

# **FDE 303**

# **FOOD CHEMISTRY**

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# Course Catalogue Contents

- ✓ Chemical composition of foods
- ✓ Significance of water and water activity and its effects on quality on foods
- ✓ Chemical structure, reactions and other properties of
  - ✓ Carbohydrates
  - ✓ Proteins
  - ✓ Lipids
- ✓ Chemical degradation reactions of foods

# Learning Objectives

- ✓ To inform students about major food components
- ✓ To empower students for designing food processes
- ✓ To evaluate changes in foods during production and storage

# Course Outline

- ✓ WEEK 1- General composition of foods
- ✓ WEEK 2- Properties of food and sorption isotherms
- ✓ WEEK 3- Water activity and quality changes in foods
- ✓ WEEK 4- Proteins (chemical composition and properties of amino acids and polipeptides)
- ✓ WEEK 5- Proteins (proteids and proteins in foods)
- ✓ WEEK 6- Proteins (chemical composition, properties and major samples of amino acids)
- ✓ WEEK 7- Carbohydrates (chemical composition, properties and reactions of monosaccharides)

# Course Outline

- ✓ WEEK 8- Carbohydrates (chemical composition, properties and reactions of oligosaccharides)
- ✓ WEEK 9- Carbohydrates (chemical composition, properties and reactions of polysaccharides)
- ✓ WEEK 10- Lipids (chemical composition, properties and reactions of fatty acids)
- ✓ WEEK 11- Lipids (chemical composition, properties and reactions of acyl lipids)
- ✓ WEEK 12- Lipids (other lipid groups, properties and samples)
- ✓ WEEK 13- Chemical degradation of foods (Enzymatic browning)
- ✓ WEEK 14- Chemical degradation of foods (Non-enzymatic browning)

# Reference Books

- ✓ Food Chemistry (Ed. O.R. Fennema).
- ✓ Fennema's Food Chemistry (Ed. S. Damodaran, K. Parkin, O.R. Fennema).
- ✓ Food Chemistry (Ed. H.-D. Belitz, W. Grosch, P. Schieberle, M.M. Burghagen).
- ✓ A Handbook of Food Chemistry (Ed. P. Chi Keung Cheung, B.M. Mehta), Springer.
- ✓ Advances in Food Biochemistry (Ed. F. Yıldız). Taylor and Francis .
- ✓ Food Biochemistry and Food Processing (Ed. W.K. Nip, L.M.L. Nollet, Y.H. Hui) Wiley-Blackwell.

# Food

- ✓ Any substance than when ingested, usually will supply to the body;
- ✓ Materials from which body can produce movement, heat or other forms of energy
- ✓ Materials for the growth, repair or regeneration and reproduction
- ✓ Substances necessary to regulate the processes of growth and repair

# Food Chemistry

- ✓ The study of the chemistry of foods, their deterioration, and the principles underlying the improvement of foods for the consuming public
- ✓ It is the application of chemistry to the development, processing, packaging, preservation, storage and distribution of foods and beverages
- ✓ “Food chemistry involves the application of biochemistry, organic chemistry, physical chemistry, and analytical chemistry to improve our understanding and manipulation of foods and their components
- ✓ **Objective:** to improve the overall quality, healthfulness, safety, cost, and diversity of the food supply

# Chemical Aspects of Food Components and Additives in Quality and Safety

- ✓ The aim of food scientists and technologists is;
  - to produce foods and food products that are fresh, natural, nutritious, safe, attractive, tasty, wholesome, convenient, readily available at all seasons, and affordable to the general public
- ✓ Food chemistry has stood up to this great challenge

# Chemical Aspects of Food Components and Additives in Quality and Safety

- Water
- Carbohydrates
- Lipids
- Proteins
- Minerals
- Vitamins
- Enzymes
- Food Additives

# Water

- Major component of many foods
- Strong covalent bonds
  - holding the two hydrogen atoms and one oxygen atom together
- Polar bonds- between oxygen and each hydrogen atom
- The nature of hydrogen bonds allows water to bond with other water molecules and also with proteins and carbohydrates such as pectin, sugar, and starch
- Important solvent or dispersing medium
  - dissolving small molecules to form true solutions and dispersing larger molecules to form colloidal solutions depending on their particle size and solubility

# Water

- An intracellular or extracellular component in vegetable and animal products
  - acting as a dispersing medium or solvent in a variety of products, as the dispersed phase in some emulsified products such as butter, and as a minor constituent in other foods
- Water content of some food and food products:

Meats: 50–82%  
Fruits: 80–95%  
Vegetables: 70–95%  
Beer: 90%  
Milk: 84–86%

Bread: 30–35%  
Butter: 16%  
Milk powder: 4–5%  
Anhydrous milk fat: 0.5%

- Water in the proper amount, location, and orientation affects;
  - ✓ the structure, appearance, and taste of foods
  - ✓ susceptibility to spoilage

# Carbohydrates

- The most abundant food component and the most important energy source (4 kcal/g)
- Definition: polyhydroxy aldehydes or ketones and their derivatives.
- Important food carbohydrates: simple sugars, dextrans, starches, and nonstarch polysaccharides including celluloses, hemicelluloses, pectins, and gums.
- Important constituents because of their nutritive values and their functional properties.
- Carbohydrates, especially polysaccharides, can be used as sweeteners, thickeners, stabilizers, gelling agents, and fat replacers

# Lipids

- Esters formed by fatty acids and glycerol
  - commonly known as triglycerides or triacylglycerides
- Sparingly soluble in water but soluble in organic solvents such as ether, chloroform, acetone, and benzene
- Up to 99 % of the lipids in plant and animal materials are consisted of triglycerides known as fats and oils
- At room temperature, fats are solid while oils are liquid
- The fatty acids in triglycerides can be saturated and unsaturated, depending on the number of carbon-carbon double bonds in the hydrocarbon chain

# Lipids

- A principal dietary component of energy source and reserve which provides (9 kcal/g) energy
- The fatty acid profile of individual fats and oils is unique
  - the measure of various parameters related to fatty acid composition such as melting point, saponification number, iodine value, and refractive index is often used to check adulteration of lipids in the food products
- Food lipids are subjected to a number of chemical reactions that would affect their quality and applications
  - Interesterification
  - Oxidation
  - Lipolysis

# Proteins

- Polymers of different amino acids joined together by peptide bonds
- Proteins have different chemical properties due to the various side chains that are linked to different amino acids.
- four types of structures stabilized by peptide bonds, hydrogen bonds, disulfide bonds, hydrophobic interactions, ionic interactions, and van der Waals interactions:
  - primary, secondary, tertiary, and quaternary structure.
- Knowledge of protein conformation and stability is essential to understanding the effects of processing on food proteins.
- Several factors, such as content of essential amino acids and digestibility, contribute to the differences in the nutritive values of proteins.

# Proteins

- Food proteins of animal origin are more completely digested than those of plant origin.
- Proteins have many useful functional properties in foods such as hydration, emulsification, gelling, and foaming.
  - They can be used as thickeners, binding and gelling agents, as well as emulsifiers or foaming agents.
- Proteins generally have a great influence on the sensory attributes such as texture, flavor, color, and appearance of foods.
- Proteins are vulnerable to many chemical reactions that would affect their nutritional and functional properties.

# Minerals

- Major minerals: calcium, phosphorus, magnesium, sodium, potassium, and chloride.
- Trace elements: iron, iodine, zinc, selenium, chromium, copper, fluorine, lead, and tin.
- Minerals play important roles in both living organisms and foods
- The most important factor causing mineral loss in foods is milling of cereals and rice
- Fortification is generally carried out in certain foods to compensate for the loss of iron

# Minerals

- Minerals interact with other food components which affect the physical and chemical properties of foods
  - For example, iron and copper are considered as prooxidants and are responsible for various oxidative deteriorations in high-fat food products.
- Iron serves as a color modifier in meat and has the ability to form blue, black, or green complexes with polyphenol compounds.
- For applications in the food industry;
  - nickel is used in the hydrogenation of vegetable oil
  - copper can be used to produce heat-stable color pigment by replacing magnesium in chlorophyll.

# Vitamins

- Minor constituents in foods, but, they play an essential role in human nutrition
- Some vitamins function as part of a coenzyme whereas others occur in foods as provitamins.
- Chemically, many vitamins are unstable during thermal processing and storage

# Enzymes

- Enzymes are proteins with catalytic properties
- Although enzymes are only minor constituents of many foods, they play a major role in foods
- Enzymes that are naturally present in foods can cause both desirable and undesirable changes in food composition