Lecture 2

Core course 14: Food Quality and Sensory Evaluation

Unit 2: Gustation

Subject: Food Technology

e-content topic: Basic tastes and taste sensations

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Introduction

Taste in the gustatory system allows humans to distinguish between safe and harmful food, liking and disliking of food, pleasurable and poisonous food. All these decisions are based on the basic tastes sensed by the receptor cells, recorded through cranial nerves in the brain. Besides this, the decision of what taste is, is dependent on pre-concept, hunger status, health condition, and desirability to eat food. The basic tastes derived mainly from the nature of human perception are sweet, sour, salty and bitter. In the recent decade, savoury called umami has been included in the list. The classification of basic taste with the genesis and properties is as follows:

CLASSIFICATION OF BASIC TASTE

GENESIS		**BASIC TASTES**	**PROPERTIES**
1.	Ayurveda	Sweet	Heavy, moist, cooling
	>5000 years old	Sour	Hot, light & moist
		Salty	Hot, heavy, moist
		Bitter	Light, cooling, dry
2	West	Sweet	Sweetness of sugar, sugar derivatives
	Aristotle period	Sour	Acidity
	384BC-322BC	Salty	Salt of cation & anion
		Bitter	Sharp, unpleasant bitter products
3	Japanese	Umami	Monosodium glutamate
	1908	(Savoury)	

This presentation deals with

1. **Basic taste**
   Sweetness
   Sourness
   Salt
   Bitterness
   Umami (Savoury)

2. **Taste Sensations**
   Astringency
   Pungency
   Metallic taste
   Alkaline taste
   Coolness
   Fattiness

Basic Tastes

sweetness being a pleasurable sensation is largely associated with sugars and sugar derivatives, alcohols, glycols, α-aminoacid, peptides, some proteins and they are usually associated with multiple hydroxyl groups and α-aminoacids. In carbohydrates, the sweetness decrease with homologous series as sugars >oligosaccharides >polysaccharides. Generally, sucrose is taken as the reference standard and fructose is the sweetest among sugars. The sweetness is perceived by sweet taste receptor sites interaction and its transmittance to the brain for signalling. As per Ayurveda concepts, (Thomas Yarema, 2005) sweetness results from the combination of water and earth, the senses of nature. It imparts heaviness, moisture and cooling to the body and is a good source for building body's vital tissues of plasma, blood, fat, muscles, bones, marrows and reproductive fluids. Sweet taste increases saliva, soothens mucous membranes, and burning sensations, relieves thirst and has beneficial effects on skin, hair and voice. Sweetness is detected by a variety of G protein coupled receptors (IGPCR) coupled to the sweetness receptors must be activated for the brain to register sweetness. TIR2+3 and TIR3 receptors account for sensing of sweetness. Natural sugars are more easily detected by the TIR 3 receptor than sugar substitutes. Synthetic sweetness such as saccharin activates different GPCR's and induces taste receptor cell depolarisation by an alternate pathway. Sweet taste in food refers mainly to sweetmeats, fruit and vegetable juices, sugar syrups, honey, chocolates, fruit bars and invisibly many ingredients rich in starch.

Sourness, though an aversive component, quite often exerts health benefits, an example of curds or yoghurt which promotes digestion and aids in brain functioning. Basically sourness is a taste that detects acidity. Sourness increases with the increase in hydrogen ion concentration, however, the predictability changes with the source of acid either aliphatic or aromatic or mineral acids. For eg. Weak acids such as acetic acid taste more sour than

mineral acid at the same pH. Increase of carbon chain length in the aliphatic acid series may enhance the stimulating efficiency. The perception of sour taste is influenced not only by the activity of the proton, but also by the quality and character of the anion. In Ayuvedic literature, sour taste is composed of earth and fire, senses of nature and provides the properties of hotness, lightness and moistness. Sour taste induces salivation, stimulates digestion, strengthens the heart, relieves thirst, maintains acidity and sharpens the senses. Sour taste nourishes the vital tissues except reproductive tissue. Sour taste in food is mainly connected with citric, malic, oxalic and tartaric acids in fruits and lactic acid in yoghurt, other diary and meat products, propionic acid in cheese etc. The transfer of positive charge into the cell can itself trigger an electrical response. According to this mechanism, the intracellular hydrogen ions inhibhit potassium channels there by inhibhits hyperpolarising of cell, with the result release neurotransmitters.

Salt, practically an inseparable ingredient in foods and salt taste is produced primarily by the presence of sodium ions. Potassium and lithium ions most closely resemble to that of sodium in saltiness. Generally, low molecular weight salts are predominantly salty while those of higher molecular weight are bitter. Ayurveda specifies that salty taste is composed of fire and water, senses of nature and is hot, heavy and moist by nature. Water retaining quality of salt imparts moist nature and it falls in between sweet and sour tastes in its moist qualities. In moderation levels in foods, salt improve the favour of food, improves digestion. Maintains mineral balance, liquefies mucous, aids in the elimination of water and calm the nerves. The most prominent role of salt is the management of electrolyte balance in the body, action on water requirements and more so this state is predominant in desert areas and hot humid zones. The simplest receptor found in the mouth is sodium chloride receptor. A sodium channel in the taste cell wall allows sodium cations to enter the cell. This on its own depolarises the cell and opens voltage dependent calcium channels, flooding the cell with positive calcium ions and leading to neuro transmitter release. The salt taste in foods is predominant in pickles, electrolytes, salt topped up fried products and moderate in almost all the savoury dishes.

Bitterness, though an unpleasant, taste, it is the most sensitive and sharp taste perceived. Bitterness quite often moves with the health concerns. Generally, bitterness is associated with alkaloids such as quinine, caffeine, strychnine, higher molecular weight salts and long carbon chain organic compounds. Though bitter compounds are unappealing, they are closely linked to sweet taste. But the difference is that the ability to perceive bitterness has been related to their lipid solubility which can be changed by pH. By nature, bitter taste is composed of air and ether, thereby it is light, cooling and dry. Bitterness contributes for stimulation of appetite, reduces water retention, solvation to skin problems, burning sensations. Bitter taste is a powerful detoxifying agent and has antibiotic, antiparasitic and antiseptic qualities. The bitterness in foods is more predominant in bitter gourd, bitter melon products. In bitter gourd, the compound similar to insulin structure is present, thereby bitter gourd juice act as an anti-diabetic agent which on consumption reduces blood sugar levels. Bitter compounds moderately present in green leafy vegetables, spices such as fenugreek, turmeric, coffee and tea, olives, walnuts etc, is the causative factor foe bitterness.

When gustducin in activated by GPCR, its submits break apart and activate phosphodiesterase, a nearby enzyme which inturn converts a precursor within the cell into a secondary compound which closes potassium ion channels. It stimulates endoplasmic reticulum to release Ca^{+2} which contributes to depolarisation, thereby, neurotransmitter release.

Savouriness called **umami** resembles to monosodium glutamate taste. Sometimes it is also called as meat like taste probably due to high content of glutamate in meat. However, it differs from the classical tastes and is connected with the L form of monosodium glutamate. The concept of umami and its details on history, physiology, usage has been discussed by Guion (1989). Savouriness is considered as a fundamental taste in Chinese, Japanese, Thai and Korean cooking. But in India, savouriness is referred to spice-salt combination processed products based on not only meat but also cerals and legumes. The glutamate taste sensation is most intense in combination with sodium ions as found in table salt and the same concept is recognized in Indian foods. Some of the nucleotides, 5'-inosine monophosphate and 5'-guaonosine monophosphate has a synergistic effect with glutamate. Ayurveda do not have this class of taste. Savoury taste refers to meat and fish products, cheese, beans, sauces, mushrooms etc. It is thought that amino acid L- glutamate bonds to a type of GPCR Known as metabotropic glutamate receptor. This causes the G-protein complex to activate secondary messanger, there by leads to neurotransmitter release.

The basic tastes with their chemical components and ayurvedic concept of the basic are consolidated.

Tastes versus components

	Taste	Chemical component	Ayurvedic concept
1	Sweetness	Sugars,sugar derivatives,glycols,peptides	Water + earth
2	Sourness	Acetic, propionic citric, malic, oxalic, tartaric, lactic acids	Earth + fire
3	Saltiness	Sodium Potassium Lithium ions	Fire + Water
4	Bitterness	Quinine Caffiene Tannin	Air + etter
5	Savouriness (umami)	Glutamic acid, aspartic acid	Not present

Generally it is stated that different tastes are perceived solely or most intensely in certain regions of the tongue, say, bitter in the back of the tongue, sweet in the front, salt at the edges and sour at the inner face of centre of the tongue. However, most of the taste buds, regardless of its location, show the receptiveness to varied taste qualities on various areas of

the tongue. Rather it can be said that tongue is a promising instrument to detect all the types of tastes at a wide range of concentrations showing its differential behaviour on the particular taste, in sensitiveness at low or high concentration at a particular region. However, almost all the tastes can be perceived on the different parts of the tongue, of course in different concentrations. Gustducin and transducin are expressed as taste receptor cells where they are thought to mediate taste transduction which normally perceives the taste. The profile of natural products exerting the basic tastes is given below.

PROFILE OF NATURAL PRODUCTS

	Basic Taste	Natural Sources
1	Sweetness	Honey, Fruit- Banana, Mango, Papaya, Pineapple, Pomogranate, Sapota, Jack fruit, Milk, Graines – Jowher, Maize, Rice,Wheat, Millets – Ragi, Bajra, Pearl, Foxtail, Vegitables –Sweet potato, Sweet pumpkin,Carrot
2	Sourness	Sourness All citrus fruits-lemon orange, Amla, Tamarind, Pseudo lemon, unripe mango.
3	Saltiness	Natural Salt, Sea Salt, Rock Salt, Sodium Chloride
4	Bitterness	Bitter gourd, Grape, Bitter melon, Fenugreek, Herbs, Spices, Dark leafy green vegetables, quinine
5	Savoury (Umami)	Mano sodium glutamate, Fried spiced foods, Meat, Chicken, Fish

2. Taste Sensations

The tongue can also feel other sensations besides the basic tastes. These are largely detected by the somosensory system. In humans the sense of taste is conveyed via three of the twelve cranial nerves. The facial nerve (VII) carries taste sensations from the anterior two thirds of the tongue. The glossopharyngeal nerve (IX) carries taste sensations from the posterior one third of the tongue. A branch of the vagus nerve (X) carries some taste sensations from the back of the oral cavity. The trigeminal nerve (V) provides taste related sensations of peppery or hot from spices, besides the textural information of the food. All sensations associated with the ingestion of foods derive from other sensory systems that innervate the oral and nasal cavities. The taste description as like chocolate, vanilla, strawberry, orange are actually odours detected retronasaly via the opening between the oropharynx and nasal cavity.

Qualities such as creaminess and crunchiness derive from mechanical stimulation and thus are mediated by the sense of touch. The burn or heat of chilli, pepper, mustard, alcohol and other irritants is mediated at least in part by the pain and thermal senses.

Astringency is a tactile taste felt as a dry, rough feeling in the mouth and contraction of tongue tissue. Some goods containing tannins, calcium oxalates, polyplenols cause an astringent sensation of mucous membrane of the mouth. It usually involves in the formation of precipitates between tannins or Polyphenols with proteins in the saliva. It is known that tannins positively influence the taste of tea, coffee, cocoa, wine and beer. Astringent taste is the 6^{th} taste of Ayurvedic class and is the least common amongst them. This taste derives from the combination of air and earth. Mostly found in beans, lentils, cranberries, pomegranates, peas, cauliflower, turnip, buckwheat, turmeric, marjoram, coffee and tea.

Pungency also referred as Spiciness, hotness is associated with spices specifically, pepper, ginger and clove. Brassica vegetables such as cabbage, horse radish, mustard have a pungent taste. Pungency causing is the reaction induced by trigeminal nerve with normal taste reception say in the presence of ethanol, capasaicin etc. Some substances activate cold trigeminal receptors which provide cooling sensation, for eg. Spearmint, menthol. In the Indian medicine, pungent taste, the fifth one is derived from the nature elements fire and air and is hottest of all tastes, mostly provided by the spices. In small amounts, it is effective to stimulate digestion, promotes sweating and detoxification, dispels gas, aids circulation, improve metabolism and relieves muscle pain. Some of the plant derived compounds which provides pungent sensation are capsaicin from chilli pepper, pipperine from black pepper, gingerol from ginger, and allyl isothiocyanate from brassica family.

Metallic taste is due to the presence of metal salts and most commonly found in drinking water. Metallic taste may be caused by food and drink and is generally considered an off flavour present. Some artificial sweetness are perceived to have a metallic taste. Blood is considered by many people to have a metallic taste. A metallic taste in the mouth is also a symptom of various medical conditions or due to amalgam dental fillings and at times it may be due to the pesticide spray.

Alkaline taste or soapy taste is associated with potassium carbonate. The distinctive taste of chalk has been referred to calcium component of that substance.

Coolness is experienced when cold trigeminal receptors are activated by some of the compounds such as ethanol, menthol, camphor and is a perceived sensation by the nerve fibres.

Fattiness is physiological response of taste bud cells when high fat foods, butter etc. are eaten. Recent research reveals a potential fat taste receptor called the CD36 receptor. In 2015, name has been proposed for taste of fat as **“oleogustus”.**

The temperature, the most important aspect has an effect on perception of taste. The perceived sweetness of sucrose, fructose and glucose increased in intensity when the

temperature of the solution increased from 20 to 36^0C.(Green & Frankmann,1987, 1988) Similarly, bitterness of caffeine grew stronger at warmer temperatures. But, the sourness of citric acid and saltiness of sodium chloride were not significantly altered. The components of mechanical stimulation refering to tactile properties with the increased temperature modulates the sensitivity of the mouth to simple pressure. Cool products are perceived heavier than warm objects and probably the initial pressure of components are higher as compared to warm objects. Thus coolness, smoothness, thickness, roughness and creaminess of perception are very important and require further research. Chemical irritation is a charactaristic property of hot spices and their flavour improvement. The changing temperature of the stimulus and tongue can drastically affect the sensitivity to an irritant. Capsaicin, a pungent compound in chilli pepper produces the burning sensation which increases directly with the increased temperature. The same is the effect with pipperine of black pepper, ethanol (Green, 1990). Therefore consuming foods that contain hot spices in a hot environment will increase the sensory impact of those foods. In general, the temperature increase along with nutritional and metabolic effects on taste perception have usually found significant effects only when deficiencies of vitamins or minerals have been extreme as found in diseased state and associated with lesion or tissue atrophy. The changes in temperature also influence psychologically the acceptance, liking, hotness etc. Normally chilled beer is preferred,while warm coffee, soups are liked. Thus the product range, the concept of the product use and the practices have a bearing with reference to temperature.

In **conclusion,** taste is one of the causative factors to distinguish between safe and harmful food, liking and disliking, pleasurable and unpleasant food This factor depends on five basic tastes called sweet, sour, salt, bitter and umami which refers to sweetmeats, acidic foods, sodium ionic foods, bitter alkaloids taste and monosodium glutamate savoury taste. Bitter is perceived at the back of the tongue, sweet in the front, salt at the edges and sour at the centre of the tongue. Tongue detects all types of tastes at wide range concentrations. The taste receptor cells through the transduction process perceives the taste. The somosensary system detects the taste sensations such as astringency, pungency, metallic taste, alkaline taste, fatty taste etc. These sensations are oriented to various chemical compounds such as pipperine in pepper, gingerol in ginger and so on. The temperature of foods tasting has a great impact on the taste buds and show stronger flavours at high temperatures.

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