Food Chemistry I

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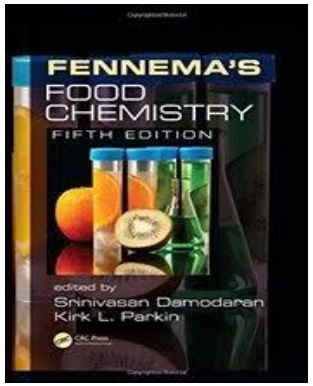
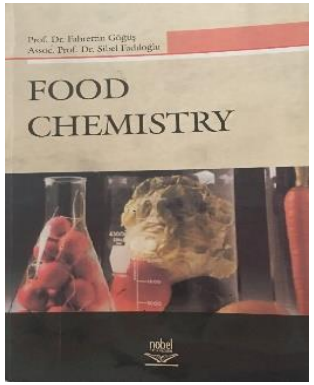
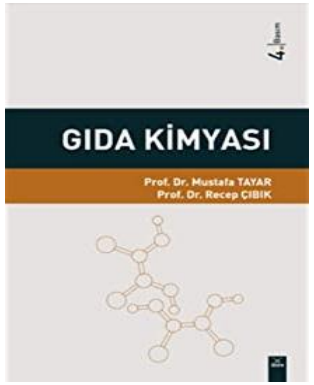
1. 

2. 

3. 

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PROTEIN STRUCTURE

Four levels of protein structure exist:

* *primary*
* *secondary*
* *tertiary*
* *quaternary*

CLASSIFICATION OF PROTEINS

By Amino Acid Composition and Quantity

Complete Protein

Partially Incomplete Protein

Incomplete Protein Incomplete Protein

By Solubility

Albumin, Globulin, Histone, Protamine

Prolamin, Gluten, Albuminoid,

By Chemical Composition

Nucleoprotein, Lipoprotein, Glycoprotein

And Mucoprotein, Phosphoprotein,

Metalloprotein, Flavoprotein

Classification by Amino Acid Composition and Quantity

According to the composition of amino acids and their contents in proteins, proteins are divided into complete, partially complete, and incomplete proteins.

Complete Protein

A complete protein (or whole protein) contains an adequate proportion of all nine of the essential amino acids necessary for the dietary needs of humans or other animals.

Partially Incomplete Protein

A partially incomplete protein contains all the amino acid species, but their proportions are insufficient for human demand. Partially incomplete proteins can maintain life, but cannot enhance growth and development.

Incomplete Protein

Incomplete proteins lack one or more essential amino acids in correct proportions as necessary for good nutrition and health.

Classification by Solubility

Based on solubility, proteins are divided into seven categories.

Albumin

Albumin refers to any protein that is soluble in water and moderately soluble in concentrated salt concentrations.

Globulin

Globulins are insoluble in water but soluble in diluted salt, acid, or alkaline solutions and can be precipitated by half-saturated ammonium sulphate.

Histone

Histones are highly alkaline proteins and are soluble in water or diluted acid solutions.

Protamine

Protamines are small, arginine-rich proteins and are soluble in water and diluted acid solutions.

Prolamin

Prolamins are a group of plant storage proteins with high proline contents and found in the seeds of cereal grains.

Gluten

Glutens are contained in plant seeds, such as barley and rye. Proteins of this category are insoluble in water or diluted salt solutions but soluble in diluted acid and alkaline solutions.

Albuminoid

Proteins of this category are not soluble in water or salt, diluted acid and diluted alkaline solutions and occur mainly in skins, hairs, and nails.

Classification by Chemical Composition

Nucleoprotein

A nucleoprotein is any protein which is structurally associated with nucleic acid.

Lipoprotein

A lipoprotein is a complex molecule consisting of both protein and lipid.

Glycoprotein and Mucoprotein

In g lycoproteins, proteins are covalently attached to oligosaccharides and the glycanscan be galactose, mannose, hexosamine, hexuronic acid, or many other sugars.

Phosphoprotein

In phosphoproteins, phosphoric acid is connected to the Ser or Thr resides of proteins through ester bonds.

Metalloprotein

Metalloproteins refer to any proteins that contain metal ion cofactors. Many important enzymes, transport proteins and storage proteins are metalloproteins.

Flavoprotein

Flavoproteins are proteins that contain a nucleic acid derivate of riboflavin.

PROTEIN DENATURATION

Definition of Denaturation

When a protein is exposed to such physical stresses as heating and ultraviolet irradiation or such chemical stresses as strong acid and base, its properties are changed, such as decrease of solubility and loss of activity, but the primary structure remains unaltered. This process is termed denaturation. Denaturation is an extremely important property of proteins and markedly affects food processing.

Mechanism of Denaturation

Denaturation is the transfer of natural proteins molecules from ordered and compact states to disordered and loose states because of environmental stresses. The compact structure of natural proteins is maintained by various secondary bonds. These secondary bonds are easily interrupted by physical and chemical factors, which induce the destruction or alternation of protein conformation. Hence, protein denaturation is actually caused by the changes of secondary, tertiary, and quaternary structures of proteins. The destruction of spatial conformation of proteins leads to reduced solubility, aggregation, irreversible gelation, increased sensitivity to protease hydrolysis, and loss of physiological activities.

After the denaturation factor is removed, the protein can restore to its natural conformation. Hence, this denaturation process is reversible.

However, the denaturation of most proteins is irreversible.

For example, egg protein is gelated when cooking and this process is irreversible; soybean protein is irreversibly denatured in tofu production.

The reversibility of protein denaturation is related to the denaturation agent species, protein property and the degree of protein conformation destruction. Generally, in reversible denaturation, the tertiary and quaternary structures of proteins are destroyed, but secondary structures remain intact.

Properties of Denatured Protein

The physical, chemical and biological properties of proteins undergo obvious changes after denaturation.

(1) Hydrophobic groups originally located inside molecules get exposed on molecule surface and the hydration layer is destroyed. Hence, the solubility of denatured proteins decreases significantly.

(2) Denatured proteins cannot crystallize as original ones.

(3) The spatial structure of denatured proteins is in random shape. The friction between molecules increases and the fluidity decreases. Hence, denatured proteins have reduced diffusion coefficient and their solutions have lower fluidity.

(4) The optical activity of denatured protein changes and the isoelectric point increases slightly.

(5) Denatured proteins are more susceptible to enzymatic hydrolysis. For example, natural haemoglobin cannot be hydrolyzed by trypsin, but denatured haemoglobin can be hydrolyzed easily. This is why cooked foods are digested and absorbed more easily.

(6) Denatured proteins have more exposed side chains, such as –SH and –OH. Hence, the degree of protein denaturation can be estimated by the reaction between these groups and specific reagents.

(7) The bioactivities of denatured proteins are completely or partially destroyed. For example, denatured enzymes lose their catalytic activities; denatured hemoglobin can no longer transport oxygen; and denatured antigens lose their immunological competences.

Denaturation Agents

Heat

Radiation

Radiation

Denaturation at Interfaces

pH

Heavy Metals

Heavy Metals

Chemical Reagents

Effects of Combined High-Pressure and Thermal Treatment on Beef Protein Denaturation

Thermal treatment in combination with high pressure improves the tenderness of beef and enhances the sterilization effect. Besides, the combined treatment changes the composition of beef muscles and affects its functional properties, such as color, texture, fat oxidation and flavor, which are related to protein denaturation.

Effects of Freezing on Aquatic Protein Denaturation

Frozen fish alter in characters during storage at sub-zero temperatures, becoming progressively tougher to eat, and extruding much fluid or drip on thawing. The deteriorative changes in texture as a consequence of long-term storage are considered to be due to protein denaturation during frozen storage and the change proceeds more slowly in low temperature.

Most of these observed changes have been attributed to the changes of proteins in low temperatures.