Food Chemistry I - UNIT 7 - FLAVOUR

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Dear Students, I welcome you all for our lecture series on FOOD TECHNOLOGY. In today's lecture, let's make an attempt to know about '**Flavour.**

Introduction

The appearance of a food is an important aspect but the flavour of a food is the feature which determines the overall quality and acceptability of foods. A food can get rejected based on the flavour only even with an acceptable colour, safety and nutritional value. Flavours exert an important effect on food choice even without any nutritional significance of theirs. Knowledge of flavour is perceived to be a recent development in food chemistry that occurred due to the invention of techniques such as gas chromatography and mass spectrometry. Food chemistry involves study of compounds derived from foodsamongan extremely wide range of chemical structures that are able to generate a response from the sensory receptors producing a psychological response.

The following aspects will be covered in this chapter:-

1. Definitionof flavour
2. Basic tastes
3. Chemical structure and taste
4. The smell sensation
5. Visual appearance, texture and flavour
6. Description of food flavours
7. Flavour enhancers and Flavourings

1. Definition

The classic definition of flavour as defined by Hall (1968) is "Flavour is the sensation produced by a material taken in the mouth, perceived principally by the senses of taste and smell and also by the general pain, tactile and temperature receptors in the mouth. Flavour also denotes the sum of the characteristics of the material which produce that sensation".

From this idea we can understand that flavour is a property of the food substance as well as the flavour sensing mechanism in an individual ingesting the food substance. Thus the study of flavour includes the composition of food in termsof compounds having a smell or taste and the process and outcome of interaction between these compounds and the components of an individual's taste and smell sensing organs. The understanding of flavour of a food originates when the signals produced by the sensory organs reach central nervous system. Flavour is mainly composed of taste and odour but is also influenced by other properties such as texture, appearance, pH of the food etc.

Flavour is one of the sensory phenomenon experienced based on the taste, odour/smell, appearance, texture, temperature of a food that can trigger the senses. Flavour of a food is the result of interaction between the components present and these are commonly non-nutritive and have the ability to induce the sensation at very low concentrations.

2. Basic tastes

The complex interaction between the senses used to judge a food based on its appearance, smell, touch and hearingresults in a decision to ingest or reject a particular food. This interaction is commonly referred to as 'taste'. There are five basic tastes are sour, salty, sweet, bitter and umami. These taste qualities are mediated to the central nervous system through specializedepithelial cells known as 'taste receptor cells' located in the taste buds thus providing different anatomy to the five basic tastes. The taste buds mostly are distributed within the papillae of the tongue and to a lesser extent in the palate and epiglottis.The perception of the basic tastes is known to be the outcome of a pattern of nerve activity from many taste cells in the tongue.

The five tastes can be perceived at any area of the human tongue although the intensity of the perception may vary based on the region of tongue and type of papilla.For instance sweet taste of saccharin is highest at the tip of the tongue whereas the taste of bitter quinine is perceived best at the back of the tongue. The taste buds are innervated by the VII, IX and X cranial nerve. Recent advancement has led to the identification of the receptors for taste and their functional properties. The five basic tastes are dealt further in detail.

2.1 Sour taste

The sour taste is recognized as a property of the hydrogen ion but the response is not proportional to the pH of a food thus acids can give rise to the perception ofdifferent levels of

sour taste. The sourness perceived depends on the nature of the acid group, pH, bufferingeffects and presence of other compounds such as sugars. At the same pH, organic acids have a greater taste effect than inorganic acids (such as hydrochloric acid). The most common acids found in foods are tartaric acid, malic acid, phosphoric acid and citric acid. The presence of buffers can increase the sourness of weaker acids. Partially neutralized acids are known to have more sourness than its pure form. Alcohol in foods is known to reduce the intensity of sourness as seen in wine.

2.2 Salty

The salty taste is best perceived by sodium chloride or table salt. Salts have different taste depending on the nature of anions andcations. Increase in molecular weight of these ions can make the salt taste more bitter.Sodium chloride is known to enhance the mouthfeel, sweetness, saltiness and have the ability to mask the off flavours. Such an action is not seen in other chloride salts such as potassium chloride.

2.3. Sweet

Compounds in food that have a hydroxyl group (-OH), imine or amine group (-NH) or methane group (-CH) are known to produce a sweet taste. Examples of such compounds are saccharides such as sucrose, glucose, maltose, sweeteners such as saccharin, sorbitol, stevioside and D isomers ofvaline , serine, histidine etc.

2.4 Bitter

The bitter taste in many foods can be due to a wide variety of inorganic and organic compounds. Although considered to be an unpleasant taste, bitterness is a part of other tastes such as sweet and sourness. Inorganic salts such as potassium iodide, amino acids like leucine, arginine can taste bitter.Alkaloids and glycosides are compounds identified best for their bitterness. Quinine, caffeine, theobromine are some of the alkaloids seen in various foods and products. Quinine is also used a standard for testing bitterness of other foods.Naringin, an alakaloid found in citrus fruits contributes to the bitter taste. Peptides formed by partial hydrolysis of proteins as seen in cheese or dairy products also results in a bitter taste.

2.5 Umami

Umami is a Japanese term used for this type of taste which means ‘delicious flavour’. It is also referred to as‘savouriness’and is the taste sensation produced by the free glutamates found in food. This sensation is further increased in the presence of sodium as seen in tomatoes. Mono sodium glutamate is an additive with a strong umami taste.

The basic taste’s themselves cannot completely describe the taste of a food without considering the inter relationships between them. For instance sugar-acid ratio plays an important role in many foods especially fruits, fruit juices and wines deciding their flavour quality. There are many factors that can affect the sense of taste of a compound or food. Temperature for instance can vary the perception of taste significantly. A sugary drink may taste sweeter when it is hot than cold. Lemon drinks can taste more sour when hot than cold. Cold tea and coffee taste more bitter than hot. Such variations may arise due to the changes in the sensitivity of the taste buds to the temperature. Other factors that affect taste are individual variations among people, mixture of more than one taste quality and concentration of compounds in foods.

3. Chemical structure and taste

The inter relationship of chemical structure of a compound and taste is more pronounced than with smell. All acids in general are sour, sodium chloride and few other salts are salty however as atoms get bigger the bitterness increases for instance potassium bromide which is both salty and bitter. Sweetness is exhibited by sugars, lead acetate, beryllium salts, and artificial sweeteners such as saccharin and cyclamate. Bitterness is a property of alkaloids such as quinine, picric acidand heavy metal salts.

Changes in the chemical structure although minor, can cause a change in the taste of compounds. Saccharin, for instance is 500 times sweeter than sucrose but the introduction of a methyl group or chloride ionat *para* position reduced to half.Some of the amino acids are known to have a bitter taste in their L configuration anda sweet taste in their D form. L-tyrosine for example is about twenty times lessbitter than caffeineand D-tyrosine is 5.5 times sweeter than sucrose.

4. The smell sensation

The role of odour or smell is important in many flavours. Smell is recognized by olfactory cells, a type of receptor cells found on each side of the septum in the upper nasal

cavity. Any molecule with odour on passage through the nasal cavity stimulates sensitive hairs that communicate with the brain resulting in perception.

Odors are usually the result of the presence of mixture of several compounds. The combined odour of these compounds seen in many natural and artificial foods may be different than the odour of individual molecules. Odours are described by two aspects namely threshold value and odour quality. The threshold value is defined as the lowest concentration of a compound that creates a perception of odour and the odour quality describes the characteristics of the aroma.The primary odours felt by humans and the compounds responsible are shown in table no 1.

5. Visual appearance, texture and flavour

5.1 Visual appearance

The willingness to accept or reject a food primarily relies on the appearance of the food. Through experience, an expectation about the odour, taste and texture of a food can be made based on the appearance. Appearance of a food is dependent on the way a food is presented, optical properties which includes features such as colour, gloss and translucency; physical form of food which consists of shape, size and visual viscosity.

5.2 Texture sensation

The textural aspects of a food also contribute to its flavour. There are primary and secondary textural aspects that contribute to food acceptability and taste. Hardness, cohesiveness, viscosity and elasticity are primary aspects whereas chewiness, brittleness and gumminess are secondary aspects.

Overall the colour, odour and texture are known to contributeindividually to the flavour of a food but the overall sensation of flavour depends on the interactions of all these aspects in the mouth (mouthfeel). The inter relationship between the innervated tissues of mouth, nasal cavity and throat creates this perception.

6. Description of food flavours

Flavours are often using the trained individuals on the basis of widely recognized taste and smell sensations. The optimum and precise description of flavours is crucial for food developers as it is the basic skills required to create new food products. Primary, secondary and

tertiary words are used to describe each flavour. For example, juicy, sweet, peely and other adjective words are used to describe the flavour of an orange. The primary word used is orange and other words such as juicy, sweet, peely are secondary words.

Let's now consider an example of an orange with higher sweet taste and with a little juicy feel, it can be described as follows:

Orange (Primary)

Sweet (Secondary)

Juicy (Tertiary)

A series of the primary, secondary and tertiary words used for describing flavour are shown in table no 2.

7. Flavour enhancers and Flavourings

7.1 Flavour enhancers

Flavour enhancers are compounds that are added to a food with an intention to supplement or increase the basic flavour. They're used widely in foods &beverages and are found in both natural and synthetic forms. In Asia, cooks practiced the addition of sea weed to soup stocks which increased their flavour; this led to the origin of use of flavour enhancers. L-glutamatewas identified as the flavour compound in sea weed. Further monosodium glutamate (MSG) became the first flavour enhancer to be used commercially. The rich flavour associated with L-glutamate was called 'umami'. Examples of compounds used as flavour enhancers include the 5′-ribonucleotides, inosine monophosphate (IMP), guanosine monophosphate (GMP), yeast extract and hydrolyzed vegetable protein. Flavour enhancers may be used in soups, broths, sauces, gravies, flavouring and spice blends, canned and frozen vegetables, and meats.

Flavour enhancers are labeled on food ingredient packets with unique E numbers ranging from E600 to E699. 'E numbers' are codes for substances that are permitted to be used as food additives in the European Unionand Switzerland. Some of the flavour enhancers used in foods along with their E number is given in table no 3.

7.2 Flavourings

Flavourings are products added to a food in order to add or modify the odour and/or taste. A flavour additive can be a single chemical or blend of chemicals which can be of natural and synthetic origin. Overall flavourings provideflavour partially or completelyon

addition to a particular food. They are often added with an intention to replace the flavour lost during processing as well as in new product development. More than 1,200 compounds are used commercially. They are not represented by E numbers instead their use is controlled by food laws of respective countries as some of them possess health risks.

Natural flavourings are derived from plants, spices, herbs, animals, or microbial fermentations. Artificial flavourings are mixtures of synthetic compounds that appear to haveidentical chemical properties compared to natural flavourings. Natural flavourings are used less often due to their high cost, lack of availability or less potency.

Based on their origin the flavourings are classified into three categories:

Natural flavouring substances obtained from plant or animals by physical, microbiological or enzymatic processes. Examples: spices, fruit juices, herbs, vegetable juice etc.

Nature-identical flavouring substances are obtained by synthesis or extractedwhich havea chemical structureidentical to the substances present in natural products. Example: Vanillin, which can be produced as a natural or a nature-identical substance.

*Artificial flavouring substances*are substances with no equivalence in nature and are produced artificially. Example: Ethyl vanillin, which is artificial and smells and tastes like vanillin.

Some of the commonly used chemicals in food flavourings are shown in table no 4.

Conclusion

Flavour of a food has an important role in food choices than taste, colour, texture alone. The ability to sense the five basic tastes are responsible for the chemical stimulation resulting in perception. Compounds in food have a large impact on the overall flavour of a food and this effect can change with alterations in physical and chemical attributes. The importance of flavour of a food has given rise to the research and use of many natural and artificial flavour compounds with an aim to boost the acceptance of a particular type of food in the targeted population.

Table no 1. Primary odours and compounds responsible for the odour

Primary Odour	**Compounds eliciting the odour**
Camphoraceous	Borneol, tert-butyl alcohol d-camphor, cineol, pentamethyl ethyl alcohol

Pungent	Allyl alcohol, cyanogen, formaldehyde, formic acid,
Ethereal	Acetylene, carbon tetrachloride, chloroform, ethylene dichloride, propyl alcohol
Floral	Benzyl acetate, geraniol, a-ionone, phenylethyl alcohol, terpineol
Pepperminty	tert-butylcarbinol, cyclohexanone, menthone, piperitol
Musky	Androstan-3α-ol (strong), cyclohexadecanone, ethylene cebacate, pentadecanolactone
Putrid	Amylmercaptan, cadaverine, hydrogen sulfide, indole

Table no 2. The primary, secondary and tertiary words used for describing flavour

Primary Words	**Secondary/Tertiary Words**
Orange	Sweet, Juicy, Peely, Fresh, Oxidized, Tangerine, Mandarin, Oily, Candy
Lemon	Juicy, Fresh, Peely, Oxidized, Oily, Candy
Coffee	Roasted, Brewed, Expresso, Sweet, Vanilla-like, Bitter, Fresh, Instant
Cola	Spicy, Citrus, Woody, Oxidized, Vanilla-like
Apple	Red, Green, Peely, Juicy, Delicious, Fresh, Ripe
Vanilla	Vanillin, Hay-like, Creamy, French, Extracted
Banana	Ripe, Green, Candy, Cooked, Spicy
Blueberry	Juicy, Perfumed, Candy, Cooked, Ripe
Grape	Concord, Muscat, Honey Floral, Herbal, Perfumed, Caramellized
Mango	Juicy, Ripe, Green, Floral, Skinny
Lime	Juicy, Peely, Oily, Candy, Fresh, Soapy
Pineapple	Juicy, Ripe, Canned, Candy
Ref: Hui, Y. H. (2006). Handbook of food science, technology, and engineering (Vol. 149). CRC press.pg 2459	

Table no.3Commonly used flavour enhancers along with their E number

Name	E number

Glutamic acid	E620
Mono sodium glutamate	E621
Mono potassium glutamate	E622
Calcium glutamate	E623
Ammonium glutamate	E624
Magnesium glutamate	E625
Guanylic acid	E626
Sodium guanylate	E627
Di-potassium guanylate	E628
Calcium guanylate	E629
Inosinic acid	E630
Sodium inosinate	E631
Di-potassium inosinate	E632
Calcium inosinate	E633
Calcium ribonucleotides	E634
Di-sodium ribonucleotides	E635
Maltol	E636
Ethylmaltol	E637
Ref: http://www.foodinfo.net/uk/e/e600-700.htm accessed on 14.08.2016	

Table no 4. Commonly used chemicals as food flavourings

Chemical	Flavour
Allylpyrazine	Roasted nut
Methoxypyrazines	Earthy vegetables
2-Isobutyl-3 Methoxypyrazine	Green pepper
Acetyl-L-Pyrazines	Popcorn
2-Acetoxy Pyrazine	Toasted flavours
Aldehydes	Fruity, green
Alcohols	Bitter, medicinal
Esters	Fruity
Ketones	Butter, caramel
Pyrazines	Brown, burnt, caramel
Phenolics	Medicinal, smokey
Terpenoids	Citrus, piney
Ref:http://www.ndhealthfacts.org/wiki/Food_Flavourings accessed on 14.08.2016	