**Properties of Proteins**

**Colour and Taste:** Proteins are colourless and usually tasteless. These are homogeneous and crystalline.

**Colloidal Nature:** Because of their giant size, the proteins exhibit many colloidal properties, such as; their diffusion rates are extremely slow, they may produce considerable light-scattering in solution, thus resulting in visible turbidity.

**Amphoteric Nature:** Like amino acids, the proteins are amphoteric, i.e., they act as acids and alkalies both. These migrate in an electric field and the direction of migration depends upon the net charge possessed by the molecule. The net charge is influenced by the pH value. Each protein has a fixed value of isoelectric point (pl) at which it will move in an electric field. Isoelectric point is the pH value at which the number of cations is equal to that of anions. Thus, at isoelectric point, the net electric charge of a protein is always zero. But the total charge on the protein molecule (sum of positive and negative charges) at this point is always maximum. Also at the isoelectric point, proteins are found to be least soluble and can be precipitated most easily. Some proteins like casein of milk, however, are readily precipitated at or near their isoelectric point.

**Solubility:** The solubility of proteins is markedly influenced by pH. Solubility is lowest at isoelectric point and increases with increasing acidity or alkalinity. This is because when the protein molecules exist as either cations or anions, repulsive forces between ions are high, since all the molecules possess excess charges of the same sign. Thus, they will be more soluble than in the isoelectric state. Functional properties of proteins depend on solubility. Generally soluble in strongly polar solvents like water, glycerol, formic acid. Other less polar solvents like ethanol, proteins are rarely soluble. Neutral salts have a two-fold effect on protein solubility. At low concentrations they increase the solubility by suppressing the protein-protein interactions. This called *salting in* effect. Salting in can be used in food technology. For example in ham production, a little amount of salty water added to the dough. Protein solubility is decreased at higher salt concentrations due to the ion hydration tendency of the salts. This called *salting out* effect. For water solvent proteins and salts compete, salt can easily bind to the water molecule and there will be no enough water left for proteins so they are start to precipitate.

**Denaturation:** Is the change in the specific three-dimensional conformation of the proteins. Secondary, tertiary, quaternary structures affected, primary structure remains. Amino acid sequencing remain the same. Hydrogen bonds can affected and the protein unfold. But it doesn’t affect the peptide bonds. Denaturation leads mainly to the unfolding of the peptide chain, thus causing disorganization of the internal structure of protein. Some proteins, when denatured, cannot be brought back to their original state. In that case denaturation is described as of ‘irreversible’ type. In this type only primary structure remains. The cooking of egg white is an example of this kind of protein denaturation. When egg white is heated, the albumins unfold and coagulate to produce a solid rubbery mass. The albumins unfold and coagulate to produce a solid rubbery mass. On the other hand, denaturation in other proteins is of ‘reversible’ type. In this denaturation, secondary and primary structures are protected. For example, if trypsin is exposed to a temperature of 80–90°C, it denatures and when this solution is cooled at 37°C, the solubility and the activity of this protein-enzyme is regained. The process of regaining normal protein properties by a denatured protein is called ‘renaturation’. The proteins, on denaturation, undergo following changes; decrease in their solubility, loss of their biochemical activity, decrease in size and shape of the molecule, increased activity of some radicals present in the molecule. Denaturation can occur in two ways, reversible or irreversible. Denaturation may be brought about by a variety of agents, both physical and chemical. The physical agents include mechanical action (like shaking), heat treatment cooling and freezing operations, rubbing, high hydrostatic pressures, and radiation. The chemical agents, that cause denaturation, are organic solvents (acetone, alcohol), pH changes (acid and alkaline), metals, ionic changes (salt). Denaturation in food industry sometimes is a wanted process for example, scrambling the egg, inactivating enzymes in order to extend shelf-life. But in some cases, denaturation has unwanted effects on food. Like denaturation of lactalbumines and lactoglobulines in milk.

**Coagulation:** In many instances the process of denaturation is followed by coagulation— a process where denatured protein molecules tend to form large aggregates and to precipitate from solution.

**Hydrolysis:** Protein hydrolysis, the cleavage of peptide bonds, can be carried out by enzymatic or chemical processes. During the hydrolysis peptide bond hydrolyzed and free amino acids are produced. It is important also for digestion of proteins. It can be happen in two ways, chemically and enzymatically. Proteins, upon hydrolysis with concantrated HCl (6–12N) and with 2N NaOH. Undesirable side-effects of acid hydrolysis is some amino acids undergo intermolecular dehydration forming cyclic anhydrides or diketopiperazines. Alkalines also disadvantges, It leads to the destruction of certain amino acids like arginine, cysteine, cystine, serine, threonine etc. It also causes loss of optical activity (or racemization) of the amino acids. Under relatively mild conditions of temperature and acidity, certain proteolytic enzymes hydrolyze the proteins. For example ficin and papain can used in meat technology, softening the meat. This enzymes hydrolyze the muscle and connective tissue proteins and make the meat softer. Chymosin we are using it in cheese technology. Enzymes are acting so specifically. They are affecting only the certain parts of the molecule, if their amount and the other conditions are suitable. Only disadvantage is it requires prolonged incubation. Autolysis, caused by catephsin enzyme is an example for enzymatic hydrolysis. Also, bacterial enzymes can cause hydrolysis. Hydrolysis, affects the nutritional and functional properties of foods by; improving digestibility and antioxidant capacity, modifying quality, reducing allergenic compounds.

**Maillard Reaction:** The Maillard reaction was first reported in 1912 by Louis-Camille Maillard, who described that upon gently heating sugars and amino acids in water, a yellow-brown color developed. The chemistry underlying the Maillard reaction is very complex. It encompasses not one reaction pathway but a whole network of various reactions. The Maillard reaction occurs between reducing sugars and principally free amino acids and peptides (usually from proteins) when heated. It is a form of non-enzymatic browning. The carbonyl group of the sugar reacts with the amino group of the amino acid, producing N-substituted glycosylamine and water. The unstable glycosylamine undergoes Amadori rearrangement, forming ketosamines. Ketosamines can react several ways further; produce 2 water and reductones or diacetyl, aspirin, pyruvaldehyde and other short-chain hydrolytic fission products can be formed or produce brown nitrogenous polymers and melanoidins. Nevertheless the Maillard reaction is notoriously difficult to control. Various factors involved in food processing influence it and they can be considered as food processing variables. It has been a central and major challenge in food industry, since the Maillard reaction is related to aroma, taste and color, in particularly in traditional processes such as the roasting of coffee and cocoa beans, the baking of bread and cakes, the toasting of cereals and the cooking of meat. The consumption of Maillard Reaction Products (MRPs) has increased in recent decades and there are evidences that these substances are absorbed and may participate in pathological processes such as, cataract, diabetes, degenerative diseases, atherosclerosis and chronic renal failure.

**Amino Acids**

Twenty important amino acids are crucial for life as they known to be the building blocks of peptides and proteins. Each of them has its specific characteristics defined by the side chain, which provides it with its unique role in a protein structure.

Amino acids can be classified in different ways. Based on the propensity of the side chain to be in contact with polar solvent like water, it may be classified as hydrophobic (low propensity to be in contact with water), polar or charged (energetically favorable contact with water). One of the most common ways to classify amino acids is based on human health requirements. Some amino acids can be synthesized by the body. These are classified as non-essential amino acids. There are eleven non-essential amino acids, Asparagine, Alanine, Arginine, Aspartic acid, Cysteine, Glutamic acid, Glutamine, Proline, Glycine, Tyrosine, and Serine. Conversely, essential amino acids must be acquired from food sources. A balanced diet usually ensures that the body acquires enough essential amino acids. Leucine, Isoleucine, Lysine, Threonine, Methionine, Phenylalanine, Valine, Tryptophan. Arginine and Histidine are essential for kids. In some special conditions, some of the non-essential amino acids can become essential. For example, cysteine synthesized from methionine, if the body cannot take enough methionine, cysteine deficiency can occur. In a congenital disease, phenylketonuria, tyrosine should be taken from outside. Under high exercise, diseases or stress conditions, glutamine need of the body increase, so it should be supported with foods.