



# **Gastronomy as an Engine of Change**

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# How microorganisms may be used to produce a new sensation and to contribute to the sustainability of food production

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# Why fermentation and microbes



- Food fermentation is a sustainable green technology of significant importance in the global food production and gastronomy.
- 18 % of the GHG emission come from livestock-derived.
- Microbial fermentation is a tools to transform an underutilised substrate into potential food source

# Spent grains



It is estimated that over 38 million tons of Brewer's spent grains (BSG) is produced worldwide each year and is usually used as animal feed, composted, or thrown into landfills.

BSG contains valuable nutritional components, including protein, fiber, and antioxidants.

# Wheat bran



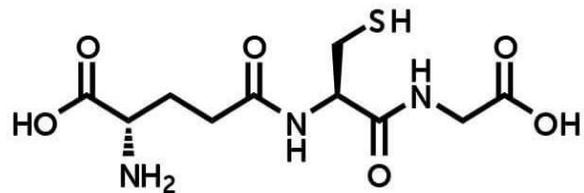
It has been reported that **over 150 million tons** of wheat bran are produced every year, and these are mostly used for livestock feeding

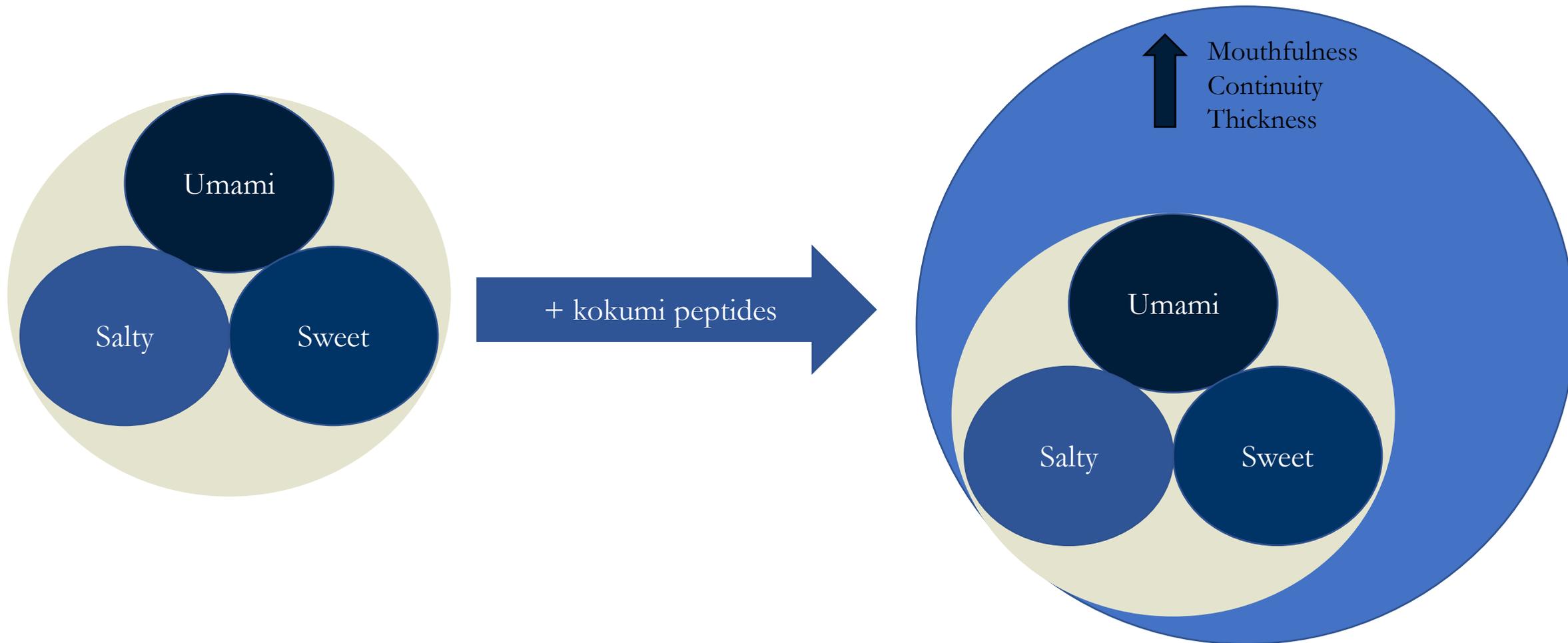
# Kokumi

In 1990, Japanese research found that adding garlic water extract in soup could make the taste more complex (Ueda et al., 1990).

It is explained by sulfur-containing amino acids, peptides, and their derivatives (Tao; Feng et al., 2016).

Glutathione  $\rightarrow$   $\gamma$ -Glu-Cys-Gly





Thickness



## Factors Involved in Food Palatability

Taste stimulation  
Aroma stimulation  
Texture stimulation

KOKUMI

Mouthfulness

Lingeringness

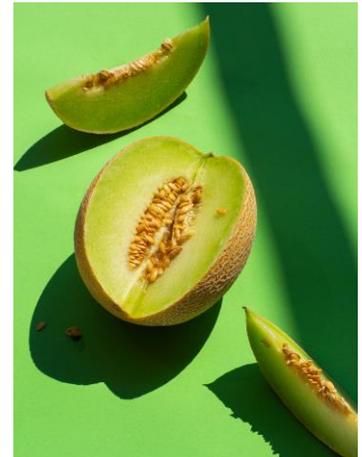


Giving us kokumi sensation



Complexity  
Lingeringness  
Mouthfulness

Giving us no kokumi sensation



Simple  
No lingeringness  
No mouthfulness

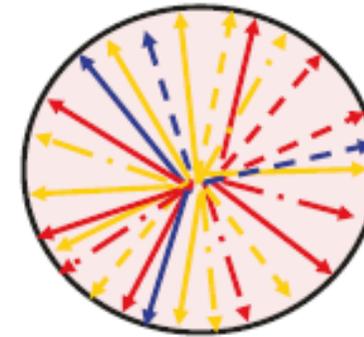
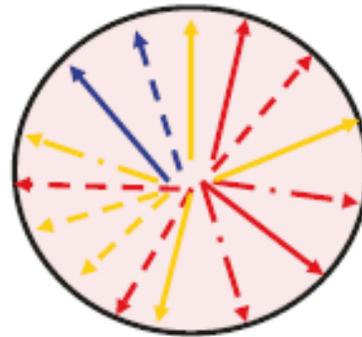
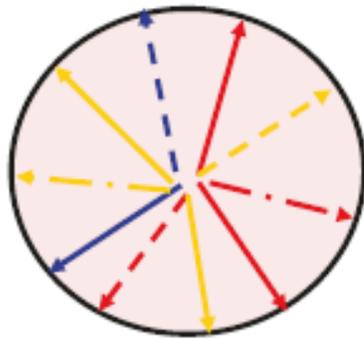


Time in heating, aging or fermentation



short

long



Weak complexity

Medium complexity

Strong complexity

- a few stimulation
- not rich

-  Taste stimulation
-  Aroma stimulation
-  Texture stimulation

- lots of stimulations
- rich

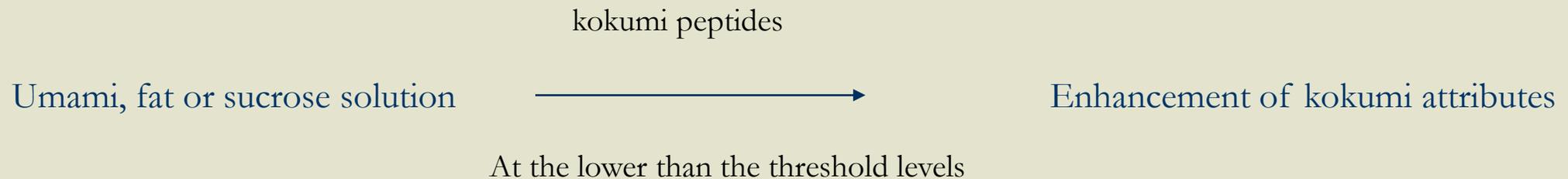
# The most important kokumi peptides

Glutamyl-valine-glycine (cEVG), (Miyaki et al., 2015)

Glutathione (GSH) →  $\gamma$ -Glu-Cys-Gly (Zhao et al., 2016)



**There is no sensation caused by kokumi peptide itself**



# Food

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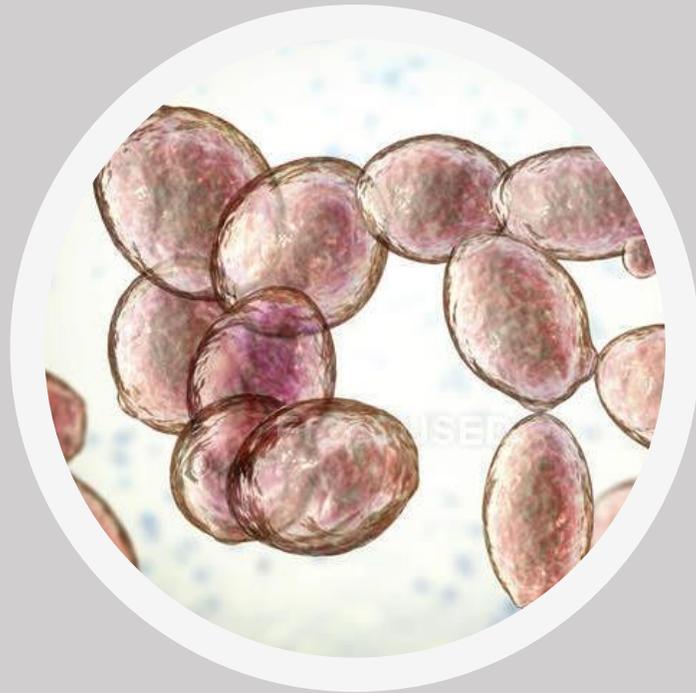
<b>Sourdough</b>	Yan et al., 2018
<b>Gouda cheese</b>	Toelstede et al., 2009
<b>Parmesan cheese</b>	Hillmann et al., 2016
<b>Fish sauce</b>	Kuroda, Kato, Yamazaki, Kai, et al., 2012; N & M, 2015
<b>Soybean seeds</b>	Shibata et al., 2017
<b>Durian pulps</b>	(Pinsorn et al., 2018),
<b>Raw and processed scallop products</b>	Kuroda, Kato, Yamazaki, Kageyama, et al., 2012; Maruyama et al., 2012
<b>Beer</b>	(Miyamura, Iida, et al., 2015a)
<b>Avocado</b>	Georg, Andreas; Hofmann, 2010
<b>Chicken consommé</b>	Miyaki et al., 2015
<b>Miso</b>	van Ho & Suzuki, 2013
<b>Cow and ewe milk cheese</b>	Kuroda et al., 2020
<b>Soy sauce</b>	Frerot & Chen, 2013; Kuroda et al., 2013a
<b>Mushrooms</b>	Tao Feng et al., 2019
<b>Cacao beans</b>	Salger et al., 2019
<b>Fermented shrimps</b>	Miyamura et al., 2014

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*Penicillium roqueforti*



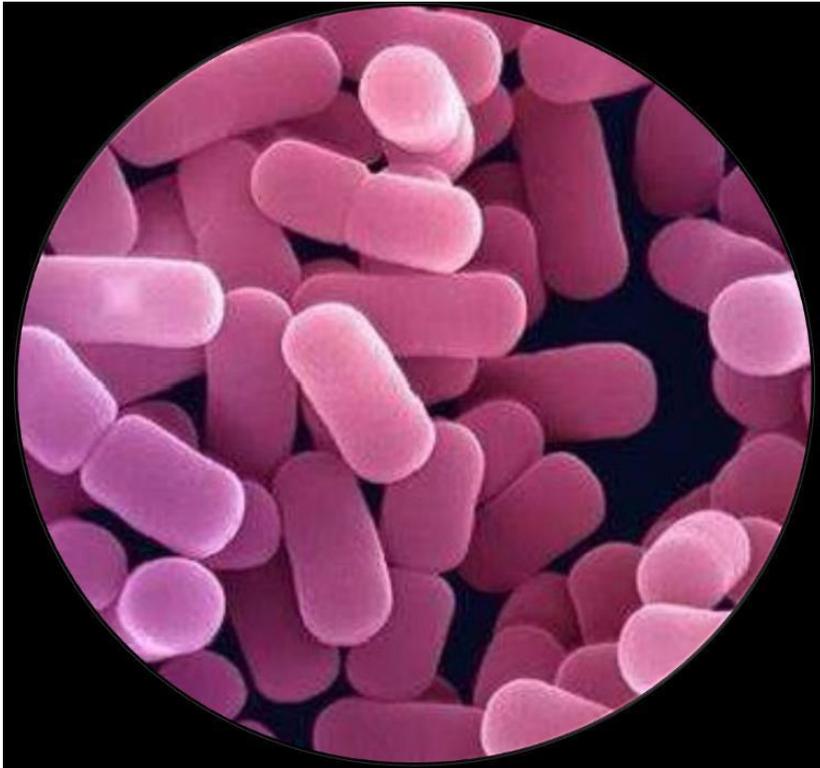
*Saccharomyces cerevisiae*



*Aspergillus oryzae*

# MICROORGANISMS

# MICROORGANISMS



*Bacillus amyloliquefaciens*



*Lactobacillus helveticus,*

*Lactiaseibacillus rhamnosus*

*Limosilactobacillus reuteri*

# Miso

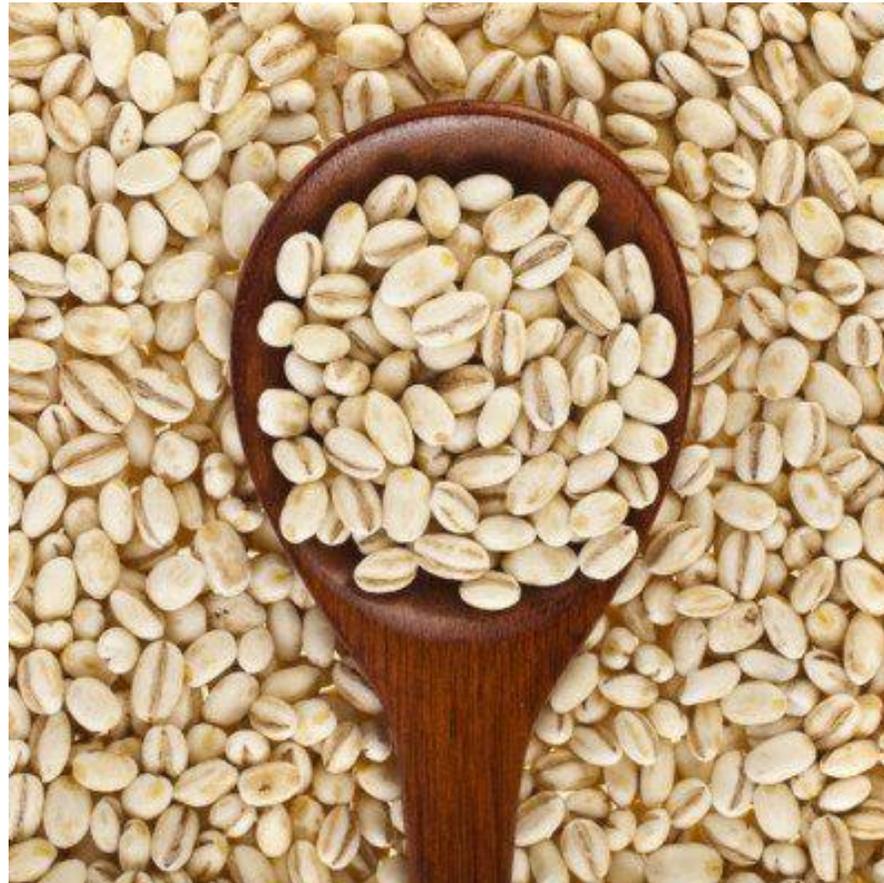
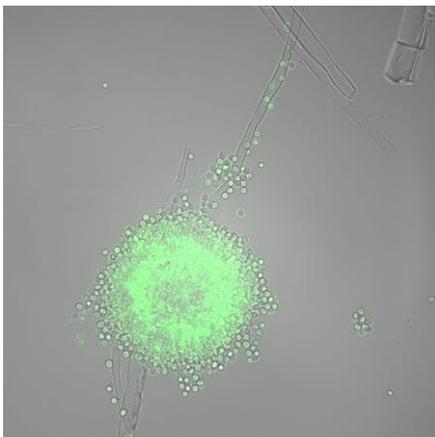
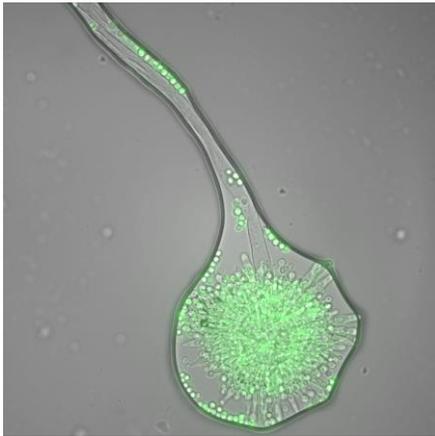
Miso is a traditional Japanese fermented food, with important quality characteristic of taste and aroma



A study performed with the miso fermented adding the enzyme GGT from *B. subtilis* obtained more concentration of  $\gamma$ -Glu-Val and  $\gamma$ -Glu-Val-Gly in relation to the fermentation without the enzyme in three months (van Ho & Suzuki, 2013).

# Koji

Steamed rice or barley naked cultivated with *A. oryzae* as a source of enzymes, mostly proteases and amylases





Glutenin (10-12 %)



Hordein (35-40%)

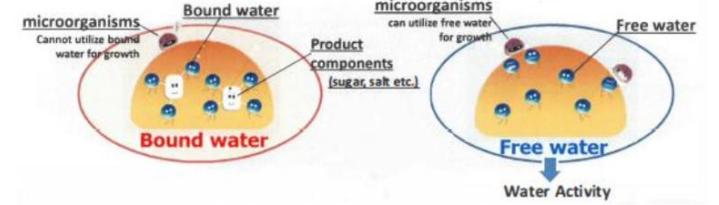
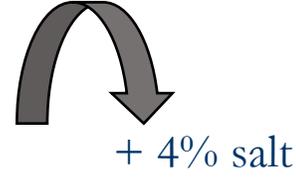
Barley koji



Koji + barley (1:2 w/w)



Miso

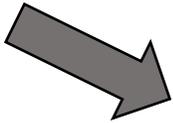


Aromas

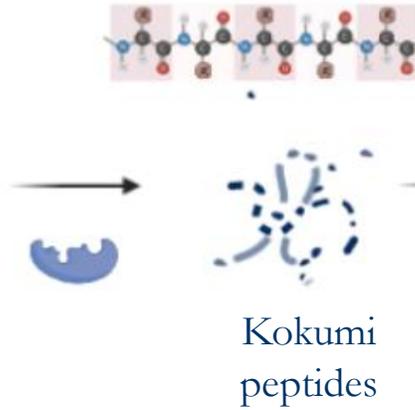
*KOKUMI* perception  
*CaSR*: calcium-sensing receptor.

Enhance  
Sweet  
Umami  
Salty

*Aspergillus oryzae*



Proteases and amylases

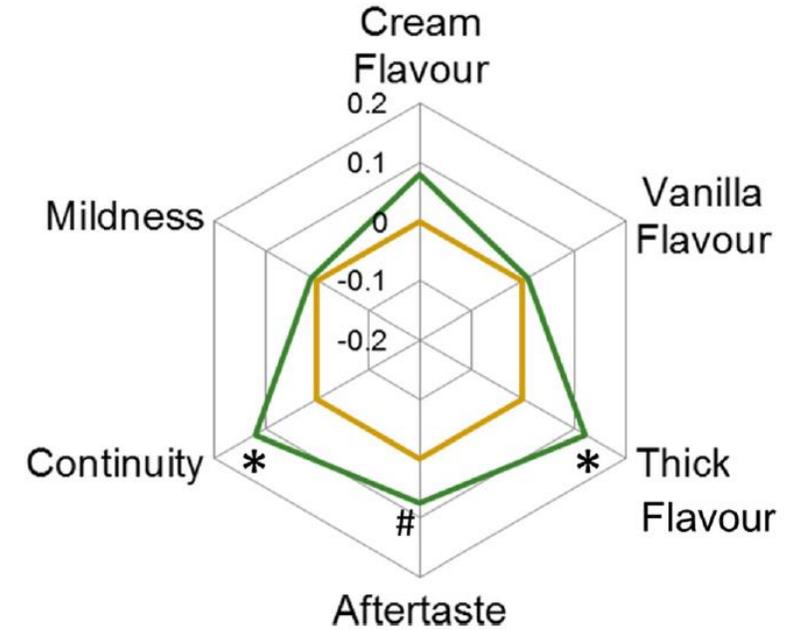


Kokumi peptides

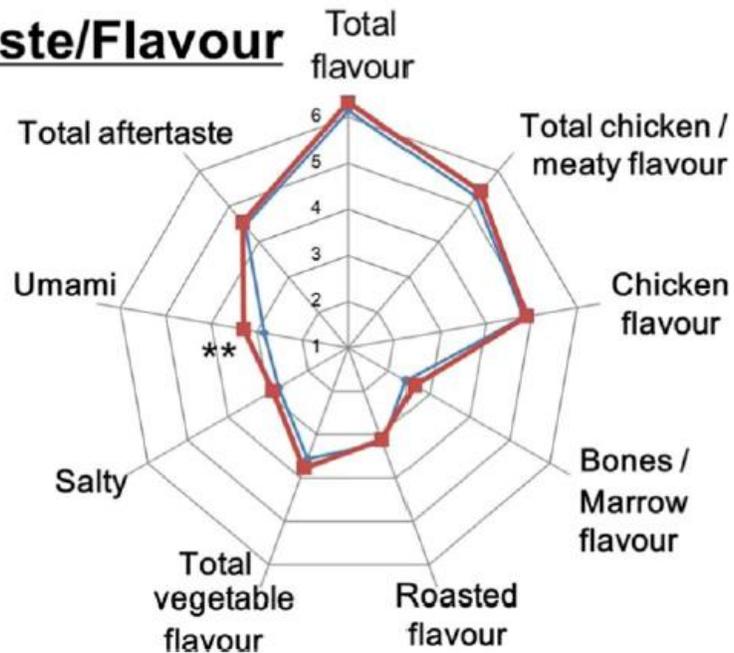
- $\gamma$ -Glu-Val-Gly
- $\gamma$ -Glu-Val
- $\gamma$ -Glu-Glu
- $\gamma$ -Glu-Leu
- $\gamma$ -Glu-Phe



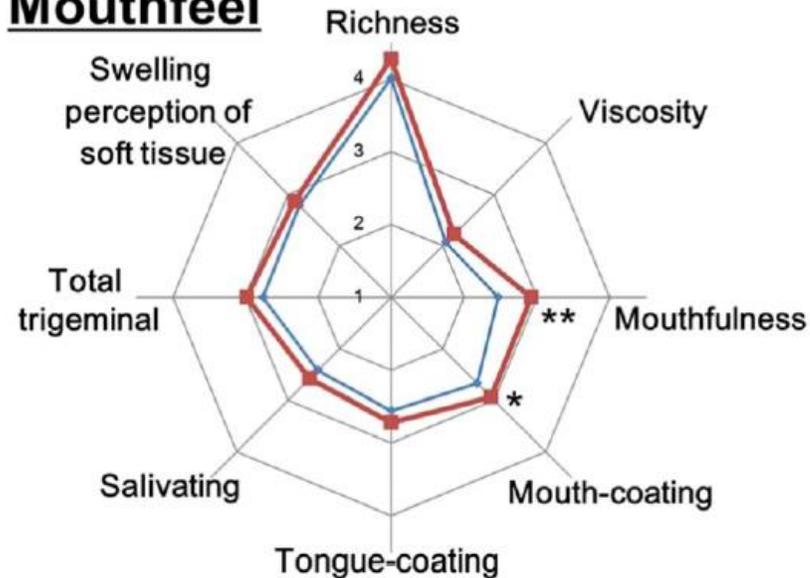
# SOME SENSORY ANALYSIS



## Taste/Flavour



## Mouthfeel



# RECEPTION OF KOKUMI SENSATION

**CaSR** is now established as a receptor of *kokumi* substances: These *kokumi* substances bind CaSR, to increase sweet, salty, and umami responses and to induce the *kokumi* effects in a human sensory test (Ohsu et al. 2010; Maruyama et al. 2012).

A recent study suggests that **GPRC6A** is another candidate receptor of *kokumi* substances. Ornithine is the potent agonist for this receptor

# Samples

1. Barley koji + spent grains

2. Wheat bran koji+ barley

3. Wheat bran koji + Spent grains

4. Wheat bran white koji + barley

# Conclusion

- Sustainable food production a point to new directions where novel microbial cultures are needed.
- Microorganism is an awarding opportunity for the industry, the consumer and the environment.
- Leftover products such as spent grains or wheat bran, may help to produce tasty and delicious food.



THANK YOU