The Food & Drink Innovation Network

THE SCIENCE AND TECHNOLOGY OF TASTE

Dr David Baines

Baines Food Consultancy Ltd and
Contributing Editor at Flavour Horizons

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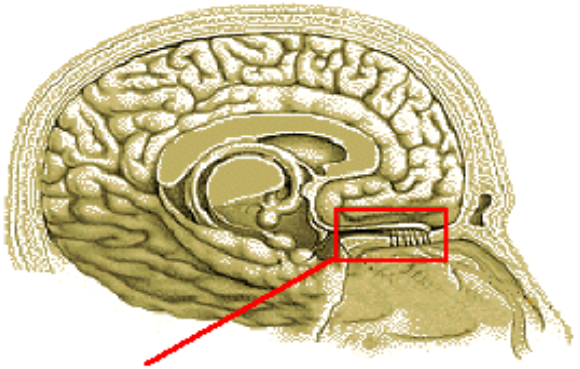
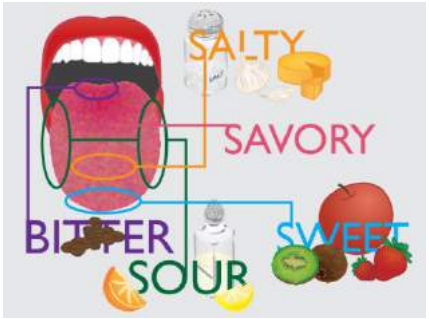
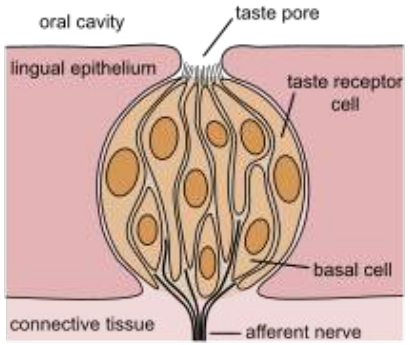
OUR CHEMICAL SENSES

Olfaction

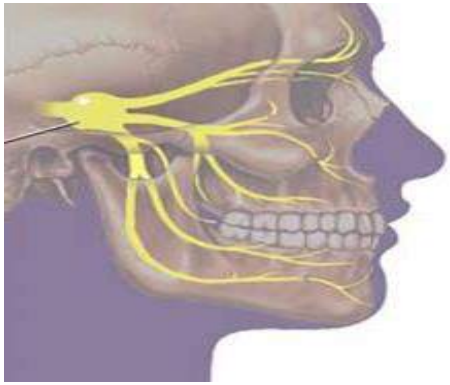


Gustation





Chemesthesis



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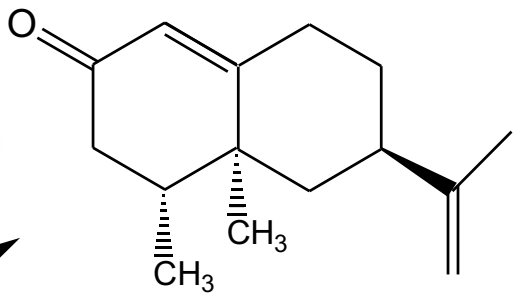
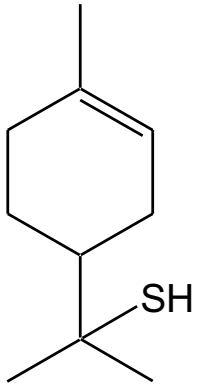
OLFACTION – Volatile Organic Compounds

1) Soybean lipoxygenase/
Linoleic acid

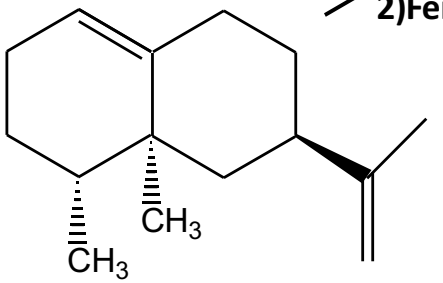
2)Fermentation



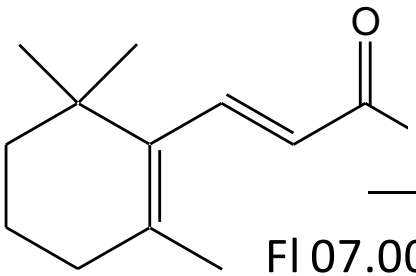
Fl 07.089
FEMA 3166



Fl 12.085
FEMA 3700



Fl 01.017
FEMA 3443



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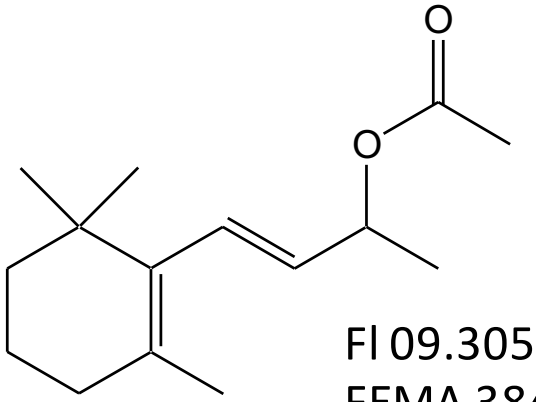
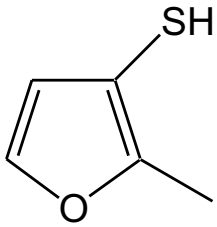
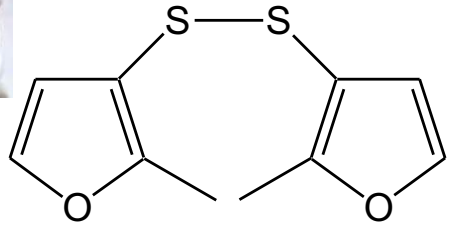
FEMA 2595



Fl 09.305
FEMA 3844

Fl 13.055
FEMA 3188





Fl 13.015
FEMA 3476

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THE UNION LIST

The objective - to establish a list of flavouring substances *'the use of which is authorised to the exclusion of all others'*.

Full compliance to the flavouring substances on the Union List by industry - 22nd October 2014

There are 2505 flavouring substances on the Union List. 2277 have been evaluated by EFSA. Evaluation continues on a further228 substances.

The USA has the FEMA GRAS List

efsa
European Food Safety Authority

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FLAVOUR LEGISLATION - EUROPE

'Regulation 1334/2008 on flavourings and certain food ingredients with flavouring properties for use in and on foods.'

Flavour categories;
(ii) made or consisting of the following categories:

- **Flavouring substances**
- Flavouring preparations
- Thermal process flavours
- Smoke flavourings
- Flavour precursors
- Other flavourings or mixtures thereof

Article 3 (2) (a) 'flavourings shall mean products: (i) not intended to be consumed as such, which are added to food in order to impart or modify odour and/or taste'.

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WE ARE IN THE ERA OF FLAVOUR MODIFIERS

What is the difference between a flavour modifier and a flavour enhancer?

Guidelines published by the European Flavour Association defining the difference;

A flavour modifier is a flavouring substance with modifying properties that changes individual organoleptic characteristics of a food product but does not produce an overall enhancement of all the sensorial properties.

A flavour enhancer is a material that influences all the attributes equally keeping the same overall profile.

A flavour enhancer is covered by the Food Additives Regulation 1333/2008 and requires an E number.

A flavour modifier is covered by 1334/2008 and is on the Union List and does not require an E number and is labelled 'flavouring'.

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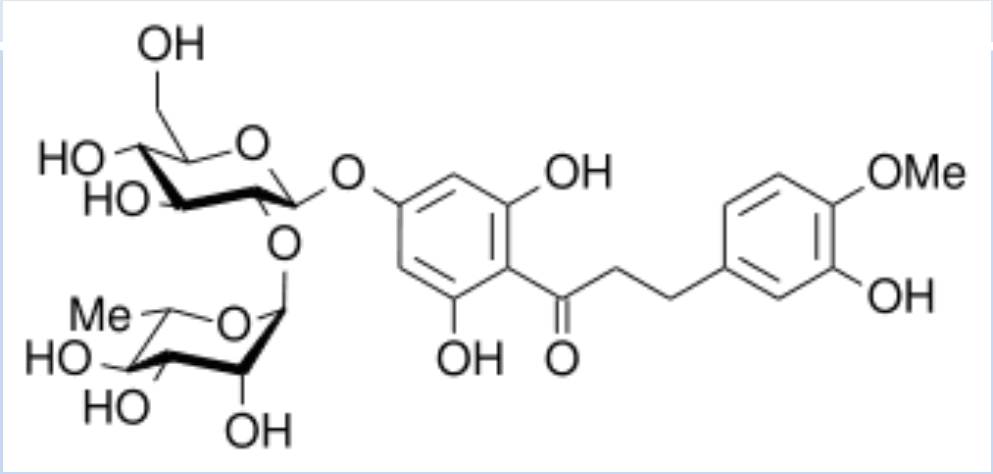
INTENSE SWEETENER - BITTERNESS MASKING

Neohesperidin dihydrochalcone (NHDC)



FEMA 3811	EU Flavis number: Fl: 16.061	Approved as a sweetener in the EU: E959

A high intensity sweetener 1500-1800 times sweeter than sugar. Neohesperidin is extracted from bitter oranges then treated to produce NHDC. Used as a bitterness blocker at levels **below 5ppm** it is classified as a flavour modifier and the E number is not declared. Used widely in dairy products where it reduces bitterness and improves creaminess and in pharmaceutical products to block bitter notes.

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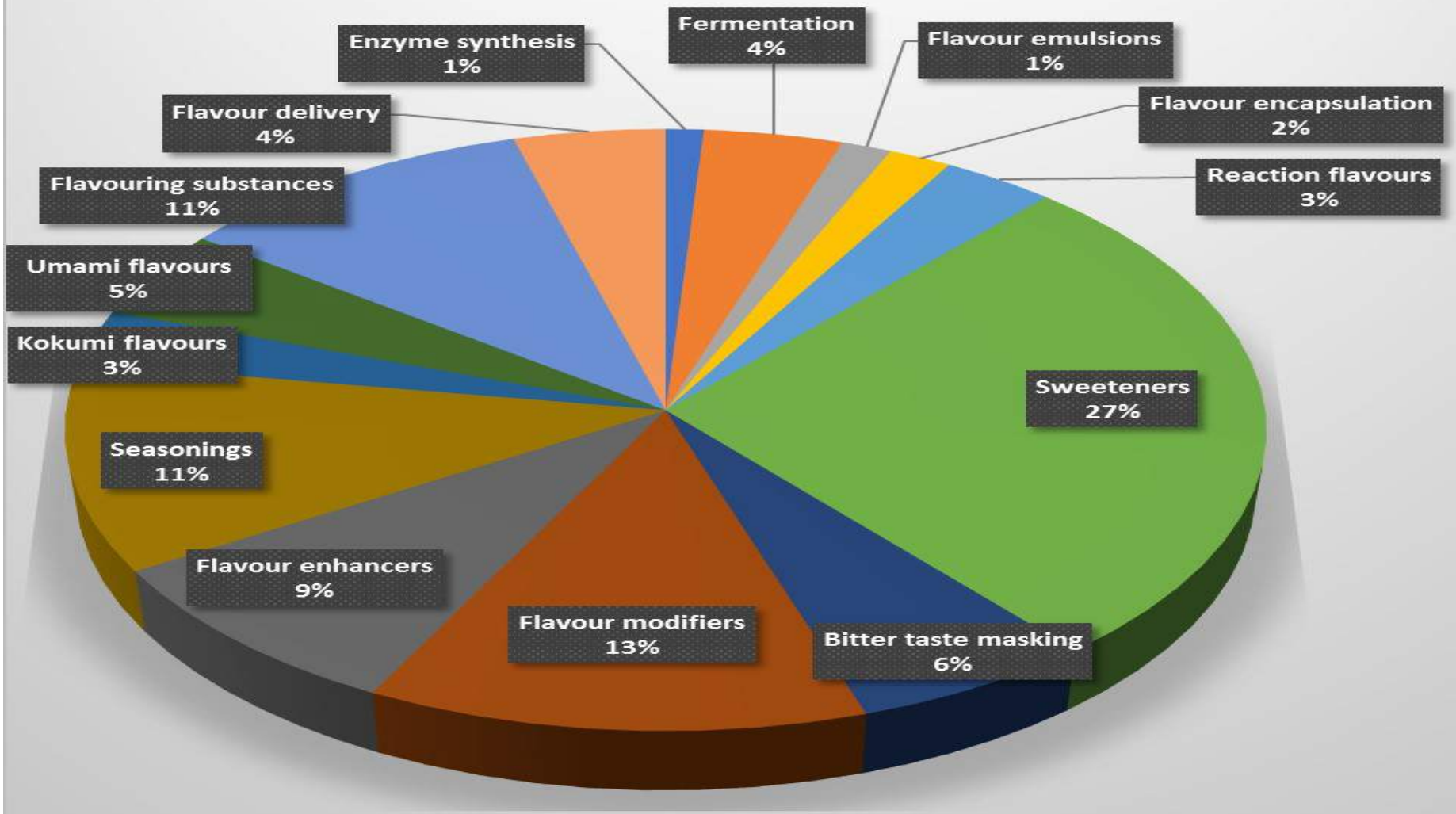
Figure 2 Categories of patents published by flavour and ingredient companies in 2016



Source: M Brown, Flavour Horizons, Issue 21, March 2017

SWEETNESS MODIFIERS - PAMs

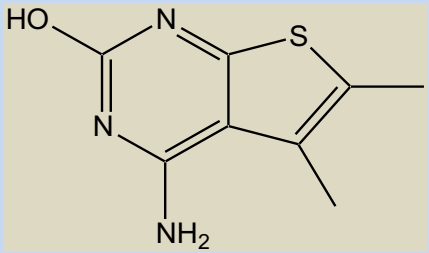
PAMs = Positive Allosteric Modulators. These are compounds that induce an amplification of a taste sensation – in this case sweetness.

These are small molecules that enhance receptor activity and sweetness perception and are very effective at potentiating the sweetness of sweet compounds

The driving force behind the development of PAMs is the US research company Senomyx who have filed a number of patents and four of the many compounds detailed in these patents have received clearance in the US and are now on the FEMA GRAS list and two have been added to the EU Union List.

PAMs

4-amino-5,6-dimethyl thieno(2,3-d)pyrimidin-2(1H)-one (and its hydrochloride salt)



FEMA 4669 (HCL salt)	EU Flavis number: 16.116 EFSA evaluation: No safety concern.	Senomyx patent: US7928111B2 (2007) Sucralose modifier SucralGem™ Licensed to Firmenich

Enhances the sweet taste of sucralose. At a level of 6-22ppm halves the amount of sucralose required to produce an equivalent sweetness.

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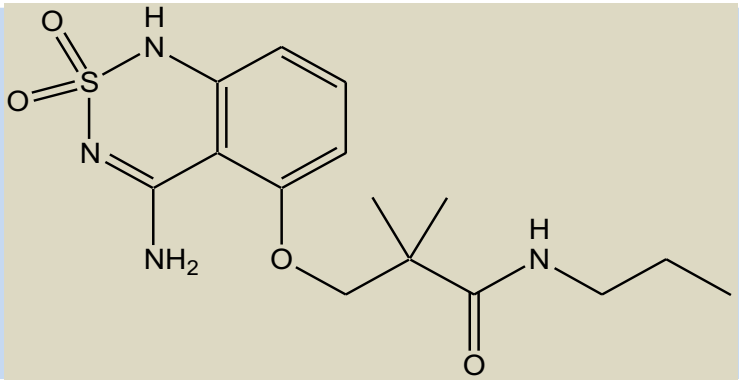
PAMs

3-(4-Amino-1H-benzo[c][1,2,6]thiadiazin-5-yloxy)-2,2-dimethyl-N-propylpropanamide-2,2-dioxide



FEMA 4701	EU Flavis number: 16.126 EFSA evaluation: No safety concern.	Senomyx patent appln: WO2015199987A1 (2014) SucroGem™ Licensed to Firmenich

'Used at ppm levels as part of a flavour system to restore the desired taste profile of products in which sucrose (table sugar) has been reduced.'

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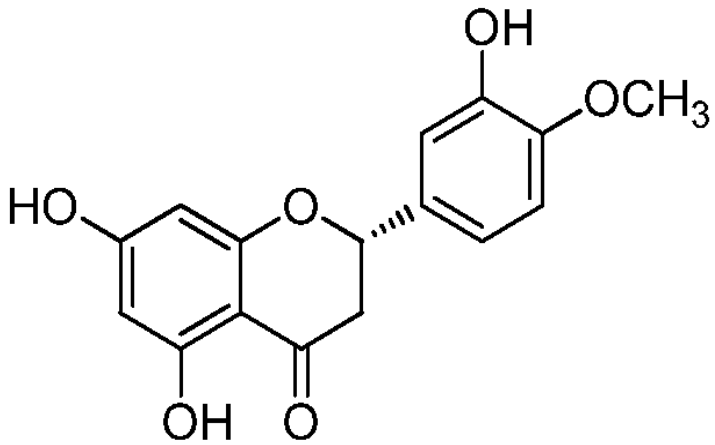
COMMERCIALISATION OF PAMs

PepsiCo invested $30 million in a four year deal with Senomyx and are reported to be developing a soft drink that will halve the level of sugar targeting health conscious consumers. A further investment of $32 million is reported to have been made taking the collaboration to 2016. Pepsico has exclusive licensed rights in non-alcoholic beverages on a worldwide basis.

Firmenich is also involved with a product discovery and development collaboration with Senomyx and has exclusive rights to commercialise Senomyx sweet flavour ingredients discovered in the collaboration programme. The Firmenich trade marks for these products are SucralGem™ and SucroGem™ and the agreement covers food and alcoholic beverages.

NATURAL SWEETNESS MODIFIER

Hesperetin



FEMA 4313	EU Flavis number: FI: 16.097	Symrise: Patented for modifying sweetness. EP 2368442 B1 (2006)

Flavonone found in grapefruit, orange, lemons and apples. Can reduce the content of sugars such as sucrose, lactose, fructose and glucose by between 5 and 60% in the presence of around 100ppm hesperetin.

Vitamin P:

- *Cholesterol lowering properties.*
- *Protective against breast, colon and other cancers.*
- *Regulation of blood pressure.*

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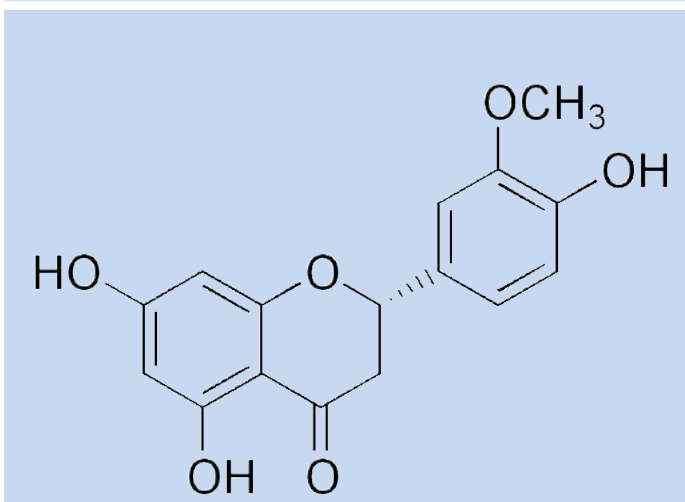
BITTERNESS MASKING

Homoeridictyol sodium salt



FEMA 4228	**EU Flavis number: 16.083**	**Symrise Patent: reducing bitter and metallic tastes. US 8685436 B2 (2002)**

Bitter masking flavanone from Yerba Santa, a plant native to North America. Also found in lemons and rose hips. Blocks the bitter notes and off-notes of high intensity artificial and natural sweeteners. Also reduces the bitter character of tea, caffeine and pharmaceutical products. Masks potassium chloride and is useful in salt reduction formulations.

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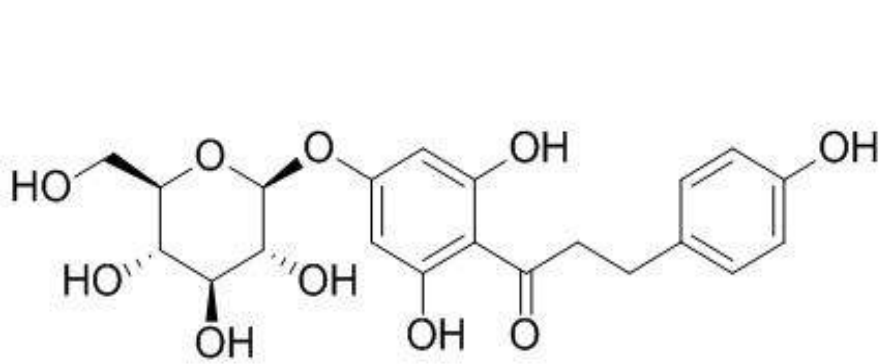
BITTERNESS MASKING

Trilobatin

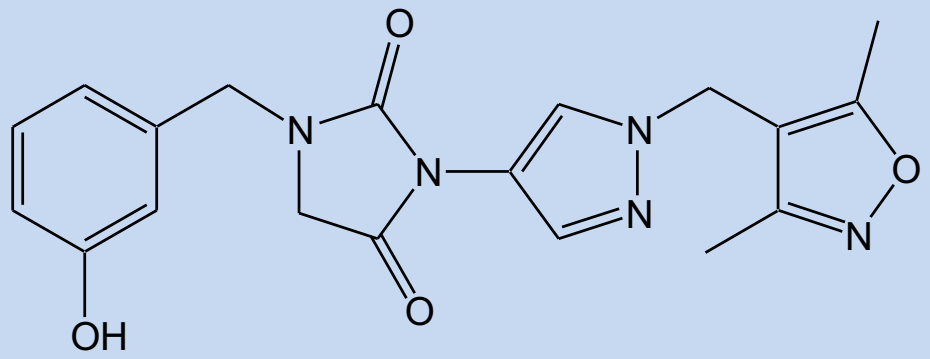


FEMA 4674	EU Flavis number: Fl 16.112	Givaudan: Patented as a bitter blocker. EP 2306851 B1 (2008)

A Glycoside Dihydrochalcone isolated from the leaves of *Lithocarpus litseiffolius* used as a sweet tea in Yunnan Province, China. Used as a sweetener but also has bitter masking properties at levels of 3-200ppm. Masks bitterness of cocoa, coffee and caffeine containing energy drinks.

BITTERNESS MASKING

3-(1-((3,5-Dimethylisoxazol-4-yl)methyl)-1H-pyrazol-4-yl)-1-(3-hydroxybenzyl)-imidazolidine-2,4-dione



FEMA 4725	**EU Flavis number:** **Fl 16.127** **Not yet on the Union List.** **EFSA evaluation: no safety concern: 21 June 2016**	**Senomyx patent appln:** **US20100254916 A1**

Found as part of a programme to identify compounds that create a response in the human T2R bitter taste receptors. Effective dosage range 2-300ppm. Blocks bitter tastes.

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TASTE: UMAMI AND KOKUMI

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‘UMAMI’ – THE FIFTH TASTE SENSE





- In 1908 Professor Ikeda discovers Monosodium Glutamate in kombu
  He founds a new company called ‘Essence of Taste or Aji-no-moto.

- ***Glutamate is found in a all savoury foods;***
  Kelp (kombu) 2240mg/100g
  Parmesan cheese 1400mg/100g
  Tomato 250mg/100g
  Walnuts 650mg/100g
  Green Tea 670mg/100g
  Potato 180mg/100g
  Mackerel 36g/100g
  Broccoli 115mg/100g

- University of Miami, Nature 2000 – publication of the discovery of a receptor on the human tongue that specifically responds to the glutamate ion.

‘UMAMI’ – THE RIBONUCLEOTIDES





In 1913 a student of Professor Ikeda, Shintaro Kodama, discovers Inosine 5’ monophosphate (IMP) in bonito flakes.

The third element of umami, Guanosine 5’ monophosphate (GMP) was found in dried shitake mushroom in 1960 by Akira Kuninaka

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SYNERGY

MSG	IMP	UMAMI ACTIVITY EQUIVALENT
1	0	1
1	1	7.5
2	1	5.5
10	1	3.4
100	1	2.0

MSG	GMP	UMAMI ACTIVITY EQUIVALENT
1	0	1
1	1	30
2	1	22
10	1	19
100	1	5.5

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Source: Ajinomoto publications

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SYNERGY

THE AMPLIFICATION OF THE DELICIOUSNESS OF FOOD

In Japanese cuisine they have learnt combine foods and ingredients that contain the elements of Umami .

The glutamate element of some foods and the ribonucleotide element of other foods produce synergy and enhance the flavour of a dish.

It is common knowledge in Japan that the combination of kombu (seaweed - glutamate) with bonito (ribonucleotides) makes a tastier soup.

Kombu (MSG)

+

Bonito (IMP)

=

Dashi

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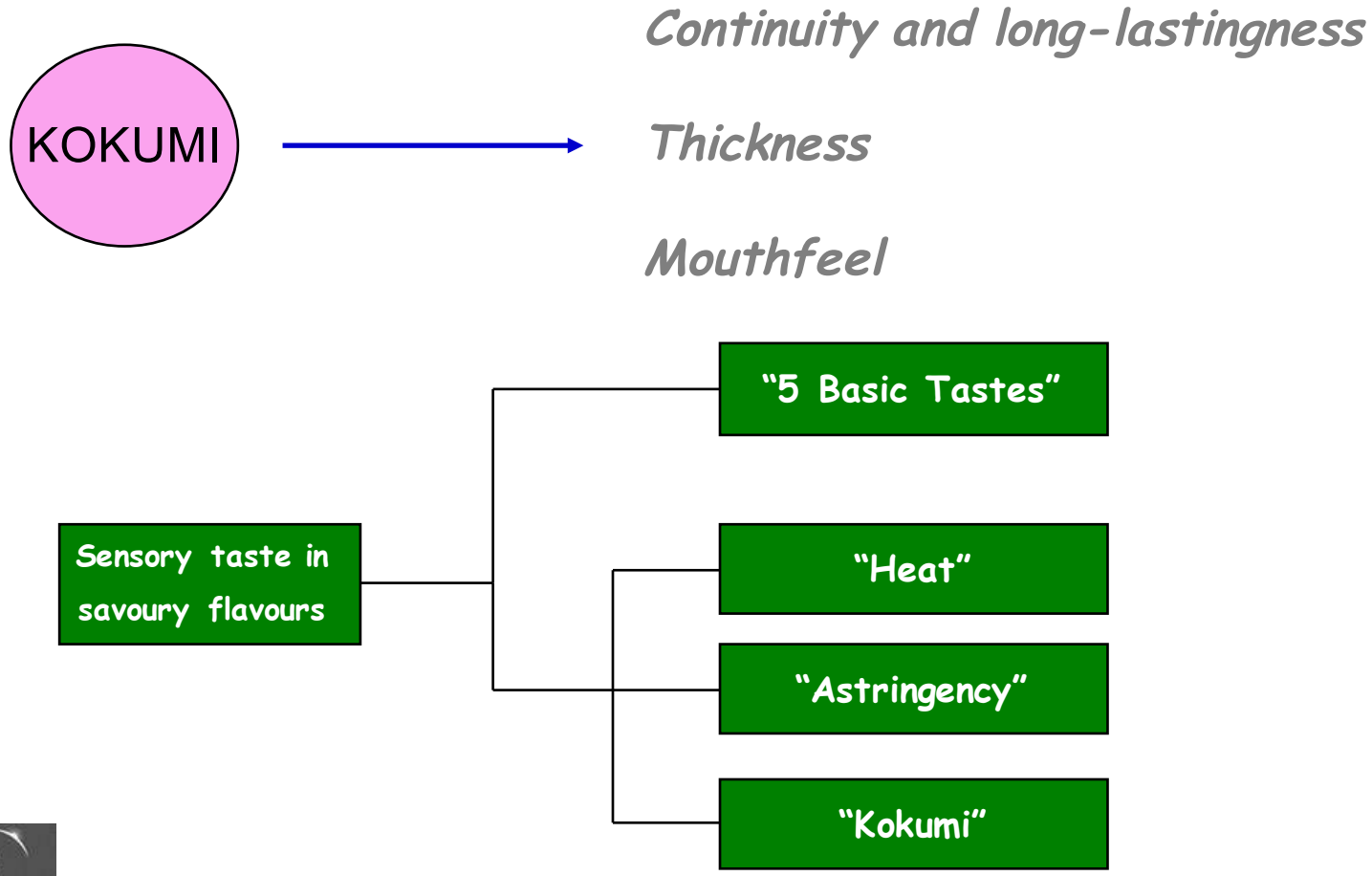
What is Kokumi?

Kokumi is a well recognised taste phenomena in Japan

According to Ajinomoto the word 'kokumi' is difficult to translate but contributes to the deliciousness of a food. 'Koku' means body and fullness and 'Mi' means taste.



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BUT – WHAT ARE THE CHEMICAL COMPOUNDS THAT INITIATE THE 'KOKUMI SENSATION?

Hofmann, et. al., J. Agric. Food Chem., **2009**, *57,* 1440-1448

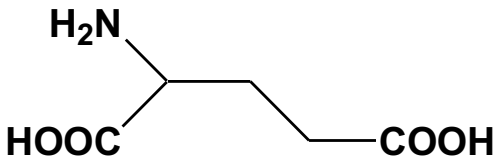
Gamma-glutamyl peptides found in Gouda cheese induce a kokumi effect

A 44-week matured Gouda cheese had a more pronounced 'mouthfullness' and long lasting taste complexity than a 4-week matured Gouda cheese.

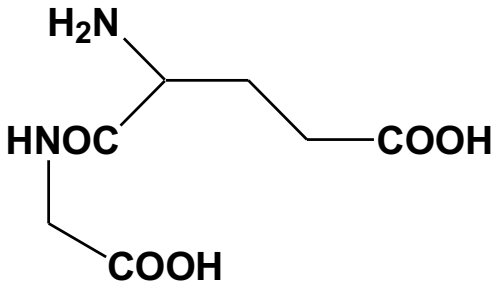
Mature cheese: 8 alpha-1-glutamyl and 10 gamma-1-glutamyl dipeptides. The gamma peptides were found to be 'active' kokumi inducers whereas the alpha did not impart the kokumi sensation.

The peptides which were found to be kokumi inducers were *γ* -Glu-Glu, *γ* -Glu-Gly, *γ* -Glu-Gln, *γ* -Glu-Leu and *γ* -Glu-His

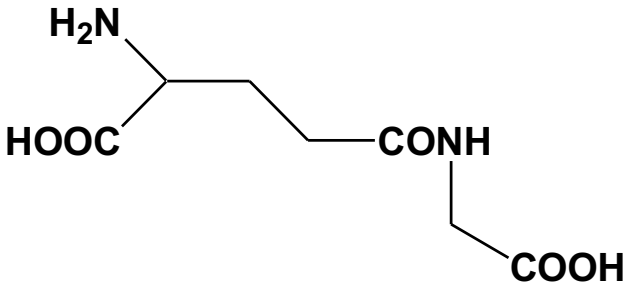
BUT – WHAT ARE THE CHEMICAL COMPOUNDS THAT INITIATE THE ‘KOKUMI SENSATION?



Glutamic Acid



Alpha Glu-Gly



Gamma Glu-Gly

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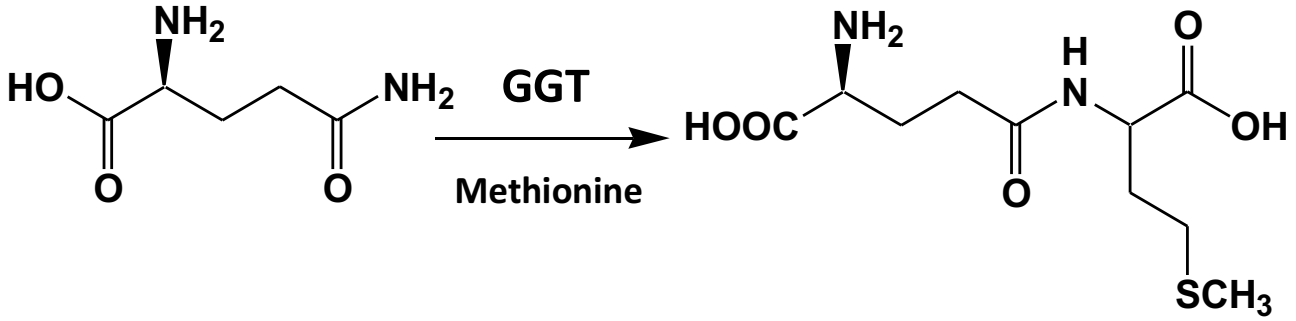
HOW ARE ɣ-GLUTAMYL PEPTIDES FORMED IN CHEESE?

Hofmann published a second paper in 2009 exploring the parameters influencing the generation of ɣ-glutamyl peptides in Gouda cheese.

The enzyme ɣ-glutamyl-transferase (GGT) is the catalyst responsible for the production of ɣ-glutamyl peptides from L-glutamine in cheese combining it with various amino acids or peptides.



In cheeses *P. roquefortii* (natural source of GGT) will produce and secrete ɣ-glutamyl peptides over time.

Toelstede, S. and Hofmann, T., Kokumi-active Glutamyl Peptides in Cheeses and their Biogeneration by *Penicillium roquefortii*. *J. Agric. Food Chem.* 2009, 57, 3738-3747

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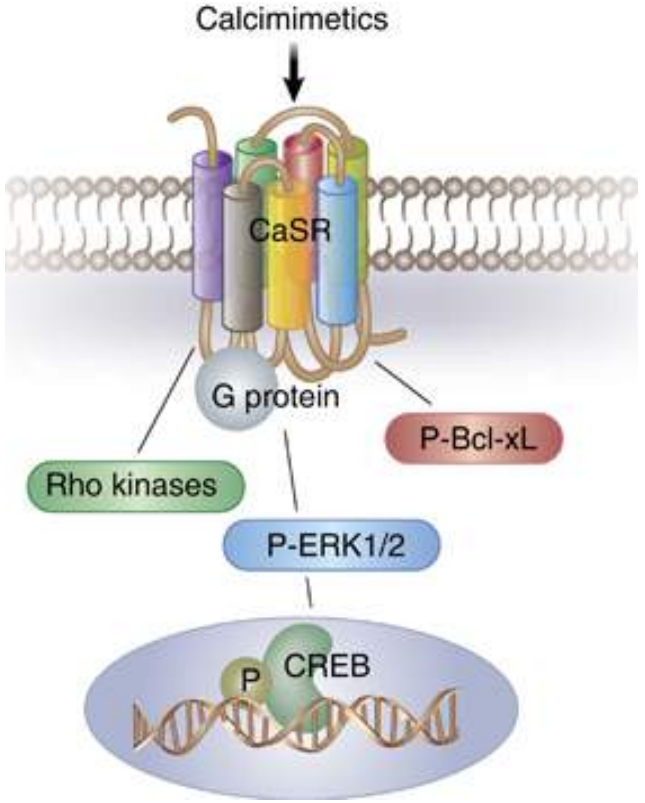
KOKUMI TASTE PERCEPTION

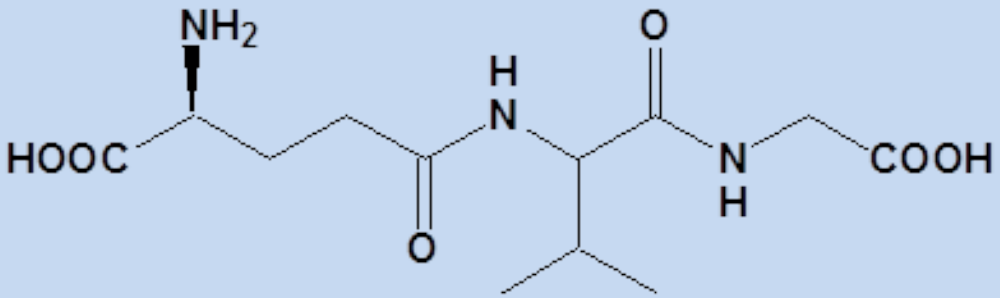
Kokumi taste perception has been linked to the calcium sensing receptor (CaSR). This receptor is a class C, G-protein receptor located in taste buds and interestingly in the parathyroid glands, the kidneys, and in many other tissues such as the liver, heart, lungs, alimentary canal, and pancreas.

Ajinomoto demonstrated that ɣ-glutamyl peptides are recognised by the CaSR in taste cells and produce the desirable kokumi taste sensation in humans. enhancing all three kokumi taste characteristics (thickness, continuity and mouthfeel) at a concentration as low as 0.002%.



KOKUMI

Gamma-glutamyl-valyl-glycine



FEMA: 4709	EU Flavis number: Fl 17.038 9th February 2016	Ajinomoto Patent Appln: EP2156752 A1 (2007)

Reported in scallops in 2012. Occurs also in fish sauce. High kokumi intensity .
At 0.01-0.1% in the presence of glutamate and/or ribonucleotides it enhances the whole taste profile.
It also improves the sweet profile of sweet substances such as sucralose, aspartame and acesulfame K by activating the calcium receptor on the tongue supressing the bitter aftertaste.

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THANK YOU

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