Food Chemistry: Components and Preservation

Food science: a science that deals with the physical, chemical, and biological properties of foods as they relate to stability, cost, quality, processing, safety, nutritive value, wholesomeness, and convenience.

Food science is an interdisciplinary subject involving primarily bacteriology, chemistry, biology, and engineering.

Food chemistry, a major aspect of food science, deals with the composition and properties of food and the chemical changes it undergoes during handling, processing, and storage. Food chemistry is intimately related to chemistry, biochemistry, physiological chemistry, botany, zoology, and molecular biology. The food chemist relies heavily on knowledge of the aforementioned sciences to effectively study and control biological substances as sources of human food.

Approach to the Study of Food Chemistry

It is desirable to establish an analytical approach to the chemistry of food facts derived from the study formulation, processing, and storage stability, so that of one food or model system can enhance our understanding of other products. components to this approach: There are four

(a) determining those properties that are important characteristics of safe, high-quality foods,

(b) determining those chemical and biochemical reactions that have important foods, influences on loss of quality and/or wholesomeness of

(c) integrating the first two points so that one understands how the key chemical quality and safety, and and biochemical reactions influence

(d) applying this understanding to various situations encountered during formulation, processing, and storage of food.

Major Chemical Components of Food

1- Water

Role: Acts as a solvent, influences texture, stability, and microbial growth.

Key Concepts:

Water activity (aw) is more important than moisture content for predicting shelf life.

Lowering (aw) reduces enzymatic and microbial activity.

Relevance: Drying, salting, and adding sugars reduce water activity for preservation.

2- Carbohydrates

- **Types:** Monosaccharides, disaccharides, oligosaccharides, polysaccharides (starch, cellulose, pectins).
- **Functions in food systems:**
  - Provide sweetness, energy, and bulk.
  - Contribute to texture through gelling and thickening (e.g., pectin in jams).
  - Participate in **Maillard browning** and **caramelization**, affecting color and flavor.
- **Stability Issues:** Susceptible to enzymatic hydrolysis and non-enzymatic browning.

3- Proteins

- **Sources:** Meat, dairy, legumes, cereals.

- **Functional properties:**
  - Gelation, foaming, water binding, emulsification.
  - Responsible for texture in products such as yogurt, cheese, and baked goods.
- **Reactions affecting quality:**
  - Denaturation during heating.
  - Enzymatic breakdown.
  - Interaction with sugars in Maillard reactions.

4-Lipids (Fats and Oils)

- **Role:** Provide flavor, mouthfeel, essential fatty acids, and energy.
- **Types:** Saturated, unsaturated, phospholipids, sterols.
- **Main deterioration pathway:**
  - **Lipid oxidation** → rancidity, off-flavors, loss of nutrients, formation of toxic compounds.
- **Factors influencing oxidation:**
  - Light, heat, oxygen, metals, degree of unsaturation.

5- Vitamins and Minerals

- **Importance**: Essential nutrients; contribute to metabolic functions, immunity, and structure.
- **Stability considerations:**
  - Vitamins (especially A, C, E, B1) are sensitive to heat, light, and oxidation.
  - Minerals are generally stable but may interact with other components (e.g., iron catalyzing oxidation).

6- Food Additives

- **Examples:** Preservatives, antioxidants, colorants, emulsifiers, stabilizers.
- **Purpose:** Improve safety, extend shelf life, enhance sensory properties.
- **Common preservatives:**
  - Sorbates, benzoates, nitrites, sulfites.

Chemical and Biochemical Reactions Affecting Food Quality

1- Maillard Reaction

- Reaction between reducing sugars and amino acids.
- Produces brown pigments, desirable flavors (bread crust), but may form harmful compounds (e.g., acrylamide).

2- Enzymatic Reactions

- Enzymes naturally present in food can cause undesirable changes.
- Examples:
- Polyphenol oxidase → browning in fruits.
- Lipases → lipid breakdown.
- Control: blanching, pH adjustment, inhibitors.

3-Lipid Oxidation

- Autoxidation leading to rancidity.
- Prevention: antioxidants (vitamin E, BHA, BHT), oxygen-barrier packaging, refrigeration.

4- Microbial Spoilage

- Caused by bacteria, yeasts, and molds.
- Leads to off-odors, texture changes, toxin formation.
- Control: temperature control, preservatives, reducing water activity.

Principles of Food Preservation

Food preservation aims to **slow chemical, enzymatic, and microbial reactions** that cause food spoilage.

1- Physical Preservation Methods

a. Heat Processing

- Pasteurization: mild heat to inactivate pathogens.
- Sterilization: high heat to destroy all microbes and spores.

b. Low Temperature

- Refrigeration slows enzymatic and microbial activity.
- Freezing stops most microbial growth but may alter texture.

c. Drying and Dehydration

- Lowering water activity inhibits microbial growth.
- Methods: sun-drying, spray drying, freeze-drying.

d. Irradiation

- Uses ionizing radiation to kill microbes and extend shelf life.

2-Chemical Preservation Methods

a. Preservatives

- Sorbates and benzoates inhibit yeasts and molds.
- Nitrites preserve cured meats and prevent *Clostridium botulinum*.
- Sulfites prevent browning in dried fruits.

b. Antioxidants

- Slow lipid oxidation.
- Natural antioxidants include tocopherols, rosemary extract.

3- Biological Preservation

- Fermentation by lactic acid bacteria (yogurt, pickles).
- Produces acids and antimicrobial compounds that inhibit spoilage organisms.