UNIVERSITY OF CHEMISTRY AND TECHNOLOGY, PRAGUE
Faculty of Food and Biochemical Technology
Department of Food Analysis and Nutrition

# Human senses I

Taste

# The aim of the lecture – what to know

- Describe in general terms sense of taste

  What are the characteristics of taste?

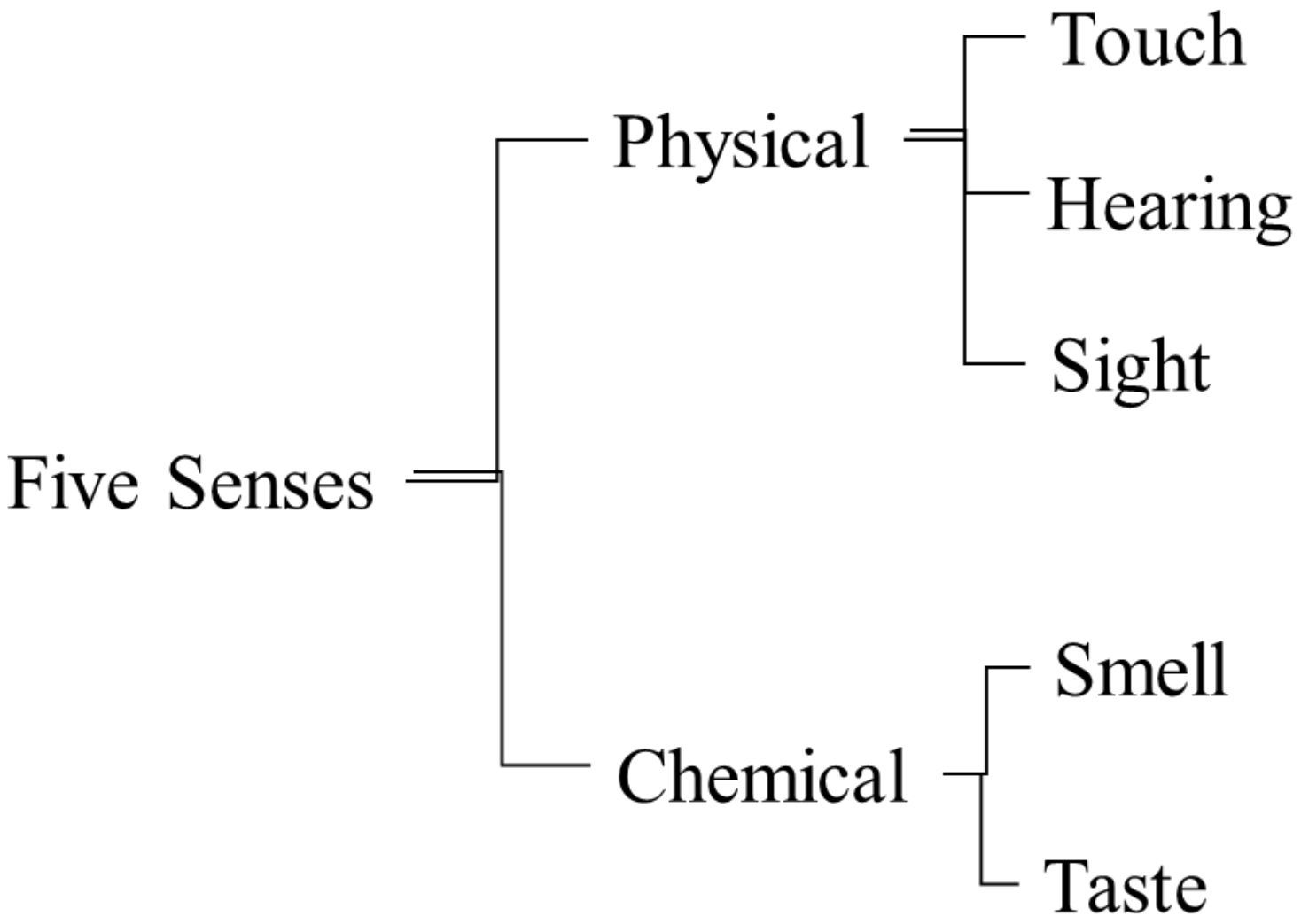
- The chemical stimulus, receptors and pathways for taste perception

- What are the limits of human taste sensitivity?

- Named sweet compounds

# Human senses – Chemical and Physical Stimulant Sense

| | | |
|---|---|---|
| • Vision | (**sight in eyes**) | Appearance |
| • Olfaction | (**smell in olfactory organs**) | Aroma |
| • Gustation | (**taste in taste buds**) | Taste |
| • Audition | (**hearing and equilibrium in ears**) | Sound |
| • Touch | | Texture |


Five Senses
Physical
Touch
Hearing
Sight
Chemical
Smell
Taste

# 'Superadditive' personalities

- The human brain actually combines the information from each of our senses according to a number of very specific rules.

- Our brains tend to combine weak signals (such as the combination of a very weak taste with a very faint odour) in a **'superadditive'** way that gives rise to a perception of flavour.

# Receptor Types

- **Chemoreceptors**
  - **respond to changes in chemical concentrations**
- **Mechanoreceptors**
  - **respond to mechanical forces**
- **Pain receptors**
  - **respond to tissue damage**
- **Thermoreceptors**
  - **respond to changes in temperature**
- **Photoreceptors**
  - **respond to light**

# We taste with all of our senses.

- our flavor perception is actually determined by the:
- Smell
- Taste
- Appearance
- Sound

# Basic Terms - I

## Stimulus

- Energy that produces a respose in a sense organ

## Sensation

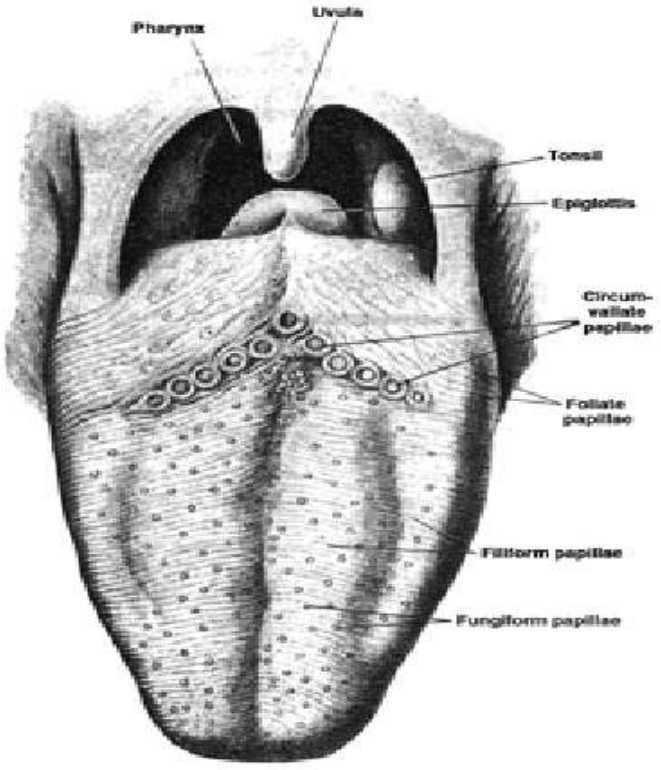
- The process by which our sense organs receive information from the environment

## Perception

- The sorting out, interpretation, analysis, and integration of stimuli involving our sense organs and brain

# Taste

**Sensors of taste are located on the tongue, soft and hard palate, pharynx and epiglottis.**




Sensors (taste buds) located in immediate vicinity of mouth

Tongue

Palate

Pharynx, oesophagus, epiglottis

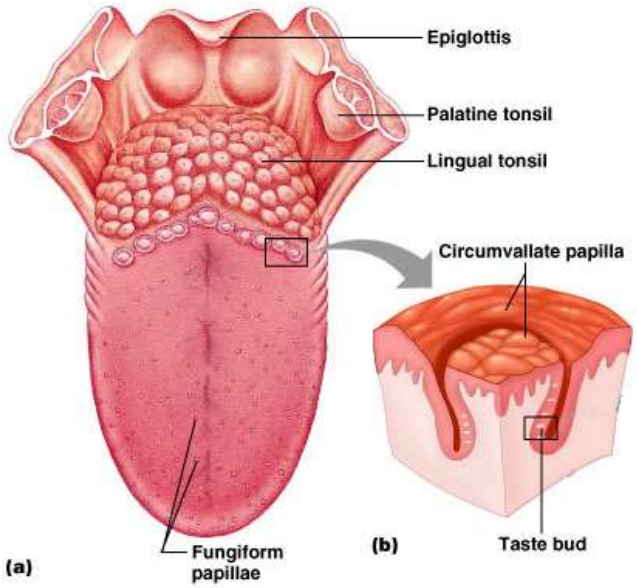
Papillae on tongue bear taste buds

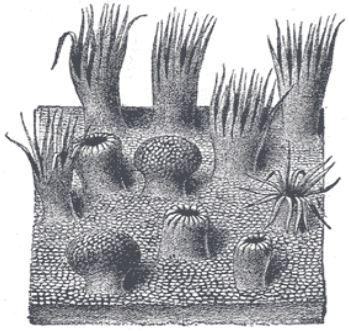
Usually 2000-5000 taste buds in humans

# Four major classes of papillae

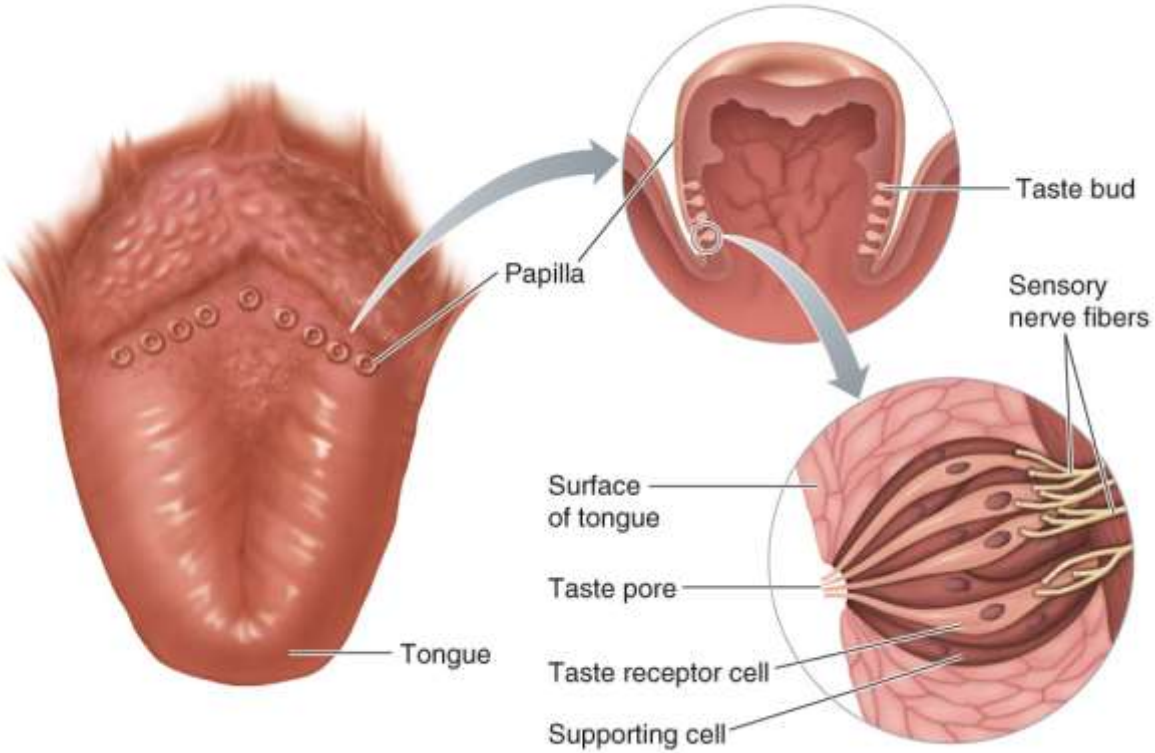
The papillae give the tongue its bumpy appearance and can be classified after their shape into four types:.

The first papillae appears when human fetus is six weeks old



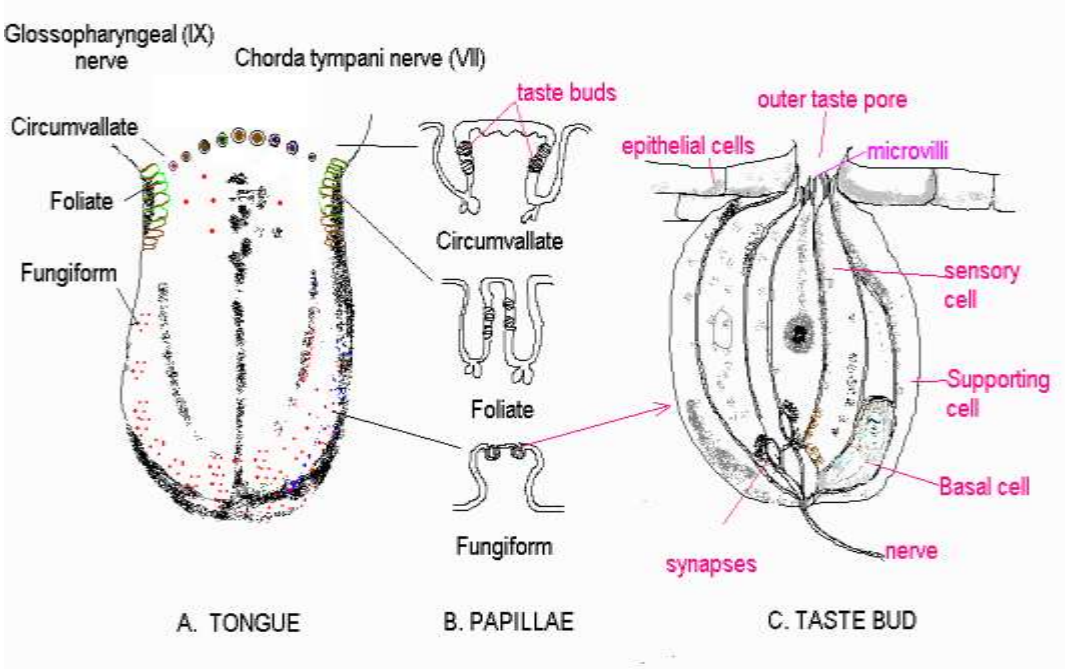



# Location and Structure of Taste Buds



# Taste buds

Taste buds - dimension is 40-80μm. Develop during 11-13 weeks.



# Taste buds

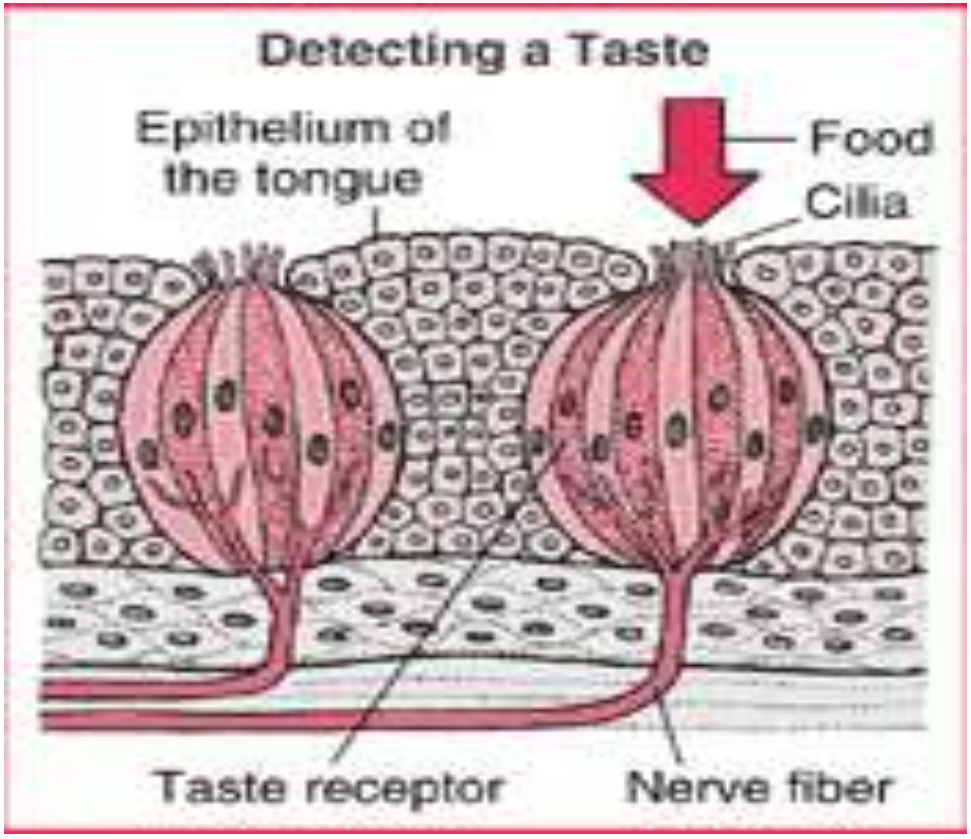
- The children have about 10 000 taste buds, but their amount decrease as we age.  The average number for adults is 2000 - 3000 buds. Each taste bud contains up to 100 taste receptor cells, which respond to different substances in your food.

- The taste bud density and placement of the taste buds among people varies. For example the density on the tongue tip range form 3 to 512 taste buds/cm2 with an average around 115 buds/cm2

- In addition there are 2500 taste buds on the epiglottis, soft palate, laryngeal and oral pharynx. Many of these taste buds are innervated by the facial nerve (Vllth cranial nerve).

- Lifespan of about 10 days to 2 weeks

# Taste Buds


Detecting a Taste
Epithelium of the tongue
Food
Cilia
Taste receptor
Nerve fiber

# Transduction

- Each taste modality is transduced by a different kind of receptor cell

- Two basically different mechanisms are involved:

- Direct interaction of taste stimuli with ion channels in the receptor cell membrane (salt, sour, bitter, and possibly umami)

-Interaction of taste stimuli with membrane-bound receptors that activate one or more second-messenger pathways in the receptor cell (sweet, bitter, umami and fatty acids).

•Both mechanisms result in an increase in intracellular calcium and neurotransmitter release.

# Nerves

Electrical signals generated in the taste cells are transmitted in three pathways:

The **chorda tympani nerve** conducts signals from the front and sides of the tongue.

The **glosso-pharyngeal nerve** conducts signals from the back of the tongue.

The **vagus nerve** conducts taste signals from the mouth and the larynx.

# Taste

Chemicals dissolve in our mouth (must be water soluble) and stimulate the taste buds in the oral cavity (tongue, soft palate, cheek, etc.)

Taste, or gustation, is the combination of three different kinds of input:

- Direct chemical stimulation of taste buds
- Stimulation of olfactory receptors
- Stimulation of chemical-sensitive and somatosensory free nerve endings mainly of the´trigeminal nerve. Trigeminal endings respond to qualities such as the pungency, spiciness, temperature, pain, texure of food.

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# Basic tastes

Sweet: Identify energy-rich nutrients

Salt: Ensures proper dietary electrolyte balance

Umami: Recognize amino acids

Sour and bitter: Warn against the intake of potentially noxious or poisonous chemicals

**The sixth receptor for long chain fatty acids has been described**
***(Laugerette et al. J. Clin. Invest. 115(11) : 3177, 2005)***

**Discussion about thermal tastes (2000), taste of Ca**

# Clinical considerations

- Ageusia: Absence of sense of taste
- Dysgeusia: Disturbed sense of taste
- Hypogeusia: Diminshed sense of taste
- Hypergeusia: increased sense of taste

# Sweet taste

- Sweet taste is one of the favorite tastes and therefore the most studied.

- There is evidence that prenatal infants detect and like sweet in utero and that human infants are born with a preference for sweet taste.

- Substances that have sweet taste are found in all chemical classes. Salts such as beryllium or lead, simple organic compounds such as chloroform, and alcohols

- The main group are carbohydrates, the sweetness decreasing in a homologous series **sugars** > **oligosaccharides** > **polysaccharides**.

- Among other sweet organic compounds belong amino acids, peptides, proteins, compounds with $NH_2$ groups such as amides, ureas and hydrazides. The benzene compounds with one single $NO_2$ group are often sweet and with more $NO_2$ groups are usually bitter.
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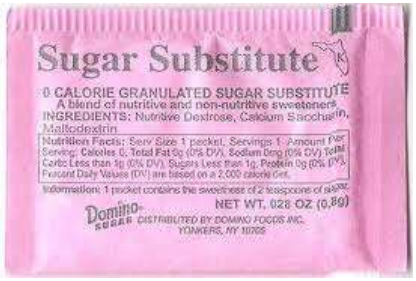
# Sweet taste continued

Small changes in the stereochemie of atoms within a molecule may affect its taste.




The chemical structure of the sweet compound also plays an important role in the determination of the area of the tongue, where the sweet taste is perceived.

For example the taste of inorganic salts and nitrogen compounds is perceived on front of the tongue, some dihydrochalcons on the back and some sweet proteins such as thaumatine and nonelline on the sides.

# Sweeteners


*Saccharin* - Discovered in 1879 when Fahlberg forgot to wash his hands before lunch, inadverently licked his fingers.
Saccharin is only sweet to humans.

*Cyclamate* - Discovered by accident. A **graduate student** at the University of Illinois in 1937 was smoking a cigarette, that came into contact with some chemicals.

*Aspartame* - James Schlatter licked fingers in preparing to pick up a piece of weighing paper. It is a combination of two naturally occurring amino acids (aspartic and phenylalanine).

# Sweeteners

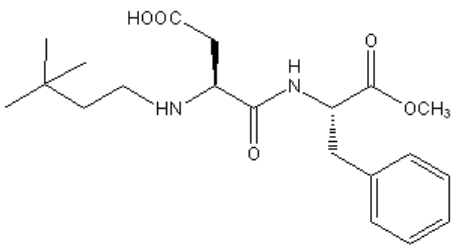
*Sucralose* - A chloride-containing carbohydrate product some 600-times sweeter than sugar. Discovered when a foreign student (Shashikant Phadnis) working in Prof Leslie Hough's lab at King's College, London, misunderstood a request for "testing" as "tasting".

**Other Sweeteners**

Alitame, similar to aspartame in that it combines two amino acids (alanin and aspartic acid) into a dipeptide, is about 2,000-times sweeter than sugar.

# New

## *Neotame, Steviosid,* Advantame




Neotam

# Stevia rebaudiana

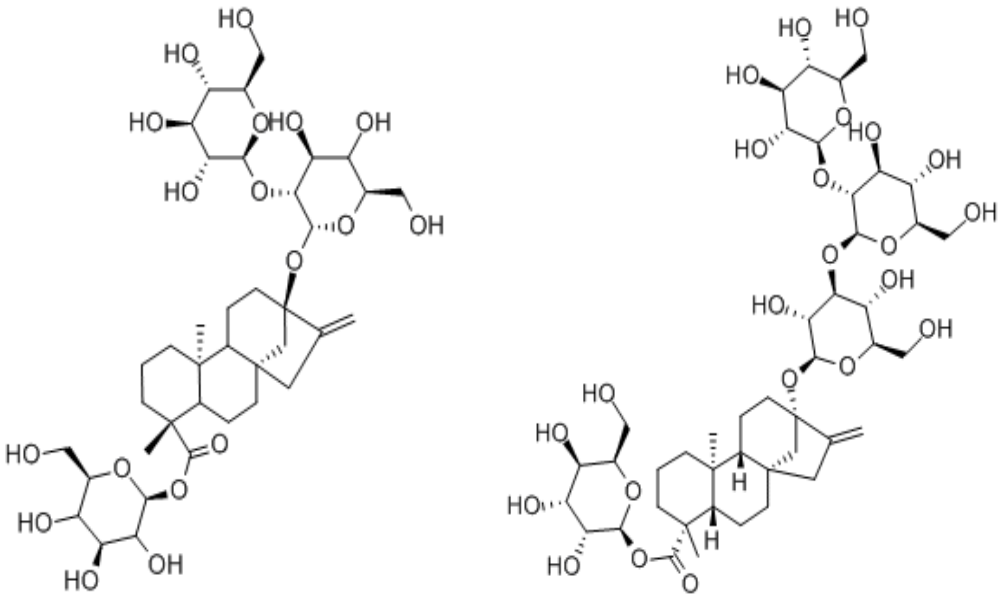

# Stevia rebaudiana - history

- Used extensively by native cultures of South Americafor centurieFirst introduced to Europe by Spanish conquistadores in 16th century
- Reintroduced in early 20th century to scientific community by Italian-Swiss botanist Dr. Moisés S. Bertoni
- 1905 – Bertoni classified & described stevia
- 1970s – Japan began using stevia in replace of artificial sweeteners & sugar
- 2012 approved by EU

# Chemistry

- Active compounds: group of diterpene (steviol) glycosides
  - dulcoside A, rebaudiosides A-E , steviolbioside, & stevioside
- Rebaudioside A (3.8%) and stevioside (9.1%) are the sweetest, most abundant, & most important commercially
- Highest yield of these compounds in leaves just before the plant begins to flower,

# Chemical structures



References:

Goyal, S. K., Samsher, and Goyal, R.K. 2010. Stevia (*Stevia rebaudiana*) a bio-sweetener: a review. Intl. J. Food Sci. and Nutr. **61**(1): 1-10.

# Commercial products


Coca-Cola

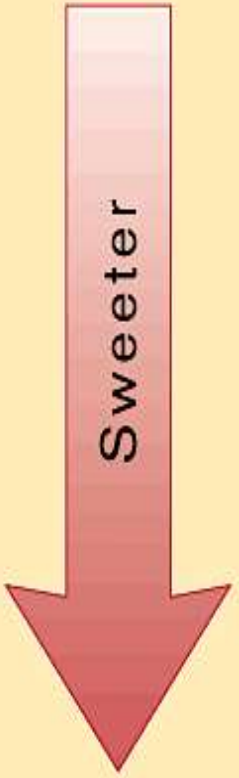


# Advantame

- is a non-caloric high-intensity sweetener found in various food and tabletop products for the replacement of caloric sugars. The European Food Safety Authority (EFSA) evaluated the safety of this compound and established an Acceptable Daily Intake (ADI) of 5 mg/kg body weight per day.
- Commission regulation (EU) No 497/2014 was published on 15 May 2014 in the purpose of adding advantame to the list laid down in Regulation (EC) No 1333/200 on food additives. Advantame was attributed the E-number E 969. Characteristics and maximum level for each food category are specified in Annex II and I of Regulation (EC) No 1333/200, respectively.
- This Regulation entered into force on 4 June 2014.
- Source : Commission Regulation (EU) No 497/2014 of 14 May 2014 amending Annex II to Regulation (EC) No 1333/2008 of the European Parliament and of the Council and the Annex to Commission Regulation (EU) No 231/2012 as regards the use of Advantame as a sweetener. Official Journal of the European Union, L 143/6, published 15/05/2014.

## SWEETNESS SCALE

| Compound | Sweetness Relative to Sucrose |
|---|---|
| **Natural sugars** | |
| Lactose | Not as sweet |
| Maltose | Same sweetness |
| Glucose | Slightly sweeter |
| Fructose | 4 times sweeter |
| **Artificial sweeteners** | |
| Cyclamate | 30 times sweeter |
| Aspartame | 150 times sweeter |
| Saccharine | 450 times sweeter |
| Sucralose | 600 times sweeter |



# Conversion Table for Sweeteners

| | Sweetness Intensity Sugar Equivalent) |
|---|---|
| Caloric Sweeteners | |
| Sucrose | 1.00 |
| Glucose | 0.70 |
| Dextrose | 0.85 |
| Crystalline Fructose | 1.30 |
| Intense Sweeteners | |
| Saccharin | 300 |
| Cyclamates | 30 |
| Aspartame | 200 |
| Acesulfame | 200 |
| Stevioside | 200 |
| Sucralose | 600 |
| Neotame | 8,000 |
| Polyols | |
| Sorbitol | 0.70 |
| Mannitol | 0.60 |
| Xylitol | 0.90 |

# Other Natural Sweeteners

- Often used as flavorings:
  - Glycyrrhizin (from liquorice)
  - Lo Han Guo (P&G involved)
  - Thaumatin
  - Some plant proteins, e.g. Monellin and Thaumatin, taste 10,000 times as sweet as sucrose