The Science of Food: Chemical and Sensory Aspects

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The food marketplace is a dynamic arena which is constantly reshaped by consumers, their cultural diversities, lifestyles and health concerns. Two of the key concerns when it comes to consumption and production of food is their nutritive value and their safety and hygiene. These two aspects are garnered by the chemical and sensory aspects of a food product. As a result, functional food, designer food, organic food, phytochemicals, prebiotics, probiotics, genetically modified organisms (GMOs) and biotechnology are now in the vocabulary of most knowledgeable consumers.

At the end of this presentation, you will learn about:

- chemical characteristics and properties of the components of food, as well as their structure
- sensory characteristics of food, e.g. colour, texture, taste, smell

The Chemical Composition of Food

All biological matter is made up of water, carbohydrates, proteins and lipids – this applies to food as well. From the perspective of nutrition, in brief, water provides the medium for biological reactions, carbohydrates are the primary sources of energy, proteins are structural components and lipids are a secondary source of energy as well as a structural component. These constituents are collectively known as macronutrients. Other than these components, food also supplies vitamins, minerals and other minor components for sustenance, which are collectively known as micronutrients. The focus of this study nevertheless, is the macronutrient elements of food.

Water

Water is a common constituent of food which is easily taken for granted, and therefore, ignored in most forms of food chemistry studies. However, the universality of its occurrence and its unique characteristics make water a subject worthy of close examination. The behavior of water

molecules is influenced by its polarity. The two hydrogen atoms are joined to the oxygen atom by two bonds which form an angle of almost 104.5^0. Water is also a dipole as shown in Figure 1. This nature affects the physical characteristics of water such as its boiling point, freezing point and vapour pressure.

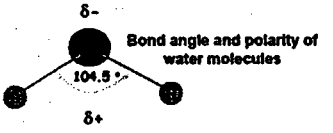
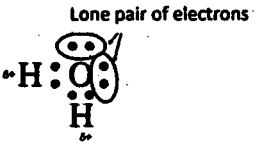


Figure 1. *The bond angle of water and the dipole structure*



Carbohydrates

Carbohydrates are generally indicated through the common formula of $C_n(H_2O)_n$. They are further divided into simple sugars (i.e. monosaccharides and disaccharides) and complex carbohydrates (polysaccharides). Examples of some well-known monosaccharides are glucose and fructose, whereas a commonly used disaccharide is sucrose. Complex carbohydrates are formed by joining many monosaccharide units with the removal of a molecule of water at each point of linkage. For instance, starch and cellulose are complex carbohydrates which are made of glucose units linked together, their structure differing only due to the type of linkage. A diagram of part of a starch molecule is shown in Figure 2.

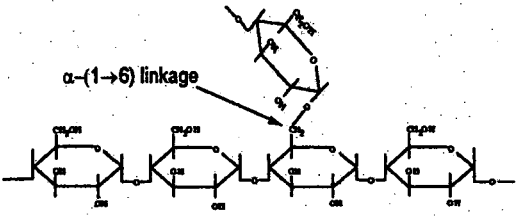


Figure 2. Part of a starch molecule depicting the glucose units and their linkages

Proteins

Proteins are very large molecules containing 100 or more amino acids linked together by peptide bonds. Amino acids are organic substances containing amino ($-NH_2$) and the carboxyl (-COOH) groups. The peptide linkage is a covalent bond formed between the nitrogen of one amino acid and the carbon of the carboxyl group of another amino acid. A molecule of water is removed in the reaction. The reaction scheme is given in Figure 3.

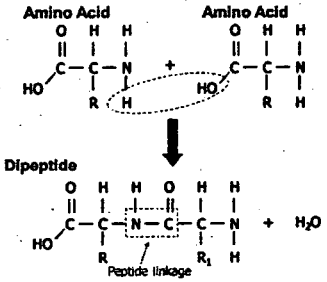


Figure 3. Formation of a dipeptide through a peptide linkage between two amino acids

Lipids

Lipids are a group of organic compounds which are insoluble in water. Lipids can exist in liquid as well as solid form. Lipids which are able to exist as liquids under room temperature are known as oils, whereas those which are able to exist as solids are known as fats. Thus, butter or margarine are technically two different types of fat. Lipids are primarily composed of triglycerides (TG), although small amounts of monoglycerides and diglycerides may also exist in nature. Triglycerides are made up of a glycerol and three fatty acid molecules as shown in Figure 4.

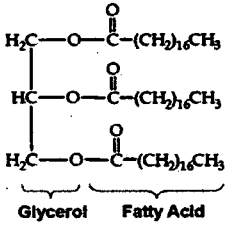


Figure 4. Basic structure of a triglyceride molecule consisting of glycerol and 3 fatty acid chains

Sensory Evaluation of Food

All consumers consciously or unconsciously evaluate food quality. Food choices in the marketplace are mostly influenced by previous experiences encountered with similar food products. Although sensory evaluations at home are probably not conducted scientifically, they nevertheless determine whether or not a particular food item would be bought again. Thus, the individual consumer's choice, combined with the decision of countless other individual consumers, dictates the quality of food to be produced. For commercial purposes, trained sensory panelists evaluated the samples and provide guidance for improvement of the product. This type of testing is termed sensory evaluation. The evaluation of food products concerns the aspects of quality control, consumer acceptance, product improvement and product matching. The sensory attributes of food revolve around the five senses: vision, hearing, taste, touch and smell. Basically, a food is never considered as acceptable, unless these five senses are satisfied.

The appearance of a food is an important sensory characteristic in determining initial consumer acceptance of products. This includes sensory attributes such as colour, shape, size, surface texture, structural uniformity and clarity. The odour / aroma / fragrance of a food is the next important aspect when it comes to acceptance of food products. This sensation is triggered when volatiles enter the nasal passage and perceived by olfactory system. The consistency and texture of a food sensory refers to the structure or inner makeup of food products and involves the sensors in the mouth. The noise emitted during the consumption of food is important as well. For instance, crispy potato chips are more acceptable than ones which have turned soggy or damp. All these sensations formulate the overall perception of food products, which are more important than the nutritive quality when it comes to consumer acceptance, since only a 'tasty' or 'delicious' food has a higher chance of being consumed, rather than a tasteless or distasteful one!

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