Chapter II : General characteristics of foods

Water

1. Water Activity: Water activity (aw) measures the availability of water in food, which is crucial for its stability. It's defined by the ratio of partial vapor pressure of water in a solution to that of pure water. Pure water has an aw of 1, and food typically has an aw less than 1. Water activity is more important than total water content for food stability.

2. Importance in Food Technology: Isotherms help predict water activity in food packaging and how food behaves during processing or storage in different humidity conditions. For instance, they can predict the water content of unprotected products in varying humidity levels, calculate water absorption over time for shelf life estimation, and assess how temperature changes affect water activity in sealed packaging with constant water content.

3. Chemical and bacteriological caracteristics of drnking water

Drinking water has several essential physical, chemical, microbiological, and organoleptic characteristics: it should be odorless, fresh, and tasteless. Regarding physical characteristics, limits are set for turbidity, clogging power, and coloration.

It should be free from parasitic or **pathogenic organisms** and should not contain:

- *E. coli* in 100ml;
- Fecal *Streptococci* in 50ml;
- Sulfate-reducing *Clostridia* in 20 ml.

For chemical characteristics:

- Total mineralization: 2000mg/l;
- Lead: 0.1g/l;
- Selenium: 0.05 mg/l;
- Fluoride: 1.0 mg/l;
- Arsenic: 0.05 mg/l;
- Hexavalent chromium: below the analytical detection limit;

- Cyanide: below the analytical detection limit;
- Copper (Cu): 1.0 mg/l;
- Iron (Fe): 0.3 mg/l;
- Manganese: 0.1 mg/l;
- Zinc (Zn): 5.0 mg/l;
- Phenolic compounds (as phenol): 0 mg.

Fats and oils

Nutritional Role:

- Fats and oils are the most concentrated form of energy, providing approximately 9 calories per gram, making them vital for energy production and storage.
- Fat-soluble vitamins such as A, E, K, and D are crucial for various bodily functions, including vision, immune function, blood clotting, and bone health. These vitamins require fats for absorption and transportation within the body.

Organoleptic Role:

- Fats contribute to the texture of foods by imparting creaminess, smoothness, and richness. For example, fats in ice cream provide a smooth mouthfeel.
- They also enhance flavor by carrying and releasing fat-soluble flavor compounds, contributing to the overall taste profile of foods.

Chemical Structure:

- The presence of an even number of carbon atoms in fatty acids is a consequence of their biosynthesis in biological systems.
- Cis double bonds create kinks in the fatty acid chain, affecting the packing of molecules and influencing properties such as fluidity and melting point.

Physicochemical Properties:

- Emulsions, such as mayonnaise and salad dressings, are stabilized by the amphiphilic nature of fats and oils, allowing them to form stable mixtures with water.
- The variation in melting points among fats and oils affects their texture and suitability for different culinary applications. For example, butter has a lower melting point than coconut oil, resulting in different textures in baked goods.

Main Characteristics of Food Fats and Oils:

- Vegetable oils, such as olive oil and soybean oil, are commonly used for frying due to their high smoke points and neutral flavors.
- Animal fats, like lard and tallow, are prized for their ability to impart unique flavors and textures to dishes, such as flakiness in pastry crusts.

Lipid Oxidation:

- Lipid oxidation can lead to off-flavors, rancidity, and nutritional deterioration of food products.
- Pro-oxidants, such as metals and enzymes, catalyze oxidation reactions, while antioxidants help delay or prevent oxidation by scavenging free radicals.

Prevention of Oxidation:

- Antioxidants like BHA, BHT, and tocopherols inhibit oxidation by donating electrons to free radicals, thus stabilizing them.
- Metal-chelating agents, such as EDTA, bind metal ions that catalyze oxidation reactions, reducing their pro-oxidant effects.
- Packaging materials with low oxygen permeability and exposure to inert gases can minimize oxygen exposure, slowing down lipid oxidation in food products.

Milk and Dairy Products

Composition and Nutritional Value:

- Milk contains water, proteins, lactose, fat, and minerals.
- The composition varies among species and can be affected by factors like diet and lactation period.
- It also contains enzymes, antibodies, hormones, and microorganisms.
- Milk has a complex physical structure with different phases.

Properties:

- Milk is white, with a faint odor and a slightly sweet taste.
- Its density, boiling, and freezing points vary within specific ranges.
- Milk is an unstable liquid due to its complex nature.

Lactose:

- The main carbohydrate in milk is lactose, which undergoes fermentation by lactic acid bacteria.
- Lactose plays a nutritional role but can cause problems like lactose intolerance.

Milk Lipids:

- Milk contains triglycerides, phospholipids, sterols, and carotenoids.
- The fatty acid composition varies between species.
- Lipids are dispersed in milk as spherical globules surrounded by membranes.

Physical and Chemical State:

- Lipids are dispersed in milk as globules, surrounded by membranes.
- Membranes protect against enzymatic breakdown and maintain dispersion in the aqueous phase.

Proteins:

- Milk proteins include caseins and whey proteins.
- Caseins constitute about 80% of milk proteins and form micelles.
- Whey proteins are of low molecular weight and have high nutritional value.

Biochemical Coagulation of Milk:

- Milk coagulation can occur through acidification or enzymatic action.
- Acidification reduces the pH, causing casein micelles to aggregate and form a gel.
- Enzymatic coagulation involves the action of proteolytic enzymes like rennet.

Effects of Heat Treatment:

- Non-enzymatic browning, or Maillard reaction, can occur during heat treatment.
- Factors like temperature, pH, and water activity influence browning reactions.
- Prevention methods include substrate elimination, pH adjustment, and the addition of inhibitory agents.

Meat – Fish-Eggs

Meat

The muscle protein system is composed of fibers, surrounding connective tissues containing blood vessels and nerves, lipid tissues, and myoglobin. The main protein constituents are distributed as follows: sarcoplasmic proteins (glycolytic enzyme, myoglobin), myofibrillar proteins (myosin and actin), and connective tissue proteins (collagen and elastin).

After death, cadaveric rigidity sets in due to ATP depletion, causing irreversible binding of actin and myosin. Acidification of muscle tissue occurs, inhibiting sarcoplasmic ATPases and leading to calcium leakage into the sarcoplasmic reticulum. Factors influencing rigidity severity

include the animal's nutritional state, glycogen reserves, ATP content, and temperature. Maturation of meat involves a decrease in hardness, improvement in texture after cooking, and increased water retention capacity. This process is influenced by ionic modifications or enzymatic actions, such as those of cathepsins from weakened lysosomes. External interventions like pH adjustments and enzyme treatments can guide maturation. Additionally, meat maturation is accompanied by reactions like lipid oxidation and the formation of various compounds.

Fish

Fish undergo various alterations post-capture due to the actions of enzymes and bacteria, favored by factors like pH and substrate abundance. This results in the development of malodorous compounds and softening of tissue. Refrigeration slows but doesn't halt these changes, as some enzymes and bacteria remain active even at low temperatures. For optimal preservation, immediate bleeding and evisceration followed by cooling in seawater is recommended. Freezing timing is crucial; freezing before rigor mortis for whole fish and after for fillets yields better texture. Pre-soaking in polyphosphate solution reduces liquid loss upon thawing. Extended storage at improper temperatures leads to protein denaturation, flesh hardening for lean fish, and lipid oxidation for fatty fish. Protection methods include glazing and vacuum packaging. A brine solution is used for freezing.

Egg

The egg consists of the yolk, white, shell membranes, and shell. It contains mostly water, minerals, and organic substances like protein and lipid. The functional properties include coagulating power, anti-crystallizing, foaming power of the white, and emulsifying power of the yolk. Nutritionally, eggs are a good source of protein, iron, and vitamins but lack carbohydrates, calcium, and vitamin C. The proteins in eggs are complete, containing all essential amino acids in balanced proportions. They are used as a reference for assessing protein content in other foods.

Fruits and vegetables

- Fruits and vegetables are rich in calcium, vitamin C, carotene, and B vitamins, low in calories, and high in fiber.
- The distinction between fruits and vegetables is primarily culinary, with fleshy fruits typically being high in sugar, acidity, and aroma, and often consumed raw.
- Vegetables include a variety of types such as fruits (cucumber, tomato), seeds (peas, beans), roots (carrot, beetroot), stems (asparagus), leaves (spinach, lettuce), and flowers (cauliflower, artichoke).
- They are high in water content, with fruits containing more organic acids and fewer starches, proteins, and minerals compared to vegetables.
- The characteristics of fruits and vegetables depend on factors like species, growing conditions, maturity, storage, and processing.
- Flavor and aroma are influenced by sugar and acid content, presence of tannins, and volatile compounds.
- Color is determined by pigments located in various parts of plant cells, belonging mainly to three classes: chlorophyll (green), carotenoid (yellow and orange), and anthocyanin (red or blue).
- The texture of fruits and vegetables is influenced by factors like cellulose, hemicelluloses, lignin, and water content, which affect rigidity and succulence.
- Cellulose, a structural polysaccharide, contributes to texture and bulk but is not digestible by humans.
- Pectin, found in cell walls, can form gels and is released under acidic conditions, contributing to texture and stability in food products.
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Chemical modification during ripening :

During ripening, fruits undergo biochemical changes that enhance their appeal for consumption. Some fruits exhibit a climacteric peak, marked by increased respiratory activity, while others progress steadily. Ethylene plays a crucial role in ripening for climacteric fruits. Chemical modifications during ripening include sugar increase, acidity decrease, softening due to pectin modification, pigment changes, and volatile compound synthesis. Enzymatic browning, a process converting phenolic compounds into brown polymers, affects certain fruits and vegetables. Prevention methods include selecting low-phenolic varieties, avoiding tissue damage, enzyme inactivation, and altering environmental conditions.

Here are the essential points from General Characteristics of Foods :

Water:

- ✓ Water activity (aw) measures water availability in food, crucial for stability.
- ✓ Isotherms help predict water activity in packaging and food behavior during processing/storage.
- ✓ Drinking water should meet physical, chemical, and bacteriological standards.

Fats and Oils:

- ✓ Essential for energy, fat-soluble vitamins, and contribute to texture/flavor.
- ✓ Chemical structure affects properties like fluidity and melting point.
- ✓ Emulsions stabilize fats and oils in water.
- ✓ Lipid oxidation leads to off-flavors, rancidity, and nutritional loss.
- ✓ Antioxidants and packaging materials help prevent oxidation.

Milk and Dairy Products:

- ✓ Milk composition includes water, proteins, lactose, fat, and minerals.
- ✓ Properties include density, boiling/freezing points, and complex physical structure.
- ✓ Coagulation can occur through acidification or enzymatic action.
- ✓ Heat treatment affects browning and preservation.

Meat, Fish, and Eggs:

- ✓ Meat structure includes muscle fibers, connective tissues, and lipids.
- ✓ Post-capture changes in fish require optimal preservation methods.
- ✓ Eggs contain water, minerals, protein, and lipids, with functional and nutritional properties.

Fruits and Vegetables:

- ✓ Rich in nutrients, low in calories, and high in fiber.
- ✓ Distinctions between fruits and vegetables are primarily culinary.

- ✓ Characteristics depend on species, growing conditions, and processing.
- ✓ Ripening involves biochemical changes like sugar increase and softening.