generally rich in nutrients that can potentially be converted into valuable food products and ingredients. Small and medium-sized enterprises (SMEs) represent 99% of all businesses in the European Union and many food related SMEs are already active in the valorisation of their waste. As an expert research group working with photonics, we mainly come across SMEs that can be divided into either technology suppliers or food product/ingredient developers. Technology suppliers create technical solutions for specific parts of a food process/product and usually have a specialised background in that field. SMEs that develop food products or ingredients do not necessarily have a strong background in food technology, however they are often very determined to contribute to a better food system. In this session we examine two case studies, taking one SME as an example of a food product/ingredient developer and the other as a technology supplier. For the food ingredient developer, one of the challenges is to have an easy and cost-effective way to analyse compounds of interest, such as fibre or protein. Currently this company spends a significant amount of its budget on having samples analysed externally. Therefore, as an expert photonics research group we have been supporting them in testing hand-held near-infrared (NIR) devices. These are standardised to measurements made with analytical methods, so the hand-held NIR device can be used to test samples in a simple, rapid and cost-efficient way. On the other hand, the technology supplier needs to adapt the technology to the needs of their customers, providing material data that is used to make decisions at multiple steps of various supply chains. Finally, other SME challenges will be discussed with the audience, who may help in finding potential solutions or ways to support SMEs for the future.
Keywords:
SME, business challenge, food waste, hand-held NIR devices, food manufacturing

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Improving Sustainability in Food Processing using Moderate Electric Fields (MEF) for Process Intensification - MEFPROC

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Improving Sustainability in Food processing using Moderate Electric Fields (MEF) for Process Intensification and Smart Processing - MEFPROC

Special Session Description:
This special session aims to present and discuss recent results from MEFPROC, an ERA-NET Susfood2 funded project, on the application of moderate electric fields (MEF) assisted by ultrasound (US) in various food processing operations. MEFPROC was aimed at bridging the gap in scientific and technical knowledge that is currently preventing the uptake of MEF (and US) by the food industry. It also aimed at investigating the impact of MEF (and US) on yield gain and energy consumption compared to existing conventional processing. The results from this project on application of MEF for pasteurization of foods, extraction of valuable materials from foods and enhancing mass transfer will be discussed. In addition, the role of science-based digital tools in optimizing and designing of MEF systems will be discussed. Furthermore, brief highlights on the implementation of MEF technology in valorization of wastes to valuable commodities will be presented.

Prof. Juan A., Cárcel and Prof. Francesco Marra[2]
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Presenter 1: Tesfaye, Bedane
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Co-authors: Lyng, James G.
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1: Evaluation of Moderate Electric Field (MEF) for pasteurization of pork sausages in a conductive casing

Abstract:
Aim:
Electro-heating methods such as moderate electric fields (MEF) reduce heating time significantly and allows elevation of food temperatures to target levels much faster than conventional heating methods. However, the extent to which a product has to be treated to achieve appropriate microbial destruction and heat induced physical and chemical changes depend on the time and target

temperature. The purpose of this study was to investigate the impacts of cook on the physical and chemical changes occurring during MEF pasteurizing of pork sausages.
Method:
Pork sausages of 57 g ± 0.9 g (3.2 cm diameter and 9 cm length) were pasteurized in conventional water bath at 80 °C to a target temperature of 72 °C at the core followed by a holding time of 2 min prior to MEF treatment to determine the minimum and maximum cook values. The maximum cook value achieved (1.84±0.36 min) was then reduced by 80%, 60% and 40% and applied in MEF treatment. For MEF treatment method, a voltage input of 300 V at 1200 Hz was used to pasteurise pork sausages in 183 ml saline solution of 0.5% salt concentration (w/w) in a MEF chamber having 20 cm gap between electrodes.
Results:
The experimental results revealed that in addition to significantly reducing the overall treatment time, MEF resulted also in better quality attributes of treated samples compared to conventional method. Minimum cook value which was 40% of the maximum value was sufficient to deliver appropriate destruction of the targeted microorganism at significantly lower energy. Analysis of instrumental texture and color indicated that there was no significant difference between samples pasteurized at the above value compared to a control one.
Conclusion:
MEF has shown the potential of using electric field for rapid and uniform heating at minimized energy consumption compared to conventional method. The lower the cook value the shorter the cooking time which may result in a lower energy consumption. However, product should be microbiologically safe (above the target F0) at the target temperature. Further study on the sensorial properties and nutritional values are required to demonstrate the application of MEF for other products.
Keywords:
Electro-heating; Pasteurisation; cook value, pork sausage

Presenter 2: Juan A., Cárcel
Affiliation/Organisation, City, Country (maximum 1 affiliation per presenter, align left, 9 point Arial)
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Co-authors: Malikeh Khanlar; José V., García-Pérez, José, Benedito
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2: Moderate Electric Fields (MEF) application during the extraction of oleuropein from olive leaves
Abstract:
Aim:
Green Food Processing concept based on the design and development of more sustainable processes, can contribute with the reduction of energy and the increase in value of wastes and by-products. In this sense, technologies such as Moderate Electric Fields (MEF) can respond to this challenge by the intensification of processes. Thus, in extraction/infusion of interesting compounds, MEF can permit the use of low temperatures or the use of no-organic solvents, enhancing the yield and the product quality. In this study, the feasibility of using MEF to improve the phenolic extraction from olive leaves was approached.
Method:
Extraction kinetics of olive leaves with distilled water were carried out at 50ºC with and without application of MEF (13 V/cm) at different frequencies (300, 600, 900 and 1200 Hz). The olive leave-

solvent mass ratio (OSR) was also studied (1, 5, 10, 15% w/v). The extraction was monitored by taking samples at pre-set times. Samples were filtered and the absorbance at 280 nm measured and compared with an oleuropein calibration curve previously determined. The extraction kinetics were mathematically described by Naik's model.

Results:

The experimental results showed a significant influence of MEF application in the extraction operation, being kinetics faster and yield greater in MEF assisted experiments than in the conventional extraction. Electric frequency resulted as an important parameter to be considered. The fastest extraction and the greatest yield was observed in experiments carried out at 600 Hz. The oleuropein extraction ratio was lower above and below of this frequency value. Moreover, it was observed a maximum yield after 20-30 min of extraction. After that, the oleuropein content remained constant or even slightly decreased being this fact attributed to degradation reactions. The increase of OSR decreased extraction capacity but, in turn, limited the degradation of oleuropein.

Conclusion:

MEF application can intensify the oleuropein extraction from olive leaves. The results indicated the existence of a frequency optimum around 600 Hz which provide the faster extraction of oleuropein. As expected, the increase in the OSR decreased the extraction yield per dried mass of olive leave but prevented the later degradation of the oleuropein.

Keywords:

Extraction kinetics; solid-liquid extraction; modelling; antioxidant

Presenter 3: J.V. García-Perez

Department of Food Technology, (Universidad Politécnica de Valencia, Valencia,) Spain

Co-authors: Abril , R. Bou, V. Sanchez-Jimenez, J.V. García-Pérez and J. Benedito

3: IMPROVEMENT OF FERROCHELATASE ACTIVITY BY USING POWER ULTRASOUND

Aim of work

The red color of some dry-cured meat products elaborated without nitrates and nitrites, such as Parma ham, is due to the formation of the zinc protoporphyrin (ZnPP), a stable purple-red pigment. In this context, pork liver presents a high activity of the enzyme ferrochelatase (FeCH) that catalyzes the ZnPP formation, which is considered a low-rate enzyme reaction. The aim of US application is improving the interaction between the enzyme and the substrates of the enzymatic reaction and the subsequent diffusion of the product. The objective of this work was to improve the process of ZnPP formation by applying power ultrasound (US) in pork liver homogenate at mild intensity.

Methodology

Kinetics of ZnPP formation were performed for 6, 12, 18, 24 and 48 h under anaerobic conditions at 37ºC and subsequently the amount of ZnPP formed was measured by fluorescence (420 nm excitation and 590 nm emission). US application was carried out by means of an ultrasonic bath, using water as a transmitting element and the temperature was controlled by recirculating the water through a heat exchanger. US was intermittently applied (30 min ON and 30 min OFF) at i) moderate (36.53 W/L) and ii) low power (7.05 W/L).

Results/Discussion

The results showed that the US application represents an effective method for intensifying the ZnPP formation. When low power US was applied, the maximum of ZnPP formed was 0.405 mmol ZnPP/L at 12 h, while in the control experiments (without US) the maximum was 0.322 mmol ZnPP/L at 24 h. Thereby, the US application greatly improves the formation of ZnPP in pork liver, increasing slightly the yield and drastically the enzyme activity (shortening the formation time by 50 %).

Conclusion

The US application could be considered an interesting alternative to enhance the FeCH activity, promoting ZnPP formation in pork liver. Therefore, the ultrasound-assisted ZnPP formation could be considered a feasible alternative for obtaining a high-added value colorant to be further used in several applications in the food industry.

Presenter 4: Oluwaloba, Oluwole-ojo
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Co-authors: Zhang, Hongwei; Howarth, Martin; Xu Xu
Sheffield Hallam University, National Center of Excellence for Food Engineering, Sheffield, UK

4: Model validation, design, implementation and real-time process control of a continuous flow ohmic heater

Abstract:
Aim:
The aim of this project is to model the Moderate Electric Field (MEF) process, validate the model, build a continuous flow ohmic heater pilot plant and apply real-time advanced process control.
Introduction:
The most common conventional heating methods for food processing require heat energy to be generated externally and then transferred to food samples by either convection or conduction. These conventional methods require excessive heat processing that leads to the degradation of the outer portion of food substance and nutritional contents. Using conventional methods, the efficiency of heat transfer to the food substance is limited by the rate of heat transfer from an external medium to the food and by the thermal conductivity of the food. This can result in over processed products and poor product quality due to the lengthy processing time required to reach the target temperature and unwanted temperature peaks. Research has shown that Ohmic Heating (OH) is a more energy efficient form of heating compared to conventional methods. OH is a Moderate Electric Field (MEF) processing technique in which the applied electric field is ≤ 1kV/cm, considerably lower than the field strength used in the high voltage Pulsed Electric Fields (PEF) technology.
Results:
The heat generated within the food substance is rapid and volumetric within the food and dissipated directly in the medium with very high efficiency (>90%) by Joule effect, thus eliminating the heat-transfer step from the surroundings to the medium by means of temperature gradients or hot surfaces. The quantitative results demonstrate significant improvements in modelling the OH process with regard to food of varying conductivities, flow rates and initial temperature. In addition, the application of advanced model-based process control including Model Predictive Control (MPC) on the continuous flow ohmic heater pilot plant gives a template that can be replicated in industry for efficient energy consumption.
Conclusion:
Overall, this research demonstrates the advantages of model-based design and validation in the food industry, the advantages of OH compared to conventional methods and the advantages of advanced process control in food engineering.

Keywords:
Moderate electric fields; Ohmic heating; Continuous flow; Mode-based process control

Presenter 5: Francesco, Marra
University of Salerno, Fisciano, Italy
Co-authors: Aldo Romano; Matteo d’Amore
University of Salerno, Fisciano, Italy

5: Assessment of MEF processing potentiality in vegetable based dressing sauce

Abstract:
Aim:
The consists in the application of an electric potential gradient ranging from 1 to 1000 V/cm (at frequency in the range of Hz to kHz) on a food item placed between two electrodes, with a consequent dissipation of large part of electrical energy into heat within the food item. In terms of energy efficiency, Moderate Electric Field (MEF) processing has been recognized to be a potential sustainable heating method for the food industry (MEFPROC, SUSFOOD2). In this scenario, this work was aimed to assess MEF processing as a sustainable method in industrial production of “pesto” a basil-based dressing, a class of products which are often over-processed. Particularly, assessment was done on MEF employed for two different operations: fresh leaves blanching, and pesto heating.
Method:
A custom MEF system, fed by a power generator delivering up to 3000 W (from 40 Hz to 1200 Hz), was used. For assessing MEF performances in blanching, fresh leaves were picked up from a plant of basil (Ocimum basilicum) acquired at local market. Blanching solutions were water/sodium chloride, at three different sodium chloride composition (0.5%, 1% and 2%, in mass). Control blanching was done using a heater with an on/off controller. MEF blanching tests, at frequency of 50Hz and 1000Hz. For assessing of pesto heating, samples at different salinities and ratio water/oil were considered. Set point temperatures were 80°C, 90°C, and 100°C.
Results:
For basil blanching, MEF processing did not improved the process energy efficiency, given most of the energy losses due to water evaporation. In any case, MEF processing showed to be competitive in terms of process start-up, on/off heating. For pesto heating, the salt content as well as the ratio between water and oil in the sample formulation played a crucial role in determining the thermo-electrical behavior of the basil-based sauce samples, at same time these parameter affect the sensory of the final product. An optimal set (salinity 1.63%) was found, at which the MEF processing results particularly efficient
Conclusion:
MEF processing has been showed being applicable along the unit operations chain in pesto production, with a clear contribution in terms of energy efficiency, especially in pesto heating.
Keywords:
Moderate electric fields; Basil-based dressing; Electrical conductivity

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The INGREEN journey from agrifood sidestream to sustainable biobased products

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The INGREEN journey from agrifood sidestream to sustainable biobased products

Special Session Description:
Find out how tailor-made sustainable biotechnologies transformed waste and low-value agrifood side streams into higher-value functional and bioactive ingredients for use in food products using a circular bioeconomy approach.
The INGREEN project, funded by the EU, developed functional innovative ingredients from paper and agro-food side streams through biotechnological processes for food, feed, pharmaceuticals, nutraceuticals, cosmetics and biodegradable packaging. During this 3,5-year project new chemicals, new materials, and new consumer products were developed from whey, wheat and rye brans, and paper milling wastewater.
In real operational environments, sustainable and efficient tailor-made biotechnologies and eco-friendly approaches to produce safe and/or health-promoting microbial biomasses and biochemicals have been demonstrated, as well as functional ingredients of interest for several industrial sectors.

Chair: Narinder Bains
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Presenter 1: Davide Gottardi
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Co-authors: Lorenzo Siroli[1], Giacomo Braschi[1], Elena Felici[2], Flavia Pisanu[2], Federica Mambelli[2], Pietro Rocculi[1], Marco Dalla Rosa[1], Narinder Bains[3], Lucia Vannini[1], Francesca Patrignani[1], Rosalba Lanciotti[1]
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1: Innovative and sustainable cheeses obtained applying *Yarrowia lipolytica* previously produced using whey as substrate

Abstract:
Cheese is a widely consumed dairy product with a global market value that is forecasted to double by 2027. Novel organic, flavorful and diversified products are constantly under research. However, as other food processes, cheesemaking generates waste. From each kg of cheese, 9 kg of whey are obtained, with several issues for the dairy industries regarding whey disposal and treatment. However, whey could be applied as substrate to grow food adjuncts to be reused in cheesemaking and obtain innovative and sustainable cheeses. *Yarrowia lipolyitca* is a common yeast, found in

several traditional cheeses, that can release lipases and proteases. These enzymes are fundamental during cheese ripening and for the final characterization of the product. In the European Union funded project INGREEN, 24 strains of *Y. lipolytica*, belonging to the collection of the University of Bologna, were assessed for their growth capability in cheese whey, but also for their proteolytic and lipolytic ability, as well as volatile molecules production. The most promising strain was selected for further scaling up process in an industrial environment, where the protocols for its productions were set up. Whey enriched in *Y. lipolytica* biomass was used as food adjunct to produce innovative cheeses at industrial scale (500 L milk) that showed a faster ripening time (a few days before the benchmark), a very specific aroma profile mainly due to the release of short chain fatty acids. In a panel test performed with trained panelists, innovative cheese was well accepted and received higher scores for what concerns taste and sapidity. The results achieved with this project allowed to set up a more sustainable process that promote circular economy.

Keywords:
Yarrowia lipolytica, innovative cheese, cheese whey, sustainability, circular economy

Presenter 2: Lorenzo Siroli
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Co-authors: Gottardi Davide[1], Braschi Giacomo[1], Rossi Samantha[1], Dalla Rosa Marco[1], Vitali Beatrice[1], Giordani Barbara[1], Morbarigazzi Nadia[2], Baraldi Simona[3], Bains Narinder[4], Vannini Lucia[1], Patrignani Francesca[1], Lanciotti Rosalba[1]
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2: Bio-based innovative bread obtained with pre-fermented ingredients from milling by-products

Abstract:
Due to their well-recognized health properties, the use of milling by-products in food formulations has increased over the past years. However, their use as food ingredient is still limited and their technological and functional potential has not being fully exploited. The fermentation performed by selected microbial strains and consortia is the most promising way to reduce the phytate content of cereals and bran increasing their nutritional values and increase the bioavailability of minerals and micro-nutrients as well as the bio-active compound and vitamin concentrations. In this context, INGREEN has developed pilot scale biotechnological processes for the production of bioactive pre-ferments, based on characterized wild strains of yeasts and lactic acid bacteria isolated from milling by-products, to be used in the formulation of innovative bakery products. The preferment MIX7C8 showed promising nutritional and functional profile. The production of this preferment was upscaled and the fermentation process optimized. In several trials the selected preferments was used for the formulation of innovative bread prototypes. Applying 20% of preferment in the dough did not adversely affect the final bread volume and resulted in a positive crust color a fine and regular cells distribution of the crumb. The rheological characteristics and shelf-life were not negatively affected by the addition of preferments, instead a couple of days increase of shelf-life compared to the benchmark was observed. The innovative prototypes produced were characterized by an increase of acidity and a greater amount of aromatic molecules mainly acids, alcohols and aldehydes. A positive effect on the functionality of the innovative prototypes, compared to the benchmark, was observed as a result of an increase in short chain fatty acids, antioxidant activity, total phenols and

ammino acids. In conclusion, the INGREEN project, through biotechnological processes, allowed the development of a functional preferment and its implementation in the formulation of innovative bakery products.
Keywords:
INGREEN; Preferments; Innovative bread; Functionality

Presenter 3: Aleksandra Augustyniak
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3: Impact of dairy by-product, cheese whey, on skin health

Abstract:
Milk and dairy products are widely consumed all over the world and their consumption will continue to increase in the near future. Cheese is the second most frequently consumed milk product, right after fresh dairy commodities. Each year, over 22 megatons of various types of cheese are produced worldwide. Such a large scale of production is also associated with a large amount of generated by-products - whey. As the goal by 2030 is to reduce the amount of waste through prevention, reduction, recycling and reuse, it is necessary to re-examine waste generated from various branches of industry, including dairy processing. The composition of whey, presence of valuable nutrients that are easily digestible for humans means that whey can be viewed as a value-added material and not only as a difficult to utilize waste. The INGREEN project evaluated the effect of whey derived from production of three Italian cheeses, caciotta, squacquerone and ricotta, on dermal and epidermal cells (fibroblasts and keratinocytes).
In order to investigate the cosmetic potential of whey, skin cell proliferation, inhibition of elastase and tyrosinase, antioxidant properties, production of collagen, elastin and glycosaminoglycans and effect on the epidermal barrier were analyzed. Tested whey inhibited activity of elastase and tyrosinase enzymes. By-products of cheese production did not show cytotoxicity against tested fibroblasts and keratinocytes. Moreover, the antioxidant activity of the samples was observed. Whey-treated dermal cells produced a significant amount of extracellular matrix molecules, collagen and glycosaminoglycans when compared to the nontreated cells. In addition, the ability of tested dairy by-products to improve the cell barrier integrity of epidermal cells was proven. The obtained results indicate that tested pure whey support skin health and show potential to be used by cosmetic industry.
Keywords:
Cheese whey, sustainability, skin health, anti-aging

Presenter 4: Edward Sliwinski
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Innoven, Verona, Italy, [7] MTU, Tralee, Ireland, [8] Universidade NOVA de Lisboa, Caparica, Portugal, [9] Avecom, Wondelgem, Belgium

4: Regulatory Aspects of Novel Bio-Based Ingredients for Use in Food, Feed, Pharma, Cosmetics and Packaging

Abstract:
Introduction: CBE JU is a €2 billion partnership between the European Union and the Bio-based Industries Consortium (BIC) that funds projects advancing competitive circular bio-based industries under Horizon Europe, the EU's research and innovation programme.
Purpose: This paper aims to identify standards, policy and regulations which pose a hurdle for market introduction of INGREEN bio-based materials and products, and to develop proposals for modification of these standards, policy and regulations.
Approach: The INGREEN project has developed functional innovative ingredients from by-products from cereal milling, cheesemaking and paper production for applications in food, feed, pharma, cosmetics, and packaging. The regulatory environment for these materials was inventoried and evaluated.
Results: As the starting materials came from different origin and were modified using different technologies and the applications covered a wide range, a quite complex picture of the regulatory landscape became visible. The more as there is a lot of attention from policymakers to make the bio-based economy more circular. Additionally, we observed that in many cases EU countries are reacting at different speeds when implementing specific policies. An example of this is the new legislation put in place to reduce single use plastic packaging.
Significance: In this paper we discuss the prospects of bio-based food ingredients in relation to the current regulatory environment and will do some proposals for improvement.
Keywords:
Sustainability, Bio-based, Regulations, food ingredients, packaging

Presenter 5: Dirk Hengevoss
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Co-authors: Victor Misev
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5: Life cycle perspectives of bio-based products using biomass residues as feedstock

Abstract:
The transition from a linear to a circular economy of the biological cycle means to extract more biochemical feedstocks from renewable biomass residues. To quantify eco-effectivity and -efficiency of the proposed processes and extracts life-cycle assessments are the established approach. Effects of the new valorisation routes on current use of the biomass residues and volume flows, e.g. in-house biogas production, have to be considered carefully. From the INGREEN project two cases will be discussed in this presentation. Case 1 - Large volume valorisation from the organic substances in paper mill wastewater by bio-technological processes. The produced polyhydroxyalkanoate (PHA) used as nutritious, prebiotic feed ingredient seems feasible and from a circularity perspective favourable. However, the substitution of the biogas production at the paper mill will be crucial for the eco-effectivity of this new valorisation route solution. Case 2 – Small volume valorisation from

whey to produce lactiobionic acid (LBA) of 95% purity, potentially used as enrichment in intimate cleanser, has been proven to be eco-effective compared with established LBA production.
For certain processes data was not available and presented results are based on pilot process data, therefore further economies of scale can be expected for industrial scale production with process optimisations. The LCA results revealed environmentally relevant processes of the new valorisation routes, e.g. significant energy consumption, that can be used for further optimisation and reduction of the environmental footprints.

Keywords:
Circular economy, transition/transformation, bio-based industry, life-cycle assessments

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Aquaculture and Fisheries sidestream proteins and bioactives as ingredients for nutritional supplements: the AQUABIOPRO-FIT project

Dr. Katerina Kousoulaki[1], Dr. Silje Steinsholm[1], Dr. Tone-Kari Østbye[2], Dr. Min Wang[3], Prof. Christos Tsatsanis[4], Dr. Zoi Georgiou[5], Mr. Léo Staccioli[6], Ms. Beatriz Cassuriaga[6]
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Aquaculture and Fisheries sidestream proteins and bioactives as ingredients for nutritional supplements: the AQUABIOPRO-FIT project

Special Session Description:
AQUABIOPRO-FIT is a Biobased Industries Joint undertake (BBI JU) Horizon 2020 project aiming to explore opportunities in lifting the value of marine biomass, currently either wasted or used in animal feeds, by transforming aquaculture and fisheries side stream materials into ingredients for human consumption. Refined fish oil and different protein concentrates with unique chemical and sensory properties, have been developed using heads, backbones, skins and trimmings from farmed salmon, cod, and pelagic fish species, such as mackerel and blue whiting, and tested for safety and bioactivity in model systems. Running now the last two months of the project's lifetime, the products we created are being tested in 5 separate clinical studies, the results of which will also be presented in this special session. Finally, we will show how these new, circular economy-based solutions can influence the environmental, economic, and social footprint of the food sectors they concern. The background and new knowledge created in the project have been compiled in net-based courses to support the green shift of aquaculture and fisheries sectors, through life-long learning educational programmes.
Chair: Tone Aspevik
Nofima, Bergen, Norway

Presenter 1: Silje Steinsholm
Nofima, Bergen, Norway
Co-authors: Tone Aspevik[1], Mats Carlehög[2], Birthe Vang[3], and Katerina Kousoulaki[1]
[1]Nofima, Bergen, Norway; [2]Nofima, Ås, Norway; [3]Nofima, Tromsø, Norway.

1: Challenges related to the production of nutritional supplements from fish side streams
Abstract:
In this talk we will present the chemical composition of the developed nutritional supplements for the clinical studies of the AQUABIOPRO-FIT project, the production technologies used. The challenges encountered in raw material choice, processing and up-scaling will also be discussed.
Unpalatable tastes and flavours are generally considered the main limitation for utilizing fish-based protein hydrolysates as food ingredients. Some of the products produced in the AQUABIOPRO-FIT project had high sensory intensity, potentially restricting participants from completing the clinical trials, thus the supplements were provided as tablets. When supplement administration as tablets

would be impractical, additives were tested to mask the unpalatable sensory attributes. Several flavour-additives were tested, and the sensory properties of the final supplement were determined through descriptive sensory profiling.
In addition to the product's sensory properties, there are several production related challenges that must also be considered in the production of fish-based protein hydrolysates. During downstream process, and before evaporation and drying of the products, the protein-rich liquids are highly susceptible to microbial contamination. Important microbial parameters, including CFU have been addressed; however, proper guidelines and limits for such products are difficult to find. Further, challenges related to powder-properties, as bulk density, and hygroscopic properties present limitations for the applicability of the protein powders and require further development of appropriate technologies.
Keywords: Protein hydrolysate, downstream processing, production challenges, sensory properties

Presenter 2: Tone-Kari K Østbye
Nofima AS, Ås, Norway
Co-authors: Tone Aspevik[1], Silje Steinsholm[1], Birthe Vang[2], Vibeke Voldvik[3], Katerina Kousoulaki[1]
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2: Fish side stream materials stimulate growth of *in vitro* cultured Atlantic salmon muscle cells

Abstract:
Protein hydrolysates and the water-soluble fraction (stickwater) from fish raw materials has been shown to have a positive effect on muscle growth when included in the diets for Atlantic salmon (Kousoulaki 2009, 2012). The aim of the present study was to investigate if there is a species or body fraction specific effect of fish raw material on muscle growth, and reveal the mechanisms involved. Hydrolysate and stickwaters were produced from backbone, head, fillet, and viscera of salmon, herring, mackerel, and cod using different processing enzymes. An Atlantic salmon *in vitro* muscle cell model was used in the study, and the cells were cultured in growth medium enriched with hydrolysates and stickwaters. The cells were analyzed at two time-points, in a proliferative and differentiating state. The metabolism, proliferation of cells, and gene expression of muscle specific markers were analyzed. Results from the study will be presented.
Keywords:
Side streams; fish; muscle growth; gene expression

Presenter 3: Min Wang
University of Valencia, Valencia, Spain.
Co-authors: Jianjun Zhou[1], María Carmen Collado[2] and Francisco J. Barba[1]
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3: Evaluation of biological properties of extracts obtained from fish side streams assisted by pulsed electric fields (PEF) and accelerated solvent extraction (ASE)

Abstract:
As an important part of biodiversity, marine resources are an important source of a variety of high-value compounds, including proteins, lipids, bioactive peptides, etc. In food processing, fish side stream is often discarded, however they are also rich in large amounts of high-added value compounds (HAVCs). Recovering HAVCs from side streams using suitable technologies is an effective

way to reduce resource waste. This study uses two innovative techniques (pulse electric fields and accelerated solvent extraction) to recover HAVCs from sole side streams (including head, skin and viscera) and evaluate bioactivities.
The results show that both PEF and ASE can significantly improve the extraction rate and antioxidant capacity of proteins in the sole side streams and change the molecular weight distribution of proteins. At the same time, the sole viscera extract obtained with the assistance of pulsed electric fields (PEF) also showed an inhibitory effect on Staphylococcus aureus, and the head and fish skin extracts also showed a promotion effect on the growth of probiotics and anti-inflammatory activity. Using PEF and ASE to assist in the recovery of HAVCs from fish side streams can not only improve the extraction efficiency, but also protecting the bioactivity of the HAVCs from being destroyed.
Keywords:
Pulsed Electric Fields (PEF); accelerated solvent extraction (ASE); high-added value compounds (HAVCs); side streams; antioxidant capacity; sole

Presenter 4: Christos Tsatsanis
School of Medicine, University of Crete, Heraklion, Greece
Co-authors: Maria Daskalaki[1], Ioanna Lapi, Ourania Kolliniati[1], Elina Paflioti[1], Sevi Xenikaki[1], Eirini Dermitzaki[1], Maria Venihaki[1], Katerina Vaporidi[1], Tone Aspevik[2], Katerina Kousoulaki[2], Zouhir el Marsni[3]
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4: Fish-side stream-derived protein hydrolysates exert anti-inflammatory actions in mouse models of human diseases
Abstract:
The health benefits of diet supplementation with fish have been widely acknowledged. Most of human pathologies are associated with chronic low grade or acute inflammation, and prevention or treatment often includes suppression of inflammation. Such conditions are obesity and insulin resistance, central traits of the metabolic syndrome, which contribute to serious pathologies, such as type 2 diabetes, hypertension, and cardiovascular disease. Similarly, skin homeostasis is maintained by tightly regulating inflammatory responses in the skin. It has been recently highlighted that the gut microbiome contributes to the development of inflammatory diseases and its modulation can suppress related pathologies. Aim of the work was to determine the impact of dietary supplementation with fish side stream-derived protein hydrolysates on obesity, metabolic inflammation, skin homeostasis and intestinal inflammation.
Fish-derived extracts and protein hydrolysates were used as nutritional supplements in mouse models of high-fat diet induced obesity and type 2 diabetes, inflammatory bowel disease and skin repair. Disease progression and inflammatory markers were determined. The impact of dietary supplementation in the gut microbiome was also determined.
Mice consuming nutritional supplements containing fish-derived extracts exhibited reduced insulin resistance and weight gain, partly improved skin homeostasis while did not affect intestinal inflammation. Ingredients of the nutritional supplements were potent in modulating the gut microbiome.
Fish-derived protein hydrolysates possess health promoting properties which may be partly due to suppression of inflammation and modulation of the gut microbiome.
Keywords:

Side streams; fish; obesity; skin; inflammation

Presenter 5: Zoi Georgiou
Biognosis, Volos, Greece
Co-authors: George Loukas[1], Maria Vatopoulou[1]
[1]Biognosis, Volos, Greece

5: Effectiveness of AQUABIOPRO-FIT innovative nutritional supplement against depression, anxiety, and stress on healthy adult volunteers

Abstract:
The AQUABIOPRO-FIT project promotes the efficient utilisation of European aquaculture, fisheries and agriculture side streams also by creating nutritional supplements for applications in human health. To measure the anti-stress/ antianxiety/anti-depression effectiveness of the developed, nutritional supplement, we conducted a double-blind placebo controlled clinical study on volunteers.
The study population involve 65 adults of both sexes, with a low or average level of stress/anxiety/depression and without any other serious illness. The efficiency of the supplement under study is compared with a placebo. The active formulation A given per day included 3 pills containing amino acids vitamins and minerals, and one capsule with fatty acids and vitamins. The placebo formulation B included 3 pills of maltodextrin also given 3 times/day and a corn oil capsule. For 3 months half of the participants received the A, and the other half the B formulations. This was followed by a washout pause of one month and then the participants received for the next three months the preparation they did not receive during the 1st trimester. The state of mental health evaluated at the beginning of the study, at the end of the 1st trimester, at the end of the pause interval and at the end of the 2nd trimester. The evaluation was done using a questionnaire for the assessment of levels of depression, anxiety and stress, the depression anxiety stress scales 21 (DASS-21), which has been used and validated for the Greek population.
For the first cycle of the study an amelioration was detected to 64% of patients receiving the active formulation A regarding all three parameters (depression anxiety stress), while for patients receiving the placebo the amelioration was up to 32%. The results of all 3 cycles we will present at the AQUABIOPRO-FIT special session at the 36th EFFoST International Conference.
Keywords:
Nutritional supplements; double-blind placebo-controlled clinical study; questionnaires for evaluation of Depression; Anxiety Stress; DAS 21 scale use; WHO wellbeing questionnaire

Presenters 6: Léo Staccioli and Beatriz Cassuriaga Dias
ARDITEC ASSOCIATION, Nice, France
6: Environmental and socio-economic considerations within the AQUABIOPRO-FIT project
Abstract:
The AQUABIOPRO-FIT project aims at promoting the efficient the utilization of European aquaculture, fisheries, and agriculture side streams in feed and nutritional supplement food products, fostering fitness and health in humans. This session will present the environmental and socio-economic impacts through the whole life cycle of the different processing technologies identified in the AQUABIOPRO-FIT project. The first part of the presentation will include and depict the methodology of each standardized tool used to assess the three pillars of sustainability,

considering the environmental, economic, and social aspects of the project (namely Life Cycle Assessment (LCA), Life Cycle Costing (LCC), Social Life Cycle Assessment (S-LCA). The second part will focus on the results of each sustainable assessment, bringing answers to the following challenges identified at the beginning of the project:

1) Environmental repercussions of the different processing technologies using LCA. Assessment of the environmental impacts and benefits compared to current solutions/loops of the innovative process developed. Different impact categories have been assessed and will be presented and commented, including climate change, fossil resources depletion, water eutrophication or water depletion (among others).

    - Economic feasibility of the concept using LCC to determine the CAPEX and OPEX and hotspots for optimization. Through the Net Present Value (NPV), we will project next ten-year expenses and future revenues to assess the economic feasibility of these innovations.
    - Social: Interaction with the society, social organization, employment benefits and public perception of the innovative process, using S-LCA. AQUABIOPROFIT has actively engaged the community of prescribers and users (clinical trials including doctors, trainers, athletes and patients).

The assessments have confirmed encouraging results concerning the three above-mentioned pillars. Better sustainability results could be achieved with further research and process upscaling.

Keywords: Sustainability, impacts, environmental, economic, social, assessments, valorization, biomass, fisheries, benefits.

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How to make food nutrition security data FAIRer: an introduction to FNS-Cloud

Mr. Paul Finglas, Mr. Igor Pravst, Ms. Eileen Gibney, Ms. Maria Traka, Mr. Enrique Carillo de Santa Pau

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Title: Symposium: How to make food nutrition security data FAIRer: an introduction to FNS-Cloud

Special Session Description:

Existing food nutrition security data, knowledge, and tools for health and agri-food sciences although widespread are fragmented, lack critical mass, and access is 'unevenly' distributed for users. This means data are not readily found, accessible, interoperable or reusable (FAIR), and existing services focus on clinical, molecular or biological sciences. Food Nutrition Security Cloud (FNS-Cloud) will bring about change through standards, demon-strators, services and FAIRer food nutrition security data. FNS-Cloud objectives are to:

1) Implement and test FNS-Cloud, as related to technical aspects of access and re-use of datasets and/ or tools,
    - Create, integrate, and test FNS-Cloud Services related to interoperability and standardisation as well as providing training and support for users,
    - Integrate existing and emerging FNS datasets, sources, and formats,
    - Develop a governance model and business operations to support sustainability and add value for prior public investment.

This session will give an update on progress in the Horizon 2020 project (FNS-Cloud). The FNS-Cloud consortium comprising 35 partners form 14 countries started 1 October 2019 and will end by 30 September 2023.

The session will consist of 6 different presentations by highly esteemed scientists:

1. Introduction to FNS-Cloud by Paul Finglas, PhD,
2. The FNS-Cloud Food Labelling Demonstrator: Branded food composition databases - how and why to collect data? by Igor Pravst, PhD,
3. Making Food data FAIR – The FNS-Cloud Nutrition & Lifestyle Demonstrator by Eileen Gibney, PhD,
4. Making Diet & Microbiome data FAIR – The FNS-Cloud Diet & Microbiome Demonstrator by Maria H. Traka, PhD,
5. FOODRUGS, integrating public data repositories to explore food-drug interactions by Enrique Carillo de Santa Pau, PhD.

Chair: Paul Finglas, PhD,

Affiliation: Quadram Institute Bioscience,Norwich, UK

Presenter 1: Paul Finglas, PhD,

Affiliation: Quadram Institute Bioscience,Norwich, UK

1: Title: Food Nutrition Security Cloud (FNS-Cloud)

Abstract:
Open Science is based on transparent and collaborative working, producing and sharing data, knowledge, tools, and services (resources) as early as possible in the research process.
Existing food nutrition security resources across Europe are fragmented, lack critical mass, and access is unevenly distributed with the majority unfindable or inaccessible because of cost.
Food Nutrition Security Cloud (FNS-Cloud, Grant Agreement No. 863059) is developing the first-generation 'food cloud' by federating existing and emerging resources and developing and integrating services to support re-use through the European Open Science Cloud (EOSC).
This talk will introduce FNS-Cloud and explore how FNS-Cloud is bringing independent activities together under three demonstrators, specifically Agri-food data and tools (DEM01), Nutrition & Lifestyle (DEM02), and Non-communicable diseases and microbiome (DEM03).
DEM01 will consider traceability, metrology, labelling and reformulation, and benefit:risk, whilst DEM02 is addressing how we measure intake, consumer behaviours (purchase, preparation, and consumption), and effects of composition, both nutrients and bioactive compounds. DEM03 is exploring the role of healthy diets in relation to blood pressure and diabetes risk and impacts of the microbiome as well as ensuring diet-drug interactions are minimised, particularly as use of supplements increases.
In September 2023, FNS-Cloud will launch these demonstrators and advance ICT tools and services, facilitating better FNS research and exploitation of knowledge as well as delivering training and support to boost confidence and build capacity amongst user communities.

Keywords:
Food Nutrition Research, Open science, Food Cloud, EOSC

Presenter 2: Igor Pravst, PhD,
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2: Title: The FNS-Cloud Food Labelling Demonstrator: Branded food composition databases - how and why to collect data?

Abstract:
Food labelling is regulated to protect and support consumers' informed food choices, but food labels also provide useful data for other uses, including businesses, policy makers and researchers. With food manufacturers being under increasing pressure to reformulate foods and improve their nutritional composition, and high market competition, food supply is changing very fast. Experiences from some countries show, that every three years about half of prepacked food products is discontinued, bringing space for new ones. This complicates construction of branded food databases. Different approaches and good practices of the compilation of branded foods datasets will be presented, together with examples of use of such data to support nutrition research and monitor food supply. Manufacturers are key sources of information for the compilation of branded foods databases, either through food labels or providing data directly. The latter approach is implemented in the LEDA database (Netherlands) by agreements with major retailers and GS1, which automatically provide new/changed data on daily basis. Alternative approach is conduction of regular cross-sectional studies in the food supply, usually with consideration of food labelling data for available pre-packed foods. Sophisticated infrastructures are available for this purpose, such as the Composition and Labelling Information System (CLAS, Slovenia) and Food tracker (FLIP, Canada), both composed of a smartphone application for data collection and online data extraction. Additional approaches for data collection are web scrapping (mostly using on-line food stores) and crowdsourcing through mobile applications, intendent for consumers. Branded food datasets can be used to support researchers, developers of IT services, food businesses, policy makers. Examples of demonstration cases will be presented.

Keywords:
Food labelling, informed food choices, data collection, branded food databases,

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3: Title: Making Food data FAIR – The FNS-Cloud Nutrition & Lifestyle Demonstrator

Abstract:
The link between nutrition and health is well established, and forms the basis for existing dietary recommendations and food based guidelines. Strong evidence, for example, exists linking calcium intake to bone health, and saturated fat to cardiovascular disease risk. However such recommendations need to be constantly reconsidered to ensure recommendations are based on the most recent and appropriate evidence. Unique challenges exist for the exploitation of nutrition and lifestyle data. Available dietary intake data can vary greatly in terms of the methods of data collection, the type of data collected, as well as the timeframe of collection. Furthermore, associated lifestyle data are equally diverse (e.g., food purchasing, parameters of lifestyle, activity, etc.). Technology is increasingly being used to collect data in alternate formats including voice recordings and digital images for example, creating further complexity. Despite these challenges, collection and exploitation of nutrition and lifestyle data is paramount for effective evidence-based policies and commercial opportunities across food and health sectors, supporting consumer choice and healthy eating. Researchers within the areas of food, nutrition and health need to be able to find and access relevant data. However, in order to maximise such use of existing datasets it is important that there are tools and services which can facilitate the mapping and harmonisation of data coming from different sources to enable harmonised or combined analysis. The FNS-Cloud project is developing solutions to support the FAIRification and continued use of existing nutrition and lifestyle data.

Specifically, these include dietary intake assessment tools the FNS Cloud catalogues, dataset quality assessment framework and data mapping tools. Providing these tools and services alongside existing nutrition and lifestyle data, FNS Cloud will support continued re-use and appropriate interrogation of such data.

Keywords:
Food data, FAIR principles, nutrition and health, nutrition and lifestyle data

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4: Title: Making Diet & Microbiome data FAIR – The FNS-Cloud Diet & Microbiome Demonstrator

Abstract:
The relationship between diet and gut microbiome is complex. Understanding their interaction requires carefully designed human intervention trials to address this. Such trials are complex in design, take a lot of effort to develop and establish, and even more effort to run. However, they gather real-life data from human participants that often challenge the observations from cellular and animal models and are therefore providing unique insights into the physiological response to foods and the interplay with our microbiota. In addition, a wealth of data and metadata are being captured in the process of undertaking each trial that could be used for understanding diet & health relationships above and beyond the primary aim of each reported study through secondary analysis and meta-analyses. The adoption of -omics technologies as well as the use of mHealth solutions to capture phenotypic data in a high-throughput format provides an additional opportunity for unforeseen discovery. However, for this to happen connected multi-domain study data need to be Findable, Accessible, Interoperable and Reusable (FAIR).
FNS-Cloud is developing a solution to make diet and microbiome data FAIR that incorporates an open source (meta)data catalogue with flexible (meta)data model and a search user interface. The new FAIRSPACE tool will be a central data point that combines data from multiple sources in a single database, making it findable by easy filtering and browsing. Diet and Microbiome (meta)data are currently scattered across resources including ENA and Mgnify, MetaboLights, and PhenotypeDatabase. These data will be brought together in FAIRSPACE to allow the user to explore data using a built-in faceted search interface and export or analyse selected data in a secure analysis environment. In the FNS-Cloud Microbiome Demonstrator three use cases are built to demonstrate the capabilities around diet and microbiome.

Keywords:
Gut microbiome, intervention trials, real-life data, human participants, FAIR principles

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5: Title: FOODRUGS, integrating public data repositories to explore food-drug interactions

Abstract:
Food and Health are intimately related. In this regard, the consumption of nutritional supplements with an active role to prevent non-communicable diseases (e.g: cancer, cardiovascular, others) have increased during the last few years raising concerns over the potential interactions between food products and drugs particularly in patients undergoing chronic therapy. At the same time, a growing portion of the population desires to improve their wellbeing, being willing to change their dietary patterns accordingly, or consume supplements or alternative medicines.
Food-drug interaction studies, while picking up traction in the last few years, are still not common. This leads to a large amount of possible food-drug interactions being unknown. Even within known food-drug interactions, current knowledge of them in clinical practice has been reported to be unsatisfactory. This calls for a better education of the issues and for better databases of known potential food-drug interactions.
Led by IMDEA Food Institute, FNS-Cloud has developed an analytical workflow in transcriptomic datasets and a natural language processing pipeline for text documents to identify and extract information about potential food-drug interactions from public data repositories. Information obtained has been organized in a database and displayed in FOODRUGS, an accessible and intuitive web tool demonstrator. A total of 6422 food-drug interactions from 2849 text documents, obtained from three different sources: 2312 documents from PubMed, 285 from DrugBank, and 252 from drugs.com. These documents describe interactions between 1378 food/bioactive compounds and 2932 drugs. In addition, contains information for potential transcriptomic interactions between 383 food or bioactive compounds from Gene Expression Omnibus, a public functional genomics data repository, and 2932 drugs from the connectivity map, a database of small molecules, including an extensive catalogue of drugs.

Keywords:
Food, Drugs, Nutri-omics, Text-mining, Natural language processing, Public data

NOTE: Abstracts (excluding title, keywords, names and affiliations) should not exceed 300 words. It must be in English and saved as a WORD file before uploading to the abstract submission system. Graphs and tables may not be included in the abstract. Abstracts will not be edited and will be added to the conference website and/or conference app as submitted. Ensure that all grammar and spelling is correct.

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Upload your scientific work to an open repository

Mr Edward Sliwinski[1], Ms. Katherine Flynn, Mr. Emilie Weynants, Mr. Luis Mayor
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Title: Workshop: Upload your scientific work to an open repository

Special Session Description:
During this 2-hour hands-on and interactive workshop, we will guide you through the world of Open Science and, specifically, how to upload your research to an open repository (Zenodo).

We will cover:
- the basics of Open and FAIR principles
- how to upload your piece of work on Zenodo, step by step
- how to publicize, advertise and raise awareness about your work.

Bring along a piece of work that you can make open and want to share on an open repository (dataset, preprint, publication, presentation…).
At the end of the workshop, you can earn a certificate of attendance by filling a short feedback survey.

This workshop is organized in the frame of the EU Funded project FNS-Cloud.

Chair: Edward Sliwinski, PhD,
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Filling knowledge gaps on alternative proteins to accelerate the dietary shift

Mr. Paul Vos, Ms. Marie Shrestha, Mr. Fabio Fanari, Mr. Teun Veldkamp, Ms. Theresa Böck, Ms. Sinead Fitzsimons
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Title: Symposium: Filling knowledge gaps on alternative proteins to accelerate the dietary shift

Special Session Description:

A transition from animal-based to alternative protein diets is key to reducing environmental impacts and improving human health. It has been estimated that food systems are responsible for 11.3% of total EU GHG emissions and replacing the use of animal-based proteins will significantly reduce the dietary CO2-equivalent impact of the European diet. The major impacts of the current food system on biodiversity, land and water use, and animal welfare, could be mitigated by a shift from traditional animal-based towards more sustainable protein sources.
This session will introduce GiantLeaps, a brand-new Horizon Europe R&I project and give an update on progress in four running Horizon 2020 projects (NEXTGENPROTEINS, PROFUTURE, SUSINCHAIN and SMART Protein). These four projects are all partners of the new GiantLeaps EU consortium comprising 31 partners form 13 countries which started 1 September 2022 and will end by 31 August 2026. Additionally, two other R&I projects that have just started under Irish coordination, will introduce themselves: U-Protein and ValPro.
The session will consist of 6 different presentations by highly esteemed scientists:

1) GIANT LEAPS towards healthy and sustainable future diets by filling knowledge gaps on alternative proteins by Paul Vos, PhD,
    6. NextGenProteins: Bioconversion of Underutilized resources into Next generation of Proteins for Food and Feed by Marie Shrestha, MSc.
    7. PROFUTURE Project - Microalgae Protein Ingredients for the Food and Feed of the Future by Fabio Fanari, PhD,
    8. SUSINCHAIN: Sustainable Large-Scale Production and Consumption of Insect Proteins in Europe by Teun Veldkamp, PhD,
    9. SMART Protein for a Changing World. Emerging outcomes from an H2020 EU project by Theresa Böck, PhD,
    10. U-Protein and ValPro by Sinead Fitzsimmons, PhD.

Chair: Paul Vos, PhD,

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1: Title: GIANT LEAPS towards healthy and sustainable future diets by filling knowledge gaps on alternative proteins

Abstract:
Accelerating the transition from animal-based to alternative dietary proteins – the dietary shift – is key to reducing the footprint of our food system in terms of greenhouse gas emissions (GHG), energy, water and land use, and other relevant environmental impacts, and for improving the health and well-being of people, animals and the planet. The EU GIANT LEAPS project delivers the strategic innovations, methodologies, and open-access datasets to speed up this dietary shift, in line with the Farm-to-Fork strategy and contributing to the Green Deal target of reaching climate neutrality by 2050. This 4-year project, funded under topic HORIZON-CL6-2021-FARM2FORK-01-12, started in September 2022.

Achieving the dietary shift in practice is inherently complex due to the diverse set of actors involved and further hindered by major knowledge gaps – scattered across the various alternative protein sources and the domains of *health* (safety, allergenicity and digestibility), *environment* (GHGs and other environmental and climate impacts, biodiversity, circularity), and/or *barriers to adoption* (technological, sensory, and consumer acceptance). The project consortium consists of the key actors and spans all expertise to address relevant knowledge gaps and proactively engages to arrive at optimized future diets based on alternative proteins that are broadly accepted across stakeholder groups. In order to deliver required insights for short-, mid- and long-term decision making and impact, protein sources have been selected for either targeted or full assessment based on their current level of specification. The innovations and improved methodologies combined with accessible and comprehensive information generated for a wide collection of alternative proteins will enable policymakers to prioritise changes in the food system towards the dietary shift based on desired impact. It will also enable value chain actors to make strategic scientific, business and investment choices, and the general public to make more sustainable and healthy dietary choices.

Keywords:
Sustainability, Dietary shift, Alternative proteins,

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2: Title: NextGenProteins: Bioconversion of Underutilized Resources into Next Generation of Proteins for Food and Feed

Abstract:
Aim: NextGenProteins aims to strengthen food security, sustainability and self-sufficiency of EU protein production by demonstrating the suitability and economic viability of microalgae, single cell protein and insects in industrially relevant environment as addition to, or substitute of traditional protein sources in various feed and food applications.
Method: NextGenProteins characterized proteins from spirulina, torula yeast, cricket (*Acheta domesticus*) and black soldier fly (*Hermetia illucens)* produced through innovative and environmentally sustainable bioconversion processes using industrial side streams. The project assessed key barriers that currently prohibit or limit their industrial application, such as scalability, production costs, value chain risks, safety, regulations and consumer acceptability.
Results: All proteins have good nutritional quality and are of excellent quality in view of toxicology. Their functional and sensorial properties were improved to meet the needs of high-quality ingredients in ready meals, bakery products, imitation meat and functional food supplements as well as in poultry and fish feed. The results of circularity and life-cycle assessments showed that alternative proteins have the potential to reduce the environmental impacts from traditional protein production. Regarding value chain, the risks identified are often idiosyncratic and firm-specific except for the risk of being unable to attract funding (special relevance for start-up firms). The large majority of 6600 European consumers surveyed in Mai-June 2021 were either positive or at least did not have strong negative prejudices towards alternative proteins and their production process.
Conclusion: These alternative proteins can be produced with substantially lower environmental footprint in terms of GHG emissions, water, land use and fuel consumption. However, their processes still need to develop in scale to improve beyond lower carbon protein sources. The willingness of consumers to accept the new, alternative proteins can be mitigated by better marketing and greater transparency along the value chains.

Keywords:
microalgae, insects, single-cell proteins, circular-economy, sustainable food
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3: Title: PROFUTURE Project - Microalgae Protein Ingredients for the Food and Feed of the Future

Abstract:
Aim: The main purpose of ProFuture is to set the basis for market uptake of innovative, socially responsible and sustainable food and feed products, reformulated with protein-rich ingredients from microalgal biomasses and to demonstrate their social and economic benefits by validating the technical and economic feasibility of innovative technological solutions, prepare market uptake, determine consumer acceptance and disseminate project results to relevant stakeholders.
Method: A multi-factors approach will be implemented to reduce fresh water and energy consumption, increase the efficiency, reduce cost and improve sustainability and resilience of the microalgal biomass production for the three species approved as novel food in the EU, *Arthrospira platensis* (Spirulina), C*hlorella vulgaris* and *Tetraselmis chui*) and one approved only for aquafeed (*Nannochloropsis oceanica*). Strain selection and technologies for the sustainable and efficient microalgae biomass cultivation and harvesting will be applied at lab and pilot plant scale, then food and feed will be formulated using single cells ingredients and protein isolates and produced at pilot and industrial scale.
Results: Yellow *C. vulgaris* strains with high protein content and more neutral sensorial traits were isolated. Mixotrophic and heterotrophic cultivation have been assessed. “Off-the-grid” photobioreactor, low-cost reactors and ultrafiltration harvesting were studied to improve production efficiency and reduce energy consumption. Four drying technologies were compared to obtain single cell proteins, and protocols for the extraction and purification of protein isolates have been designed. Different food products (pasta, vegan sausages, vegetable cream, soups, bread, sport bars and drinks) and feed (for piglet, poultry, shrimps and fish) have been reformulated with microalga ingredients.
Conclusion: The development of microalgal products that are widely accepted by consumers enables more people to benefit from their beneficial properties and could be a future direction for the food sector. More efficient and sustainable processes are key for the development of the entire microalgae value chain. Next steps of the project will be the scale-up of foods prototypes reformulated with microalgal ingredients and consumer tests to assess product acceptance.

Keywords:
Sustainable food & feed, Microalgae protein ingredients

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4: Title: SUSINCHAIN: Sustainable Large-Scale Production and Consumption of Insect Proteins in Europe

Abstract:
Aim: SUSINCHAIN (SUStainable Insect CHAIN) aims to contribute to novel protein provision for feed and food in Europe by overcoming technical and market barriers to increase the economic viability of the insect value-chain, enable safe and sustainable large-scale production and consumption of insect proteins in Europe.
Method: SUSINCHAIN identifies and assesses protein derived from four different insect species (Black Soldier Fly, Housefly, Mealworm and Crickets) as novel protein sources for food and/or feed. Efficient production and processing technologies to convert insect biomass into high quality, safe, healthy, and sustainable products/ingredients are tested and validated. Nutritional values, functional and sensory properties of insect products are characterised and (re)formulations of human diets that partly or fully could substitute traditional sources are evaluated. Insect products are incorporated in formulations for both regular human diets and animal feeds (rainbow trout, seabass, salmon, laying hens, broilers and piglets).
Results: Large scale insect rearing conditions were improved by optimising feed substrate, prevention of insect diseases, ensuring insect egg quality, and sharing best rearing practices. Transport and processing capacities of harvested insects and derived products were investigated. Nutritional value and bioactive properties of insect protein products in animal feed were assessed.

Specifications and batches were produced for six insect-based products for sensory testing, which will be tested for consumer perception in two European countries. Safety and environmental sustainability were assessed along the insect value chain.
Conclusion: The project contributes to creating the optimal conditions for dynamic and innovative insect farming, processing and feed and food production, in which low-grade side streams are up-graded into high-quality products with high safety and environmental standards. At the same time, project results help to secure food production under increasingly uncertain future environmental conditions and move towards resource-smart, climate-smart, and "eco-healthy" production and consumption.

Keywords:
insect protein, sustainable food and feed, safety

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5: Title: Smart Protein for a Changing World. Emerging outcomes from an H2020 EU project

Abstract:
To make diets healthier, safer, and more sustainable, novel and future foods, that comprise plant, insect meal, mycoprotein and microalgae have been proposed.
However, the speed of their inclusion in our everyday diet could be significantly increased by adopting well-known and consumer-trusted (bio)technologies able to minimise food neophobia and disgust sensitivity. Transformative innovation strategies have been implemented and validated within the 4.5-year H2020 project 'Smart Protein for a Changing World. Future-proof alternative terrestrial protein sources for human nutrition encouraging environment regeneration, processing feasibility and consumer trust and acceptance' - SMART PROTEIN. The project, which is coordinated by University College Cork, began in January 2020 and will end in June 2024 It involves 32 partners from 9 EU countries (Denmark, Austria, Belgium, Netherland, Italy, Germany, Ireland, Spain, Portugal) two associated countries (Switzerland and Israel), and three third countries (US, New Zeland, Thailand), including 12 academic/scientific institutions, two non-profit organisations, (ProVeg, The Good Food Institute) and five SMEs, with which joint research and innovation activities are conducted to strengthen the transition towards a higher inclusion of plant protein in the human diet. The project aims to industrially validate and demonstrate innovative, cost-effective and resource-efficient, EU-produced, nutritious plant (fava bean, lentil, chickpea, quinoa) and microbial biomass proteins from edible fungi by up-cycling side streams from pasta (pasta residues), bread (bread crust) and beer (spent yeast and malting rootlets) industries. The alternative SMART proteins will be used for direct human consumption through developing future-proofed seafood and meat analogues, dairy alternatives, follow-up infant formula, sauces, pasta and bakery products. We are harnessing plant and microbial protein knowledge to significantly enhance the sustainability and resilience of a new European protein supply chain, improving professional skills and competencies.

Keywords:
plant proteins, microbial protein, food upcycling, food sustainability

Presenter 6: Sinead Fitzsimons, PhD
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6: Title: U-Protein and ValPro Path

Abstract:
The current trend towards including more plant protein in our diet is paralleled by the need to implement a system-wide change towards a carbon-neutral industry. The U-Protein and VALPRO Path projects address these challenges by focusing on creating novel value pathways for plant protein.
U-Protein is an Irish Department of Agriculture Food and Marine funded project (2019PROG702) which aims to create new scientific and technological knowledge with long-term potential to re-engineer Ireland's agro-ecological system. It proposes to achieve this through greater diversification of protein resources, delivering sustainability, circularity and quality nutrition. Studies are examining the role of Crop (i.e. grassland, cereals, legume, oilseed and niche crops) and Marine resources as alternative sources of protein, with the potential to generate novel biomass streams through biotransformation. U-Protein brings together the research expertise of five Teagasc sites and five universities (UCC, NUIG, UL, QUB, NUI Maynooth) and several representatives from Irish food and agriculture based industries.
VALPRO Path is a Horizon Europe funded project funded under the Horizon-CL6- 2021-FARM2FORK-01-02. It aims to co-create, validate and demonstrate new value landscapes that promote the sustainable, circular and transparent production of plant proteins for food and feed in the EU. Proteins are a key component in food with various nutritional and technological functionality, so a considerable opportunity exists for Europe to develop new ingredients and markets. A well-balanced and robust supply chain, with multi-actor co-creation is critical to de-risk investments in new business models. By setting the stage and bringing state-of-the-art approaches across the whole value chain via VALPRO Path it will be possible to re-invent how we grow, what we grow and how we process the protein of the future. The VALPRO Path team harnesses the expertise of 25 academic and industry-based organisations from across Europe and officially started on the 1st September 2022.

Keywords:
plant proteins, legume protein, marine protein, novel biomass, supply chain

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Creating transparency from farm to fork to strengthen trust and create a healthier food system

Mr. Edward Sliwinski, Ms. Giada Mastandrea, Mr. Antonio Del Casale, Ms. Neolia da Quinta, Ms. Danielle McCarthy
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Title: Symposium: Creating transparency from farm to fork to strengthen trust and create a healthier food system

Special Session Description:

Food goes through many hands before it reaches our plate, from grower, processor, transporter, wholesaler and finally to retailer. Processed food has longer and more opaque chains, with more opportunities for breakdown of trust. Creating transparency from farm to fork can strengthen trust and create a healthier food system.

Trust is an essential ingredient in a well-functioning food system. To trust the food on our plate, we need to know that it's safe to eat, its origin, the quality of ingredients, its nutri-tional value, and whether its production has harmed people, animals or the environment. In an industrialised food system, raw ingredients go through many hands before they end up on our plate. These long and complicated chains, with sometimes opposing incentives (e.g. profit and safety) can lead to risks being taken that negatively affect people, animals or the environment (such as the horsemeat scandal).

A food system where every link of the chain is in the open would create transparency and trust and help avoid abuses and risks.

This session will introduce TITAN, a brand-new Horizon Europe R&I project and some of its industrial and research partners (Agricolus, MicroBion and AZTI). The new TITAN EU con-sortium comprising 28 partners form 15 countries started 1 September 2022 and will end by 31 August 2026. Additionally, a presentation will be given on related research by Danielle McCarthy.

The session will consist of 5 different presentations by highly esteemed representatives from both academia and industry:

1) TITAN Transparency solutions for transforming the food system by Edward Sliwinski, PhD,
    11. Making Agritech sustainable – Agricolus for precision farming by Giada Mastandrea, MSc,
    12. Food safety and transparency through cutting edge DNA-based analysis methods by Antonio del Casale, CEO,
    13. Helping children make better dietary choices by widening their knowledge on nutrition and food science by Noelia da Quinta, PhD,

14. Food Possibilities: A framework for an integrated approach to healthy, sustainable food behaviours across schools, communities, business and government by Danielle McCarthy, PhD,

Chair: Edward Sliwinski, PhD,

Affiliation: The European Federation of Food Science & Technology, AgroBusiness Park 82, 6709 PA, Wageningen, The Netherlands.

Presenter 1: Edward Sliwinski, PhD,

Affiliation: The European Federation of Food Science & Technology (EFFoST), Agro Business Park 82, 6709 PA, Wageningen, The Netherlands.

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1: Title: TITAN Transparency solutions for transforming the food system

Abstract:
A major transformation of the food system is required if Europe is to address the two major challenges of the 21st century, i.e., addressing societal and planetary health. The Farm to Fork Strategy is at the heart of the European Green Deal (EGD) objective to make food systems fair, healthy, and environmentally friendly. A key point of the EGD is that it provides the basis for the EU agri-food economy to thrive in a new business environment that embraces the new technologies, concepts and behaviours that are required to meet 2030 and 2050 goals.
Comprising 28 partners from 15 countries (10 MS and 5 associated countries), TITAN will provide an extensive platform for the development of a wide range of innovations that aid transparency and address key challenges identified in the EGD. The project comprises a mix of technology providers and research centres linked to agri-food actors and businesses through an interactive co-creation approach that was initiated prior to the submission process. Innovative solutions showcased in TITAN have already been sense-checked by stakeholders through answering a pre-proposal questionnaire that was conducted earlier in 2021. The TITAN innovations, all transparency related, address the following themes: enhancing transparency in agri-food businesses with a focus on SMEs; improving food choices by providing more transparent information to the consumer; using improved transparency to enhance food safety and authenticity of products; and providing improved information on the health and sustainability of food products. TITAN will showcase 15 innovations covering these themes with TRLs moving on average from TRL 5 to 7 within the lifetime of the project. The project has included the provision of an extensive tender for an open call (€1.2M) to

provide financial support to third parties and supply more innovations on transparency related solutions.

Keywords:
Food system, Transparency, Trust, Food safety, Sustainability, Health

Presenter 2: Giada Mastandrea, MSc
Affiliation: Agricolus s.r.l., Perugia, Italy

Co-authors:
Sofia Maria Lilli[1]

Affiliations:
[1] Agricolus s.r.l., Perugia, Italy

2: Title: Making Agritech sustainable – Agricolus for precision farming

Abstract:
Agricolus is an innovative Start-up working in the Smart Farming Sector. Agricolus goal is to provide tools dedicated to farmers, the association of farmers, professionals, and food processors, etc. One of this technologies Agricolus platform is a complete decision support system (DSS) that supports the work of farmers in the field with different features that are included in one easy-to-use solution. With the use of our technologies, it is possible to enhance fieldwork, optimize crop operation and help farmers become more economically and environmentally sustainable.
The mission of Agricolus is: "Make AgriTech sustainable" for that reason Agricolus works to spread precision farming. Precision farming aims to provide each plant with what it needs at the time it needs it. This allows more efficient use of inputs: fertilizers, pesticides, and herbicides and simplifies the work in the field and it makes the agricultural sector more sustainable. Different technologies can be used in precision farming but all of these are based on the collection of data that can give different advice to farmers who can make rational decisions.
As a matter of fact, digitization has also taken hold in the agricultural sector. The use of new tools affects the entire supply chain from the production stage to the consumer and makes it possible to produce quality, healthy, and more sustainable food, all the elements required by today's consumer. For that reason, the project TITAN was born. The goal is to contribute to the transformation of the food sector into a demand-driven economy that provides consumers with healthy and sustainable food. By developing a new traceability tool for helping tomato and rice farmers to collect data for their supply chains, Agricolus wants to contribute to that transformation.

Keywords:
#precision farming #digitalization #sustainability #TITAN #foodtransparency

Presenter 3: Antonio Del Casale, PhD,
Affiliation: MicroBion s.r.l., Verona, Italy

Co-authors:
Fabio Fracchetti[1], Francis Bourdichon[2], Vania Patrone[2], Lorenzo Morelli[2],

Affiliations:
[1] MicroBion s.r.l., Verona, Italy.
[2] Dept Food Microbiology, UCSC, Piacenza, Italy.
3: Title: Food safety and transparency through cutting edge DNA-based analysis methods

Abstract:
As supply chains expand, food safety and traceability increasingly become a major challenge for businesses within the food industry. Due to the complex nature of supply chains, tracking products and ingredients through all stages of sourcing, processing and distribution makes it difficult to ensure food safety and traceability.
Microbion, a University of Verona spin-off founded in 2011, provides solutions that suit all needs of microbiology-related features of industrial productions including safety, quality and innovation, such as the development of DNA-based methods for the characterization and identification of food-related and environmental microorganisms. Microbion provides a broad range of analytical and innovation services:

(i) Analytical services, customised genotypic analysis (based on DNA) and phenotypic analysis (based on strain performance) of pro-technological microbial strains and contaminants,
(ii) Research & Development services, research programs focused on problem-solving and innovation of products and processes, and
(iii) bio-bank services, by collecting and storing pro-technological microbial strains for industrial application, their DNA for analytical assays and the relevant information of industrial performance.

In the TITAN project MicroBion and UCSC are running two pilots. The first one is concerned with the safety of fermented foods. In this pilot MicroBion and UCSC will develop and validate an analytical method based on Next-Generation-Sequencing for the rapid characterization of the microbial ecology in fermenting foods (inoculated or not inoculated). Important aspects to study are the presence of biogenic amines producing strains and the spread of antibiotic-resistance genes. The other task is. The main aim of the second task, which is focussed on the safety of long shelf-life products, UCSC and MicroBion work closely together, on the food safety assurance of plant-based beverages through omics and molecular approaches. Specifically, third-generation sequencing technologies will be exploited to highlight the presence of spore-forming pathogenic contaminants.

Keywords:
#microbiome #DNA-detection #sustainability #TITAN #foodtransparency

Presenter 4: Neolia da Quinta,
Affiliation: AZTI, Food Research, Basque Research and Technological Alliance (BRTA). Parque Tecnológico de Bizkaia. Astondo Bidea, Edificio 609, 48160 Derio, Spain

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[3] Univeristy of Helsinki, Helsinki, Finland.
[4] University of Warsaw, Warsaw, Poland.
[5] TotalCtrl, Oslo, Norway.

4: Title: Helping children make better dietary choices by widening their knowledge on nutrition and food science

Abstract:
Healthy eating patterns during childhood promote optimal health, growth and intellectual development. Families with children represent a large and important consumer group within the European Union (65 million European households have children). The increasing concern for health and the awareness that healthy nutrition contributes to the overall well-being of families has led to an increasing demand for information and educational resources on child feeding, family nutrition, and transparency of the food system. Although this content is already included in the school curriculum in different subjects, finding a suitable, age-appropriate, and adapted approach based on challenges or fun games could mark the success of interventions and ensure that children show a positive attitude towards what they learn.
Five TITAN partners (AZTI, AITalentum, University of Helsinki, University of Warsaw and Totalctrl) will join forces with the aim of developing a gamification approach to adapt intervention activities to the participants' cognitive stage of development. With the help of Artificial Intelligence (AI) behind the game, a chatbot and other features will be included to communicate specific information to children, including content about three main topics: food nutrition, food science and technology (about how food is manufactured) and food waste management at home.
Previous studies conducted by the partners of this pilot case confirmed that the combination of gamification activities and AI ("*Cómo como yo?* (How do I eat?)" app and "Mole's Veggie Adventures" app) increases children's knowledge related to food since the game provides an interactive place where children can learn by playing.
To ensure that the tool and the AI behind it are adapted to the stage of development of children from different countries and provide the appropriate content, parents, caregivers, and other stakeholders as well as children themselves will be consulted in Finland, Poland, Norway and Spain to co-create the best solution.

Keywords:

children, food behaviour, healthy eating habits, gamification, artificial intelligence, transparency, digital tool.

Presenter 5: Danielle McCarthy, PhD,
Affiliation: School of Biological Sciences, Institute for Global food security, Queen's University Belfast, Belfast, Northern Ireland,

Co-authors:
Jayne Woodside[1]

Affiliations:
[1] School of Biological Sciences, Institute for Global food security, Queen's University Belfast, Belfast, Northern Ireland,

5: Title: Food Possibilities: A framework for an integrated approach to healthy, sustainable food behaviours across schools, communities, business and government

Abstract:
Dr Danielle McCarthy from Queen's University Belfast has been leading research in regions of social disadvantage in Northern Ireland to help improve health and wellbeing through food-based experiences and adaptations to school food environments. Results showed a 6 month's period of intervention led to improvements in children's emotional wellbeing, behaviour, quality of life (boys), willingness to try new foods and perceived cooking competency. Subsequent research has focused on the co-design of a sustainable mechanism for implementation of this effective food-based approach. Parents, teachers, principals, local councils, government officials from a number of departments, charities, businesses, community organisations and their users have contributed to the co-creation of the Food Possibilities framework. This framework provides a mechanism to structure, evaluate and enable an integrative approach to sustainable healthy food behaviours. This evidence-based framework, informed by research findings and lived experiences, provides a well-governed approach to bring civil society, business and government together to ensure an efficient, effective, sustainable route to improving people and planetary health for everyone. A critical element of the framework to ensure sustained implementation is the social-enterprise-led business model which underpins it. This unlocks a route for diverse partners, including public and private organisations, to invest in the delivery of this concept as they value the environmental and social capital the concept generates. In this talk Danielle will share the Food Possibilities model alongside insights from the co-creation work and the challenges and opportunities this research has highlighted.

Keywords:
Children, social disadvantage, improve health & well-being, School food environments,

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Innovations for food producers and food SMEs:
How to encourage putting innovations into practice

Geneviève Gésan-Guiziou[2], Jonas Lazaro-Mojica[3], Imca Sampers[4], Inés Echeverría[5], Marianna Gkavrou[6], Elisa Carloni[7], Juan S. Angarita-Zapata[8], Katherine Flynn[1]
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Innovations for food producers and food SMEs:
How to encourage putting innovations into practice

Special Session Description
The transition towards a more sustainable food system requires that small and mid-sized enterprises increase their economic competitiveness and resilience and strengthen their innovation capacity. However, their specific needs are often neglected, especially in innovation processes that focus on large and expensive improvements. In this session, we will present technical and technological innovations demonstrated in several current European projects, innovations devoted to SMEs and producers which may increase food sustainability. We will discuss challenges, supporting and hindering factors for putting innovations into practice and possible solutions for their successful implementation. The session will close with a roundtable discussion and Q&A from the audience.

Chair : Geneviève Gésan-Guiziou[1]
Moderator: Katherine Flynn[2]
[1] National Research Institute for Agriculture, Food and the Environment, INRAE, Rennes, France
[2] IFA – ISEKI-Food Association, Vienna, Austria

Presenter 1: Geneviève Gésan-Guiziou
National Research Institute for Agriculture, Food and the Environment, INRAE, Rennes, France

1: Introduction
Abstract: The introduction presents the agenda and objectives of the session

Presenter 2: Jonas Lazaro-Mojica
Food Drink Europe, Brussels, Belgium

Co-author: Daniel Rossi
Chairman Copa Cogeca Research and Innovation WP, Brussels, Belgium

2: Agrifood Innovation: New Needs in the FOOD 2030 Scenario

Abstract:
We see 11 million farmers and 280 thousand food and drink SMEs in Europe asking for more innovations in technology as well as new products and services to be aligned with consumer needs and trends. Issues from the global - such as climate change – to the personal – such as nutritional facts and eating behaviours – have given us the opportunity to review our frameworks and scenarios in the short and medium term. Now, by accelerating the sustainability features of the agrifood sector and by introducing horizontal and vertical innovations – we call them practical solutions – we aim to help farmers and SMEs in the transition.
Keywords:
Innovations, sustainability, farmers, SMEs, agrifood scenarios, climate change, eating behaviours, nutrition.

Presenters 3: Imca Sampers[1] and Geneviève Gésan-Guiziou[2]
[1] Ghent University, Kortrijk, Belgium
[2] National Research Institute for Agriculture, Food and the Environment, INRAE, Rennes, France

3: Innovative upgrades to value and packaging of small quantities of liquid food products

Abstract:
Upgrading the value of co- and by-products and the packaging of liquid food produced in small quantities are some of the major issues faced by farmers and SMEs, especially those in geographically isolated areas. The H2020 project FAIRCHAIN (https://www.fairchain-h2020.eu/) proposes development and adaptation of technological innovations that tackle these issues and allow the scale-up and expansion of the production of nutritious food at a regional level. This talk will present two: 1) the development of an innovative fermented whey-based drink to upgrade the value of whey, a co-product of cheese manufacture, by producing healthy flavoured fermented drinks (no added sugar, no artificial additives, no chemicals); 2) the development of an innovative packaging machine for liquid or viscous food products in the fruit & vegetables and dairy sectors, using green or sustainable packaging materials and designed to fulfil hygienic requirements (air quality and sterile packaging material). The main challenges in adopting these innovations have been identified thanks to a co-creation process and assessment framework developed in FAIRCHAIN. These include the economic sustainability of the whey drink, including acceptability by consumers, and the business model for a mobile packaging machine, including e.g., fixed, cooperative, or individual ownership.

Keywords:

FAIRCHAIN_H2020; food processing; Fermentation; packaging; Fruit & vegetable sector; dairy sector; sustainability; co-creation

Presenter 4: Inés Echeverría
Centro Nacional de Tecnología y Seguridad Alimentaria (CNTA), San Adrián, Spain.
Co-author: Mónica Pérez Martinez
CNTA, San Adrián, Spain.

4: Biotechnology tools for clean label plant-based new foods

Abstract:
There is a global trend towards meat analogues with better flavours and textures and, at the same time, with a clean label approach. The development of these types of products, with a good shelf-

life, can take advantage of the use of starters in fermentation processes, creating clean label and superior sensorial and nutritional profile products.
The innovation proposed in the CO-FRESH project focuses on the formulation of a plant-based substrate and its use with different combinations of starters for both sensorial and protective (biocontrol) purposes. In the evaluation of the final product, priority will be given to the sensory profile and the shelf life of the "fermented" product compared with current unfermented plant-based food products.
Keywords: Biotechnology, Fermentation, Plant-based, Clean label, New food products, Biocontrol.

Presenter 5 : Marianna Gkavrou
NEUROPUBLIC SA, Piraeus, Greece
Co-authors: Nikos Kalatzis[1], Nikolaos Marianos[2]
[1] NEUROPUBLIC SA, Piraeus, Greece
[2] GAIA EPICHEIREIN SA, Piraeus, Greece

5: Supporting a frozen fruit value chain of small farmers for optimising production, reducing environmental footprint and re-using data for certification and subsidies

Abstract:
Fruit producers in Greece, like Proodos Farmers' Union, face sustainability problems, as they have small and fragmented farms and face high inputs costs, lack of resources for investments and lack of financing. In addition, they use old production methods that result in increased input consumption while damaging the environment. They need environmentally friendly ways to reduce their production costs and increase their revenues. Alterra is a food processing company working closely with Proodos in order to produce high quality frozen fruit products. They give contracts to farmers offering a better price for high quality products but they need to a) to support the production of these products and b) prove the high quality to their customers and build up their brand name, adding additional value.
In the context of the Ploutos project, the innovative AgriTech SME NEUROPUBLIC SA, is leading a Sustainable Innovation Pilot aiming to find a solution for these challenges. A holistic Smart Farming solution called gaiasense has been established in the area of Proodos, helping farmers to reduce the application of inputs (water, fertilisers, pesticides), thus reducing costs and improving fruit quality (less pesticides), while reducing the environmental footprint of production. So far, gaiasense helped achieve a reduction of pesticides by 58%-65%, water consumption by 36-70% and production costs by 32-39%, depending on a variety of conditions. Furthermore, gaiasense and the systems of Alterra are connected with the Ploutos traceability solution, that will help in collecting all the needed data/proof to secure the necessary certificates and sustainability related labels, which will help prove the "high quality" claims of Alterra and Proodos and allow them to secure higher prices.
Keywords: Ploutos_H2020, Smart Farming, Traceability, Sustainability, gaiasense, Frozen Fruits, IoT

Presenter 6 : Elisa Carloni
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[2] The James Hutton Institute, Aberdeen, Scotland, UK
[3] University of Bologna, Bologna, Italy

[4] FH Münster iSuN - Institut für Nachhaltige Ernährung, Münster, Germany
[5] University of Tuscia Viterbo, Italy

6: A second chance for food surplus: a digital marketplace to promote circular economy and avoid food waste

Abstract:
The Horizon 2020 project LOWINFOOD aims to implement innovative solutions to prevent food loss and waste at all stages of the food value chain. Fourteen innovations are considered, ranging from technological solutions to social, managerial, and organizational innovations. Fruits & vegetables, bakery products, and fish value chains are the demonstration settings as they are particularly concerned by food loss and waste. One way to reduce environmental impact, including food waste, is by promoting circular pathways to reuse food surplus. This requires facilitation of supply and demand interaction, which geneally operate in different markets and with different logic and scarce interaction. A LOWINFOOD pilot now being tested is LEROMA, a digital B2B marketplace operating at the upstream stages of the value chain that builds a bridge between producers and manufacturers. The platform also provides a surplus market to exchange excess raw materials and a valorisation forum to make possibilities available in a structured way. Thanks to the multi-actor LOWINFOOD approach, the interface of the platform allows users to upload information on surplus products more quickly, potential buyers can easily search the products they need, and the interaction among them is facilitated. The challenges of this innovation are environmental and socioeconomic impacts from commercialisation of food surplus (e.g. implications of logistics). By assessing this, and the quantity of unwasted food, LOWINFOOD provides the innovator with useful information to be exploited on the market.
Keywords: Food Waste Prevention, Circular Economy, Innovation, Digital Market

Presenter 7 : Juan S. Angarita-Zapata
University of Deusto, Bilbao, Spain
Co-authors: Dario Pellegrino[1], Ainhoa Alonso Vicario[2]
[1] Engineering Ingegneria Informatica, Palermo, Italy
[2] University of Deusto, Bilbao, Spain

7: Collaborative Artificial Intelligence for Sustainable Manufacturing in the Food Industry

Abstract:
Food manufacturing is the largest industry in the European Union (EU), where 99% of the companies are small and medium-sized enterprises (SMEs). The sector accounts for approximately 26% of all global CO_2 emissions, with resource efficiency one of the main challenges of the manufacturing stage (e.g., waste due to overproduction). The challenge of resource efficiency could be alleviated by Industrial Digital Technologies, such as Artificial Intelligence (AI). However, the lack of AI expertise and the absence of a comprehensive and collaborative vision among the actors in food value chains, make it challenging to deploy such technological solutions. In this context, the FOODRUS project will present new and collaborative AI methods to tackle resource efficiency challenges in the food industry, particularly its manufacturing stage. This is achieved using a co-creation methodology that involves actors of the food industry who actively participate in designing the most suitable AI tools to meet their needs and requirements. Thus, this FOODRUS work improves sustainability by developing AI-based solutions which support a common vision among food value-chain actors. In

the end, such a shared vision allows effective coordination of heterogeneous actors to get the best of AI in dealing with food waste in demand forecasting and production processes.
Keywords: Artificial Intelligence, Food Manufacturing, Resource Efficiency, Food Supply Chains

Moderator : Katherine Flynn
ISEKI-Food Association, Vienna, Austria

8. Round table discussion
A roundtable discussion with a panel of the speakers from the sister projects and questions from the audience including on the benefits, challenges and good practice for the integration of small and mid-sized actors' needs in the R&D&I process.

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Multi-criteria framework to evaluate safety and environmental impacts: Application to a large dairy farm

Mr Rodney Feliciano[1], Dr. Géraldine Boué, Dr. Miguel Mauricio-Iglesias, Dr. Almudena Hospido, Dr. Jeanne-marie Membré
[1]*Secalim, INRAE, Oniris, Nantes, France*

Aim:
The dairy supply chain is susceptible to the effects of climate change and these may pose additional threats through the increase in microbial hazards and disruptions to daily operations. Consequently, pressure may increase on the current dairy farming operations and food safety programs may need to be reviewed to guarantee the microbial safety of raw milk. In parallel, related greenhouse gas emissions and other relevant environmental impacts should be considered to make sure that the possible solutions do not bring new problems to solve. Therefore, this research aims to present and evaluate food safety mitigation strategies that can potentially draw together human health safety and environmental impact.

Method:
The research identified a selection of food safety mitigation strategies to be applied at the dairy farm level under hot weather conditions. These were evaluated first in terms of food safety using literature data and microbial risk assessment models. Second, environmental impacts were evaluated using Life Cycle Assessment (LCA) with milk production as Functional Unit. Third, the cost of implementing the mitigation strategies was assessed using literature and dairy farm inputs. Ultimately, several multi-criteria frameworks (e.g. TOPSIS distance-based technique, PROMETHEE outranking technique) were set up to evaluate and rank the mitigation strategies.

Results:
Five mitigation strategies were suggested based on experts' knowledge and the needs of the dairy farm. None of them outperformed the others on the three criteria (food safety, environmental impact and cost of implementation). Nevertheless, multi-criteria frameworks allowed for the ranking of the best compromise solution. Moreover, multi-criteria techniques enabled to take into account the priority of the stakeholders through assigning a weight to each criterion, in a transparent manner.

Conclusion:
This study presented different methodologies to evaluate food safety mitigation strategies while minimizing environmental impacts. That was demonstrated with a large dairy farm operating under hot weather conditions. The approach can be implemented by food safety managers to address the intensification of climate change impacts and aid in the decision-making process in controlling these effects.

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Quantifying Human Exposure to Aflatoxin M1 through Raw Milk under Climate Change Scenarios

Ms Rhea Sanjiv Chhaya[1], Dr Jeanne-Marie Membré[2], Prof. Enda Cummins[1]

[1]University College Dublin, School of Biosystems and Food Engineering, Dublin, Ireland, [2]Secalim, INRAE, ONIRIS, Nantes, France

Aim:

Climate change may impact the production of mycotoxins in food and feedstuffs. Following the consumption of contaminated feed, mycotoxins may carry over into animal products, including milk from dairy cows. Aflatoxin B_1, produced by *Aspergillus flavus* and *Aspergillus parasiticus*, is a Group 1 carcinogenic mycotoxin linked to liver cancer in humans. Its metabolite, aflatoxin M_1, has been found in milk due to biotransformation occurring in the livestock after consuming contaminated feed. A feed to fork probabilistic exposure assessment was developed to assess the risk from aflatoxin-contaminated milk under different climate scenarios.

Method:

Data from the scientific literature was collected to model each stage, including pre-harvest and post-harvest stages of the cereal crop and subsequent potential transfer of the mycotoxin from farm to consumers via dairy milk. The exposure assessment integrates predictive mycology models to assess the potential exposure to aflatoxin M_1 from raw milk. Changes in temperature and relative humidity are variables used to assess the effect of climate change on aflatoxin M_1 in milk. The exposure model assessed the increase in initial spore count of *Aspergillus flavus* in soil based on temperature and previous cropping history, the effect of fungicide application on mycelium inhibition and the effect of temperature and relative humidity on the growth of *Aspergillus flavus* and subsequent production of aflatoxin B_1 on maize destined for animal feed.

Results:

The exposure assessment results are compared with the current scenario to assess the impact climate change may have on potential aflatoxin contamination in raw milk. A sensitivity analysis has been carried out to understand the impact of each variable on human exposure estimates.

Conclusion:

The information generated by the model will be useful for policy-makers and risk managers to better assess the potential risk of aflatoxin B_1 contamination in feed and subsequent potential human exposure through milk under various climate change scenarios.

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Assessing the impact of climatic factors on the quality and safety of raw milk

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Aim:
The quantity and quality of milk are closely associated with seasons, animal diet, health status, and breed. This work evaluates the impact of several environmental factors, such as temperature, precipitation, wind speed and feeding system, on the variability of cow milk production traits that account for milk quality (e.g., fat content) and microbiological state (e.g., total bacterial counts).

Method:
The case study selected for this work consists of a set of 289 dairy farms in Spain. Raw milk data were analysed for five years (2014-2019). The farms had two different feeding systems, one with an unknown component ratio (HAND) and the other with a known ratio (TMR). Data-driven techniques were utilised to correlate milk variables with climatic factors to assess the impact of the environment on the dairy industry. On the one hand, Principal Component Analysis (PCA), applied to investigate variability and possible correlations among variables, showed potential relationships between fat, protein and dry lean among content, somatic cell and total bacteria counts. Additionally, Partial Least Squares (PLS) regression models were developed by capturing the main covariance between the two datasets.

Results:

The PCA and PLS models were found to characterise well the impact of environmental factors on milk quality. In addition to temperature, the importance of precipitation, radiation, and wind speed was illustrated. Specifically, low fat, protein and dry lean values are associated with high precipitation, radiation, and minimum environmental temperature. PLS models performed poorly in explaining the total bacteria counts for the overall data, although they were improved when trained on yearly data sets ($R^2 > 0.84$). These models highlighted the importance of precipitation, radiation, vapour pressure and minimum temperature in the microbial population for most years (VIP scores > 40%). Lastly, milk quality was influenced by different variables in the two feeding systems. Specifically, the HAND system was affected by wind speed and relative humidity, apart from precipitation and radiation.

Conclusion:
This work demonstrates the impact of climate on milk production while including the effect of animal diet. The results add to the scientific evidence of the potential climate change impact on the dairy industry.

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Risk prediction with machine learning and deep learning models using the data from RASFF portal

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Aim: To forecast incoming food alerts and classify the risk associated with chemical contaminants into 'serious' and 'non-serious' categories by employing machine learning (ML) and deep learning (DL) models using data obtained from the RASFF portal.

Method: To estimate and clarify the risk using ML and DL, food alert data were obtained from the RASFF portal. For each chemical contaminant appearing in the RASFF data, reference dose values (RfD) were scraped from studies conducted using that chemical substance. This is followed by pre-processing, which uses several categorical encoding methods to select appropriate training datasets and analyse, using ML and DL techniques, to predict the risk to human health. The work's originality derives from using RfD values in conjunction with food alert data to solve the challenge of predicting food issues in the European Union using ML and DL approaches. The models enable the classification of serious and non-serious chemical risks based on key features.

Results: The results show that the model accuracy depends on the RfD values and categorical encodings. Non-neural models obtained the best results. Decision Tree (DT), Random Forest (RF), and Support Vector Machine (SVM) can classify the risk with an accuracy ranging from 95% to 99%.

Conclusion: A total dataset of 3,683 RASFF chemical alerts of 96 chemicals was used to demonstrate risk estimation by encoding food alert data with categorical embeddings and using machine learning and deep learning models for forecasting with an accuracy of 95% to 99%. A validation data set was used to test the models. As a result, the models are robust since the accuracies obtained are the same, with no major variations from the validation results.

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Climate change challenges in the transition to an environmentally sustainable European dairy sector by 2050

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Aim: The European Union (EU) dairy sector is in its transition towards environmentally sustainable production by 2050 (European Dairy Association, 2019). However, this transition can be challenged by future climate change as biophysical impacts and potential adaptation strategies to cope with them might alter the environmental performance of dairy value chains, modifying the primary and secondary data of the Life Cycle Inventory (LCI) (Guzmán-Luna et al., 2021). Despite the large number of factors and uncertainty and as part of PROTECT (www.protect-itn.eu), this research aims to support the dairy sector by developing a toolbox to estimate the biophysical impacts of climate change and their effect on the LCI under climate change scenarios.

Method: The Food and Agriculture Biomass Input-Output table called FABIO (Bruckner et al., 2019) is used to identify the main agricultural biomass producing countries that supply the largest EU dairy producers. Also, the Representative Concentration Pathways (RCP) are the climate change scenarios used (IPCC, 2014). A risk assessment approach is followed due to the paucity of projections on the intensity of biophysical impacts on dairy value chains by 2050, in which Geographical Information Systems, literature review, and mathematical modelling are used. Later, a mind-map identifies the LCI data affected by the quantified biophysical impacts. Sub-scenarios on these data are created as they are modified by non-climate factors (i.e. energy transition). Finally, the inventory is ready for being transferred to the impact assessment stage.
Results: Dairy farms in the Mediterranean need to increase their resource consumption to face climate change in the Business-As-Usual scenario. Fertilizers application doubles to compensate the crop yield reduction caused by climate variability. The increased application of it, along with others, has resulted in 30% rise in the carbon footprint of raw milk in this region. However, if regulations are considered, an increase in fertilizers is not conceivable, and hence, it will have repercussions on the land footprint to provide the same amount of crop will be affected.
Conclusion: The proposed tools are needed to support the dairy sector in continuing to improve its environmental sustainability in a climate change future full of uncertainties.

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Towards resource sustainability: Modelling fouling and cleaning in milk pasteurisation processes

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Aim: During the thermal treatment of milk, a fouling layer develops on the inner surface of processing equipment. This fouling layer has an adverse effect on the energy performance of milk pasteurisation processes. Fouling acts as a thermal insulator and thus, heating energy needs to be supplied at an increasing rate during fouling growth to ensure sufficient pasteurisation. In addition, cleaning is required for fouling removal which demands significant amounts of resources including energy, water, and chemicals. Contributing towards net-zero carbon by 2050, the aim of this study is to model fouling and cleaning in milk pasteurisation to minimise energy and integrated resources.
Method: The developed model integrated chemical engineering process design, first principle, and empirical modelling approaches. Specifically, a simplified geometry that represents a plate heat exchanger was used, and kinetic models for fouling and cleaning were applied. Sensitivity analysis was performed to identify the model parameters that most affect the model output. The model was then used to identify processing conditions that can minimise the energy and water use of the pasteurisation process.
Results: The developed fouling and cleaning model was able to predict the dynamic behaviour of key parameters associated with heat transfer. According to model outputs, moving from conventional, to more sustainable processing conditions can save up to 70% of the energy use and 65% of the water use related to fouling and cleaning. However, selecting optimal processing conditions (as determined by the model) may pose a risk of ineffective pasteurisation and/or cleaning due to uncertainty under real processing conditions. To understand how parameter uncertainty propagates to the output of the model, uncertainty analysis was performed and results were visualised through carbon footprint heatmaps.
Conclusion: The uncertainty output allowed the incorporation of a safety margin to the theoretically optimal processing conditions so that sufficient pasteurisation and cleaning is successfully performed for every process. The developed model has the potential to improve sustainability in milk processing and at the same time prevent any risk related with ineffective pasteurisation or cleaning.

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Predicting milk contamination under climate change scenarios

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Aim:
This work aims to predict microbial food safety risks due to climate change for dairy. This is realized by utilizing impact models describing the effect of climatic factors on the contamination of raw milk, i.e., total bacterial counts, as well as future projections originating from climate models accounting for different climate scenarios.
Method:
This work follows the impact modelling methodology. This requires the use of an impact model that, when initialised with future projections trajectories, evaluates the risk under study due to climate change. In this study, microbial contamination of raw cow milk is considered. The impact model utilised was developed and validated based on a 5-year data set from 121 Maltese dairy farms using data-driven modelling. The climate change projections used to initialise the impact model are generated through a multi-model ensemble of CMIP6 climate models. These are first screened based on grid quality, and then bias-corrected based on observations using the delta method as well as the quantile mapping method. Finally, the multi-model ensemble is computed using a weighted average and is used to predict microbial contamination under climate change scenarios.
Results:
The developed impact model successfully predicts raw milk contamination using temperature, precipitation, wind speed, and humidity as predictors. 11 CMIP6 climate models are selected based on data quality and applicability. The weights of the multi-model ensemble are estimated based on the climate sensitivity of each model. The impact model predicts the raw milk contamination for Malta under different climate change scenarios with an average 10% relative error. Thus, it allows the assessment of food safety issues that arise under climate change. According to the results, milk contamination is predicted to become a food safety issue under all climate change scenarios. The business-as-usual scenario corresponds to the highest milk contamination levels.
Conclusion:
The approach presented can be applicable to other case studies, referring to different regions and/or products, given the necessary data. The results from climate change impact assessments such as this one are valuable for policy-making and adaptation planning. Eventually, both the public health and the resilience of the food system are promoted.

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Shaping our Future Sustainable Food Systems

Dr. Daniela Lüth[1], Dr. Hugo de Vries[2,3], Dr Jeroen Knol[3], Dr. Jonas Lazaro-Mojica[4], Dr. Denisa E. Duta[5], Dr. Kaye Burgess[6], Dr. Michał Janiak[7], Dr. Manuela Pintado[8]
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Special Session Description:
The new European framework program for research and innovation is called Horizon Europe. Herein, a new instrument is launched, called 'Partnerships', which are foreseen to play a crucial role in the Green Deal, Farm-to-Fork Objectives, and, overall, the transition towards sustainable societies. One of the Partnerships is called Sustainable Food Systems, providing interesting, new research topics for the food communities. In this session we will present how European Partnerships in Food may contribute to the Green Deal and Farm-to-Fork objectives. Then, the recently started FOODPathS project will be introduced that will develop a prototype of the European “Partnership for Sustainable Food Systems (SFS). Followed by a presentation on how a new network of universities, that will be created within the framework of FOODPathS, will support local food ecosystem; The next FOODPathS presentation will discuss the setting of the structure for a European Knowledge Hub, composed of a network of Food Systems Living Labs (FS-Labs). The session will be closed with four Sustainable Food System case-studies in different European Countries.

Chair: Dr. Hugo de Vries
INRAE, Paris, France

Presenter 1: Daniela Lüth
DG Research and Innovation, Unit Bioeconomy and Food Systems, European Commission, Brussels, Belgium
European Partnerships in Food responding to Farm 2 Fork objectives

Abstract:
Horizon Europe Partnerships drive green and digital transitions and support the achievement of EU priorities, such as the European Green Deal. They are impact-driven by deploying a broad range of R&I activities from concept to demonstration and validation.
One of the foreseen Partnerships is the Partnership on “Sustainable Food Systems for People, Planet and Climate” to collectively develop and implement an EU-wide committed research and innovation partnership to accelerate the transition towards healthy diets that are safe and sustainably produced and consumed in resilient EU and global food systems.
The Partnership supports main EU policy objectives, especially the farm-to-fork strategy and the Food 2030 framework, a cornerstone in system thinking that provides a vision and narrative for a systemic R&I approach to deliver co-benefits, Nutrition for sustainable, healthy diets, Climate smart

and environmentally sustainable food systems, Circularity and resource efficiency of food systems, and Innovation through empowerment of communities.
The Partnership aims to do nothing less than 1) Change the way we eat, 2) Change the way we process and supply food, 3) Change the way we connect with food systems and 4) Change the way we govern the food system by using Pooled R&I resources and joint programming, a Food Systems Observatory and Knowledge Hub as well as Knowledge sharing and scaling.

Keywords:

Presenter 2: Hugo de Vries
INRAE, Paris, France
FOODPathS leading to the future Partnership Sustainable Food Systems
Co-author(s): Niels Halberg1, Emmanuelle Lagendijk2, Damien Guimond2
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2 INRAE Transfert SAS, Clermont-Ferrand, France

Abstract:
In Europe, the Farm-to-Fork Strategy and the overarching Green Deal strive for reaching sustainable food systems in the coming decades. One of the new instruments in the current framework programme HorizonEurope (HE) is the Partnership. In HE cluster 6 'Food, Bioeconomy, Natural Resources, Agriculture and Environment', DG Research and Innovation together with the Standing Committee on Agricultural Research (SCAR) Strategic Working Group Food Systems have been preparing the Strategic Research and Innovation Agenda (SRIA) and the narrative of the candidate Partnership Sustainable Food Systems (P-SFS).
The SRIA will address four R&I focus areas, namely (i) Change the way we eat, (ii) change the way we process and supply, (iii) change the way we connect and (iv) change the way we govern food systems. It will also target four transversal activity areas, namely (A) co-funding and programming, (B) Observatory, (C) The Hub of Hubs and (D) Knowledge sharing and scaling. Since the Partnership SFS is a very ambitious instrument, a preparatory HorizonEurope CSA (coordination and support action) project FOODPathS will develop the prototype Partnership. This is thanks to 17 network organisations active in the public and private domains at local to global levels. A view on its main building blocks will be here presented, including the elaborated SRIA, governance model, modus operandi, system approaches and network of Living Labs. Several case studies will elucidate the inspiring trajectory, the need for joint actions, potential trade-offs globally and potential contributions of the audience.
Keywords:

Presenter 3: Jeroen Knol
European Federation of Food Science and Technology, Wageningen, The Netherlands
Towards an EU network of university-driven local food ecosystems
Co-author(s): Paweł Chmieliński1
1 Institute of Rural and Agricultural Development of the Polish Academy of Sciences, Warsaw, Poland
Abstract:
The FOODPathS project will set up a prototype for the European "Partnership for Sustainable Food Systems (SFS) for people, planet and climate" - a new European governance model to co-fund future research and innovation (R&I) activities at local, national and EU level. As European Food Systems

are affected by complex challenges requiring a systemic approach, FOODPathS creates a powerful network with diverse public and private entities to ease the food systems transition. One of the main activities is the setup a network of university-driven local food ecosystems in which the actors adhere to a code of practice and action plan that motivates the organisation, staff, and students to foster Food 2030 inspired food system transition.
The project will aim to build this EU network of university-driven local food ecosystems through the following actions: mapping European universities and research centres that can act as SFS actors in a new-to-build network; reviewing food systems education and lifelong learning programs; establish an improved FS education and training program by helping to fill skills and knowledge gaps; Develop a charter for exemplary SSFS universities, research centres and education programs for FS-oriented trainings.
Keywords:

Presenter 4: Jonas Lazaro-Mojica
FoodDrinkEurope, Brussels, Belgium
FOODPathS Exploring collaboration between diverse actors in a network of Food System Labs
Co-author(s): Françoise Gorga1, Eduardo Cotillas2, Hugo de Vries3
1 ANIA, Paris, France
2 FIAB, Madrid, Spain
3 INRAE, Paris, France

Abstract:
The project FOODPathS will be used as a prototype of the Sustainable Food Systems Partnership. One of the main activities is the setting of the structure for a European Knowledge Hub, composed of a network of Food Systems Living Labs (FS-Labs). The Food Systems Living Labs are understood as collaborative, stakeholder-driven R&I approaches to co-create new products and services which should support the transition to Sustainable Food Systems. A variety of FS-Labs may target different objectives bringing together public and private stakeholders such as the food manufacturers, the end-users, other members of the Food Systems (e.g. farmers, retailers, etc.), service and technology suppliers (e.g. digitalisation, nutrition, health, environmental sustainability and circularity, social sciences, etc.), and other stakeholders such as policy makers and institutions at national, local, and regional level.
The project will aim to build this network of Living Labs through the following actions: Reviewing existing structures and identifying best practices for co-creation in Food Systems; Establishing a possible framework for engagement of private parties at EU level; Co-creating national and regional Food System Living Labs mixing public and private actors through a pilot example; and Develop a 'hub of Food System Labs' concept.
Keywords:

Presenter 5: Denisa E. Duta
National Institute of Research and Development for Food Bioresources IBA, Bucharest, Romania
Stimulating short food supply chains (fruit, vegetables, traditional foods)-case study Romania
Co-author(s): Nastasia Belc1
1 National Institute of Research and Development for Food Bioresources IBA, Bucharest, Romania
Abstract:

Covid-19 had a significant impact upon the consumers' behavior during the year 2020 in relation with food choice, quantity and, even, quality of food. This change affected especially the distribution of fresh fruit / vegetables and traditional foods. In March 2020, during the "state of emergency" the public alimentation activities were drastically limited. The farmers' and small producers' access to markets to valorize their products was limited as a result of transport restrictions and quarantine measures. Disturbances in food distribution influenced the production, the level of food waste as well as the income of operators along the food system.
On the other hand, consumption habits/patterns and consumer behavior changed, it was observed an increase in both basic foods and ready-to-eat products that can be stored. As such, fresh vegetables and traditional food product losses occurred. The lack of a sales market and a distribution network determined vegetable growers to destroy their spring vegetable crops - lettuce, spinach, etc. - or use them as animal feed.
In order to stimulate short food supply chains, consumption from nearby farms was promoted on social networks. Both online product sales and home deliveries have been accelerated. Food Hubs were organized to collect and sell the products of small agricultural entrepreneurs from different areas and different online platforms were developed. In Food Hubs, farmers and small producers received support to update their recipes, training, consulting, and they were taught to promote themselves through online platforms. As a result, online sales increased by 400%. The shift towards a more digital world will have lasting effects for the future. The Internet became a mediator between producers and consumers with the power to create new demand for Romanian fruit and vegetables and traditional food during the COVID-19 crisis.
Keywords:

Presenter 6: Kaye Burgess1
Teagasc, Moorepark, Ireland
Embedding food safety considerations for water usage in food production systems
Co-author(s): Declan Troy1, Brijesh Tiwari1
Teagasc, Moorepark, Ireland
Abstract:
Providing food safety assurance is critical to the integrity and success of food systems. Food may become contaminated from water at any stage during its production, post-harvest processing or distribution. Within the wider food industry water is used in a range of unit operations; as an ingredient, cleaning, cooling, processing and other purposes. Water can be obtained from a range of sources, including municipal water supplies, groundwater, recovered rainwater, surface water, or reutilised wastewater. Water sources of poorer microbiological quality can be a source of contamination and many outbreaks of foodborne disease globally have been linked to contaminated water. It is therefore essential that water of good microbiological quality is used in food production. In recent years there has been increased focus on reducing water use and reusing water. The treatment of wastewater to enable its reuse for a range of purposes, including for food production. Within food production systems there are a number of opportunities to capture wastewater and treat it to enable reuse. This case study will focus on the risks posed by the use of contaminated water in food production, the application of novel technological interventions (e.g. cold plasma, ultraviolet light, cavitation technologies) for the treatment of wastewater in the sector, and the added benefits of the application of these technologies in food production systems. This case study will also demonstrate innovative approaches for water reuse with the food industry without

compromising the food safety concerns whilst improving environmental credentials of the food production systems.
Keywords:

Presenter 7: Michał Janiak
Institute of Animal Reproduction and Food Research, Polish Academy of Sciences, Olsztyn, Poland
‘Soup-action’ as an example of local campaign against the challenges of food systems during the pandemic.
Co-author(s): Iwona Kieda1, Tomasz Jeliński1
1 Institute of Animal Reproduction and Food Research, Polish Academy of Sciences, Olsztyn, Poland
Abstract:
The SARS-CoV19 pandemic affected many actors of the food systems. Some groups of people are more at risk of COVID-19 exposure. During the early stage of the pandemic, they suffered severely from the procedures and ways of behaving that were being developed from the beginning and after the first shock. Main groups that were automatically at the higher risk were elderly and disabled people. At the same time, food producers also suffered from the restrictions and sudden change in the behaviour of clients.
Soup-action was coordinated by Food Bank Olsztyn and it took place in Olsztyn, Poland. It ensured that elderly and disabled people who were excluded from their daily routine due to the SARS-CoV19 pandemic were provided with the full meals. They are among the group associated with the highest risk related to the COVID-19 exposure. Soup-action delivered them on a daily basis complete meal to minimize risk taken during daily actions.
Meals were prepared from ingredients secured from retailers and food producers. It also limited food wasting by those entities during the early stages of the pandemic. Meals were provided as ready to eat / cook for three days and delivered by volunteers during the first and second wave of cases in Poland.
This activity involved many actors from local food systems such as NGOs, consumers from high-risk groups, food producers and retailers. It provided meals for consumers, limited food wasting and provided income for food producers and retailers. This action also contributed in raising awareness of the food wasting problem during the pandemic.
Keywords:

Presenter 8: Manuela Pintado
Universidade Católica Portuguesa, Porto, Portugal
Synergies and value creation from losses and waste and efficient use of resources in the agri-food chain
Abstract:
Currently along the agrifood chain, about 1/3 of the food produced is lost or wasted, which requires urgent solutions, involving waste reduction, efficient use of resources and the reuse and valorisation of waste, by-products and effluents. The great variability of by-products and effluents generated in the food system makes the development of integrative solutions difficult but allow added value and expands the possibility of end users of the solutions developed. During the presentation, the project MOBFOOD - Waste and Efficient Use of Resources in Agrifood sector will be presented responding to one of the great challenges of the integrating strategies in food chain in the context of Circular Economy and the Bioeconomy. The project was developed by a multidisciplinary consortium (7 companies and 5 R&D institutions) and was organized into 4 main lines: 1 - valorisation of protein

by-products with elimination costs (blood, hair and blood serum) and those with low value solutions (blood and bone flours), 2 - valorisation of vegetable by-products, 3- valorisation of aromas generated in the processing condensates and 4 - efficient use and recovery of effluents.
The project resulted in 6 new prototypes for food, 6 prototypes for animal feed, and 3 for other applications, including agriculture and energy. The opportunity to integrate the food chain and the engagement of different stakeholders made it possible to maximize the application of a circular economy approach, ensuring regeneration and creation of added value, promoting the diversification of new products and solutions, as well as the creation of industrial synergies.

EFFoST/IFT-NPD Workshop Abstracts

Oral Presentations

6

Non-thermal Plasma for Fresh Produce:
Scaling Efficacy from Bench to Prototype/Industry for gaseous/liquid applications

Dr Uta Schnabel[1], Dr. Thomas Weihe[1], Mr. Jörg Stachowiak[1], Prof. Paula Bourke[2], Dr. Jörg Ehlbeck[1]
[1]Leibniz Institute For Plasma Science And Technology, Greifswald, Germany, [2]School of Biosystems and Food Engineering, University College Dublin, Dublin, Ireland

Aim of work: Organic and fresh-cut produce such as apple and lettuce may contain a very high microbial load, and despite a good safety/quality record overall, have been associated with human/plant pathogen associated outbreaks/losses. The need for sustainable, non-thermal interventions and effective antimicrobial agents at post-harvest stages for increasing food safety/shelf-life by reducing food losses simultaneously remains.
Methodology: Sanitation steps based on non-thermal plasma (NTP) opens up innovative food processing possibilities through application at different points and modes of delivery along the food chain; for production, modification, and preservation, as well as in packaging of plant-originated food. Plasma contains reactive species and free charge carriers caused by ionization processes of the gas atoms and molecules, which mediate effects either in gaseous or liquid forms of delivery.
Results/Discussion: This talk describes innovations in a plasma process that resulted in a complete industrial scale fresh produce (lettuce) processing line for cutting, washing and drying based on Plasma Treated Water (PTW). Further, a new possibility to sanitize organic apples by Plasma Processed Air (PPA) at prototype level will be presented. The treatment of natural products with changing parameters (size, surface, water content) is challenging for the design/optimization of non-thermal plasma processes. To overcome these challenges, a specific plasma process based on microwave plasma operated with air was established to deliver PPA as the antimicrobial agent to sanitize apples or to process tap water. The latter served to generate and scale the PTW with antimicrobial properties. The primary process development focus was on the antimicrobial efficacy when used on the produce and in the washing water, but changes in product quality and potential by-products were also monitored.

Conclusion: To successfully scale up, the PPA/PTW-application, an understanding of the antimicrobial properties, the chemical composition of plasma, PPA, PTW and process water, and resultant food quality characteristics (e.g. texture, color, nitrite/nitrate content, Chlorophyll a/b, and ascorbic acid) was developed. The optimized PPA process was implemented into a prototype-scale apple-sanitizing process. More important, the optimized PTW production and decontamination process was implemented into an industrial-scale lettuce-processing line thus demonstrating the industrial scalability and applicability.

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Continuous recovery of valuable ingredients from microbial production systems by pulsed electric fields

Dr Felix Schottroff[1]
[1]*Boku Vienna, Vienna, Austria*

Aim of work:
Precision fermentation is among the most promising concepts for future food processing. Microbial expression systems bear great potentials for sustainable and efficient production of functional compounds. However, high recovery yields often rely on cell disruption, which is usually accompanied by complex and expensive purification processes. Thus, novel technologies can help to improve the processing of these new raw materials. In this regard, pulsed electric field (PEF) treatment can be considered as a powerful tool for cell disintegration and selective protein release from bacteria.

Methodology:
A study is presented, in which *E. coli* BL21(DE3) was cultivated in a 10-L bioreactor, to a cell dry weight of 41.5 g/L. Recombinant protein A (~50 kDa) was chosen as a functional model compound. The cell suspension was PEF-treated, using a specific self-designed continuous system (1.5 L/h, 3 µs pulses, 25.6-44.0 kV/cm, 50-1000 Hz, 10.3-241.9 kJ/kg), and influence of the treatment on product and contaminant release, as well as viability was assessed.

Results/Discussion:
Results showed a maximum product yield of 89%, with increasing energy input. Inactivation of bacterial cells also gradually increased, with a maximum of 0.9 $\log_{10}$ at 241.9 kJ/kg. Based on the DoE, optimum conditions (protein release ≥75%; cell death ≤3%) among the investigated parameter range were determined to be electric field strengths ≤28 kV/cm, and frequencies ≥825 Hz. Moreover, samples showed distinctly higher purity of the target protein, compared to conventional homogenization.

Conclusion:
PEF treatment and the associated electroporation were shown to be an innovative alternative to cell disintegration technologies commonly used in downstream processing. Moreover, due to the ability to preserve viability, PEF may potentially be implemented for continuous bioprocesses with intermediate removal of intracellular products. Therefore, this process opens a wide field of potential applications reaching from production of food-grade proteins and enzymes to biotechnological and pharmaceutical compounds.

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Application of pulsed light in a hurdle approach in winemaking process

Assoc. Prof. Gianpiero Pataro[1,2], Ms. Vittoria Del Grosso[1,2], Prof. Giovanna Ferrari[1,2]
[1]Department of Industrial Engineering, University of Salerno, Fisciano, Italy, [2]ProdAl Scarl, Fisciano, Italia

Aim of work:

Pulsed Light (PL) is a promising non-thermal technology used for microbial inactivation in food and food contact surfaces. In this work, the susceptibility to PL treatments of *S. cerevisiae* inoculated in a white model wine (pH=3.5, absorption coefficient 5 cm^{-1}) was investigated, with the main aim to demonstrate its potential as an alternative or to reduce the use of synthetic disinfectant chemicals (methabisulphite) in winemaking process..

Methodology:

PL treatment was carried out in a continuous flow system at different total fluence (from 2 to 12 J/cm^2) and inlet temperature (from 20 to 45 °C) to the treatment chamber. The experiments were carried out to investigate the effect of PL treatment alone, or in a hurdle approach when applied before or after the addition of an optimal concentration of methabisulphite (85mg/L) determined upon preliminary experiments. The cell viability in the samples before and after each treatment was determined by the plate count method. Survival fraction of *S.cerevisiae* was detected after an incubation period of 4 days at 28°C and the stability of processed wine was monitored for up to 30 days.

Results/Discussion:

Results showed that PL is effective in the inactivation of *S. cerevisiae* cells in model wine (5 log reduction), especially when applied at moderate temperature (35-45°C), which seems to increase the sensitivity of microbial cells to the irradiation treatment. The higher the fluence and the inlet temperature, the greater the inactivation level. The combination of PL treatment with relatively low concentration of methabisulphite, especially when this latter was added to wine before PL exposure, can allow the microbial stabilization of wine for at least 30 days.

Conclusion:

In conclusion, results of this work highlighted the potential of PL to be implemented in winemaking process for the yeast inactivation in must or wine, allowing to markedly reducing the amount of synthetic chemical disinfectant substances (SO_2) typically used in current practice.

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Recovery of bioactive compounds from fruit juice waste streams by industrial Ultrasound Assisted Extraction.

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Aim:
Orange and apple juice industry generate million tons of waste per year.
The aim of this study is to extract bioactive compounds from orange peels and apple pomace using ultrasound at pilot scale and to assess their antioxidant and antimicrobial activities.

Method:
Fresh orange peel and apple pomace, obtained from juicing processes, were subjected to ultrasound in water at 20 kHz (Hielschier UIP2000hdT) and 1:4 sample to water ratio. A response surface design was done to optimise the ultrasonication conditions (time and amplitude). The extracts were then either spray dried with pectinase pre-treatment or freeze dried and analysed for total phenolic content (Folin-Ciocalteu method); antioxidant activity using Ferric Reducing Ability of Plasma (FRAP), and radical scavenging (DPPH and ABTS); and antimicrobial activity (disk diffusion assay).

Results:
The extracts produced had a high total phenolic and antioxidant content which were proportionally significantly increased ($p < 0.05$) with the increasing ultrasonication time. Spray dried extracts expressed similar or higher antioxidant response than the freeze-dried products. The highest phenolic content was 2181.39 ± 21.78 and 80.01 ± 2.72 µM gallic acid equivalents for orange peel and apple pomace spray dried extract, respectively. The highest antioxidant content was 636.01 ± 7.46 and 36,20 ± 0,40 µM of trolox equivalents (ABTS), 232,82 ± 1,79 and 16,24 ± 0,07 µM gallic acid equivalents (FRAP) for orange peel and apple pomace spray dried extract, respectively. No antimicrobial activity was detected against *Candida albicans*, *Saccharomyces cerevisiae*, *Escherichia coli*, *Staphylococcus aureus*, and *Bacillus subtilis*.

Conclusion:
This work showed how the extracts from orange peel and apple pomace produced by ultrasound were rich in phenolic compounds with high antioxidant capacity. The results provide a better understanding on the performance of the ultrasound which helps for next steps in development of new food ingredients.

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Nonthermal processes for the valorization of yeast biomass

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Aim of work:
S. cerevisiae constitutes the second most abundant brewery by-product, utilized for the production of high added-value products with application in the food industry. The process of autolysis plays a pivotal role in their production. Its duration exceeds 24 h at elevated temperatures. A preceding cell disintegration step accelerates the process of autolysis by removing cell compartmentalization and increasing cell permeability. Production of yeast extract leaves behind significant amounts of cell wall material, rich in β-glucans, also dependent on previous disintegration. Nonthermal technologies can be implemented for the processing of yeast biomass to enhance the production of yeast-derived products. Pulsed Electric Fields (PEF), High Pressure (HP) processing and High Pressure Homogenization (HPH) can disrupt cellular structures or affect endogenous enzyme activity, leading to increased efficiency in autolytically-derived processes and products. This work utilizes PEF, HP and HPH pretreatments for increasing the effectiveness of yeast biomass valorization.
Methodology:
Yeast suspensions were subjected to various PEF (5-20 kV/cm, 1-1000 pulses), HP (200-750 MPa, 1-120 min) and HPH (200-800 bar, 1-6 passes) treatments. All samples were subjected to autolysis (52°C, pH=5.5) for production of yeast extract. The course of autolysis was assessed and mathematically modelled based on the release of soluble protein, free α-amino nitrogen, proteolytic activity, β-glucan and total solids. The increased permeability of cells was also studied in terms of using yeast cells as carriers for the encapsulation of oregano essential oil.
Results/Discussion:
Autolysis time was reduced up to 78% by PEF treatment. HP treatment affected cellular disintegration and proteolytic activity which was enhanced up to 1.5-fold, leading to acceleration of amino acid release up to 50%. HPH treatment led to a twofold yield increase in amino acids and an acceleration of autolysis up to 78%. In the insoluble cell wall residue of autolysis, HPH significantly increased the content of β-glucans by 56% while decreasing protein content by 26%. Encapsulation of oregano essential oil in PEF and HPH treated cell material was enhanced leading to 95% faster encapsulation.

Conclusion:
The results obtained from this work highlight the potential use of PEF, HP and HPH as cell pretreatments for the valorization of yeast biomass.

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Sublethal moderated pressure and ultrasound pre-treatments for subsequent shorter and improved whole egg pasteurization

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Aim

Salmonellosis is the second most common zoonosis in humans in the European Union, with eggs and egg products being the food vehicles most frequently associated to this infection. The use of liquid egg products as a substitute for shell eggs, in the food industry, requires processing, but thermal pasteurization (TP) induces changes in egg properties. Thus, one possible advantageous strategy to overcome TP limitations may be to apply pre-treatments at sublethal intensities, weakening the microorganisms to decrease thermal resistance, allowing a subsequent less intense TP.

Method

In this work liquid whole egg (LWE) was submitted to pre-treatments of moderate pressure (MP, 50 – 160 MPa/5 min) and ultrasound (US, 50% amplitude (166 µm at 100 %)/1 – 3 min), alone and sequentially combined, before a shorter TP (60 ºC/1.75 min) than the usual commercial TP (60 ºC/3.5 min), to assess the effect on the inactivation of *Salmonella* Senftenberg 775W, aiming to cause minimal impact on LWE quality.

Results

The results showed that most promising pre-treatment combination order to improve LWE TP was MP followed by US. In the combined pre-treatments, the increase of US time showed no significant effect on *S.* Senftenberg 775W inactivation, while the increment of pressure up to 160 MPa improved the lethal effect. Thus, the combination of MP (160 MPa/5 min) followed by US (50 %/1 min) before a shorter TP (MP-US-TP) achieved 5.10 $\log_{10}$ cycles reductions, similar to commercial TP. Regarding LWE quality, overall, a higher protein solubility (19 %), similar emulsifying stability and thermal properties studied by DSC, and a lower viscosity (44 %), emulsifying activity (39 %) and global volatile profile compounds (7-fold lower) was found for MP-US-TP compared to commercial TP. Generally, the results point to US effect on quality being predominant in MP-US-TP samples, since these samples showed values closer to US-pre-treated LWE.

Conclusion

Therefore, the results showed that the combination of MP (160 MPa/5 min) followed by US (50 %/1 min) before a shorter than commercial (half of the time) TP resulted in a safety level for *S.* Senftenberg 775W similar to commercial TP, with generally no major deleterious quality effects.

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Effect of PEF pretreatment on physical and chemical properties of freeze-dried strawberries and bell peppers

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Aim of work:
Freeze-drying is considered a gentle drying process able to preserve nutritional and qualitative properties of thermal sensible food materials. Freeze-dried products represent high-value ingredients often used in dried soups, dried snacks, breakfast cereals and cereal bars. However, during the freeze-drying, phenomena as collapse and shrinkage are likely to happen in sugar-rich plant materials. The aims of this study is the application of pulsed electric fields (PEF) as pre-treatment to improve the process performances and reduce the shrinkage and collapse phenomena, without negatively affecting the final quality of freeze-dried strawberries and bell peppers.
Methodology:
The effects on chemical and physical properties of PEF pre-treated freeze-dried strawberries and red bell peppers was investigated. PEF treatments at fixed electric field strength and frequency (E= 1.0 kV/cm and f = 1 Hz) and a variable number of pulses (20, 50, 100 and 200) have been applied. The resulting energy inputs were between 0.3 and 6.0 kJ/kg The effects on the process efficiency were evaluated via freezing kinetics and freeze-drying kinetics. Moreover, the quality of freeze-dried fruits and vegetables were evaluated by cell disintegration index, shrinkage measurement, rehydration capacity, mechanical properties, colour determination and chemical analyses (ascorbic acid, polyphenols, antioxidant compounds and anthocyanin content).
Results/Discussion:
Results showed that the PEF treatment has positive effects on the freeze-drying process and on the overall quality of the freeze-dried products. In particular, it positively affected the physical characteristics of the samples better preserving the original shape of the fresh fruits and vegetables. Moreover, the treated samples showed a lower firmness and increased rehydration capacity. PEF treatment does not appear to have any additional negative effects on the analysed nutritional compounds compared to untreated samples.
Conclusion:
The reduction of shrinkage phenomenon in the PEF treated plant materials could represent an important advantage for marketing purposes as due to the less volume losses, they resulted in more similar to the corresponding fresh products and likely more desirable for customers. Overall, the results of this study suggest that PEF could be an effective pre-treatment to improve the freeze-drying process and the final quality of freeze-dried fruits and vegetables

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Role of sugars on the inactivation of polyphenoloxidase induced by cold atmospheric plasma

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Role of sugars on the inactivation of polyphenol oxidase induced by cold atmospheric plasma

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Abstract

Aim of work:
Polyphenoloxidase (PPO) is one of the most detrimental enzymes in plant processed foods being responsible for enzymatic browning, off-flavors, and loss of bioactive compounds. To propose a "gentle" alternative to traditional enzymatic inactivation methods, the present study investigated the effect of cold atmospheric plasma (CAP) in inactivating PPO and the role of different sugars, naturally present in plant products, on the inactivation and structural modification of this enzyme.
Methodology:
Model systems were prepared using a commercial purified PPO and different concentrations of glucose, fructose, sucrose, and trehalose in phosphate buffer (pH 6.5). CAP treatments (6 KV; 23 KHz; duty cycle 10 %) were applied at times ranging from 5 to 30 min. Spectrophotometric analyses were conducted (fluorescence, circular dichroism, atomic absorption UV-VIS) before and after CAP treatments to evaluate the PPO activity and structural changes.
Results:
The different sugars depending on their concentration showed to interact with PPO by modifying its catalytic activity and ternary and secondary structure.
Cold plasma treatment determined a significant reduction of the enzymatic activity in all the investigated systems; this effect was time-dependent. Sugars differently interacted with the PPO and modified its structure and catalytic activity depending on their type and concentration. In particular, fructose showed to positively influence the inactivation of the enzyme both at low and high concentrations while sucrose and trehalose, at the highest concentrations and treatment times showed a protective effect on the structure and functionality of the protein.
Conclusions:
The presented study shows the CAP capability of reducing the activity of PPO in model food systems. In addition, it describes the role of sugars in the inactivation of the enzyme. Future experiments will be aimed at evaluating the effect of CAP on the inactivation of PPO in real fruit and vegetables characterized by different sugar compositions.

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Using High Pressure Processing to create novel protein based structures and textures

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Aim of work: This work explores pressure-induced structural and functional changes in protein systems of varying concentrations, and the effect of pH and Calcium addition on these changes.

Methodology: Milk protein concentrate (MPC), micellar casein concentrate (MCC) and pulse (pea, lentil, and faba bean) protein concentrate (PPC) powders were reconstituted in water to form solutions of up to 12.5% concentration for milk proteins, and up to 15% for pulse proteins. A reduction in pH was achieved by using glucono delta lactone. The protein solutions were packed in flexible packaging and subjected to HPP (600 MPa, 4 min, 5ºC, in a 50L Hiperbaric unit). Structural differences amongst untreated and HPP-treated proteins were investigated using rheological analyses and scanning electron microscopy (SEM). For PPC, changes in protein solubility, water holding capacity, emulsifying properties, and foaming properties were determined. Experiments were performed in triplicate, and data was analyzed statistically.

Results/Discussion: HPP induced significant concentration and pressure dependent changes in all protein systems, with globular proteins being denatured and casein micelles destabilized. SEM provided evidence of protein aggregation observed at lower concentrations and network formation at higher concentrations. Gel formation occurred above a minimum protein concentration of 10% (w/w) for MPC and MCC, and 12% for PPC. HPP treated high concentration samples had 2-4 orders of magnitude higher elastic modulus (G') compared to untreated controls. For all proteins, gel strength and structure were affected by the decrease in pH, with the net effect being different for the various proteins. The addition of Calcium increased gel strength for all protein concentrates. For PPC, water holding capacity increased from 19-32% for untreated samples to 94-96% for HPP-induced gels. Protein solubility was 57-65% in the untreated samples and 25-30% for HPP-treated samples ($p<0.05$). HPP treatment also increased emulsifying stability, foam expansion, and foam liquid stability, but decreased emulsifying activity.

Conclusion: These findings demonstrate that controlled structure engineering of high concentration protein systems by HPP can result in unique structures and textures. This data provides a basis for the development of novel protein based foods, with built in safety and interesting textures and structures.

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Ultrasound effect on the bioactive compounds and physicochemical properties of almond beverages

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Aim of work: Ultrasound (US) is a non-thermal emerging technology developed to minimize process severity and thus improve the quality and safety of food products. In the present work, the content of biocompounds and the physicochemical properties of almond beverages were evaluated after treatments by high-intensity ultrasound and compared to a conventional high-temperature short time thermal treatment.

Methodology. Raw almond *(Prunus dulcis*) seeds were purchased in Irapuato, México. After overnight soaking at 4°C in distilled water (3:1 ratio w/v), almond seeds were drained, and the skin was removed manually. Almonds seeds mixed with water (1:6 ratio w/v) were ground in a blender for 180 s. The almond beverage (200 ml by sample) was processed by non-thermal high-intensity ultrasound at 20 kHz for 15 and 30 min and wave amplitude of 50, 80 and 100%, and by high-temperature short time (90 °C for 60s) thermal treatment. Total phenolic compounds (mg GAE/100 mL), total flavonoids (mg QE/100 mL), pH, cloud value, total soluble solids, color, moisture content, and ash content were analyzed.

Results/Discussion. Ultrasonic amplitude and time affected the content of biocompounds in the almond beverage, where a lower ultrasonic amplitude (50%) and time (15 min) increased the content of total phenols and flavonoids. The thermal treatment resulted in lower values for the content of flavonoids and phenolics (0.12 mg GAE/100 mL, 5.04 mg QE/100 mL), compared to treatments with ultrasound, mainly when applying 50% amplitude and 15 min of treatment (0.33 mg GAE/100 mL and 40.01 mg QE/100 mL, respectively). The pH and cloud values increased with amplitude and time, while the color parameters (a *, b *, C * and H *) decreased. However, an increase in lightness and whiteness index were observed. Moisture, total soluble solids and ashes did not show significant changes (p>0.05).

Conclusion: In comparison with the conventional thermal treatment, ultrasound treatments improved the retention of the almond beverage biocompounds. However, negative changes in physical properties were observed.

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Optimization of bioactive compounds from marigold flower using ultrasound-assisted extraction by response surface methodology

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Aim:
The objectives of this study were to use response surface methodology (RSM) based on Box-Behnken design (BBD) to optimize the bioactive compound and antioxidant activity of marigold flower by an ultrasound-assisted extraction (UAE) and to evaluate the antimicrobial activity against pathogenic bacteria in marigold flower extract (MFE)
Method:
Temperature (30–50 °C), extraction time (5-15 min), and ethanol concentration (60–100%) were the extraction variables. The responses were; total phenolic compound (TPC), total flavonoid content (TFC), total carotenoid content (TCC) and antioxidant activity (DPPH and FRAP assays). The antimicrobial activities against *Escherichia coli* (*E. coli*) and *Staphylococcus aureus* (*S. aureus*) were conducted on the optimized extract by minimum inhibitory concentration (MIC) and disk diffusion methods. Chloramphenicol and ethanol were respectively used as positive and negative controls.
Results:
The RSM analysis revealed that the model was significant ($p \leq 0.05$) in interactions between all variables (TPC, TFC, TCC and antioxidant activity by DPPH and FRAP assays), with a lack of fit test for the model being insignificant ($p > 0.05$). The RSM analysis also showed that temperature (40℃), time (15 min), and ethanol concentration (68%) (v/v) were the optimal extraction conditions which showed the greatest values of TPC (75.699 mg GAE/g db), TFC (68.740 mg QE/g db), TCC (234.741 mg β-carotene/100g db), and antioxidant activity by DPPH (630.37 mM TE/100g db) and FRAP (3226.17 mM TE/100g db) assays. The antimicrobial results (disk diffusion method) showed that the optimized MFE produced inhibition zones of 9.66 mm and 8.00 mm vs ethanol as a negative control (no inhibition) and chloramphenicol as positive control (20.3 and 18.3 mm) against E. coli and S. aureus, respectively. Corresponding to the MIC values, MFE was able to inhibit to E. coli and S. aureus with the values of 25 and 50 mg/mL, respectively.
Conclusion: The findings of this research will be applied in the food sector for eventual integration into processed foods to develop products with higher bioactive and health benefit.

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Impact of Pulsed Electric Field (PEF) on Vegetable Processing: Case Study on Carrot Processing

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Aim:
The aim of this study was to analyze the impact of pulsed electric field (PEF) pre-treatment on the industrial processing steps of carrot tissue in a holistic view.
Method:
The PEF treatment was performed at an electric field intensity equal to 1.07 kV/cm and varying specific energy inputs of 0.25, 0.5, 1 kV/cm. The raw material was cut into cubes of 10x10x10 mm, blanched (*T*= 88 °C, *t* = 6 min) and afterwards frozen (*T* = -34 °C, *V* = 2m/s). The cutting, blanching and the freezing behaviour were evaluated. The blanching process was assessed determining the influence on enzyme inactivation and leaching effect during water blanching. The quality of the processed carrot cubes was evaluated by color and texture analysis.
Results:
A PEF pre-treatment led to a cutting force reduction of fresh cut carrot cubes of up to 22 %. Moreover, PEF treated samples were characterized by a noticeably smoother cutting surface compared to untreated once being responsible for higher yield due to the quality improvement. Furthermore, a PEF pre-treatment resulted in a reduced blanching time by up to 30 % and an enhanced inactivation of peroxidase. In addition, the freezing time of PEF treated blanched carrots was reduced by up to 25 % compared to untreated ones. No significant difference in texture has been found after thawing for untreated and PEF treated samples indicating a high quality of the final product. The water content after thawing of PEF treated samples was higher although a higher water loss was observed for fresh carrot cubes immediately after cutting compared to the untreated sample. However, the lightness was slightly decreased for PEF pre-treated thawed carrot cubes.
Conclusion:
Applying PEF as a pre-treatment in vegetable processing shows the potential to shorten processing times and therefore positively impacting the sustainability of the process, while keeping the product quality high.

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Application of cold plasma technology for the shelf-life extension of fish fillets: industrial scale validation

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Aim:
The aim of this study was to implement in an industrial scale and validate the optimum results of laboratory experiments for the production of extended shelf-life fish fillets by using cold atmospheric plasma (CAP) technology: i. plasma activated water (PAW, as antimicrobial agent) and ii. plasma activated ice (PAI, as antimicrobial agent and cooling capacitor).
Method:
PAW was produced using a CAP Helium jet (flow rate 0.5 L/min, nozzle–water surface distance 4.3 mm, 7.2 kV, 100 kHz). PAW produced had H_2O_2 and NO^{3-} concentrations as 36.4 mg/L and 25.0 mg/L, respectively. PAW was transformed to ice flakes (PAI) having previously set the concentration of H_2O_2 to 3.8mg/L.
Two case studies were studied:

1. Fish (*Sparus aurata*) fillets followed the typical production procedure and at the final stage they were immersed into PAW for 10 min (fish:antimicrobial agent ratio=1:3). Then, the fillets were placed in insulated boxes with conventional ice flakes (plain water).
2. Same (non-immersed) fillets followed the typical production procedure and were finally placed in insulated boxes along with PAI flakes (fillets weight: ice weight was 1:1 in all cases).
3. Conventional fillets stored at insulated boxes with plain water ice flakes were also used as control.

In both cases, the fillets followed the typical chill chain (storage to the production warehouse for 1 day, transportation to the distribution warehouse and transportation to the supermarket warehouse). After totally 2 days of storage and transportation, the fillets were stored to consumers' refrigerators. Comparative evaluation (microbial load and physicochemical characteristics) of fillets stored to PAI and plain water ice flakes was conducted after 2 days from production and during 7 days storage at consumers' refrigerators.
Results:
In both cases, an approximately 30% microbial load reduction was measured after 2 days from their production, compared to control samples. The quality parameters were not affected by PAW immersion or PAI storage. The shelf-life of the treated samples was 1.5-fold the corresponding of control samples.
Conclusions:
The efficiency of PAW and PAI on perishable products (i.e. fish fillets) shelf-life extension was validated in industrial scale production and storage and distribution scenaria.

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Impact of high-pressure processing on qualitative and quantitative attributes of fresh pumpkin

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Aim: Novel food processing technologies are commercially applied to produce high quality fruit and vegetable products. In particular, High-Pressure Processing (HPP - non-thermal technology) is an emerging technology used for preservation of vegetables with health promoting properties. The primary aim of this study was to evaluate the effects of HPP on pumpkin samples.

Methods: In this study pumpkin cubes were treated at six different pressures (HPP100 to 600) at 20 °C for 3 min. Colour and texture as well as bioactive compounds such as polyphenols and carotenoids (LC-MS), volatiles (HS-GC-MS) and sugars (HPLC) were measured and compared to untreated (UNTR) samples. For the microstructure examination, the fixed and dyed sections were observed by means of an optical microscope at different magnifications (20,40 and 63X).

Results: Noticeable difference was observed in HPP600 samples, with a difference in terms of colour (i.e., ΔE 11.3+1.9) and hardness (87.4+27.8 N), compared to the UNTR ones (194.9+37.9 N). Pumpkin tissue showed great structural modifications such as changes in cell size and shape, cell wall damage, thickness of cell wall, cell dehydration, pectin degradation and calcium ions deposition mainly at very high pressures (300 to 600 MPa). UNTR samples showed the highest value of maximum and minimum cell elongation (88.9 and 72.2 µm respectively), perimeter segment (267.7+6.4 µm) and more regular cell wall thickness (1.5+0.1 µm) whereas HPP600 samples showed the lowest values for the same parameters. Specifically, higher number of extractable polyphenols was observed at middle pressure (200 to 400MPa), whereas at lower pressure (100 to 300 MPa) higher carotenoids content than UNTR was observed. Regarding volatile compounds, significant changes were observed for some aldehydes that increase after HPP application, while the opposite trend was observed for total sugars content.

Conclusion: This research revealed that high-pressure treatments from 200 to 400MPa could ensure a higher amount of "bioactive, volatiles and sugar components availability. On the contrary, treatments from 400 to 600 MPa pressure negatively influenced the structural quality.

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Plasma for food application: opportunities and challenges

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Aim
The need for non-thermal, sustainable technologies as an intervention to enhance food safety remains. Non-thermal plasma technology is an innovative food processing technology that offers opportunities to improve hygiene along different steps of the food production chain. Plasma is an ionized gas containing highly reactive species and uncharged molecules that have antimicrobial properties. It can be applied both in a gaseous form typically using air or nitrogen as the carrier gas or in a liquid form referred to as Plasma Activated Water (PAW). Within the public private partnership project Plasma4Hygiene, different applications of plasma technology have been evaluated using different food matrices and plasma sources.
Method
In the Plasma4Hygiene project, both the gaseous plasma and PAW were tested for different plant-based and animal-based food matrices and compared to performance in reference conditions typically used in laboratory setting.
Results
The presentation will discuss several results of plasma technology on food to highlight opportunities and challenges for food application. The application of PAW for mushroom, poultry meat and additional agri -products will be shown. Nitrite levels in the products were measured before and after treatment and showed significantly raised levels for most products. The implication of this will be discussed. To evaluate opportunities for poultry meat processing, both PAW and non-thermal air- and nitrogen-based atmospheric plasma were used on poultry meat model matrices. The poultry meat model matrix allowed to study impact of matrix composition without the complexity of the matrix structure. The results showed that a very fast inactivation of *Escherichia coli* on reference matric leading to more 4 log reduction within 15s. Strikingly, in the presence of either skin or meat components the inactivation of *E. coli* was largely reduced suggesting that the matrix composition and not the matrix structure protects cells from inactivation. These and other examples will be discussed in this contribution.
Conclusion
Cold plasma offers a new inactivation strategy different from conventional decontamination methods applicable to resistant food pathogens and spoilage strains. It is important to select the right match between type of technology and product application and to consider the food matrix complexity.

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The impact of pulsed electric field pretreatment on convective and vacuum drying of strawberries

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Aim:
Electroporation induced by the action of a pulsed electric field (PEF) leads to an increase in the permeability of the cell membrane. This intensifies diffusion-based processes, e.g. drying. The study aimed to determine the effect of PEF pretreatment on the drying of strawberries by two methods (convective - CD, vacuum - VD), and the antioxidant activity of obtained dried materials.

Method:
The experiment was designed using the Response Surface Method (RSM). The first variable was the temperature (55, 70, 85°C - CD, and 40, 55, 70°C - VD), and the second was the PEF energy input (1, 2.5, 4 kJ/kg). The optimization responses were: drying time to MR = 0.02 and the ability to scavenge DPPH• radicals (based on the EC_{50} values). The DPPH assay was carried out via spectrophotometric method.

Results:
The temperature had a higher impact on the drying time and antioxidant properties of the dried materials, than the PEF energy input. The higher the air temperature, the shorter the drying time of the strawberries. It could be due to intensifying the mass and heat transfer by increasing the drying temperature. Among the analysed range of PEF energy input, the shortest drying time of strawberries was noted after supplying them 1 kJ/kg of energy during the pretreatment. Mild process conditions induced electroporation, which facilitated diffusion of water, and, at the same time, did not lead to overtreatment of the material. Generally, the lowest EC_{50} was obtained in samples dried at the lowest temperature (gentle conditions of drying), or at the highest temperature (the shortest drying time). In both cases, the better properties of dried strawberries could have resulted from the limitation of thermal degradation of antioxidant compounds.

Conclusion:
The study shows that it is possible to optimize the convective and vacuum drying of strawberries with pulsed electric field pretreatment. Considering all the obtained results, the process parameters' combinations of 1.5 kJ/kg + 85°C, and 1 kJ/kg + 68°C were the most optimal, in the case of CD and VD, respectively.
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Effects of ultrasound on off-flavour-related aroma compounds in a pea protein-based yoghurt alternative

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Aim:
The intake of plant proteins is recommended for a healthy diet. However, their incorporation into conventional foods may be challenging due to techno-functional and sensorial limitations. This study aimed at developing a plant protein-based yoghurt alternative, consisting of 4.65 % pea protein isolate, 3 % rice syrup, and 2.5 % rapeseed oil fermented by lactic acid bacteria. Ultrasound (US) treatment was used as an alternative to conventional high-pressure homogenisation (HPH). Off-flavour reducing potential, texture characteristics and quality parameters were determined.

Method:
Aroma analyses by Head Space-Gas Chromatography-Mass Spectrometry were combined with the analyses of texture characteristics and quality parameters, including rheology, syneresis, pH, and colourimetry.

Results:
Aroma analysis showed that the US treatment significantly reduced the concentrations of the legume off-flavours hexanal, 2-pentylfuran, and 2-methylpropanal. The concentrations of the yoghurt aromas diacetyl and acetoin were significantly increased. These effects were attributed to the cavitational forces of US: It was assumed that an increased availability of substrate increased the fermentation rate and the yoghurt aromas.

Further, conformational changes due to US may have altered hydrophobic patches on the surface of the proteins. This might have resulted in the detaching of the hydrophobic, reversibly bound off-flavour-related aromas. The cavitational forces of the US treatment promoted aldol reactions and Schiff base formations contributing to the reduction of off-flavour-related aromas. The kind of homogenisation system affects off-flavour reduction. The US treatment was an open system allowing detached aromas to evaporate, whereas HPH was a closed system. No significant differences on texture characteristics by US were detected compared to HPH. Lighter colour was detected in HPH yoghurts, which might indicate higher particle size reduction compared to US.

Conclusion:
This study showed the potential of US as an alternative homogenisation treatment for the off-flavour reduction of pea protein-based yoghurt. US might be a promising tool to increase consumer acceptance for plant protein-based products as a more sustainable alternative to animal proteins. Additional sensory analysis is recommended to investigate effects of US on consumer acceptance since flavour perception is a multisensorial mechanism.

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Enhancement of wheat dough functional properties by non-thermal plasma treatment of wheat flour

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Aim:
Chemical like, Cl_2, KIO_3 and, ascorbic acid are industrially important due to their abundant use to improve wheat flour functionality, such as water absorption, elasticity, gas retention, bulk density etc. Demand to inhibit the use of such chemicals to improve food quality attributes is exponentially rising since few years. Non-thermal Plasma (NTP) is embraced by the scientist in the field of food technology, due to its unique non-toxic, non-chemical, low temperature and non-post treatment nature.
Method:
In the present research, the concept of an *in-situ* dielectric barrier discharge (DBD) plasma production inside a rotational reactor for a direct interaction between the NTP and wheat flour (150 g, type 550 and 1050) was experimentally analyzed. Reactor consists of two concentric cylindrical electrodes, i.e. outer rotating ground electrode, and inner stationary high voltage electrode. Different operating parameters were tested (treatment time, flour mass in reactor and change of air temperature) to observe the effect of NTP. The changes in structural attributes of flour and doughs were studied by a set of analytical techniques.
Results:
Rheology analysis demonstrated the ability of NTP, to intensify the visco-elastic properties (G' and G") of the wheat dough, which indicates the enhancement of intermolecular di-sulphide bonds of gluten protein (stronger protein – starch network formation) by plasma. Obtained results showed a 1 – 3% increase in flour hydration properties. Experimental findings also confirmed the dependency of the NTP treatment efficiency on the air temperature. However, for each test case, longer treatment times (> 180 seconds) did not significantly contributed to a further increase of visco-elastic properties of wheat dough.
Conclusion:

4. NTP was 90% more effective in enhancing the visco-elastic properties of type 550 flour compared to type 1050.

- In case of dough, an increase of more than 100% in G' and G" was observed for type 550 after NTP treatment.
- Moisture content of flour stayed under 14%.
- Three minutes was identified as optimal treatment time for all test cases in the rotational chamber.
- Change in visco-elastic properties of type 550 flour is of an order of magnitude, if air temperature is changed from 20 °C to 30 °C.

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Ultrasound-assisted extraction and polymer-based encapsulation of phycoerythrin from Phorphyridium purpureum

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Aim:

Phycoerythrin (PE), a red color phycobiliprotein, is employed to prepare biomarkers, food colorants, therapeutics, medicines, and health-promoting products. This study comprises two primary objectives, including 1) ultrasound-assisted extraction (UAE) of PE from freeze-dried biomass of *Phorphyridium purpureum (P.p)* in the aqueous phase; 2) encapsulation of a heat-sensitive compound (PE) with improved stability and functional properties.

Method:

Initially, four UAE strategies and a control method were investigated for the extraction. Based on the recovery of crude extracts and their concentrations of phycoerythrin (PE), crude extracts were subjected to cytotoxicity analysis against A549 human lung carcinoma and Caco-2 human colorectal adenocarcinoma cells using Alamar blue assay. Further, these PE extracts were encapsulated using 5% inulin as the coating material (core-shell ratio of 1:3.3) using a nano-spray dryer (inlet temperature: 80 °C; gas flow 100 l/min; chamber pressure 31 hPa; spray rate 80%, pump 50%; vibration frequency 120 kHz). Physicochemical properties of the encapsulated extract were estimated, comprising the color, yield, and scanning electron microscopy (SEM) for size and morphology analyses.

Results:

PE concentration in the extracts was improved from 0.1 mg/ 100 g in the control sample compared with 0.55 mg/100 g of extract in the UAE-treated samples. Inulin with a 5% concentration level resulted in higher retention of red color (a* + value), with 3.01 ± 1.08 µm particle size and 83.82 ± 2.49% yield. SEM micrographs of encapsulated freeze-dried PE extract confirmed its spherical shape. Additionally, cytotoxicity results indicated the effects of PE extract on A549 and Caco-2 cell lines studied under different concentration gradients (from 200 µg/ml to 1.5625 µg/ml) and cells post incubated for six days at 37 ˚C in 5% CO_2. An IC_{50} of 157.6 µg/ml and 124.6 µg/ml for control and UAE samples in A549, while an IC_{50} of 199.7 µg/ml and 149.0 µg/ml were found for control and UAE samples in Caco-2 cells. Two-way ANOVA demonstrated a significant difference in viability between the highest and lowest concentration ($P<0.0001$).

Conclusion:

UAE is more effective for the recovery of PE than the control extraction method. The obtained extract proved its potential as an anticancer agent. Moreover, inulin has shown to be a suitable carrier for preparing encapsulates, focusing on the stability improvement of bioactive compounds.

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Effect of cold plasma on physicochemical properties of gum arabic and its microencapsulation with oil

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Aim:
Gum arabic (GA) is a dried exudate plant gum collected from Acacia trees such as *Acacia Senegal* or *Acacia seyal*. GA is commonly used as stabilizing, thickening, film forming encapsulating and binding agents. Currently, GA is processed with various chemicals to alter its texture and obtain desirable characteristics. However, with changes in consumer preference for food free of chemical residues, the agri-food sector and processors require sustainable and clean technology interventions. Cold plasma technology is a novel, non-thermal and green process with demonstrated potential for application in food industry. Cold plasma has been studied extensively to modify the surface properties of biopolymers due to cross-linking, surface-etching, grafting, and deposition.
Method:
In the present study, gum arabic was treated in a contained DBD reactor with air as the working gas. The treatment process was 70kV for 5,10, 20, and 30 min.
Results:
The DSC analysis showed a change in endothermic peaks with treatment, suggesting breaking of gum arabic into lower energy components like arabinose and galactose monosaccharides. As the treatment time increases, a shift in the particle size distribution was observed along with an increase in d(0.1) values, indicating the breakage of large-sized particles into smaller-sized particles, particularly in the range of 10µm to 120µm. An increase in the average roughness value of the samples was observed with the plasma treatment due to surface etching by SEM analysis.
The emulsification properties of gum arabic were examined by the droplet size distribution of the emulsions. The d(0.5) value of samples was found to increase with plasma application, and an increase in the d(0.9) value was also observed. The increase in the d(0.9) value signifies the agglomeration of small size particles. Furthermore, to understand the application of plasma-modified gum arabic in new ingredient development, the microencapsulation of oregano essential oil was studied using spray-drying as an encapsulation technique for plasma-modified gum arabic encapsulating agents. The final particles were characterized by size, product yield, moisture content, pH, and hygroscopicity.
Conclusion:
Thus, cold plasma biopolymer modification can provide new opportunities for developing innovative products while also addressing variability in natural gum ingredient functional properties.

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Phenolic compound profiles and antioxidant concentrations in Lettuce grown under AI developed LED light recipes

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Aim: Development of different LED light recipes can reduce nitrate content and increase phytochemical concentrations within antioxidant effects using AI, big data and IoT.

Lettuce (*Latuga sative*) is one of the major leafy vegetables consumed worldwide. It has also important role in human nutrition by containing wide range of bio-active compounds such as vitamins, minerals, and antioxidants. Among many factors affecting plant growth, light is considered one the main environmental factors, since it regulates growth, photosynthetic activity and accumulation of metabolites. Therefore, different custom-made wavelengths/spectrum recipes could regulate concentration of nutritionally important phytochemicals.

Method: Growth under different light recipes and phytochemical analysis
Lettuce (*Lactuca sativa L*. cv. Butterhead) was grown under different LED lighting conditions based on the light recipes combining red (R), blue (B), infrared (FR), with and without green (G) at different intensity and spectrum. PlantEye phenotyping scanner was used to collect big-data representing growth conditions. All datasets were analysed using different AI algorithms for optimising the best growth conditions. Nitrate and chlorophyll concentrations were measured by spectrophotometric method. Total polyphenols and flavonoids were analysed by established methods. Profiling of phenolic compound was conducted by spectrometric analysis (HPLC-MS, GC-MS, ICP-MS). All analysis was also conducted for control treatment to be compared to the AI developed light recipes.

Result: Combination of R, B, G and FR lights has significant effect on plant nutrients
Statistical analysis showed significant interaction between total phenolic content and light combinations. Nitrate content has significantly reduced under RBFR and RBGFR light recipes compared to control, whereas total phenolic content and antioxidant activity has increased under both RBFR and RBGFR lights compared to control. The biomass (fresh and dry weights) of the plants under the light recipes calculated based on AI algorithms (RBGFR 4:1:1:1 100-300µmol) were two times higher than the controlled growth conditions (RB 4:1 200µmol).

Conclusion: Enhanced nutritional quality
Findings from our study suggest that proposed light recipes can significantly increase nutritional quality of lettuce grown indoor and can contribute designing optimal condition for high quality crops in greenhouse.

Posters

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Biorefinery cascade of microalgae A. platensis and C.vulgaris

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Aim:
Owing to the wide variability in structural features characterizing the plethora of existing microalgal strains, this work investigated the applicability of pulsed electric field (PEF) technology to promote the release of intracellular compounds from two model species (e.g., *A. platensis*, and C. vulgaris) in combination with different mechanical cell disruption techniques, namely high-shear homogenization (HSH), and high-pressure homogenization (HPH).
Method:
For this purpose, two different routes were followed, based on delivering PEF treatments of constant intensity (20 kV/cm, 100 $kJ/kg_{SUSP.}$) to i) *A. platensis* after a gentle HSH step (20.000 rpm, 96 $kJ/kg_{SUSP.}$), and ii) *C.vulgaris* prior to an ultimate HPH process (5 passes at 150 MPa, 750 $kJ/kg_{SUSP.}$). Cell disruption efficiencies associated with either single or combined techniques were properly assessed through morphological (optical/scanning electron microscopy, and particle size distribution), quali-quantitative (content of water-soluble carbohydrates, and proteins in the achieved supernatant after aqueous extraction step), and economical (calculation of the specific energy consumption per unit mass of dry weight target compound) analyses.
Results:
As a general trend, single PEF treatments induced no measurable effect on the cell shape/structure, but only a surface shrinkage could be detected, which was likely attributed to the occurrence of intracellular compounds leakage during water diffusion step. Interestingly, the application of PEF in a sequential mode with mechanical treatments boosted the yield and selectivity of extraction from *A. platensis* and *C. vulgaris* cells, with an outstanding additive effect detected towards low molecular weight compounds (e.g., carbohydrates).
The cascaded combination of PEF and HSH/HPH techniques led to comparable and, in some cases, lower specific energy requirements for proteins and carbohydrates recovery than those granted by single HPH processing, with the latter causing cell debris formation and an undifferentiated release of intracellular compounds, which complicated the subsequent separation/purification stages.
Conclusion:
This work demonstrated the feasibility of coupling electrical and mechanical technologies in the frame of microalgal biorefinery, with the aim to develop a tunable technological platform capable of efficiently valorizing disparate microalgal strains, thus increasing the availability of high-added value molecules to feed multiple industrial sectors.

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Optimization and upscaling of non-thermal atmospheric plasma for decontamination of (a)biotic surfaces

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Aim of work: Non-thermal plasma technology is well-known for its strong antimicrobial efficacy on food and food production environment associated microorganisms, in regard to enhancement of food safety and food shelf-life. However, the lack of scientific knowledge of the physical and chemical processes differences in upscaling degrees inhibits the transfer from lab to industry. Therefore, the aim of this thesis work is to study the relation between plasma processed air (PPA) composition and its antimicrobial effects, the mechanism of action as well, for three different air plasma torch devices characterizing three distinct steps of upscaling.

Methodology: Microwave plasma torch operated with compressed air delivers PPA as antimicrobial acting process gas. In order to find specific correlations between the plasma generated process gas composition and the antimicrobial efficiency, Fourier-transform infrared spectroscopy (FTIR) is used for gas analysis and performance diagnostics.

Results/Discussion: Preliminary screening with L. *plantarum* to check the inactivation efficacy of PPA on different strains was performed with the newly designed plasma treatment sample box. Key reactive nitrogen species (RNS) in PPA have been discovered via spectroscopic measurements for the lab-size device. Further quantitative analysis for different plasma devices will be carried out.

Conclusion: The results from this thesis will accelerate the development of the application of non-thermal atmospheric pressure plasma as a promising alternative method for disinfection and cleaning, which is applicable on both biotic and abiotic surfaces e.g. PET bottles, dry herbs and spices. It is environmentally friendly as well by reducing the use of hazardous chemicals. Gentle sanitation also supports a better food quality with higher consumer acceptance.

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Modelling approach on the improvement of the sustainability of tomato processing industry

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Aim

Food processing industries typically require a substantial amount of water and energy, which are often linked to each other, given that energy is required to transport, heat, and cool water. Further, water in the form of steam may be used to generate thermal energy. These relationships are known as the water-energy nexus (WEN). Among the food industry, the tomato processing industry consumes significant quantities of water and energy (thermal and electrical). In particular, the washing phase represents the most consuming step of water. On the other hand, evaporation, hot break, pasteurization and peeling requires large amount of thermal energy in the form of steam, while pumps used to transport water and create vacuums consumes large amount of electrical energy, followed by cooling tower fans.

In this frame, the adoption of conservation measure of water based on closed loop system, as well as to reduce and optimize the usage of energy even through the integration of innovative technologies, is crucial to improve the sustainability of tomato processing industry.

The aim of this work, which has been carried out in the frame of the European project AccelWater (Project ID: 958266), is to model and simulate the tomato processing lines for the production of peeled and tomato sauce, by implementing different conventional and innovative strategies, such as PEF technology, in order to assess their impact on water and energy savings before putting it in practice.

Methods

A real scenario of an Italian tomato processing industries producing both peeled tomato and tomato sauce, was analyzed and Current Value Stream Maps (CVSM) was developed for each processing line. The developed CVSM was then modeled and simulated using SuperPro Designer software in order to define the unknown streams and the potential steps where PEF could be integrated. Then, simulations were performed and the impact of different conventional and innovative (PEF) strategies were assessed.

Results:

The results highlight that the adoption of water in closed loop system in the washing phases can enable to save up to 25% of water. Similarly, recycling of steam condensate from thermal units to boiler can allow to save significant amount of water and methane. Moreover, it was verifies that the integration of PEF before peeling of tomato, can reduce the energy and water consumption (up to 20-30%) during the steam peeling phase.

Conclusion

Overall, it was demonstrated that the adoption of ad hoc strategies including the integration of innovative technologies such as PEF, can represent a sustainable and efficient practice that could contribute to water and energy savings in tomato processing chain, improving its economic performance and decreasing the environmental impact.

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Hybrid grey-box models for predicting microbial inactivation by nonthermal technologies in food systems

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Aim of work:
The efficiency of the microbial inactivation by nonthermal technologies, such as pulsed electric fields (PEF), high-intensity light pulses (HILP), and high-pressure homogenization (HPH) significantly depends on the type of equipment used, the operating conditions, the process fluid, as well as the microorganism resistance to the treatment. The lack of predictive tools for process performance, especially during industrial scale-up, therefore, limits the industrial application of the different processes.

Methodology:
In this work, we have collected and analyzed the microbial inactivation data available in the scientific literature for PEF, HILP, and HPH (>1000 data points for each technology), based on the use of different types of equipment, different operating conditions, different process fluids, and for different microorganism species. The data have been engineered, where possible, through the introduction of dimensionless numbers (e.g. Reynolds, Weber, Capillary, and Cavitation numbers) and covariance analysis, to reduce the dependence of the level of microbial inactivation on truly independent variables.
Different predictive models have been tested: (a) a multilinear model, used as a benchmark, (b) two back-box, machine-learning models, such as artificial neural networks and random forests, and (c) a grey-box model, based on the combination of an empirical Weibull model and a machine-learning model.

Results/Discussion:
The results show that the significant improvements in the predictive ability of the models can be observed when moving from the multilinear model to the black-box and the grey-box models.
The developed predictive tools, therefore, enabled the satisfactory prediction of microbial inactivation levels for the selected operating conditions, once the specific technology, type of apparatus, process fluid, and main contaminating microorganism class (gram+ bacteria, gram-bacteria, yeast, or molds, spores) have been selected.

Conclusion:
This work contributes to developing predictive tools for microbial inactivation by different nonthermal technologies, such as PEF, HILP, and HPH in different process fluids, with the final goal of facilitating their industrial scale-up.

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High-pressure homogenization as a tool for stabilizing emulsions to produce a homogenous plant-based yogurt alternative

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Aim:
Many plant-based proteins have limited techno-functional properties, such as poor aqueous solubility, limiting their use in plant-based alternatives food. High-pressure homogenization (HPH) has been suggested to cause physical changes in the fluid, and it constitutes and attenuates some of these technological limitations. Such changes have crucial importance in various applications such as preparation and stabilization of emulsions, reduction in droplets and particle size of emulsions and suspensions together with a narrower size distribution, and changes in the techno-functional properties of proteins. Our work studied the combination of alternative plant protein source, potato protein isolate (PPI), with the utilization of HPH to produce a fermented yogurt alternative with a homogenous structure without adding stabilizers.
Method:
We characterized the influence of HPH on solubility, emulsion stability, particle size distribution, and color. To study the effect of HPH on yogurt physical properties, microscopy, rheology, and texture measurements were performed.
Results:
HPH utilization as a pre-processing step (200 MPa and Tin=15°C) increased isolate solubility (from 92.7± 1.1% to 97.5±0.8%) and reduced downstream PPI sedimentation. Before inoculation with lactic acid bacteria, PPI emulsion was subjected to homogenization at pressures ranging from 30-200 MPa. Such a process stabilized the emulsion against separation and allowed sufficient time to form a homogenous gel-like system during fermentation, i.e., no phase separation during fermentation that will result in a non-homogeneous product. The results show that increasing the homogenization pressure reduced the particle size and allowed the formation of finer and whiter emulsion with improved physical stability against separation. The physical stability of the gel, measured at accelerated conditions, increased with increasing HPH pressure. The hardness was the highest for the yogurt alternatives fermented from the emulsion formed at 200 MPa, suggesting that HPH can significantly assist in attenuating physical properties of plant-based milk alternatives.
Conclusion:
While many commercial yogurt alternatives contain stabilizers or have low protein content, this presented process, using HPH, allowed the production of a stabilizer-free PPI yogurt substitute with higher protein content and homogenous structure. Therefore, this suggested process can be a promising tool for a variety of novel yogurt alternatives with improved texture.

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Sensitive multi-vitamin analysis method for fruit juices to assess the influence of non-thermal food processing

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Aim of work: One of the reasons attributed to the gap in knowledge regarding the elaborate comparison of effects of non-thermal processing techniques on vitamins in fruit juice is attributed to the absence of a sensitive and quick multi-vitamin analysis method. There are only a few studies that explored the topic of multi-vitamin analytical methods and most of them were limited to a few selected vitamins. This study aims to present an HPLC-MS/MS multi-vitamins analysis method for nine major water-soluble B-vitamins. Additionally, the study is the first of its kind that investigates the use of ammonium fluoride as an eluent modifier in improving the LOQs for the analytes.

Methodology: A simple dilute and shoot method was used for sample preparation. A reverse-phase HPLC system coupled with the ESI-MS method was developed and optimized. A calibration and accuracy study was conducted as described in the ISO/DTS 21748 guide and the method was validated accordingly in strawberry puree and multi-vitamin juice. The effect of ammonium fluoride as an eluent modifier was investigated by studying the effect of different concentrations on the response signal. The statistical analysis was performed with RStudio (1.2.5033).

Results/Discussion: A HPLC-MS/MS method is developed that offers a simultaneous analysis of 9 water-soluble vitamins in little less than 20 minutes of run time. The LOQs based on the calibration study were in the range of 0.5 µg/kg – 8 µg/kg. The method was successfully validated with recoveries ranging between 70 % - 100 % in both the matrices under study. The use of ammonium fluoride led to a multi-fold increase in the signal intensity i.e., a 5-fold increase for nicotinic acid and cyanocobalamin and a 4-fold increase for folic acid.

Conclusion: A simple and quick multi-vitamin analysis method is presented that can be used to conduct a systematic and robust comparison of the effect of different emerging food processing technologies, Method facilitates easy kinetic studies of vitamins in different matrices that will help in the optimization of non-thermal industrial processes. The positive influence of ammonium fluoride on signal intensity will enable the use of higher dilution factors during analysis leading to minimized matrix effects.

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Ultrafiltration of skim milk: analysis of the streams, retentate and permeate, and membrane fouling

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Ultrafiltration (UF) as one of the non-thermal types of membrane filtration technique, is widely used in dairy production and processing. It is of great importance to understand how operational variables can influence the efficiency of the UF process and the properties of the produced streams. In this study, skim milk (SM) was concentrated to volumetric concentration ratio (VCR) of 1.0, 1.5, 2.0, 2.5 and 3.0 at temperatures of 10, 25 and 55°C. Physicochemical analysis of retentate and permeate collected at different VCRs were investigated including ionic calcium concentration ([Ca^{2+}]), mineral profile, pH, conductivity, particle size and zeta-potential. Minerals, especially ionic calcium was found differently distributed in both retentate and permeate. Calcium (Ca) and phosphorus (P) was efficiently removed with permeate and the depleted amount being dependent on the filtration temperature. The highest Ca and P concentration was found at 25°C and the lowest at 10°C in retentates. UF performance was impaired with increasing VCR due to high total solid of milk components and viscosity, thereby influencing the length of filtration time in conjunction with membrane fouling. The findings of this work can provide a better understanding of UF parameters of milk processing, and be used for underpinning, optimizing and standardizing the production of dairy-based products (cheese, dairy powders, and ingredients) in which UF is a critical process.

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Physical-chemical changes in caseins induced by pulsed electric field (PEF) as non-thermal processing

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Aim: Caseins comprise 80% of the total content of milk proteins and are organized in a heterogenous micellar network. They may release bioactive peptides, like casomorphins, which were associated with allergic response during digestion. In the food industry, pulsed electric field (PEF) is an emerging technology for inactivating pathogen microorganisms. PEF was investigated as a non-thermal process that can induce physico-chemical changes in micellar casein from bovine milk and may reduce the allergic potential without altering the nutritional and sensory properties.

Method: Micellar caseins were kept at 25 and 4 ˚C prior to PEF treatment in a continuous-flow chamber with an electric field strength of 16 kV/cm for 12 and 62 µs.

Results: A formation of aggregates in micellar caseins PEF-processed at room temperature with particle sizes, ranging from 196.8 ± 6.5 to 224.1 ± 43.1 nm, was noted. Fluorescence measurements showed a slight decay in the emission of tryptophan and tyrosine, suggesting that the thermal effect may promote the aggregation of casein micelles. PEF treatment also promoted slight changes in the secondary structure ($P<0.05$) such as an increase in the contribution of α-helix and a decrease in stretching of carboxyl groups. Raman spectroscopy displayed broader peaks of spectra for PEF-treated samples, which might be attributed to a loss of structure. The increasing of degree of hydrolysis suggest that enzyme cleavage sites were more accessible following PEF treatment.
For chilled samples AFM images indicated a significant decrease in dimensions of particle size ($P<0.05$). Fluorescence yielded an increase in the emission of tryptophan and tyrosine, which is attributed to the exposure of hydrophobic casein regions to the solvent. Also, changes in the secondary structure were observed, resulting in increased stretching of carboxyl groups and a reduced fraction of α-helix structure. The Raman spectrum analysis was similar to untreated conditions ($P\geq0.05$), indicating that the aromatic amino acids are holding the micellar structure .

Conclusion: The effect on the conformation of the casein micelles, following different PEF processing conditions, suggested a thermal effect at 25 ˚C and electrical effect at 4 ˚C. The profile of peptides released after gastric digestion is under investigation.

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Effect of Pulsed Electric Pulse Processing pretreatment on osmotic dehydration of fresh-cut potatoes

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Effect of Pulsed Electric Pulse Processing pretreatment on osmotic dehydration of fresh-cut potatoes

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Aim: Osmotic dehydration (OD) is a nonthermal mild food processing method which can be used to increase the quality and shelf life of fresh-cut, high-moisture content fruits/vegetables. Osmotically dehydrated potato can be used as a quick-cooking product or as an ingredient in salads and soup mixes. Due to plant tissue structure, OD is inhibited by slow mass transport. Pulsed Electric Fields (PEF) induces electroporation and as a pretreatment can accelerate mass transfer phenomena in plant tissues during OD. The effect of PEF pretreatment to OD of fresh-cut potatoes was studied regarding the mass transfer phenomena, water distribution and physico-chemical parameters, aiming to optimize processing conditions that accelerate OD and improve product quality.

Method: Water blanched (95°C, 1min) fresh-cut potatoes were pretreated at pulse length 0.5-1.5 kV/ cm (pulse number up to 100 (PEF). Determination of enzyme activity (PPO) and objective firmness, were performed. Non- and PEF treated samples were dehydrated using an osmotic solution of glycerol, sodium chloride, calcium chloride, ascorbic acid, citric acid, at a liquid to solid ratio of 1:5, at 25, 40 and 55°C. Water loss (WL), solids gain (SG), water activity (a_w), sensory properties and quality indices (pH, objective color and discoloration, firmness, ascorbic acid) evolution was determined (0-180 min). WL and SG were modelled using Fick's second law of diffusion.

Results: PEF treatments up to 100 pulses accelerated OD by increasing the moisture diffusion coefficient. Further increase in process intensity did not accelerate dehydration. OD led to the production of high-quality potatoes of lower a_w (0.870-0.920) and stability. Pre-treated potatoes improved the overall visual quality, reduced browning and surface dehydration. PPO activity of pretreated potatoes which was significantly inhibited was modelled as a function of pressure and temperature.

Conclusion: Mild processes such as PEF are sought to improve the quality and shelf life of fresh-cut fruits/vegetables. Results confirmed the acceleration of a_w reduction by PEF and OD of fresh-cut potatoes while improving final product quality via acceleration of mass transfer.

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Ελλάδα 2.0
ΕΘΝΙΚΟ ΣΧΕΔΙΟ ΑΝΑΚΑΜΨΗΣ ΚΑΙ ΑΝΘΕΚΤΙΚΟΤΗΤΑΣ
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Plasma Activated Water and Computer Vision System application to control and evaluate melanosis in crustaceans

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Aim of work:
The aim of this work was to find a new, environmentally friendly and consumer-oriented alternative to control melanosis in crustaceans, different from the commonly applied chemical treatments based on sodium bisulphite and 4-hexylresorcinol. From a methodological point of view, melanosis was evaluated using an optimized Computerized Vision System (CVS) to overcome sensory evaluation problems.
Methodology:
Innovative Plasma Activated Water (PAW) treatment was used since its composition in reactive species can chemically interact with browning enzymes and/or substrates. All treatment solutions (distilled water (control); sodium bisulphite 3%; 4-hexylresorcinol 0.1% (conventional chemical tretments) and PAW (15kV, 5kHz, 1min)) were prepared and applied to two crustaceans species, caramote prawn (*Melicertus kerathurus*) and deep-water pink shrimp (*Parapenaeus longirostris*) using vacuum impregnation at 200 mbar for 10 min. Melanosis has been monitored for 9 days (at 4°C) using CVS. Images were obtained in a standardized environment and processed to identify browned areas and color changes of the carapace.
Results/Discussion:
Image analysis showed that all samples developed some browned areas during shelf-life, except for the samples treated with 4-hexylresorcinol, which showed a reddening phenomenon, which was also measured and quantified.
Tests on M. *keathurus* showed a protective effect of PAW against browning during the first 5 days of storage, while no significant differences ($p < 0.05$) were observed in deep-water pink shrimps compared with the samples treated only with water. The same observation was confirmed by a principal component analysis using the modes obtained from the histograms of the mains channels of each image.
Conclusion:
Under the conditions used, PAW showed the ability to delay melanosis in some species, resulting in a longer shelf-life. However, the mechanism behind this is still unclear, so further research is needed to find the optimal treatment conditions.
The application of CVS showed promising potentialities; it has been possible to identify the parameters that can describe both the phenomenon of browning due to melanosis, and the secondary reddening of the samples treated with 4-hexylresorcinol. However, to validate the model presented here, the results of the image analysis must be compared with the sensory evaluation carried out by trained panelists.

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Integrating Cold Plasma Processes with Plant Essential oils to Control Microbiological Risks in Poultry Processing

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Aim:
Poultry meat is a nutrient-rich matrix which can support microbial growth at various points within the poultry processing chain. Cold Plasma (CP) is an emerging non-thermal technology under investigation for decontamination and preservation of an increasing range of foods. This study considered the optimum combinations of three cold plasma approaches (plasma functionalized water (PFW), In-package CP, CP functionalized hydrocolloid as an edible coating) combined with essential oils for the retention of the microbial quality of fresh poultry meat.
Method
The range of processes were applied alone or in a sequence combination to fresh chicken breast. Plant essential oils (EO) of lemongrass, thyme, and oregano were incorporated separately within an edible coating. The edible coating was generated from cold plasma functionalised sodium alginate (SA) powder. The SA powder was treated with CP process of 70 kV for 5, 10, 20, and 30 min using a contained DBD reactor. The coating was applied on raw chicken breast meat (10 ± 0.44 g) by dipping. The chicken was then packaged in 35%CO_2 and 65% N_2, and further treated with an in-package cold plasma process at 70 kV for 1, 3 or 5 min. A separate plasma process was used for some samples, which were treated with PFW using a misting chamber developed to mimic current processing steps prior to blast chilling. Physicochemical analyses and microbial analyses were performed at regular intervals up to 7 days.
Results:
An increase in both oil holding capacity and roughness of treated SA powder was observed. The pH of the formulated edible coating was in the range of 5.9±0.4, which matches the pH of fresh chicken of 5.93±0.02. The combined approaches and the sequence of their application in this study led to a significant ($p<0.05$) reduction in the microbial growth of TVC, Enterobacteriaceae, and psychrophilic populations by up to 1.37 log CFU/g reduction compared to control. There were no significant changes in pH, colour or lipid peroxidation observed during the storage.
Conclusion:
This study offers a promising approach for controlling the background microflora of fresh poultry meat without inducing any adverse effects on the meat quality.

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Reaction kinetics at elevated pressures: The structure-dependent manifestation of elevated pressure on polyphenol degradation

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Aim: Polyphenol stability is important for the sensorial and health-promoting properties of this large group of diverse secondary metabolites. While not often studied, pressure can affect the kinetics of non-enzymatic reactions such as oxidation. Under elevated pressure, the reaction rate constant is increased, decreased, or non-affected depending on the activation volume ($\Delta V^{\#}$). While during industrial pressure pasteurization such effects on the outcome are mild, they can be of significance when pressure is applied for long times or when pressure is combined with elevated temperatures, as occurs during hyperbaric storage or high-pressure high-temperature conditions, respectively. This research evaluated the impact of pressure on the degradation kinetics of polyphenolic compounds, focusing on the influence of polyphenol structure and the presence of sugar in solution.
Method: A set of 10 polyphenols from several flavonoid subgroups (catechins, anthocyanins, flavonols) were selected differing in their structural features such as the number and location of hydroxyl group, the presence of gallate group, and the type and size of the attached sugar. Their degradation in pressure stable buffers (to avoid pressure-induced pH shifts) were studied for long exposure times (hours) and mild pressures (up to 200 MPa) to simulate accelerated hyperbaric storage conditions and to minimize all non-isobaric and non-isothermal effects that can interfere with the $\Delta V^{\#}$ calculation.
Results: A linear dependence of the degradation rates of the polyphenols as a function of pressure was observed in pressure stable buffers, allowing quantification of $\Delta V^{\#}$. The degradation rate of all flavonoids was increased by pressure. For catechins, the presence of OH at 5' position in addition to a gallate moiety was found to be more affected by pressure (a more negative $\Delta V^{\#}$). For anthocyanins, interestingly, despite a large structure-dependent difference in the degradation rate at atmospheric pressure, the $\Delta V^{\#}$ was similar. Under pressure, sugar had a larger protective effect than under atmospheric conditions.
Conclusion: Pressure enhances the degradation rate of polyphenolic compounds in a structure and composition-dependent manner. While such effect may negatively impact quality, it should be remembered that in real food systems the pressure-induced pH shifts may even have a larger impact than the observed negative activation volume.

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Mycotoxins degradation by cold atmospheric plasma: kinetic study varying parameters of the SBDB device

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Aim of work:
Mycotoxins are the major food contaminants that reduce global food safety and security. Alongside the most studied and regulated mycotoxins such as ochratoxin A and aflatoxins (B1, B2, G1, G2), concern has been currently extended to other toxins produced by fungi, the so-called ‘emerging’ mycotoxins, such as beauvericin (BEA) and ochratoxin B (OTB). Neither maximum level, nor tolerable daily intake, have been defined for these mycotoxins until today. Several chemical processes and physical treatments have been developed for reducing mycotoxin formation and concentration in foods. However, their limitations have articulated the need for novel technologies, which act as detoxifying methods maintaining the food quality and safety. Among these, cold atmospheric plasma (CAP) is emerging with a great potential in the detoxification of many mycotoxins.
In this study, the CAP treatment was tested for the degradation of seven mycotoxins, aflatoxins B1, B2, G1, G2, and ochratoxin A, as principal mycotoxins, and ochratoxin B and beauvericin, among the emerging mycotoxins. The influence of CAP regimes (different electric power), distance from source and exposure time has been investigated.
Methodology:
The CAP system was based on a surface dielectric barrier discharge (SDBD) configuration, using ambient air as the working gas and two different powers, leading to two different CAP regimes, the ozone (O_3) regime and the nitrogen oxides (NO_x) one.
Aliquots of mycotoxins standard solutions were deposited into a polystyrene six-well plate, that, after solvent evaporation at room temperature, were placed in the treatment chamber and subjected to plasma for different times, at two different distances from the plasma source and for the two O_3 and NO_x regimes.
Mycotoxin determination was performed by LC-MS/MS analysis.
Results/Discussion:
Cold plasma treatment resulted in a significant reduction of all investigated mycotoxins, reaching 99% in the case of aflatoxins B1 and G1 under the O_3 regime. The degradation effect was time-dependent, and the NO_x regime showed to be less effective. Moreover, a minor distance from the plasma source determined a better efficiency of the treatment for all mycotoxins.
Conclusion:
This study add information about the application of the atmospheric cold plasma as a valid method to degrade mycotoxins.

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Nonthermal germination-activation strategies of A. acidoterrestris endospores for subsequent inactivation by moderate-pressure (150-250MPa) at 20ºC

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Aim of the work:
Alicyclobacillus acidoterrestris is a spore-forming bacteria resistant to pasteurization and prevalent in acidic fruit juices, whose spores are an atypical case since they can germinate/outgrow at pH-values below 4.6, thus spoiling juices during storage due to the production of off-flavours. In a previous study, hyperbaric inactivation (HI) during hyperbaric storage (HS) at 100MPa for 48h revealed the possibility of inactivating *A. acidoterrestris* endospores at room-temperature to below detection limits. Considering the different effects of nonthermal technologies on spores, and as a possible way to accelerate the inactivation of *A. acidoterrestris* spores while under HS, different nonthermal technologies were used (namely high pressure processing (HPP), pulsed electric fields (PEF) and ultrasounds) as pre-treatments to enhance spore death along storage under pressure.

Methodology:
Commercial apple juice was inoculated with *A. acidoterrestris* endospores and pre-treated by HPP (600MPa, 3 min, 18ºC), PEF (30kV, 80µsec, 1400Hz, 20ºC), ultrasounds (73W, 24kHz, 5 min, 20ºC), followed by HS for HI at 150, 200 and 250 MPa at 20ºC for up to 24h. Then, samples were plated onto *Bacillus acidoterrestris* agar followed by incubation at 43ºC for 5 days.

Results/Discussion:
Ultrasounds pre-treatment accelerated endospore inactivation (despite the temperature increased to 50ºC during sonication), being reached the quantification limit (2.00 log CFU/mL) after 6h under hyperbaric storage conditions, regardless of the storage pressure (reduction of approximately 5-logs). Samples pre-treated by HPP and PEF showed a slower decay on the endospore load by HI, presenting a behaviour similar to control samples, with loads reaching values below quantification limit only after 24h, no matter what the pressure level. Additionally, the experimental data fitted well the Log-logistic model of microbial decay.

Conclusion:
These results demonstrate the possibility of US in combination with HI to accelerate the inactivation of *A. acidoterrestris* spores at room temperature thus avoiding the conventional intense thermal-based processes. Still, only by HI during HS and so with no heating (complete nonthermal methodology), this thermal resistant spore was inactivated after 24h up to approximately 5-logs, which is an important result *per se* that deserves further studies.

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Antibacterial properties of Maillard reaction products against pathogenic bacteria

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Aim of work:
Although the antimicrobial effect of Maillard resction product has been reported in some foods, there have been few comprehensive investigations on the effects of combinations of reaction substrates of the Maillard reaction on their antimicrobial activity. The present study comprehensively investigated the potential of various combinations of reducing sugars and amino acids.
Methodology:
Twenty-two types of melanoidins were examined by combining two reducing sugars (glucose and xylose) and 11 L-isomers of amino acids (Alanine, Arginine, Glutamine, Leucine, Methionine, Phenylalanine, Proline, Serine, Threonine, Tryptophan, and Valine) to confirm the effects of these melanoidins on the growth of *Listeria monocytogenes, Salmonella enterica* Typhimurium, *Escherichia coli* O157:H7, *Bacillus cereus, Brevibacillus brevis* in triptic soy broth at 25 °C.
Results /Discussion:
The melanoidins produced from the combination of D-xylose and L-phenylalanine (Xyl-Phe) and L-proline (Xyl-Pro) which absorbance at 420 nm are 3.5±0.2 completely inhibited the growth of *L. monocytogenes* at 25 °C for 48 h.Both the melanoidins exhibited growth inhibition of *L. monocytogenes* equivalent to the effect of nisin (350 IU/mL). The antimicrobial spectrum of the both melanoidins was also investigated for ten different species of bacteria, including both Gram-positive and Gram-negative bacteria. While Xyl-Phe based melanoidin successfully inhibited the growth of *B. cereus* and *B. brevis*, Xyl-Pro based melanoidin inhibited the growth of *S. enterica* Typhimurium. However, no clear trend in the antimicrobial spectrum of the melanoidins against different bacterial species was observed.
Conclusion:
The findings in the present study suggest that melanoidins generated from xylose with phenylalanine and/or proline could be used as potential novel alternative food preservatives derived from food ingredients to control pathogenic bacteria.

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IMPROVEMENT OF FERROCHELATASE ACTIVITY BY USING POWER ULTRASOUND

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IMPROVEMENT OF FERROCHELATASE ACTIVITY BY USING POWER ULTRASOUND

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Aim of work

The red color of some dry-cured meat products elaborated without nitrates and nitrites, such as Parma ham, is due to the formation of the zinc protoporphyrin (ZnPP), a stable purple-red pigment. In this context, pork liver presents a high activity of the enzyme ferrochelatase (FeCH) that catalyzes the ZnPP formation, which is considered a low-rate enzyme reaction. The aim of US application is improving the interaction between the enzyme and the substrates of the enzymatic reaction and the subsequent diffusion of the product. The objective of this work was to improve the process of ZnPP formation by applying power ultrasound (US) in pork liver homogenate at mild intensity.

Methodology

Kinetics of ZnPP formation were performed for 6, 12, 18, 24 and 48 h under anaerobic conditions at 37ºC and subsequently the amount of ZnPP formed was measured by fluorescence (420 nm excitation and 590 nm emission). US application was carried out by means of an ultrasonic bath, using water as a transmitting element and the temperature was controlled by recirculating the water through a heat exchanger. US was intermittently applied (30 min ON and 30 min OFF) at i) moderate (36.53 W/L) and ii) low power (7.05 W/L).

Results/Discussion

The results showed that the US application represents an effective method for intensifying the ZnPP formation. When low power US was applied, the maximum of ZnPP formed was 0.405 mmol ZnPP/L at 12 h, while in the control experiments (without US) the maximum was 0.322 mmol ZnPP/L at 24 h. Thereby, the US application greatly improves the formation of ZnPP in pork liver, increasing slightly the yield and drastically the enzyme activity (shortening the formation time by 50 %).

Conclusion

The US application could be considered an interesting alternative to enhance the FeCH activity, promoting ZnPP formation in pork liver. Therefore, the ultrasound-assisted ZnPP formation could be considered a feasible alternative for obtaining a high-added value colorant to be further used in several applications in the food industry.

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Potential of High-Pressure Processing to Inactivate Pathogens in Cold Brew Coffee and Extend its Shelf-Life

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Aim of work: To assess the potential of high-pressure processing (HPP) to inactivate vegetative pathogens (*Listeria monocytogenes*, *Escherichia coli* O157:H7 and *Salmonella enterica*) in cold brew coffee, and to preserve its physicochemical, antioxidant and microbiological quality attributes during refrigerated (4 °C) or room temperature (23 °C) storage compared to unprocessed samples of the beverage.

Methodology: Commercial medium-roasted grounded coffee was mixed with mineral water to a final concentration of 7% (w/v). Cold brewing was performed at 4 °C for 17 h. After filtration, 30-ml aliquots of the beverage were dispensed on PET bottles and inoculated in triplicate with separate five-strain cocktails of *L. monocytogenes*, *E. coli* O157:H7 or *S. enterica* to a final concentration of 10^7 cfu/ml. Half of the spiked samples were processed at 600 MPa for 3 min at 10 °C, whereas the other half remained unprocessed as controls. Each set of processed and unprocessed samples was further divided for storage under refrigeration (4 °C) or room temperature (23 °C) for 90 days. Overall antioxidant capacity was evaluated by ABTS and FRAP assays, total phenolic content was determined by the Folin-Ciocalteu test and microbial quality indicators (mesophilic bacteria, *Enterobacteriaceae*, molds and yeasts) were determined following the same experimental set up previously described for pathogen-inoculated samples.

Results/Discussion: Processing cold brew coffee (pH 5.9) at 600 MPa for 3 min at 10 °C achieved a >5-log reduction of *L. monocytogenes*, *E. coli* O157:H7 and *S. enterica*. This reduction was sustained during 90 days of storage at 4 °C and 23 °C, irrespectively. Unprocessed control samples did not support growth of the pathogens, but the inoculated species could be detected throughout the experiment. Similarly, microbial quality indicators remained below 10^2 cfu/ml during refrigerated or room temperature storage after HPP. Antioxidant capacity did not change as a consequence of HPP and remained stable regardless of storage conditions, although total phenolic content slightly decreased during shelf-life.

Conclusion: HPP effectively inactivated foodborne pathogens in cold brew coffee during 90 days of refrigerated or room temperature storage. Additionally, antioxidant and microbiological quality attributes were maintained. Hence, HPP emerges as a nonthermal technology to ensure safety and extend shelf-life of the beverage.

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Meta-analysis on decontamination efficacy of non-thermal plasma (NTP)

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Aim of work: Determination of decontamination efficacy of nonthermal processing technologies is a cornerstone for widescale implementation. In this study, we performed a meta-analysis to gain generic insights regarding decontamination efficacy and to determine main parameters that influence the efficacy of non-thermal plasma (NTP) treatment.

Methodology: After a search of ~900 potentially relevant articles related to non-thermal plasma treatment of *Escherichia coli* and *Listeria monocytogenes*, ~60 were further analyzed according to predetermined eligibility criteria. This led to the development of a database that includes processing, food- and microbial-related parameters as listed in the relevant articles. The achieved microbial reduction was expressed in the decimal reduction value (D-value), which is the exposure time needed to reduce the microbial population with a factor 10. This resulted in ~200 D-values extracted from the studies, and the most important factors that affect the D-values were determined through statistical analysis. A z-value with respect to power per sample size was also estimated for both microorganisms.

Results/Discussion: After the meta-analysis conducted to the reported parameters, input power and the size of the treated sample were found to be the most important parameters for nonthermal plasma processing. Other significant factors include the selectivity of the recovery media, the distance between the electrodes (for the relevant NTP settings) and the volume of the treatment gas. The reactive oxygen and nitrogen species (RONS) concentration in the plasma are rarely reported, thus the available data were not sufficient to determine their importance.

Conclusion: To our knowledge, this is the first study that performs a meta-analysis to establish global kinetic parameters and to evaluate the most important factors of non-thermal plasma processing. However, other important parameters such as RONS concentration may be just as important, but are not widely reported. The establishment of a standardized protocol for reporting the essential processing parameters and the inclusion of more studies and microorganisms would make the estimation of global kinetic parameters and the influencing factors more representative.

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Enhancement of biomethane potential of brown sludge by pre-treatment using vortex based hydrodynamic cavitation

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Aim of work:
Develop novel, non-thermal and economically benign pre-treatment process for enhancing valorisation potential of brown sludge generated by dairy industry wastewater treatment plant (WWTP).
Methodology:
We developed a pre-treatment method based on hydrodynamic cavitation for enhancing digestibility of brown sludge. We used novel vortex-based hydrodynamic cavitation (HC) device which offers many advantages such as early inception of cavitation, less erosion (lower operating expenses), better ability to handle solids (stable and trouble-free operations) for the pre-treatment. The influence of pretreatment was quantified by measuring biomethane potential (BMP) of untreated and treated brown sludge. Brown sludge was collected from WWTP/effluent treatment facilities in a dairy industry. Laboratory scale cavitation unit with nominal capacity of 1 LPM was used. No additional chemicals were used for the pre-treatment. Pre-treatment parameters, primarily, number of passes through the cavitation device were varied to quantify influence on BMP. All experiments were carried out with 5 % total solid. The pretreated and untreated sludge was then used in bioreactor to determine BMP. BMP tests was performed at 41°C using an automatic methane potential test system containing 15 reactors with each volume of 500 mL fitted with overhead stirrer.
Results/Discussion:
Hydrodynamic cavitation treatment increased the soluble chemical oxygen demand (sCOD) of 41.9 % and 24.8 % and degree of disintegration enhanced by 12.4 % and 6.3 % in two different batch of substrate, which increased the BMP in anaerobic digestion process. Performance enhancement with pre-treatment was higher if the difference in theoretical BMP and BMP of substrate was larger. In both the substrate, methane production increased more than 38.7 % and 13.3 % but reached more than 80 % of theoretical BMP. Volatile solids removal was more than 65.5 %. Biomethane production from brown sludge from dairy waste treatment plant followed dual rate kinetic model.
Conclusion:
Vortex based hydrodynamic cavitation was shown to push the realisable BMP of brown sludge more than 80% of the theoretical BMP. The methodology and results presented here show significant potential to valorise brown dairy sludge via enhancing its BMP.

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High Pressure technology: application as pretreatment technique for green table olives debittering and fermentation acceleration

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Aim of work:
Commercial Greek-style green table olives production includes a time-consuming (3-6 months) natural fermentation in acidified brine (8-10% salt) where: (a) endogenous lactic acid bacteria (LAB) of olives promote the de-bittering process, by reducing oleuropein content, (b) brine pH-value is decreased, not allowing spore germination, (c) olives organoleptic characteristics are improved. In Spanish-style table olives production, a chemical pretreatment of olives with NaOH solution is applied aiming to oleuropein hydrolyzation, minimizing the long natural debittering process duration. However, high volumes of heavily contaminated wastewaters are produced. A new promising approach is the application of novel technologies targeting to oleuropein content reduction in a more efficient way without chemicals use, while simultaneously increasing the olives' permeability leading to accelerated fermentation.
The aim of this work was to study the alternative to cold pasteurization application of High Pressure (HP) as a pretreatment of table olives for debittering and fermentation processes acceleration.
Methodology:
HP-assisted debittering process (100-400 MPa, for 5-20 min) in brine (acidified brine NaCl 8%, pH=5), in parallel with lye (2% NaOH, 16 h) and conventional de-bittering (brine-NaCl 8%w/v) processes were conducted, all followed by the fermentation step. Oleuropein content and pH-value were measured throughout all the steps studied. Quality and sensory evaluation were also performed.
Results/Discussion:
HP pretreatment (P>250MPa) led to fast oleuropein degradation, decreasing its concentration by up to 80% immediately after treatment (400 MPa-20min) compared to control. HP conditions 250 MPa-5 min were selected as optimal for accelerating the de-bittering process based on: (a) oleuropein content decrease in as shorter time as possible, (b) minimal effect on quality (texture mainly), (c) maximum organoleptic acceptance in terms of bitter taste. HP pretreatment at these conditions did not affect the endogenous LAB population of olives and consequently the beginning of fermentation. Fermentation step ended (when pH<4.5) in less than half (1 month) the duration of the conventional production (2.5 months).
Conclusion:
HP could efficiently be applied for table olives de-bittering process minimization, while simultaneously not affecting the quality of final fermented olives and limiting the use of alkali solutions that is a major concern for the relevant industry.

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Application of semidirect and indirect cold atmospheric plasma treatment on gilthead sea bream fillets

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Aim of work:
The aim of this study was to implement non-thermal (cold) atmospheric plasma (CAP) on perishable fresh fish fillets, targeting to shelf-life extension. Semidirect (Surface-dielectric-barrier-discharge, SDBD) and indirect (production of Plasma Activated water-PAW and Plasma Activated Ice-PAI) treatment of fillets was studied.
Methodology:
Semidirect treatment (SDBD) was performed in a closed rectangular glass reactor chamber (3 kV, 45 kHz). PAW was produced using a CAP Helium jet (flow rate 0.5 L/min, nozzle–water surface distance 4.3 mm, peak-to-peak voltage 7.2 kV, 100 kHz) (H_2O_2 and NO^{3-} concentrations set to 36.4 mg/L and 45.1 mg/L, respectively). PAW was dispersed to deionized water and transformed (frozen) to ice (PAI) (H_2O_2 concentration: 3 mg/L).
Three cases were studied for Gilthead Sea bream fillets:
1. Fish fillets were semidirectly treated for 15 min and then stored at 4°C for up to 20 days.
2. Fish fillets were immersed into PAW for 10 min (fish:antimicrobial agent ratio equal to 1:3) and then stored at 4°C for up to 20 days.
3 Fish fillets were placed in PAI flakes and stored at 0.5°C for 30 days.
During storage, all treated fish fillets, along with untreated ones, were evaluated in terms of their microbiological (total aerobic bacteria-TAB, yeasts/molds, H_2S producing microorganisms, lactic acid bacteria–LAB, *Pseudomonas* spp, *Brochotrix thermosphacta* and *Enterobacteriaceae*) and physicochemical (color, texture, lipid oxidation) characteristics. The shelf-life of all fillets was estimated.
Results/Discussion:
Semidirect treatment resulted in initial microbial load reduction by up to 18.5%. Slight brightness increase was instrumentally observed, while the fish odor intensity was decreased as organoleptically perceived. The shelf-life was extended by 40%, compared to control. For indirect treatment, (both PAW and PAI), an approximate 20-30% microbiological load reduction was measured after 2 days of storage compared to control. PAW and PAI applications delayed the fillets microbial growth, while simultaneously retarded their quality loss, leading to a significant increase of their shelf life (by up to 50%) compared to control samples.
Conclusion:
The results validate the applicability and efficiency of CAP technology on production of improved fish fillets with extended shelf life.

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Cold Atmospheric Plasma Processing for Quality Retention and Shelf-life Extension of Plant Foods

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Aim of work:
Cold atmospheric plasma (CAP) has emerged as a potential alternative to traditional methods for food decontamination, minimally affecting food quality. Depending on food treated, CAP could be applied on foods directly through activated gas flow, semi-directly through reactive oxygen and nitrogen species (RONs) diffusion on the surface of the food or indirectly through food immersion in plasma activated water (PAW) in which RONs are generated.

Methodology:
In a closed rectangular reactor, Surface Dielectric Barrier Discharge was applied (2-3 kV, 32-42 kHz, 5-20 min) for fresh strawberries (*Fragaria Ananassa cv ELSANTA*), fresh pistachio (*cv. Aegina*) and a ready-to-eat (RTE) rocket salad. A CAP jet (0.5-3 kV, 80-85 kHz, 0-30 min, Helium 0.5-5 L/min) was used to i) activate water (PAW) to be used as a RTE salad washing agent and ii) to directly process freshly squeezed orange juice. For all products, their main quality parameters were evaluated immediately after processing or/and during their shelf-life.

Results/Discussion:
SDBD led to total viable count (TVC) inactivation in strawberries by ~1.0 logCFU/g, resulting in lower microbial load during storage compared to Control. The quality was enhanced as derived from the increased trends in antioxidant activity and ascorbic acid, while the activity of pectin-methylesterase (PME) remained lower compared to Control. Correspondingly, TVC load of pistachio was reduced by ~0.7 logCFU/g after CAP, resulting also in no aflatoxin detection, in contrary to Control. A TVC reduction of ~0.5-1 log CFU/g was observed for the RTE rocket, depending on the processing conditions. Processing time of 10 min was considered as the optimum, for a satisfactory TVC reduction and quality retention. Direct CAP resulted in orange juices PME inactivation, with increased rates at higher voltages, leading to residual activities ranging from 15-35%. Regarding CAP indirect use, increase of the immersion time of RTE rocket in PAW led to TVC decrease (by up to 2.0 logCFU/g) and partial degradation of the color and texture. Immersion time of 10 min was considered as the optimum for a satisfactory reduction of microbial load and quality retention.

Conclusion:
The results obtained validate the efficiency of CAP in producing plant foods of high quality and longer shelf-life.

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A novel UV-C device for effective disinfection of hard to reach surfaces

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Aim of work: Surfaces in food processing and healthcare environments can become contaminated with pathogenic microorganisms. Due to their shape and design intricacies, instruments, computers, and other small equipment pose a sanitation challenge. This study demonstrates the efficacy of a UV-C device for the inactivation of foodborne bacteria on surfaces that cannot be subjected to washing and chemical disinfection, using both an experimental and a computational approach.

Methodology: *Escherichia coli* ATCC 25922 and *Listeria innocua* FSL C2-008 were used as nonpathogenic surrogates for *E. coli* O157:H7 and *L. monocytogenes*, respectively. Early stationary phase (16h) colonies were streaked on tryptic soy agar and spot-inoculated on the coupons of food grade stainless steel (SS), 99.9% copper metal (Cu), and copper polymer (CuPoly). Coupons were placed at various locations in the enclosure, which contained a desk and a laptop, and exposed to UV-C light emitted by two linear lamps (200W output irradiance), located at the top of the unit, for 30 to 180s. Controls were prepared without UV treatment. Survivors were recovered, plated, and enumerated using standard plate counting. Experiments were performed in triplicate, and data analyzed statistically. The spatial irradiance distribution of UV inside the unit was simulated with the FRED® Optical Engineering Software.

Results/Discussion: Inactivation levels increased with UV-C exposure time for both microorganisms. Inactivation effectiveness was significantly ($p<0.05$) affected by the substrate and species. Maximum inactivation was observed for *L. innocua* at the center of the keyboard; the fastest inactivation for both strains was observed at the back of the laptop, with over 4-log reduction achieved after 30 s. For both strains over 5-log reduction was obtained on stainless steel and copper surfaces after 180s. The calculated spatial irradiance distribution of UV light inside the unit had an overall discrepancy of ±13% compared with experimental values, while simulated inactivation levels had <10% discrepancy compared to experimental ones across multiple tested locations.

Conclusion: The proposed all-directional UV-C enclosure device has great potential for antimicrobial treatments in the food and healthcare industry. The optical simulation approach can help predict inactivation performance, and facilitate the design highly effective, uniform UV treatments.

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Pulsed light treatments to maintain physical properties and nutritional quality of fresh foods

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Aim of work: Pulsed light (PL) is a nonthermal food technology with potential as a postharvest decontamination strategy for fresh fruit and vegetables, mainly inactivation of foodborne spoilage or pathogenic microorganisms (Franco-Vega *et al.,* 2021). PL process consists of the exposure of foods to a series of short (from 100 ns to 1 ms), high-intensity pulses (flashes) of polychromatic light (200 nm–1100 nm) produced by a xenon flash lamp. PL has been applied in several food products without affecting their quality and sensory properties (John & Ramaswamy, 2018; Mahendran *et al*., 2019). The objective of this review is to critically the information available on the retention of the physical properties and nutritional quality of foods after PL treatments.

Review: In horseradish, PL reached the complete inactivation of peroxidase by applying 10 pulses at the intensity of 500 J/pulse (Wang *et al.,* 2017). Apple juice color, pH and soluble solids were not affected under treatments at 0.4 J/cm^2/pulse (Matfei *et al.,* 2014). However, other fresh products are affected by PL treatments. For instance, a marked discoloration was observed in endive salad (Kramer *et al.,* 2015). PL reduced the microbial load in mung bean sprouts and endive salad when combined with washing water (5 cm between the water surface and the flash lamp, 320 and 580 mJ/cm^2 per light pulse) resulting in a significant shelf-life increase (Kramer *et al*., 2017). PL treatment with fluences of 2.2 J/cm^2 has been used as a surface treatment of red-ripe tomatoes with no effect on the nutritional value but caused negative changes in appearance (Aguiló-Aguayo *et al*., 2013). The use of PL treatment with fluence of 8 J/cm^2 in fresh cut mangoes maintained their firmness, color, carotenoids content, phenolic content, and ascorbic acid (Charles *et al*., 2013). PL treatment (1.75 mJ/cm^2) was used on shrimps, Atlantic salmon, and flatfish fillets without observable effect on color (Cheigh *et al.,*2013).

Conclusion: PL technology has potential in the food industry to improve the safety and shelf-life of various fresh foods, such as fresh vegetables, fresh cut fruit and some seafoods and fishes.

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Non-thermal Plasma for Fresh Produce:
Scaling Efficacy from Bench to Prototype/Industry for gaseous/liquid applications

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Aim of work: Organic and fresh-cut produce such as apple and lettuce may contain a very high microbial load, and despite a good safety/quality record overall, have been associated with human/plant pathogen associated outbreaks/losses. The need for sustainable, non-thermal interventions and effective antimicrobial agents at post-harvest stages for increasing food safety/shelf-life by reducing food losses simultaneously remains.
Methodology: Sanitation steps based on non-thermal plasma (NTP) opens up innovative food processing possibilities through application at different points and modes of delivery along the food chain; for production, modification, and preservation, as well as in packaging of plant-originated food. Plasma contains reactive species and free charge carriers caused by ionization processes of the gas atoms and molecules, which mediate effects either in gaseous or liquid forms of delivery.
Results/Discussion: This talk describes innovations in a plasma process that resulted in a complete industrial scale fresh produce (lettuce) processing line for cutting, washing and drying based on Plasma Treated Water (PTW). Further, a new possibility to sanitize organic apples by Plasma Processed Air (PPA) at prototype level will be presented. The treatment of natural products with changing parameters (size, surface, water content) is challenging for the design/optimization of non-thermal plasma processes. To overcome these challenges, a specific plasma process based on microwave plasma operated with air was established to deliver PPA as the antimicrobial agent to sanitize apples or to process tap water. The latter served to generate and scale the PTW with antimicrobial properties. The primary process development focus was on the antimicrobial efficacy when used on the produce and in the washing water, but changes in product quality and potential by-products were also monitored.
Conclusion: To successfully scale up, the PPA/PTW-application, an understanding of the antimicrobial properties, the chemical composition of plasma, PPA, PTW and process water, and resultant food quality characteristics (e.g. texture, color, nitrite/nitrate content, Chlorophyll a/b, and ascorbic acid) was developed. The optimized PPA process was implemented into a prototype-scale apple-sanitizing process. More important, the optimized PTW production and decontamination process was implemented into an industrial-scale lettuce-processing line thus demonstrating the industrial scalability and applicability.

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Optimization of bioactive compounds from marigold flower using ultrasound-assisted extraction by response surface methodology

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Aim:
The objectives of this study were to use response surface methodology (RSM) based on Box-Behnken design (BBD) to optimize the bioactive compound and antioxidant activity of marigold flower by an ultrasound-assisted extraction (UAE) and to evaluate the antimicrobial activity against pathogenic bacteria in marigold flower extract (MFE)
Method:
Temperature (30–50 °C), extraction time (5-15 min), and ethanol concentration (60–100%) were the extraction variables. The responses were; total phenolic compound (TPC), total flavonoid content (TFC), total carotenoid content (TCC) and antioxidant activity (DPPH and FRAP assays). The antimicrobial activities against *Escherichia coli* (*E. coli*) and *Staphylococcus aureus* (*S. aureus*) were conducted on the optimized extract by minimum inhibitory concentration (MIC) and disk diffusion methods. Chloramphenicol and ethanol were respectively used as positive and negative controls.
Results:
The RSM analysis revealed that the model was significant ($p \leq 0.05$) in interactions between all variables (TPC, TFC, TCC and antioxidant activity by DPPH and FRAP assays), with a lack of fit test for the model being insignificant ($p > 0.05$). The RSM analysis also showed that temperature (40℃), time (15 min), and ethanol concentration (68%) (v/v) were the optimal extraction conditions which showed the greatest values of TPC (75.699 mg GAE/g db), TFC (68.740 mg QE/g db), TCC (234.741 mg β-carotene/100g db), and antioxidant activity by DPPH (630.37 mM TE/100g db) and FRAP (3226.17 mM TE/100g db) assays. The antimicrobial results (disk diffusion method) showed that the optimized MFE produced inhibition zones of 9.66 mm and 8.00 mm vs ethanol as a negative control (no inhibition) and chloramphenicol as positive control (20.3 and 18.3 mm) against E. coli and S. aureus, respectively. Corresponding to the MIC values, MFE was able to inhibit to E. coli and S. aureus with the values of 25 and 50 mg/mL, respectively.
Conclusion: The findings of this research will be applied in the food sector for eventual integration into processed foods to develop products with higher bioactive and health benefit.

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Microstructural changes of Vanilla planifolia induced by high hydrostatic pressure applied during the curing process

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Aim:
Vanillin, the major aroma component of vanilla (*Vanilla planifolia*), is obtained when vanilla pods undergo a process of curing which traditionally involves the application of scalding; however, it has been observed that scalding does not cause major changes in the microstructure of the pods, required to facilitate enzyme-substrate interaction. High hydrostatic pressure (HHP) has shown to favor modifications in cell arrangement under certain conditions. The present work describes the microstructure of the pods observed under stereomicroscope after using the traditional killing method (scalding) or high hydrostatic pressures (100-400 MPa) at different curing stages (cycles 1-20).
Method:
The vanilla pods were cross-sectioned and three main sectors were identified (total, annular and central). Morphometric parameters, namely, area (A), Feret's diameter (FD), circularity (C), and compactness (ϕ), were quantified by digital image analysis (DIA).
Results:
The greatest decrease in the total area was obtained at cycle 16, as shown by the shrinkage ratio with respect to the scalded vanilla pod on the total and annular area. A pronounced contraction was found at cycles 7 and 20, while in intermediate cycles no significant shrinkage was found. Respect to the central area, the digital image analysis showed a significant shrinkage from the first cycle up to cycle 10, compared to the scalding method. Concerning circularity, the values oscillated from 0.2 to 0.4, with no significant differences between the killing methods. In the case of the Feret's diameter of the total area, a pronounced decrease was observed at cycle 20, independently of the pressure applied.
Conclusion:
The digital image analysis suggested in the present work allowed to correlate morphometric data of vanilla pods (cross-sectional area) as well as to obtain useful information to evaluate the shrinkage ratio of the samples processed through different killing methods and conditioning cycles, which was important to quantify affectations to the vanilla pod shape and their dependence on the treatment applied.

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Effect of pulsed electric fields pre-treatment on the debittering process of cherry kernels

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Aim:
Cherry kernels occur in significant amounts as waste material during the processing of fruits. In the food industry, cherry kernels are considered by-products and their further use is limited due to the presence of cyanogenic glycosides which are potentially dangerous to human health. In the present study, the application of pulsed electric fields (PEF) was investigated as pre-treatment to improve the debittering process and to facilitate the degradation of cyanide precursors, naturally present in cherry kernels.
Method:
The PEF treatments were performed using a batch system. Rectangular monopolar shape pulses with a pulse width of 5 µs and a frequency of 10 Hz were applied. The voltage was set to 19.8 kV, resulting in an electric field strength of 2.2 kV/cm. The number of pulses used was 1000, 2000 and 4000, resulting in a total energy input of 10, 20 and 50 kJ/kg, respectively. Two different debittering procedures were performed: a) incubation of whole kernels in deionized water; b) incubation of whole kernels without water stored in air at 80 % relative humidity. The kinetics of amygdalin and HCN content were investigated by HPLC and the sugars content was determined spectrophotometrically.
Results:
In both debittering methods, the PEF-treated samples with the highest intensity (2.2 kV/cm, 50 kJ/kg) showed higher and faster detoxification efficiency for both the investigated compounds, compared to the untreated sample. In particular, compared to the untreated material, the amygdalin and HCN contents in the PEF treated samples incubated with water were reduced up to 86 % and 72 %, respectively. Moreover, the PEF pre-treatment led to comparable efficiency in amygdalin reduction between the two debittering processes: 86 % reduction for the incubation with water and 81 % for the incubation without water. Additionally, the PEF treatment did not enhance the release of sugars, but only the release of antinutritive compounds.
Conclusion:
The combined application of PEF and debittering process by incubation without water has remarkable potential as industrial application to reduce water consumption and issues related to wastewater management as well as the negative side effect of sugar loss typically occurring during the debittering by soaking.

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Non-thermal extraction processing via PEF of essential compounds from by-products of orange and olive processing

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Aim: In the last years several studies have demonstrated the feasibility of pulsed electric fields (PEF) as a good pre-treatment technology able to enhance the bioactive compounds extraction. Within the EU founded project SHEALTHY it was investigated to what extend the extraction yield of essential oils as well as polyphenols could be increased with PEF in the range of 1-5 kJ/kg in comparison to an untreated sample.
Methods: Based on the literature, higher electric field strength are necessary to extract valuable compounds from side streams, especially from orange peels. The HVP 5 PEF (30 kV) systems with a 2 cm treatment cell was used to apply an electric field strength up to 10 kV/cm. The experimental parameter setup for orange peels was based on literature, where different electric field strength for the extraction of polyphenols from different side streams were applied. For the PEF-treatment of olive leaves, parameters from a study conducted by UGR were used. The knowledge of the possible effective process conditions was translated into a Design of Experiments (DoE). After the treatment the samples were dried and send to the analytic partner for analyses.
Results: For orange peels the electric field strength was between 1.0 – 2 kV/cm. Based on the DoE the optimal treatment conditions for the increase of extraction in comparison to the control 50 % (Flavonoids), 26 % (Polyphenols), 32 %(Hesperidin), 68 % (Narirutin) was 1.5 kV/cm, 30 pulses and a pulse width of 30 us. In comparison to ultrasound optimal conditions for TPC 22 % more was extracted. The optimal treatment conditions for olive leaves were 0.8 kV/cm, 110 Hz, 11 s of treatment time and a pulse width of 15 us. This led to an increase of TPC by 9% and of DPPH by 22 % in comparison to the control. Ultrasound and PEF extraction had similar results.
Conclusion:PEF extraction shows high potential for the extraction of valuable compounds from side streams in comparison to untreated as well as other green extraction technologies like ultrasound. The validation of the optimal treatment conditions as well as the scale up are ongoing.

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Slightly acidic electrolyzed water and high pressure processing extend refrigerated storage of Meretrix lusoria

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Aim: For consumer demands of natural, fresh, safe, delicious food, innovative non-thermal processing is developing accordingly. This study explored slightly acidic electrolyzed water (SlAEW), high pressure processing (HPP) and the hurdle technology for hard clams on the shelf life and the impact of quality changes during storage at 4ºC.
Method: The available chlorine concentration (ACC) of SlAEW were 0.5, 5 and 10 ppm. HPP at 200-600 MPa and 3-10 min were selected. We investigated proximate composition, water activity, microbiology (total plate count TPC, coliform, *E. coli*), chemical stability indicators (pH, TVB-N, chlorine residues, TBARs), physical properties (de-shelling, texture, Lab, whiteness), and sensory evaluation of hard clam during 4ºC storage at 2 weeks.
Results: SlAEW at ACC 5 ppm had the best inhibitory effect on TVB-N and TPC productions, and a slowly decrease on the whiteness index. SlAEW at ACC 0.5 ppm had the best performance on the texture quality. Regarding HPP, 200 and 300 MPa exceeded the limit of TPC in 14 days, and 500 MPa treatment had best inhibitory effect on TVB-N and TPC levels. In addition to Control (Boiled), 400 and 500 MPa for 3 minutes were shown better sensory profile plot in overall preference. Hence, SlAEW at ACC 0.5 and 5 ppm coupled with HPP at 400 and 500 MPa were optimally combine as the hurdle technology. SlAEW-HPP at 0.5 ppm-500 MPa and 5 ppm-500 MPa had lower levels on TVB-N. According to TPC results, control, 0.5 ppm-500 MPa and 5 ppm-500 MPa can be stored up to 14 days. The 500 MPa can be stored within 10 days, and 0.5 ppm-400 MPa and 5 ppm-400 MPa can be stored until 7 days. The de-shelling rate can reach 100% when the pressure exceeds 400 MPa. The shelf-life of hard clams treated with 0.5 ppm-500 MPa and 5 ppm-500 MPa is extended to 14 days according to the tested indicators.
Conclusion: SlAEW-HPP (5 ppm-500 MPa) is superior to single HPP or SlAEW treatment, which can improve safety, texture and delay the blackening of hard clams during refrigerated storage.

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Impact of Pulsed Electric Field (PEF) on Vegetable Processing: Case Study on Carrot Processing

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Aim:
The aim of this study was to analyze the impact of pulsed electric field (PEF) pre-treatment on the industrial processing steps of carrot tissue in a holistic view.
Method:
The PEF treatment was performed at an electric field intensity equal to 1.07 kV/cm and varying specific energy inputs of 0.25, 0.5, 1 kV/cm. The raw material was cut into cubes of 10x10x10 mm, blanched (T= 88 °C, t = 6 min) and afterwards frozen (T = -34 °C, V = 2m/s). The cutting, blanching and the freezing behaviour were evaluated. The blanching process was assessed determining the influence on enzyme inactivation and leaching effect during water blanching. The quality of the processed carrot cubes was evaluated by color and texture analysis.
Results:
A PEF pre-treatment led to a cutting force reduction of fresh cut carrot cubes of up to 22 %. Moreover, PEF treated samples were characterized by a noticeably smoother cutting surface compared to untreated once being responsible for higher yield due to the quality improvement. Furthermore, a PEF pre-treatment resulted in a reduced blanching time by up to 30 % and an enhanced inactivation of peroxidase. In addition, the freezing time of PEF treated blanched carrots was reduced by up to 25 % compared to untreated ones. No significant difference in texture has been found after thawing for untreated and PEF treated samples indicating a high quality of the final product. The water content after thawing of PEF treated samples was higher although a higher water loss was observed for fresh carrot cubes immediately after cutting compared to the untreated sample. However, the lightness was slightly decreased for PEF pre-treated thawed carrot cubes.
Conclusion:
Applying PEF as a pre-treatment in vegetable processing shows the potential to shorten processing times and therefore positively impacting the sustainability of the process, while keeping the product quality high.

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Effect of the pulsed electric field on olive enzyme activity – a model system experiment

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Aim:
Pulsed electric field (PEF) is an emerging new technology that is finding more and more applications in the food sector. Virgin olive oil is no exception, as its application can significantly increase oil yield. However, changes in the chemical composition of virgin olive oil vary from study to study. This could be due to the fact that the chemical composition of the oil is directly influenced by the endogenous enzymes of the olive fruit responsible for the distribution of polyphenols in virgin olive oil and its sensory properties. Therefore, the aim of this study was to determine the effect of PEF on endogenous olive enzymes in model systems.

Methods:
Model systems of commercial enzymes (β-glucosidase and lipoxygenase) and their substrates (p-nitropheniygluco-pyranoside and linoleic fatty acid, respectively) were treated with HVG60/1 PEF (Impel, Zagreb, Croatia) for 1, 2, and 5 min with voltages of 0.1 and 0.5 kV/cm^2 and a frequency of 25 and 125 Hz. Then, the treated enzyme/substrate solution was incubated at 25°C for 30 minutes to simulate a malaxation process. The activities of the enzymes were determined spectrophotometrically.

Results:
The activity of PEF-treated enzymes increased 4.5-fold for β-glucosidase and 2-fold for lipoxygenase compared to the untreated enzymes. The β-glucosidase activity measured immediately after PEF treatment was significantly affected by all factors and also by the interaction of voltage and time and frequency and time. Higher voltage resulted in an increase in β-glucosidase activity with longer treatment duration. After an additional 30-min incubation at 25 °C, β-glucosidase activity was affected only by PEF voltage, whereas it increased with higher voltage.
Immediately after PEF treatment, lipoxygenase activity for linoleic fatty acid was significantly affected by treatment duration, with longer PEF treatments increasing activity. However, after incubation, longer treatment time resulted in lower amounts of hydroperoxides produced, which might be related to their spontaneous degradation.

Conclusion:
The introduction of PEF in virgin olive production as a pretreatment of malaxation could lead to a higher concentration of phenols and an improvement of the sensory characteristics of the oil due to an increased enzymatic activity.

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Enhanced seed germination by atmospheric-pressure plasma: effect on germination rate and nutritional value

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Mung bean (*Vigna radiate*) and lentil (*Lens culinaris*) are important leguminous crops, widely consumed, and rich in nutrients. Many factors can result in a considerable loss in production, nutritional value and economic yield of these foods. In these sense, different plasma-based technologies have been studied as an alternative to the existing techniques with ecologically safe, economical and effective ways to improve seed performance. The present study aimed at exploring the effects of non-thermal atmospheric plasma on seed germination of lentils and mung bean, and on nutritional value of germinated seeds. A novel large gap pin-to-plate nonthermal atmospheric plasma was used to treat lentils and mung bean seeds. The reactor consists of 88 slightly convex pins attached to stainless steel electrode, paired with a flat stainless-steel ground plate powered by an AC power supply (Leap100, PlasmaLeap Technologies). The air gap between the pin electrodes and the ground plate serves as the sample treatment area, with all seed samples in this study being placed in the center. Seeds were treated at a discharge voltage of 250 V, discharge frequency of 1000 Hz and duty cycle of 91 µs during an exposure time of 5 minutes. The study evaluated the germination rate of both seeds and the content of polyphenols, flavonoids, vitamin C, soluble and total nitrogen of sprouts. Plasma-treated seeds showed a significant increase on germination rate compared with controls. The germination time was reduced by 20%, where the time to reach 100% germination was 10 and 14 h less for plasma-treated mung bean and lentils seeds, respectively. Additionally, plasma treatment did not affect the content of the compounds analyzed in the germinated seeds. This study suggested that plasma treatment could provide a green and effective mean of stimulating seed germination, and thus accelerate the growth cycle without affect their nutritional value.

Mung bean, lentils, seed germination, non-thermal atmospheric plasma, nutritional value

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The use of different non-thermal technologies to control biofilms on food industrial surfaces

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Microbial communities colonizing food processing environments in the form of biofilms have a major impact on food quality and safety. Given the limitations of traditional disinfection methods for removing biofilms, the potential of novel biofilm control strategies was investigated, including multiple non-thermal technologies, such as ultraviolet, ultrasound and plasma-based technologies. Thus, the objective of this study was to evaluate the biofilm-removal efficacy of direct atmospheric air plasma (AAP), plasma activated water (PAW), LED-UV light and airborne acoustic ultrasound (AAU) against *Listeria innocua* biofilms grown on stainless steel for 6 days at 12 °C. Additionally, an approach based on the application of a previously developed coating that prevents bacterial adhesion through the modification of the physico-chemical characteristics of the surface was tested. The results showed that the highest inactivation efficacy was obtained with LED-UV light, achieving 1.7 ± 1.0 log reductions after a treatment of 4 seconds at a wavelength of 285 nm, followed by PAW and AAP, with barely no inactivation observed with AAU. Biofilm exposition for 15 and 20 min to PAW immediately after its generation resulted in log reductions of 1.4 ± 0.2 and 2.44 ± 0.1, respectively. However, the maximum inactivation achieved with AAP under the tested conditions was 0.7 ± 0.1 log reductions, using 500 Hz and 5 min of exposition time. Although no inactivation was observed with the AAU 15-min treatment, the combination with the 15-min PAW treatment resulted in a higher antimicrobial effect, obtaining log reductions > 2.6 (detection limit of the method). The anti-biofilm coating allowed a reduction of *L. innocua* biofilm formation by 68% compared to the uncoated stainless steel.

Biofilm, plasma-based technologies, LED-UV light, airborne acoustic ultrasound, anti-biofilm coating

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Thermosonication applied to blueberry juice – Impact on quality properties

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Aim: The conventional heat treatment (HT) is still used by the food processing industry as a solution to inactivate pathogenic agents and to extend the shelf-life of juice products. However, pasteurization involves quality modifications of the final product by losing part of its nutritional value and properties. This factor is critical in industrial juice manufacture, whose freshness is essential. This study aims to evaluate if thermosonication (TS) can be considered a potential alternative to the pasteurization of blueberry juice.
Method: Juices were prepared by defrosting the frozen blueberries and then using a cold centrifugal juicer. Freshly prepared juices were thermosonicated with a sonicator probe (700 W, 20 kHz, 100% amplitude) at 45 and 55 °C for 25 and 1 min and using an ultrasonic bath (230 V, 35 kHz) at the same temperatures for 30 and 60 min. These processes were compared to the traditional pasteurization by the juice heat-treated at 75 °C for 1 min. The temperature/time binomials were chosen based on the 5-log10 *L. innocua* reduction. Physicochemical parameters, anthocyanins content, total phenolics, antioxidant activity, and enzyme activity were monitored before and after treatments.
Results: The TS applied with the probe (TSP) had significant positive effects on blueberry juice, such as the increase of antioxidant activity (according to the ABTS scavenging method), the inactivation of enzymatic activity (a residual activity of about 25% and 1% was achieved for POD and PPO), and the decrease on the browning index. However, a significant reduction of phenolic compounds and anthocyanins was observed. HT had the most impact on juice colour parameters but was the most effective method in totally inactivating the POD enzyme. TS with ultrasonic bath (TSB) showed no significant differences in antioxidant activity and anthocyanins compared with the untreated juice. However, also juice colour was significantly changed.
Conclusion: TSP and TSB effectively maintained or improved most blueberry juice quality characteristics compared with HT and untreated samples. Nevertheless, since TSB needs a higher treatment time for the 5log10 microbial inactivation, physicochemical parameters were more negatively affected. Therefore, thermosonication (especially TSP) seems a possible processing option to preserve blueberry juice quality.

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Application of cold plasma technology for the shelf-life extension of fish fillets: industrial scale validation

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Aim:
The aim of this study was to implement in an industrial scale and validate the optimum results of laboratory experiments for the production of extended shelf-life fish fillets by using cold atmospheric plasma (CAP) technology: i. plasma activated water (PAW, as antimicrobial agent) and ii. plasma activated ice (PAI, as antimicrobial agent and cooling capacitor).
Method:
PAW was produced using a CAP Helium jet (flow rate 0.5 L/min, nozzle–water surface distance 4.3 mm, 7.2 kV, 100 kHz). PAW produced had H_2O_2 and NO^{3-} concentrations as 36.4 mg/L and 25.0 mg/L, respectively. PAW was transformed to ice flakes (PAI) having previously set the concentration of H_2O_2 to 3.8mg/L.
Two case studies were studied:

1. Fish (*Sparus aurata*) fillets followed the typical production procedure and at the final stage they were immersed into PAW for 10 min (fish:antimicrobial agent ratio=1:3). Then, the fillets were placed in insulated boxes with conventional ice flakes (plain water).
1. Same (non-immersed) fillets followed the typical production procedure and were finally placed in insulated boxes along with PAI flakes (fillets weight: ice weight was 1:1 in all cases).
2. Conventional fillets stored at insulated boxes with plain water ice flakes were also used as control.

In both cases, the fillets followed the typical chill chain (storage to the production warehouse for 1 day, transportation to the distribution warehouse and transportation to the supermarket warehouse). After totally 2 days of storage and transportation, the fillets were stored to consumers' refrigerators. Comparative evaluation (microbial load and physicochemical characteristics) of fillets stored to PAI and plain water ice flakes was conducted after 2 days from production and during 7 days storage at consumers' refrigerators.
Results:
In both cases, an approximately 30% microbial load reduction was measured after 2 days from their production, compared to control samples. The quality parameters were not affected by PAW immersion or PAI storage. The shelf-life of the treated samples was 1.5-fold the corresponding of control samples.
Conclusions:
The efficiency of PAW and PAI on perishable products (i.e. fish fillets) shelf-life extension was validated in industrial scale production and storage and distribution scenaria.

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Impact of high-pressure processing on qualitative and quantitative attributes of fresh pumpkin

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Aim: Novel food processing technologies are commercially applied to produce high quality fruit and vegetable products. In particular, High-Pressure Processing (HPP - non-thermal technology) is an emerging technology used for preservation of vegetables with health promoting properties. The primary aim of this study was to evaluate the effects of HPP on pumpkin samples.

Methods: In this study pumpkin cubes were treated at six different pressures (HPP100 to 600) at 20 °C for 3 min. Colour and texture as well as bioactive compounds such as polyphenols and carotenoids (LC-MS), volatiles (HS-GC-MS) and sugars (HPLC) were measured and compared to untreated (UNTR) samples. For the microstructure examination, the fixed and dyed sections were observed by means of an optical microscope at different magnifications (20,40 and 63X).

Results: Noticeable difference was observed in HPP600 samples, with a difference in terms of colour (i.e., ΔE 11.3+1.9) and hardness (87.4+27.8 N), compared to the UNTR ones (194.9+37.9 N). Pumpkin tissue showed great structural modifications such as changes in cell size and shape, cell wall damage, thickness of cell wall, cell dehydration, pectin degradation and calcium ions deposition mainly at very high pressures (300 to 600 MPa). UNTR samples showed the highest value of maximum and minimum cell elongation (88.9 and 72.2 µm respectively), perimeter segment (267.7+6.4 µm) and more regular cell wall thickness (1.5+0.1 µm) whereas HPP600 samples showed the lowest values for the same parameters. Specifically, higher number of extractable polyphenols was observed at middle pressure (200 to 400MPa), whereas at lower pressure (100 to 300 MPa) higher carotenoids content than UNTR was observed. Regarding volatile compounds, significant changes were observed for some aldehydes that increase after HPP application, while the opposite trend was observed for total sugars content.

Conclusion: This research revealed that high-pressure treatments from 200 to 400MPa could ensure a higher amount of "bioactive, volatiles and sugar components availability. On the contrary, treatments from 400 to 600 MPa pressure negatively influenced the structural quality.

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Plasma for food application: opportunities and challenges

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Aim

The need for non-thermal, sustainable technologies as an intervention to enhance food safety remains. Non-thermal plasma technology is an innovative food processing technology that offers opportunities to improve hygiene along different steps of the food production chain. Plasma is an ionized gas containing highly reactive species and uncharged molecules that have antimicrobial properties. It can be applied both in a gaseous form typically using air or nitrogen as the carrier gas or in a liquid form referred to as Plasma Activated Water (PAW). Within the public private partnership project Plasma4Hygiene, different applications of plasma technology have been evaluated using different food matrices and plasma sources.

Method

In the Plasma4Hygiene project, both the gaseous plasma and PAW were tested for different plant-based and animal-based food matrices and compared to performance in reference conditions typically used in laboratory setting.

Results

The presentation will discuss several results of plasma technology on food to highlight opportunities and challenges for food application. The application of PAW for mushroom, poultry meat and additional agri -products will be shown. Nitrite levels in the products were measured before and after treatment and showed significantly raised levels for most products. The implication of this will be discussed. To evaluate opportunities for poultry meat processing, both PAW and non-thermal air- and nitrogen-based atmospheric plasma were used on poultry meat model matrices. The poultry meat model matrix allowed to study impact of matrix composition without the complexity of the matrix structure. The results showed that a very fast inactivation of *Escherichia coli* on reference matric leading to more 4 log reduction within 15s. Strikingly, in the presence of either skin or meat components the inactivation of *E. coli* was largely reduced suggesting that the matrix composition and not the matrix structure protects cells from inactivation. These and other examples will be discussed in this contribution.

Conclusion

Cold plasma offers a new inactivation strategy different from conventional decontamination methods applicable to resistant food pathogens and spoilage strains. It is important to select the right match between type of technology and product application and to consider the food matrix complexity.

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Effect of High Pressure and pH-value on polysaccharides extraction from Arthrospira platensis (Spirulina) fresh biomass

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Aim:

Spirulina, a blue-green microalgae, contains numerous valuable compounds, such as proteins (up to 70% of the cell mass), lipids (6–13%) and carbohydrates (15–20%). Most of the carbohydrates are polysaccharides (PSCs), known for their health promoting profile. For that reason, PSCs have been used as food and cosmetic ingredients and in nutraceutical and pharmacological applications. Commonly used extraction techniques require high extraction times and temperatures, high-energy costs, and the use of toxic solvents. High Pressure (HP) is a green technology implemented for intracellular compounds extraction from natural sources, with the reported yields being significantly higher compared to conventional techniques. A study on the combined effect of HP and pH-value on the extraction of polysaccharides from Spirulina was conducted targeting to an optimized extraction protocol.

Method:

Wet biomass of *Arthrospira platensis* (80% moisture content, 12.0 g/100 g dm PSCs) was diluted in a ratio of 1/20 in phosphate buffer 0.1 M of different pH-values ranging from 4.5 to 9.0. Samples were processed under HP at 100-600 MPa at 20°C for 0.1 min. In a 24-h period after processing, at appropriate time intervals, all the samples were analyzed for their concentration in total PSCs. Mathematical modelling was used to describe the effect of HP and pH-value on the extraction rate at 20^{o}C.

Results:

First order kinetics were used to describe the combined effect of HP and pH on the extraction of PSCs. The extraction rate constants were estimated at all conditions studied. At each studied pressure, pH increase led to higher concentrations in PSCs. For pH values up to 7.0, pressure increase led to higher PSCs concentrations. For pH-values ≥8.0 and pressures ≥400 MPa a reverse behaviour was observed. The higher extraction rates were estimated at 300 MPa leading to 80% yield at approximately 3.5, 1.0 and 0.6 h when environmental pH was 7.0, 8.0 and 9.0, respectively.

Conclusions:

HP is a green technology which could potentially be used for PSCs extraction, leading in significantly reduced time and high yields compared to commonly used techniques.

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The impact of pulsed electric field pretreatment on convective and vacuum drying of strawberries

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Aim:
Electroporation induced by the action of a pulsed electric field (PEF) leads to an increase in the permeability of the cell membrane. This intensifies diffusion-based processes, e.g. drying. The study aimed to determine the effect of PEF pretreatment on the drying of strawberries by two methods (convective - CD, vacuum - VD), and the antioxidant activity of obtained dried materials.

Method:
The experiment was designed using the Response Surface Method (RSM). The first variable was the temperature (55, 70, 85°C - CD, and 40, 55, 70°C - VD), and the second was the PEF energy input (1, 2.5, 4 kJ/kg). The optimization responses were: drying time to MR = 0.02 and the ability to scavenge DPPH• radicals (based on the EC_{50} values). The DPPH assay was carried out via spectrophotometric method.

Results:
The temperature had a higher impact on the drying time and antioxidant properties of the dried materials, than the PEF energy input. The higher the air temperature, the shorter the drying time of the strawberries. It could be due to intensifying the mass and heat transfer by increasing the drying temperature. Among the analysed range of PEF energy input, the shortest drying time of strawberries was noted after supplying them 1 kJ/kg of energy during the pretreatment. Mild process conditions induced electroporation, which facilitated diffusion of water, and, at the same time, did not lead to overtreatment of the material. Generally, the lowest EC_{50} was obtained in samples dried at the lowest temperature (gentle conditions of drying), or at the highest temperature (the shortest drying time). In both cases, the better properties of dried strawberries could have resulted from the limitation of thermal degradation of antioxidant compounds.

Conclusion:
The study shows that it is possible to optimize the convective and vacuum drying of strawberries with pulsed electric field pretreatment. Considering all the obtained results, the process parameters' combinations of 1.5 kJ/kg + 85°C, and 1 kJ/kg + 68°C were the most optimal, in the case of CD and VD, respectively.
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Influence of PEF pretreatment, temperature and ultrasound application in kiwifruit drying trough a Box-Behnken Design

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Abstract:
Aim:
Convective drying of kiwifruit involves important energy needs due to its high moisture content and the low process kinetics. The increase of the air-drying temperature and the combination with alternative technologies can shorten the process and then the energy cost. The application of power ultrasound (US) during drying or the pretreatment with pulsed electric field (PEF) could enhance mass transfer process. The Box-Behnken Design (BBD) is a statistical tool that allows to reduce time and resources while determining the best process conditions. So, the aim of this work was to identify the combined influence of drying temperature, power ultrasound and PEF pretreatments in the drying kinetics of kiwifruit.
Method:
Kiwifruit drying experiments were carried out according to a BBD considering a temperature range of 40 to 70 ºC, US power between 0 and 20.5 kW/m^3 and the PEF pretreatment at electric field strengths between 0 and 0.63 kV/cm. To quantify the influence of the drying conditions, a diffusion model based on Fick's second law was considered, identifying the values of effective diffusivity (Deff) and the mass transfer coefficient (k). With the data obtained, a second-order polynomial regression model was fitted.
Results:
The results showed that the increase in drying temperature led to a clear increase in Deff and k values. Likewise, the US application improved the drying rate, especially at low temperature. On the other hand, the influence of PEF was not significant. However the interaction of PEF with US showed significant enhancing in the drying rate. The good fit of the polynomial expression indicated that it was a good model to predict the drying kinetics in the range studied.
Conclusion:
The BBD allowed studying the influence of the variables temperature, US application, PEF pretreatment and the interaction between them. The temperature was the variable that most affected the kiwifruit drying, although the application of US and the combination PEF and US also demonstrated to improve the drying kinetics. In addition, it was possible to obtain a polynomial expression, which allow predicting Deff or k, according temperature, US power and electric field (PEF) applied.

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Plasma activated water to develop functional edible coating: effect on the quality of fresh-cut apples

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Aim
Edible coatings are a promising sustainable preservation technology able to extend the shelf-life of food products. Plasma activated water (PAW) is an important application of the cold atmospheric pressure plasma that can be used as an antimicrobial liquid for decontamination of food surface. The objective of this work was to evaluate the possibility to use PAW for develop edible coating.
Method
Due to the low pH of the PAW, a biopolymer soluble at low pH must be used. In this work, two natural biopolymers were tested: a low molecular weigh chitosan (CH) and proteins extracted by house cricket (PE). PE and CH were used at different concentrations to optimize the solution stability in PAW. Then, the optimal coating obtained with and without PAW was applied on fresh-cut apples to study the effect on the quality of the product. Firstly, respiration rate (RR_{CO2}) and transpiration rate (TR) at 60, 76, 86 and 96% of RH were measured at 5°C. Secondary, chemical-physical and nutritional properties were studied during storage at 5°C for 13 days.
Results
Results showed that PAW was a good solvent for cricket protein in 1 and 2%, whereas chitosan was not soluble in PAW at any concentration. The optimal coating composition was a blend of 2 % of protein dissolved in PAW and 2% chitosan dissolved in 1% acetic solution (ratio 1:1). All coatings preserved the physiological properties of the fresh-cut apples compared to the control samples. However, no differences were observed between coating prepared with or without PAW. Chemical-physical properties of the fresh-cut apples were not affected by the coatings during shelf life, whereas antioxidant capacity (+20%) and total polyphenol (+20%) were preserved when PAW was used to prepare the coating.
Conclusion
Results showed a potential application of PAW for develop edible coating. The solubility of the biopolymer in the PAW is a critical parameter for the coating development. PAW was a good solvent for PE and blend of CH (2%) and PE (2) were successfully applied on fresh-cut apples. Coating obtained with PAW reduced RR_{CO2}, TR and preserved nutritional quality of fresh-cut apples.

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Effect of PEF treatment on water retention capacity and shearing force of butternut squash

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Abstract:
Aim:
Pulsed electric field (PEF) technology is used for the electroporation of food matrices. This fact could be interesting to improve mass transfer processes such as the drying. For this reason, it is interesting to quantify the level of cell disintegration produced by PEF and its influence in physical properties related with the water retention in the samples. In this sense, the aim of this work was to study the cell disintegration index (CDI) produced by PEF in butternut squash and its relationship with texture and water retention capacity (WRC).
Method:
The CDI produced by PEF in butternut squash samples was characterized by applying different levels of electric field strength (0.67, 1.34 and 2.00 kV/cm) and treatment times (between 0 and 20000 μs). The cellular impedance of the untreated and completely destroyed samples was measured, ranging between values of 0 and 1 respectively. Moreover, the shearing force of the samples was measured before and after the different PEF treatments. Likewise, the WRC was evaluated by centrifugating the samples at 5000 rpm for 10 min.
Results:
Both the increase in electrical field strength and the treatment time affected the CDI. The higher the field strength and treatment time, the higher the CDI, reaching values close to 1 (completely destroyed) at the more extreme conditions tested. This fact was reflected in the mechanical properties. Thus, the untreated samples required a higher shearing force, while those treated with PEF presented significant lower values of force. On the other hand, the WRC was significantly affected by the PEF treatment. Samples treated for a longer time at higher field strengths had lower WRC.
Conclusion:
It was identified a relationship between the CDI produced by PEF pretrement and the shearing force study, and its water retention capacity decreased. The more intense the PEF treatment, the softer the samples and the lower water retention capacity. This study may be of great interest for choosing the best PEF conditions as pretreatment for subsequent mass transfer enhancement processes.

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Effect of Pulsed Electric Fields on the Osmotic Dehydration of fresh-cut spinach leaves

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Aim:
Fresh cut spinach is commonly distributed in chilled storage, but due to its extremely short shelf-life and delicate structure it cannot be readily incorporated into products such as ready to eat meals. Dehydration processes such as air drying are effective in preserving the tissue, but the quality of the final product is far removed from that of the initial fresh vegetable. Osmotic Dehydration (OD) provides a gentle dehydration to delicate plant tissues by immersion in a hypertonic solution. The dehydration barriers posed by the plant cell's structure can be overcome by increasing cell permeability. Pulsed Electric Fields (PEF) permeabilize cells by exposing them to a high strength electric field and are suitable for enhancing mass transfer during dehydration processes. Nevertheless, a balance must be struck between tissue deterioration and mass transfer enhancement. In this study we assessed the application of PEF as a pretreatment to osmotic dehydration of fresh cut spinach with the aim of producing a fresh-like product with reduced water activity.

Method:
Fresh cut spinach leaves were PEF treated at 0.6 kV/cm with 0 to 200 pulses of 15 µs width. Samples were osmotically dehydrated (25°C, 1:20 solid to liquid ratio) in solutions with 50% or 60% glycerol. The kinetics of OD were described in terms of water loss and solids gain and modelled through Fick's second law of diffusion. Samples were assessed in terms of objective color, burst strength, water activity and sensory acceptance, in order to pinpoint the most suitable treatment conditions.

Results:
All conditions led to an acceleration of OD (up to 25% increase in moisture diffusion coefficient). For 50% glycerol, water activity did not drop below 0.91, whereas at 60%, PEF treatments exceeding 50 pulses led to a decrease down to 0.88 for 1 h of OD. Intense PEF conditions (over 100 pulses) led to increased burst strength and unacceptable chewiness up to 20% accompanied by significant color darkening (total color difference $\Delta E>8$).

Conclusion:
Although PEF causes unacceptable spinach texture at high processing intensities, when applied at suitable conditions it effectively enhances osmotic dehydration, leading to a high quality product with expectedly increased stability during storage.

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Influence of ultrasonication in plant-based proteins and nanoemulsions made thereof

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Aim:

The properties of plant-derived proteins demand new strategies for their incorporation into foods. One of the strategies is the ultrasonication process (US), which modifies proteins' structural and physiological properties and thus extends its application. In this work, we studied the influence of the US on proteins structural features and on the development of plant-based nanoemulsions.

Method:

The effect of the US time (0, 3, 4.5 and 6 min) at 40 W in the potato (*Solanum tuberosum*) and lupin (*Lupinus angustifolius*) proteins structural features was analysed through intrinsic fluorescence, exciting tryptophan present in the protein, and extrinsic fluorescence, using the 1-anilino-8-naphthalene sulfonate fluorescent probe.

Oil-in-water nanoemulsions were produced through high-speed homogenization, followed by US, using potato and lupin protein as emulsifiers. A 2^3 central composite rotatable experimental design was used to evaluate the influence of three independent variables: oil:water ratio (65-75% of water), protein content (1-6%) and US time (1-7 min) on the average size and polydispersity index (PDI) of the nanoemulsions. A total of 17 experiments were performed with 14 two-level experimental points, and 3 replicates at the central point.

Results:

When subjected to US, the lupin protein showed a slight increase of the intrinsic fluorescence maximum, as a possible result of a decreased quenching from the neighbour amino acids. All the US times on lupin protein resulted in the increase of extrinsic fluorescence, which could be explained by changes in protein conformation resulting from protein unfolding. For potato protein, there was no clear differentiation in both fluorescence spectra among different US conditions and non-treated protein.

Results also showed that the use of lupin and potato proteins led to stable nanoemulsions for 50 days. The smallest mean droplet size for potato protein was 439.9 nm and PDI value 0.464 [21:73 (w/w) oil:water, 5% (w/w) of protein and 6 min of US], while for lupin protein was 505.5 nm and PDI value 0.434 [23.6:73 (w/w) oil:water, 3.4% (w/w) of protein and 6 min of US].

Conclusion:

US seems to be an effective strategy to develop plant-based nanoemulsions and, in some cases, led to changes in protein structures that could improve its capability as natural emulsifiers.

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High pressure and pressure assisted thermal processing for developing gluten-free buckwheat flours with antioxidant properties

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Non-thermal technologies are gaining interest over the last decade; high hydrostatic pressure (HHP) has been successfully applied to extend shelf life of food industry matrices without detriment on sensory and nutritional values. Furthermore, HHP has many additional advantages associated with the pressure applied. One of the novel uses is to enhance the bioavailability of bioactive compounds of the final product. Most of industrial HHP equipment do not include temperature control; however, the potential combination of temperature and pressure (Pressure assisted thermal processing, PATP) can favour the extractive efficiency of this technology.

Aim:
In this study, the effect of pressure, time and temperature processing was investigated. The optimization of these parameters was aimed to enhance the antioxidant activity of buckwheat whole grain for industrial applications of gluten free flours, generally characterized by poor nutritional and bioactive profiles.

Method:
Whole buckwheat grains cultivated under control condition were used for the experiment. Pressures of 300 and 600 MPa were compared at 5- and 15-min using room temperature (below 20ºC) and mild temperature and pressure (PATP) conditions from 40 to 50 ºC, considering the adiabatic compression heating effect were applied to the samples. Effect of the different conditions on total phenol content (TPC) and antioxidant activity (ORAC, ABTS, DPPH and FRAP) using extractive and quencher methods have been evaluated to gain insight and optimize novel industrial processes.

Results:
Results of samples treated at low temperature showed a slight loss of phenol content compared to native buckwheat flour. Significant variability of antioxidant capacity was observed depending on the processing conditions. The results showed higher antioxidant capacity values in grains pressurized at higher levels (600 MPa) and longer holding times (15 min).

Conclusion:
The results presented in this work highlight the importance of HHP and PATP processing conditions in order to improve the antioxidant properties of whole buckwheat flour.

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Effect of innovative extraction processes on protein functionality from duckweed in indoor farming systems

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An interdisciplinary Team of scientists from food technology, horticulture and biotechnology from HSWT are establishing the basis for optimal cultivation conditions for duckweed in an indoor farming cultivation system. In corporation with industry partner Elea Technology GmbH, gentle extraction methods will be established for optimal protein extraction assisted by physical processes like pulsed electric fields (PEF) and ultrasound to observe their implications on cell disruption to release protein from duckweed (L. minor and L. gibba).

Aim: The project aims to investigate the effect of cultivation parameters (light spectra/intensity and nutrient solutions), innovative extraction technologies and their implications on protein release, techno-functional properties from duckweed. As alternative protein source for food applications, duckweed, besides all green plants, has an increasing potential with RuBisCo protein as main component and its protein content, protein density and amino acid composition.

Methods: Different light spectra and intensities as well as compositions of macro- and micronutrients of the nutrient solution are tested for their effect on protein composition in duckweed species L. minor and L. gibba, with the aim of optimizing protein content, yield and characteristics of the final protein extract. Extraction process of RuBisCo protein as well as other leaf proteins is divided into three steps: pre-extraction, separation of pigments/antioxidants and protein isolation. Pre-extraction of freeze-dried and subsequently ground duckweed powder as well as fresh material is assisted by ultrasound, pulsed electric fields (PEF) or microfluidization (MF).

Results: Ultrasound shows that 97% of the particles are smaller than 100 µm, indicating cell disruption of plant cells, which are normally 100-300 µm in size. Ultrasound treatment resulted in about 10-15% increased protein solubility compared to the untreated reference. In addition, PEF, MF and selected enzymes will be used for cell disruption and compared in terms of their performance on protein yield and techno-functional properties.

Conclusion: Isolation of proteins will be performed based on pre-defined optimum pre-extraction procedure. Isolation of the proteins will then be carried out by mild heat and ultrafiltration. The protein extract obtained from this, will be tested for its functionality in food matrix.

Keywords: duckweed, mild protein extraction, pulsed electric fields, microfluidization, ultrasound, indoor farming cultivation

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Effect of HPP and temperature on the antioxidant activity of wheat and oat bran ingredients

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Wheat and Oat brans (WB, OB) are by-products from the milling industry produced by grain milling. Brans are rich in fibre, minerals, vitamin B6, and vitamin E and phytochemicals, in particular antioxidants such as phenolic acids. Phenolic acids have well known anti-oxidant and anti-inflammatory properties. However, their bioavailability is limited. Strategies to increase the bioavailability of those compounds are required. Enzymatic hydrolysis (EH) has previously shown effectivity in enhancing bran bioactive compounds' bioavailability; EH combined with hydrothermal processes have shown improved efficiency in this regard. On the other hand, impact of thermal technologies on thermolabile nutrients of bran make interesting to investigate alternative non-thermal technologies. High hydrostatic pressure (HPP) is an emerging, yet commercially available non-thermal technology. The potential of a combination of hydrolytic processes and limited temperature (40 to 70 ºC) and pressure (600 MPa) treatments was proposed for obtaining bioactive-rich bran-based nutraceutical ingredients.

Aim:
This study focuses on the application of HHP and temperature, before or after an enzymatic hydrolysis step, in order to increase the efficiency and yield of the bioavailability of bioactive compounds in wheat and oat brans.

Method:
Wheat and Oat brans were hydrolyzed (47 °C, pH 5, 20 h) using UltraFloXL or Viscoferm enzyme cocktails, respectively. Pressure of 600 MPa for 5 min were applied at temperature conditions of 40, 50, 60 and 70 ºC during the pressure holding time before and after the enzymatic hydrolysis. Temperature was monitored over the entire cycle and adiabatic heat was considered for reaching target temperatures. Glycemic index (GI), total phenol content (TPC), antioxidant activity (ORAC, ABTS, DPPH) and reducing power (FRAP) were evaluated using methods on extracts and solid samples to gain knowledge of the process and optimize novel industrial applications.

Results:
TPC was significantly higher in wheat bran before and after the hydrolysis. The use of HHP-temperature enhanced extractability of TPC. Increasing temperature also improved antioxidant and FRAP results. An increased yield was also observed due to the HPP-temperature pre-treatment. No significant effect on GI was observed.

Conclusion:

HHP treatment with controlled mild temperature showed potential for replacing hydrothermal pre-treatments used for improving enzymatic hydrolysis efficiency in brans.

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Impact of power ultrasound (frequency and power) on quality attributes of fresh-cut lettuce (cv. Vera)

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Aim:
There is an increasing demand for fresh-cut products, leafy vegetables being the most consumed. Disinfection step is one of the most important operations in fresh-cut production where different strategies are used to minimize and reduce microbial hazards. Cavitation bubbles formed by power ultrasound have been used for decontamination step because of their ability to remove or reduce microbial loads. The aim of this work was to evaluate the effect of two different acoustic power densities (APD) and frequencies on quality attributes of fresh-cut lettuce when combined with peracetic acid (HPA) in disinfection step.
Method:
Parameters associated with disinfection solution (HPA concentration, pH, conductivity and microbiology) were determined before and after US treatment. Parameters associated with ultrasound performance were measured: dissipated power and acoustic power density (25 and 45 W/L). To quantify treatment's effects, parameters associated with quality before and after treatments were measured: microbial load, pH, color, electrolyte leakage (EL), chlorophylls (A, B and Total) and carotenoids content, total phenolic compounds (TP) and antioxidant capacity (AC).
Results:
An exploratory analysis with principal component analysis was performed for lettuce parameters. 78% of the total variance could be explained with two components (CP1, CP2). pH couldn´t be well represented by these components (cos2<0.5). AC, carotenoids and TP showed negative correlation with CP1 while microbial loads, EL and chlorophylls content were correlated positively. Carotenoids and chlorophylls showed a negative correlation with CP2, while the rest a positive one. Treatments differed significantly in parameters measured from no treated lettuce, with the exception of EL. Reductions on microbial load ranged between 1.6 to 2.1 log ufc g-1. AC, TP and carotenoids presented higher values with respect to non-treated lettuce while total chlorophyll showed lower values which was reflected in differences in color measurement.
Conclusion:
Although differences were found between treatments for almost all parameters, we couldn't find a tendency associated with APD nor frequency studied. CP1 separated non-treated lettuce from treated one. We could observe an enhancement in important parameters such as phenols and AC probably due to abiotic stress caused by treatments.

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Impact of Cold Plasma treatment on lipid oxidation and microbial inactivation in Mussels (Mytilus galloprovincialis)

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Aim:
Since non-thermal plasma technology is still under skeptical evaluation in regard to its application on food products, this research was conducted to provide deeper knowledge on the effect of cold plasma technology namely plasma activated water (PAW) on the lipid oxidation level and microbial inactivation on mussels' flesh (*Mytilus galloprovincialis*). Considering the importance of mussels for consumers as a low-cost source of protein with high biological value and the significant amount of polyunsaturated fatty acids in their tissues.

Method:
The treatment was carried out using an innovative prototype device that allows indirect plasma treatment of food products by exposing half a liter of distilled water for 4 min to a pulsed corona discharge driven by a high voltage power generator (AlmaPulse, AlmaPlasma s.r.l.) using peak voltage of 18 kV and a pulse repetition frequency of 5 kHz. The resulted water was used for samples dipping for 5, 10, and 15 minutes and correspondingly to the same time slots, samples dipped in untreated demineralized water were kept as controls.
The treated and controls samples were subjected to total lipids extraction and the latter was taken for further analysis on non-volatile (peroxides, oxysterols) and volatile lipid oxidation products. Microbial decontamination of total mesophilic aerobes, Enterobacteriaceae, Pseudomonadaceae, and Escherichia coli was performed on treated and controls samples.

Results:
Six cholesterol oxidation products (COPs) were identified in the unsaponifiable matter. A total amount of 110-140 µg of COPs/g of total lipid were observed in the analyzed samples, corresponding to 10-20 µg of COPs/110 g of fresh matter. Twelve oxygenated derivatives from the splitting of the fatty acid hydroperoxide isomers were detected in the headspace of mussels' lipids (C5-C9 aldehydes, alcohols, and ketones). There was no significant effect of PAW on peroxide value, total fatty acid composition, volatile levels, cholesterol and COPs. Likewise, the microbial inactivation showed no differences.

Conclusion:
PAW technology appears to be a promising technology to replace or enhance conventional processing technologies to achieve food decontamination and stabilization. However, dipper investigations are still required.
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High pressure processing (HPP) of phycocyanin: functionality, stability and strategies to mitigate functionality loss

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Aim: Increasing demand for clean-labels has fueled the search for alternatives to synthetic food additves. *Spirulina* extract, rich in phycocyanin (PC), a blue pigment-protein conjugate is considered a natural option to replace synthetic blue dyes in food formulations. PC's high sensitivity to heat and acid make it susceptible to thermal processing and limit its industrial application. Hence, exploring PC's stability under non-thermal treatments such as HPP could expand its utilization. The aim of the study was to systematically assess the functionality and stability of PC aqueous solutions treated under different HPP conditions. The contribution of acidic pHs to instability was also explored.
Method: Aqueous dispersions of PC (pH=4, 5, 6) were subject to HPP at pressures from 500 to 600 MPa for 1 to 5 min. The photophysical properties (i.e., energy, fluorescence intensity and anisotropy) of PC's fluorophores (i.e., chromophore and aromatic amino acids -AA) were measured using a Fluoromax-4 spectrophotometer equipped with polarizers. PC concentration and purity were determined based on absorbance intensities of PC's chromophore and AAs. Particle size of PCs was evaluated after each treatment to assess aggregation. Post-HPP pH adjustment was assessed as a strategy to improve PC's stability and functionality.
Results: pH of the system played a significant role in PC stability towards HPP (lower stability at lower pH) as indicated by a significant reduction in fluorescence intensity. A blue-shift in the emission energy and increased anisotropy suggested conformational changes followed by aggregation of PCs, which was more predominant at lower pHs, higher pressures and longer processing times. The chromophore's initial intensity was reduced by 92% when treated at pH 4 and 600 MPa for 5 min, while at pH 6 the intensity only decreased by 20-50% depending on the testing conditions. Anisotropy values correlated well with particle size increases at low pHs, indicating molecule aggregation. Adjusting solution pH after HPP treatments mitigated PC degradation significantly, possibly due to milder effect of high pressure on the peptides conformation.
Conclusion: Results obtained provide insights about the instability mechanisms of PC under HPP, which can facilitate developing adequate processing steps to maximize stability and functionality in beverages.

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Ultrasounds processing of buckwheat whole-grain modifies the rheological characteristics of obtained flour

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Aim:
Flour properties impact strongly the possible products made with them, therefore many physical methods of flour functional properties modification have been tested. One of the less used method while perceived green and sustainable is ultrasonication. Buckwheat is pseudocereal cosindered as important gluten-free raw material. However very different to wheat rheological characteristics of buckwheat flour results in serious problems with processing for bakery purposes. The aim of the study was to evaluated the impact of two frequencies of ultrasonication (40 kHz and 23 kHz) on rheological characteristics of buckwheat flour and flour gels.
Method:
Dehulled buckwheat grains (achenes) were processed with two frequencies (40 kHz and 23 kHz) in water in 1:5 solid liquid ratio at temperature 30º-35ºC for 30 minutes in cycles 3 X 10 min with 5 min resting between cycles, dried in 50ºC for 24 h and milled. Pasting properties of flours (RVA), flour gel texture (TPA tests) and fundamental rheology (oscillation and amplitude sweep) were obtained.
Results:
The visible difference was observed in the impact on particular functional properties between the frequencies applied. G' and G" moduli were changed after treatment with both frequencies, however 23 kHz treatment had stronger impact than 40 kHz. Pasting curves were smoothen with 23 kHz while more pronounced with 40 kHz treatment. Gel texture was modified in both cases resulting in less hard texture.
Conclusion:
Pseudocereals like buckwheat can offer a high nutritional profile however the unfavourable functional properties can restrict their usage as valuable raw material in bakery. Ultrasonication offers a very convenient and controllable way to modifying the rheological behavior of flours.

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The effect of ultrasound and pulsed electric field on bioactive compounds of red bell pepper

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The effect of ultrasound and pulsed electric field on bioactive compounds of red bell pepper
Aim: The aim of the research was to determine the impact of non-thermal treatments: sonication (US) and pulsed electric field (PEF) on physical, and chemical changes, as well as the content of bioactive compounds in plant tissue in the example of red pepper.
Method: The treatment was carried out with the use of ultrasound: in an ultrasonic bath (300W, 21 Hz, time: 5-30 min), and with an ultrasonic probe (400 W, 24 kHz, time: 30-300 s), and the PEF treatment (1-10 kJ/kg). The color and texture of the material were determined. The water state (DT-NMR) and the content of bioactive compounds, including polyphenols, flavonoids, carotenoids, vitamin C and sugars, were examined. The antioxidant activity (ABTS, DPPH, PRAP) was determined.
Results: The use of US applied in the bath for 30 min and PEF with 5 and 10 kJ/kg resulted in a decrease of over 14% of the total sugar content. The concentration of total polyphenols was unchanged, while samples from US bath treated for 10 min and from US probe treated for 30 and 300 s, and PEF with 4 kJ/kg noted a significant decrease in the content of flavonoids. These samples were also characterized by a lower content of the sum of ascorbic acid and dehydroascorbic acid. The tissue treated with a US probe and the pulsed electric field showed lower antioxidant activity with DPPH and FRAP methods.
Conclusion: Both techniques can be used to intensify mass transfer. The application of ultrasounds and a pulsed electric field with specific parameters as pre-treatment methods may shorten the time of certain operations, e.g. drying, freezing, which will positively affect the energy consumption of the process, and will also allow the creation of a product with the desired properties.
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Valorisation of fruit and vegetable surplus into soup and juice treated by high hydrostatic pressure

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Aim:
In the produce food chain, one way to reduce food waste and valorise surpluses is to develop soups or juices with added value, such as rich in bioactive compounds. However, classic thermal preservation destroys bioactive compounds such as vitamin C or polyphenols. This work evaluated the effect of two preservation technologies, high hydrostatic pressure (HHP) and thermal pasteurization (TT), on vitamin content, polyphenol content and bioaccessibility, and oxidative enzymes of vegetable soup and juice made of produce surplus.

Method:
Two products were elaborated with different produce surpluses: *i)* cooked vegetable soup (VS) made of pumpkin, broccoli, and Swiss chard (pH 5.6) and *ii)* raw vegetable/fruit juice (VFJ) made of beet, apple, and lettuce (pH 4.7). TT had mildest conditions to achieve 6 log reductions of *Listeria monocytogenes*, as the most relevant vegetative pathogen for refrigerated ready-to-eat products, with an accumulative thermal lethality =2 min at the cold spot. Two HHP treatments were performed at 600 MPa for 3 and 6 min, and their listericidal efficacy was assessed through challenge tests. Vitamin C was determined by HPLC-DAD and total polyphenolic (TP) content by spectrophotometric method (Folin-Ciocalteu). TP bioaccessibility was performed following a simulated gastrointestinal digestion (INFOGEST). Polyphenol oxidase (PPO) and peroxidase (POD) activities were determined by detection of degradation products from catechol and *p*-phenylenediamine, respectively.

Results:
The safety of HHP treatments was validated (≥6 log reduction of *L. monocytogenes*) at 3 and 6 min for VS and VFJ, respectively. Under these conditions, HHP-treated VS had higher vitamin C content than TT, while no differences were found in TP content and bioaccessibility and enzymatic activities. Similar results were obtained with VFJ, with higher vitamin C content after HHP, and no differences in TP content and bioaccessibility, although HHP had higher PPO and POD activities. In pressurized juice, the lower inactivation of oxidative enzymes could be a drawback for the shelf-life, that need further studies to be determined.

Conclusion:
Produce surpluses were valorised into soup and juice with higher vitamin C content using HHP as preservation technology, compared to a thermal pasteurization of similar lethality.

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The impact of PEF and hybrid drying on the bioactive components of apples

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Aim:
Nowadays, different treatments before drying are investigated in order to enhance the process and obtain a better quality. Among them, pulsed electric field (PEF) and ultrasound (US) are of particular interest. However, their effect is dependent on the parameters of pretreatment and hybrid drying. The objective of this study was to analyze the impact of PEF treatment combined with US-convective drying on the drying kinetics, bioactive component contents and antioxidant properties of organic apples.

Method:
The response surface methodology was applied in order to optimize the parameters of pretreatment (PEF) and hybrid drying of apples. The following values of parameters were analyzed: PEF: 1, 3.5 and 6 kJ/kg of specific energy input; US-convective drying: 120, 160, 200 W of US power. The total phenolic content, reducing power, scavenging activity against DPPH and ascorbic acid contents were determined.

Results:
The drying time was the shortest when the highest US power during hybrid drying was set. PEF shortened the dehydration time especially when 3.5 kJ/kg was utilized. The scavenging activity against DPPH, the reducing power and the total phenolic content were the highest when the highest US power and the lowest PEF energy input were set, as well as when the highest energy during PEF and the lowest US power were applied. The most significant was the simultaneously effect of US power and PEF energy. Ascorbic acid retention was the highest when the lowest PEF energy and when 160 and 200 W of US power were used. PEF significantly decreased the content of every bioactive component and both antioxidant activities, irrespectively of the drying parameters.

Conclusion:
PEF contributed to shorten the drying time but also decrease of bioactive components probably due to leakage of cellular content and increase enzymatic activity. It seems that too high power level during both treatment and drying resulted in degradation of bioactive components.

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Storage temperature and pH-value effect on C-phycocyanin stability extracted by freeze-thaw and high pressure techniques

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Aim:

Arthrospira platensis (Spirulina), synthesizes C-phycocyanin (C-PC), a blue water-soluble pigment-protein complex of increased interest for its antioxidant and anti-inflammatory properties. The aim of the study was to investigate the effect of storage temperature and pH-value on the stability of rehydrated freeze-dried or air-dried C-pc extracts produced by freeze-thaw and high pressure-assisted extraction techniques.

Method:

C-pc was extracted by fresh biomass of *Arthrospira platensis* (80% moisture content) through freeze-thaw technique (3 cycles from (-)80^{o}C to (+)25^{o}C) and high pressure (HP) processing (300 MPa, 10 min, 20^{o}C, 3 h post processing extraction) using deionized water as extraction medium (1/20 w/v). The obtained extracts, after centrifugation (10.000 rpm, 10 min) were freeze and air-dried (40^{o}C, 4 h). The four powders formed were rehydrated in phosphate buffer 0.1 M of pH-values 4.5, 7.0 and 9.0. C-pc extracts were stored under darkness in cooling incubators at 4, 10 and 20^{o}C. During a period of 3 months, analyses of chroma, total protein content and C-pc concentration were conducted.

Results:

HP processing led to extracts of higher purity in C-pc compared to the freeze-thaw technique in significantly shorter time. Air-drying led to significant lower (up to ~50%) C-pc concentration compared to the freeze-dried extracts mainly attributed to denaturation process. C-pc was found to be decreased immediately after powder rehydration at higher pH-values by up to ~18% and ~50% at pH 7.0 and 9.0, respectively, compared to the pH-value of 4.5. Increase of temperature and environmental pH led to lower C-pc stability during storage. The pH-value of 4.5 was considered as the most suitable for C-pc stability, where only up to 17 and 22% loss of C-pc was observed after a 3-month storage at 4 and 10^{o}C, respectively.

Conclusions:

HP processing could be used as a green technology, alternative to conventional extraction techniques, leading to extracts of high purity in C-pc in short time. Combined with freeze-drying accompanied with rehydration at low pH-values, a protocol may be proposed for retaining C-pc concentration throughout a period of at least 3 months.

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Physical and chemical properties of sonicated organic apples subjected to ultrasound-assisted drying

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Aim: The aim of the study was to evaluate the impact of sonication (US) and ultrasound-assisted drying on the selected physical and chemical properties of dried organic apple tissue.

Method: The experiment was designed with Response Surface Methodology. The treatment was carried out with the use of bath ultrasound with a frequency of 21 kHz and 180 W for 10-30 min and the hot-air drying (temp. 70°C) was assisted with ultrasound power from 120-200 W. Drying was performed until a constant mass was reached. The physical properties were evaluated on the basis of rehydration and hygroscopic properties, while chemical properties were on the basis of polyphenols, flavonoids, vitamin C and antioxidant activity with DPPH radicals.

Results: The drying last from 125 to 170 minutes. The results showed that the use of specific parameters, e.g. 20 min sonication and ultrasound-assisted drying with ultrasound power of 120 W may result in better rehydration properties as well as good hygroscopic properties. Ultrasound-assisted dried apples absorbed water vapor in most cases in the same or lower amount in comparison to those treated only with the US. Furthermore, the use of sonication combined with ultrasound-assisted drying resulted in most cases unchanged or higher polyphenols, flavonoid content, and antioxidant activity, when compared to only pretreated with the US. The content of vitamin C was higher while longer sonication (20 and 30 min) and ultrasound-assisted drying were used. Only for 10 min sonicated samples apples obtained lower vitamin C content, regardless of the used ultrasound power during drying.

Conclusion: The combination of different technics may result in a positive way. Performed analysis showed that US treatment in the range of 10-30 min applied before hot-air drying assisted with ultrasound power of 120-200 W increased the concentration of analyzed bioactive compounds and antioxidant activity.

Acknowledgment: This project has received funding from transnational funding bodies, partners of the H2020 ERA-NETs SUSFOOD2 and CORE Organic Cofunds, under the Joint SUSFOOD2/CORE Organic Call 2019 (MILDSUSFRUIT) as well as National Centre for Research and Development (POLAND, decision DWM/SF-CO/31/2021).

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Enhancement of wheat dough functional properties by non-thermal plasma treatment of wheat flour

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Aim:
Chemical like, Cl_2, KIO_3 and, ascorbic acid are industrially important due to their abundant use to improve wheat flour functionality, such as water absorption, elasticity, gas retention, bulk density etc. Demand to inhibit the use of such chemicals to improve food quality attributes is exponentially rising since few years. Non-thermal Plasma (NTP) is embraced by the scientist in the field of food technology, due to its unique non-toxic, non-chemical, low temperature and non-post treatment nature.
Method:
In the present research, the concept of an *in-situ* dielectric barrier discharge (DBD) plasma production inside a rotational reactor for a direct interaction between the NTP and wheat flour (150 g, type 550 and 1050) was experimentally analyzed. Reactor consists of two concentric cylindrical electrodes, i.e. outer rotating ground electrode, and inner stationary high voltage electrode. Different operating parameters were tested (treatment time, flour mass in reactor and change of air temperature) to observe the effect of NTP. The changes in structural attributes of flour and doughs were studied by a set of analytical techniques.
Results:
Rheology analysis demonstrated the ability of NTP, to intensify the visco-elastic properties (G' and G") of the wheat dough, which indicates the enhancement of intermolecular di-sulphide bonds of gluten protein (stronger protein – starch network formation) by plasma. Obtained results showed a 1 – 3% increase in flour hydration properties. Experimental findings also confirmed the dependency of the NTP treatment efficiency on the air temperature. However, for each test case, longer treatment times (> 180 seconds) did not significantly contributed to a further increase of visco-elastic properties of wheat dough.
Conclusion:

3. NTP was 90% more effective in enhancing the visco-elastic properties of type 550 flour compared to type 1050.

- In case of dough, an increase of more than 100% in G' and G" was observed for type 550 after NTP treatment.
- Moisture content of flour stayed under 14%.
- Three minutes was identified as optimal treatment time for all test cases in the rotational chamber.
- Change in visco-elastic properties of type 550 flour is of an order of magnitude, if air temperature is changed from 20 °C to 30 °C.

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EMERGING TECHNOLOGIES IMPROVING MALT PRODUCTION: EFFECTS OF ULTRASOUND-ASSISTED HYDRATION AND ETHANOL PRE-TREATMENT TO CONVECTIVE DRYING

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Aim
Malting is a process that includes operations such as hydration, partial germination and drying of grains to obtain new products. The aim of this work was to evaluate emerging technologies to improve barley malting. For this, the hydration process was assisted by ultrasound and the pre-treatment with ethanol was employed before drying.
Method
Barley grains were hydrated by static immersion in water and assisted by ultrasound, both at 20°C; Peleg and Miano-Ibarz-Augusto models were used to describe experimental data. After reach the necessary moisture, the grains were submitted to germination for 84 hours at 16°C. Rootlets growth was analyzed by images during germination. Then, the green malt was conducted to convective drying at 50°C, with and without the pre-treatment by immersion in ethanol (30 min). The barley seed drying was also evaluated at the same conditions of malt. Page model was used to describe drying. To evaluate the malting process, the grains were submitted to compression analysis in texturometer. Additionally, alpha, and beta-amylase activities were determined.
Results
Ultrasound-assisted hydration requires shorter time to reach the necessary moisture to germination, reducing 38% compared with the conventional process. Miano-Ibarz-Augusto model best fitted the hydration data (R^2>0.99, *RMSE*<0.52% and *MRE*<0.71%), characterized by two steps. The application of ultrasound during hydration resulted in higher grow of the rootlets. Page model adjustment to drying resulted in R^2>0.99, *RMSE*<4.2% and *MRE*<4.5%. The main effect on the drying process was the ethanol pre-treatment, being even higher for barley drying, reducing the drying time in 27%. On the other hand, the combination of the treatments with ultrasound and ethanol resulted in higher alpha and beta-amylase activities, 9.0 and 6.2% higher than the malt produced without the utilization of these technologies. From compression analysis, it was possible to observe the decrease in the compression force of malt when compared with barley grain.
Conclusion
Ultrasound and ethanol have shown interesting and promising technologies to improve malt processing, reducing the hydration and drying times and increasing the enzymatic activity.

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Effect of cold plasma on physicochemical properties of gum arabic and its microencapsulation with oil

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Aim:
Gum arabic (GA) is a dried exudate plant gum collected from Acacia trees such as *Acacia Senegal* or *Acacia seyal*. GA is commonly used as stabilizing, thickening, film forming encapsulating and binding agents. Currently, GA is processed with various chemicals to alter its texture and obtain desirable characteristics. However, with changes in consumer preference for food free of chemical residues, the agri-food sector and processors require sustainable and clean technology interventions. Cold plasma technology is a novel, non-thermal and green process with demonstrated potential for application in food industry. Cold plasma has been studied extensively to modify the surface properties of biopolymers due to cross-linking, surface-etching, grafting, and deposition.
Method:
In the present study, gum arabic was treated in a contained DBD reactor with air as the working gas. The treatment process was 70kV for 5,10, 20, and 30 min.
Results:
The DSC analysis showed a change in endothermic peaks with treatment, suggesting breaking of gum arabic into lower energy components like arabinose and galactose monosaccharides. As the treatment time increases, a shift in the particle size distribution was observed along with an increase in d(0.1) values, indicating the breakage of large-sized particles into smaller-sized particles, particularly in the range of 10µm to 120µm. An increase in the average roughness value of the samples was observed with the plasma treatment due to surface etching by SEM analysis.
The emulsification properties of gum arabic were examined by the droplet size distribution of the emulsions. The d(0.5) value of samples was found to increase with plasma application, and an increase in the d(0.9) value was also observed. The increase in the d(0.9) value signifies the agglomeration of small size particles. Furthermore, to understand the application of plasma-modified gum arabic in new ingredient development, the microencapsulation of oregano essential oil was studied using spray-drying as an encapsulation technique for plasma-modified gum arabic encapsulating agents. The final particles were characterized by size, product yield, moisture content, pH, and hygroscopicity.
Conclusion:
Thus, cold plasma biopolymer modification can provide new opportunities for developing innovative products while also addressing variability in natural gum ingredient functional properties.

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Green Biobased Solvent and Ultrasound Assisted Extraction of Betalains and Phenols from Dried Beetroot Powder

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Aim:

Betalains (Betacyanin (BC) and Betaxanthin (BX)) are a class of natural pigments widely occurring in plants known for their health promoting properties and their use as natural colourants. The extraction of betalains and other phenolic compounds is normally performed using conventional solvents such as ethanol. Citric acid solution could be a potential replacer to this conventional solvent for the extraction of betalains and phenols which may also offer greater environmental benefits. This study compares the extraction yield of betalains and phenols using both sets of solvents.

Method:

Freeze dried beetroot powder was used for the extraction of betalains. A full factorial design was used to cover the range of extraction parameters (ultrasonication time (5-30 minutes), extraction temperature (20, 30, 40 °C), pH in the case of citric acid solution (3, 4, 5) and ethanol concentration (10, 20, 30% v/v)) and response surface methodology (RSM) was used to assess the individual and interactive effects of the parameters. The yield of each component was determined spectrophotometrically and expressed as mg/g of dry powder.

Results:

The extraction yield for betacyanin, betaxanthin and total phenolics obtained by citric acid solution was found to be 85-90% that of the ethanolic extract under otherwise identical operating conditions. The maximum yield for betacyanin, betaxanthin and total phenolic compounds in citric acid solution was 3.98 mg/g, 3.64 mg/g, and 8.28 mg/g of dried beetroot powder, respectively. Whereas, for ethanol, the maximum yield for betacyanin, betaxanthin and total phenolic compounds was 4.38 mg/g, 3.95 mg/g, and 8.45 mg/g of dried beetroot powder, respectively. The optimized conditions for both solvents retained more than 90% of betalains and 85% of the total phenolic compounds in their corresponding extracts.

Conclusion:

Citric acid solution was observed to be equally good with ethanol for extraction of betalains and phenols. This study demonstrates the possibilities of exploring alternative bio-solvents for extraction of phytochemicals from dried plant materials which is more environmentally friendly than petrochemical solvents.

Keywords: Extraction, Betalains, Betacyanin, Betaxanthin, Ultrasound, Optimization.

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Effect of Non-thermal plasma exposure on the functional and dough properties of protein-enriched cereal flours

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Aim:

Enrichment of cereal flours with protein-rich legumes can improve the amino acid balance and nutritional value in plant-based food product development. However, this may alter the product process interactions i.e., the addition of legume flour can result in changes to the dough making rheology, hydration, and dough properties of the flour. Previous studies using non-thermal plasma (NTP) have shown promising findings for modifying the functional and hydration properties of flours. The current study aim was to understand the impact of NTP on the dough, rheological and hydration properties of protein-enriched cereal flours.

Methodology:

The different ratios of the selected legume flour (fava beans- *Vicia faba*), cereal flours (wheat and barley) were exposed to in-package dielectric barrier discharge (DBD) at 80 kV for 15 and 30 min treatment time using air as the working gas. A complete proximate analysis was carried out on control, individual and mixed flour preparations. The particle size distribution, DSC, FT4 Rheology, Farinograph and Rapid visco-analysis were conducted to analyse the functional properties of the individual and treated flours and legume: cereal mixtures.

Results:

Our previous studies on wheat flour demonstrated how the structure and functionality of wheat flour may be modified using NTP to provide an alternative to chemical additives to support functionality (Chaple et al., 2020). Plasma exposure increased the flour hydration properties of wheat flour. The decrease in both endothermic enthalpies and crystallinity was attributed to the depolymerization of starch and plasma-induced changes (Chaple et al., 2020). Farinograph analysis now suggests that an improvement in water absorption capacity, dough development time, and dough stability can be achieved using plasma treated cereal flour.

Conclusion:

Considering the cereal flour studies as a foundation, the legume enrichment of cereal flours exposed to NTP and the resultant changes in the hydration, rheological, dough mixing, and solid rheology were compared. The NTP exposure has modified the hydration, rheology and dough properties of the flour mixtures. This study provides insights as to how NTP may be tuned to enhance functionality in new product development in plant-based food formulation.

References:

Chaple, S., Sarangapani, C., Jones, J., Carey, E., Causeret, L., Genson, A., Duffy, B., & Bourke, P. (2020). Effect of atmospheric cold plasma on the functional properties of whole wheat (Triticum aestivum L.) grain and wheat flour. *Innovative Food Science and Emerging Technologies*, *66*(October). https://doi.org/10.1016/j.ifset.2020.102529

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Exploring the impact of ultrasound and polysaccharidase enzyme on protein extraction from fresh Alaria esculenta

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Aim:
To study the impact of a novel and green technique for protein extraction using ultrasound and polysaccharidase enzyme from fresh brown macroalgae, *Alaria esculenta*
Method:
Fresh brown macroalgae, *Alaria esculenta* pre-treated by optimised conditions of either microwave, ultrasound or combined ultrasound and microwave were further extracted under varied ultrasonication conditions assisted with application of polysaccharidase enzyme, Viscozyme^{TM} using water as the green extraction solvent. Pre-treatment conditions that were initially optimised on the basis of highest soluble protein yield were microwave treatment at 1340 W, 10 min, ultrasound treatment at 200 W, 20 min and combined ultrasound and microwave treatment at 100 W and 1340 W for 20 min. These three type of pre-treated macroalgal residues underwent extraction using ultrasound bath (25 and 45 kHz) alone, Viscozyme™ (0.25% (v/v)) addition alone and application of Viscozyme™ simultaneously with ultrasonication at the aforementioned conditions at a fixed macroalgae: water ratio (1:10) for 3 and 6 h.
Results:
Simultaneous use of Viscozyme™ and ultrasound did not help in protein extraction over use of either ultrasound or Viscozyme™ alone. Ultrasonication might have compromised the protein structure of the enzyme hindering the activity of the enzyme, when used together.
Conclusion:
Hence it can be proposed that fresh macroalgae pre-treated with non-conventional technologies can be potentially exploited for protein extraction either using ultrasound or polysaccharidase enzyme individually, through a green approach without the requirement of any harsh solvent.

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Influence of static electric field on the surface tension of aqueous solution

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Aim:
Food foams are thermodynamically unstable systems and their stabilisation is still a challenge in the industry. Today, foams are mostly stabilized with surfactants. The foam generation, coupled with the use of a static electric field (SEF), appears to be an innovative method that would allow to stabilize a foam durably, by limiting the use of additives in the product, while reducing the energy consumption and the heatup during processing.
Method:
The impact of an electrostatic field on the surface tension force os selected solutions (water, WPI solution and chickpea liquor) was studied using a modified pendant drop method (TECLIS, France). Two parallel electrodes were installed around the pendant drop and were subjected to a range of DC voltages (0 to 10 kV); such voltages corresponded to SEF in the range of 0 to 250 kV/m. The images of the pendant droplet were recorded throughout the experiment. Based on Laplace's equations and thanks to an algorithm that uses the profile of the drop, the surface tension force was calculated as a function of the applied voltage (or SEF).
Results:
It appeared that the geometry of the drop was deformed under the action of the SEF. The drop were elongated with increasing SEF and the deformation was perpendicular to the SEF direction. In agreement with previous publication, the surface tension decreased proportionally to the rise of the voltage applied to the electrodes. A linear fit was observed and was compared to theoretical model developed by Sato & al (1997). Intersingly, the impact of the SEF on surface tension was lower for the two other model solutions.
Conclusion:
Applying a SEF yielded a significant reduction of the surface tension of liquids. The mechanism causing surface tension reduction during voltage application was found to be the electric charge existing on the liquid surface. By reducing the surface tension, liquid or gas drops exposed to SEF are likely to break up more easily under shearing conditions (emulsion or foaming process), offering new horizons in terms of processing using “clean labelled” foams or emulsions. In the case of foams, the formation of smaller cells under SEF are expected, which would yield less destabilization phenomena (coalescence, drainage) and a more stable foam during storage. Further investigations are carried out to assess the impact of SEF on foam stability during storage.

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Nonthermal processing of plant-based dairy alternatives

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Aim
The objective of this study is to explore the potential of nonthermal processing such as High-pressure processing (HPP) and cold plasma processing (CPP) for the treatment of plant-based dairy alternatives by investigating the effect of HPP and CPP on various physico-chemical and microbiological properties of soy milk and almond milk.
Method
Freshly prepared soy milk and almond milk were treated with a co-axial plasma system having dielectric barrier discharge for various treatment times and a high-pressure processing system at different treatment pressures. The treated samples were studied for physical properties such as rheology, particle size distribution and microstructure, chemical properties such as total phenolic content, total flavonoid content and antioxidant capacity, and shelf-life extension.
Results
The reactive oxygen species and reactive nitrogen species produced during the plasma treatment impart microbial inactivation in soy milk and almond milk. The HPP treatment extended the shelf life of soy milk and almond milk. The HPP and DBD plasma treatment modified the physico-chemical properties of the treated soy milk and almond milk.
Conclusion
The HPP and CPP can extend the shelf-life of plant-based dairy alternatives without thermal treatment. In addition, the use of cold pressure for HPP and environmentally friendly gas such as air and lower energy inputs for CPP make these technologies a potential alternative for thermal processing.

Applying ultraviolet light-emitting diode technology for reducing Campylobacter and Salmonella in chicken meat

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Aim:
Poultry meat is frequently contaminated with some of the most common bacterial pathogens associated with foodborne illness, including *Campylobacter* and *Salmonella*. Ultraviolet (UV) light has been shown to be capable of reducing the bacterial burden on meat surfaces. Nowadays, new UV devices like Light-Emitting Diodes (LEDs) offer an economical and highly efficient approach with potential for application in the agri-food sector. This study aimed to investigate the effectiveness of UV light to inactivate *Campylobacter* and *Salmonella* using a novel LED device while also assessing the impact of this treatment on the meat quality of fresh chicken.

Method:
Chicken fillets were purchased locally and cut into ~10 g pieces. *Campylobacter jejuni* NCTC 11168 and *Salmonella enterica* serovar Typhimurium ACTC 14028 were inoculated on chicken samples. Chicken cubes were exposed for 3 and 6 min to UV light at 280 nm using a LED device at a 5 cm distance from the light source. Microbiological analysis was carried out with suspensions of stomached samples which were serially diluted in maximum recovery diluent and plated on appropriate growth media. *Campylobacter* was counted using modified charcoal-cefoperazone-deoxycholate agar (mCCDA) after incubation for 48 h at 42°C micro-aerobically. *Salmonella* counts were carried out using xylose lysine deoxycholate (XLD) agar after incubation for 24 h at 37°C. Moreover, total viable count (TVC) and total Enterobacteriaceae count (TEC) were determined using plate count agar (PCA) and Violet Red Bile Glucose agar (VRBGA) and incubation for 30°C for 48 h and 37°C for 24 h, respectively. Additionally, changes in pH, colour, and texture were evaluated before and after exposure to UV light at 280 for 6 min.

Results:
Maximum reductions of 0.8, 0.6, 1 and 1 log CFU/g were achieved in *Salmonella*, *Campylobacter*, TVC and TEC, respectively, on chicken meat, for UV light treatment at 280 nm for 6 min as compared with untreated samples. Moreover, colour, pH, and texture were not significantly ($P > 0.05$) affected to UV light treatment.
Conclusion:
UV light-emitting diode technology offers a promising method to reduce the *Campylobacter* and *Salmonella* on chicken meat without adversely affecting meat quality.

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