UNIT 3

UNIT OPERATION IN FOOD PROCESSING

Sedimentation

Sedimentation is the process by which particles in suspension settle out of the fluid in which they are entrained and come to rest against a barrier. This process relies on the gravitational force.

Applications in the Food Industry:

- **Juice Clarification:** In juice production, sedimentation is used to remove suspended solids from freshly extracted juice.
- **Brewing:** Sedimentation helps in separating yeast and other solids from the beer during brewing.
- **Dairy:** In milk processing, sedimentation is used to separate cream from milk based on density differences.

Centrifugation

Centrifugation is a process that uses centrifugal force to separate components of different densities within a mixture.

Applications in the Food Industry:

- **Cream Separation:** In the dairy industry, centrifugation is used to separate cream from milk.
- **Juice and Beverage Clarification:** Centrifuges are used to clarify juices and beverages by removing pulp and other suspended particles.
- **Oil Extraction:** In the production of vegetable oils, centrifugation helps in separating oil from water and other solid impurities.

Filtration

Filtration is a mechanical or physical operation used to separate solids from liquids or gases using a filter medium that allows the fluid to pass through but not the solid.

Applications in the Food Industry:

- **Water Purification:** Filtration is crucial in purifying water used in food processing.
- **Juice and Wine Production:** Filters remove pulp, yeast, and other suspended solids to produce clear juices and wines.
- **Cooking Oil:** Filtration is used to remove impurities and particulate matter from cooking oils.

Each of these processes plays a critical role in ensuring the quality, safety, and efficiency of food production and processing.

Drying and Dehydration

Drying and dehydration are processes used to remove moisture from food products to extend their shelf life and reduce weight for easier transportation and storage. These processes help in preserving the nutritional value and flavor of the food while inhibiting the growth of microorganisms.

Drying Rate

The drying rate is the speed at which moisture is removed from the food product. It is influenced by several factors:

- **Temperature:** Higher temperatures generally increase the drying rate.
- **Humidity:** Lower humidity levels in the drying environment increase the drying rate.
- **Airflow:** Increased airflow can enhance the drying rate by removing moisture-laden air from the surface of the food.
- **Surface Area:** Foods with larger surface areas dry faster because more of the product is exposed to the drying medium.
- **Thickness:** Thinner food items dry more quickly than thicker ones because the moisture has a shorter distance to travel.

Changes During Drying

During drying, various physical and chemical changes can occur in the food product:

- **Shrinkage:** As water is removed, the food can shrink, leading to changes in texture.
- **Color Changes:** Pigments can degrade, leading to color changes.
- **Flavor Changes:** Volatile flavor compounds may be lost during drying, affecting the taste.
- **Nutrient Loss:** Some nutrients, particularly vitamins, can degrade during the drying process.
- **Texture Changes:** Drying can lead to textural changes, making foods more brittle or chewy depending on the method used.

Methods of Drying

There are several methods used for drying foods, each suitable for different types of food products:

Sun Drying:

- **Description:** Food is spread out in the sun to dry naturally.
- **Applications:** Used for fruits, grains, and fish.
- **Advantages:** Low cost and simple.
- **Disadvantages:** Weather-dependent, risk of contamination, and slower process.

Hot Air Drying:

- **Description:** Hot air is blown over the food to evaporate moisture.
- **Applications:** Commonly used for fruits, vegetables, and spices.
- **Advantages:** Faster and more controlled than sun drying.
- **Disadvantages:** Can cause nutrient loss and textural changes.

Freeze Drying (Lyophilization):

- **Description:** Food is frozen and then exposed to a vacuum, causing the ice to sublimate directly to vapor.
- **Applications:** Used for coffee, fruits, vegetables, and prepared meals.
- **Advantages:** Retains nutritional value, flavor, and texture.
- **Disadvantages:** Expensive and energy-intensive.

Spray Drying:

- **Description:** Liquid food is sprayed into a hot air chamber, causing the water to evaporate and leaving behind a powder.
- **Applications:** Used for milk, eggs, coffee, and flavorings.
- **Advantages:** Produces a fine, consistent powder.
- **Disadvantages:** Limited to liquid or semi-liquid foods.

Drum Drying:

- **Description:** Food is spread as a thin film on the surface of a heated drum, where it dries rapidly.
- **Applications:** Used for mashed potatoes, baby food, and fruit leathers.
- **Advantages:** Rapid drying and good retention of flavors.
- **Disadvantages:** Can result in uneven drying and some nutrient loss.

Microwave Drying:

- **Description:** Microwaves are used to heat and evaporate moisture from the food.
- **Applications:** Used for herbs, vegetables, and fruits.
- **Advantages:** Fast and efficient.

- **Disadvantages:** Can cause uneven drying and potential for overheating.

Vacuum Drying:

- **Description:** Food is dried under reduced pressure, allowing for lower temperature drying.
- **Applications:** Used for heat-sensitive foods like fruits and vegetables.
- **Advantages:** Minimizes nutrient loss and color changes.
- **Disadvantages:** More expensive and complex equipment.

These drying methods are chosen based on the specific requirements of the food product, considering factors like cost, desired quality, and shelf life.

Equilibrium Moisture Content (EMC)

- **Definition:** Equilibrium Moisture Content is the moisture level at which a material neither gains nor loses moisture when exposed to a specific relative humidity and temperature.
- **Importance:** Understanding EMC is crucial in industries like food processing, agriculture, and material science to ensure product stability, quality, and longevity.
- **Factors Influencing EMC:** Relative humidity, temperature, type of material, and previous treatment of the material.

Concentration

- **Definition:** Concentration refers to the amount of a substance (solute) present in a given quantity of solvent or solution.
- **Types:**
  - **Mass Concentration:** Mass of solute per unit volume of solution (e.g., g/L).
  - **Molar Concentration (Molarity):** Moles of solute per liter of solution (mol/L).

- **Volume Concentration:** Volume of solute per unit volume of solution.
- **Mole Fraction:** Ratio of the number of moles of a component to the total number of moles of all components.
- **Weight Percent:** Weight of solute per weight of solution, multiplied by 100.

Methods of Concentration

Concentration methods are processes used to increase the concentration of solutes in a solution. They are crucial in various industries such as pharmaceuticals, food processing, and chemical manufacturing.

Physical Methods:

1. **Evaporation:**
   - **Description:** Removal of solvent (usually water) by heating.
   - **Applications:** Concentrating fruit juices, syrups, and chemical solutions.
2. **Centrifugation:**
   - **Description:** Uses centrifugal force to separate components based on density.
   - **Applications:** Separating cream from milk, blood components, and sediment from liquids.
3. **Filtration:**
   - **Description:** Passing a mixture through a filter to separate solids from liquids.
   - **Applications:** Water treatment, beer clarification, and chemical processing.

Chemical Methods:

1. **Precipitation:**
   - **Description:** Adding a reagent to form an insoluble compound (precipitate) that can be separated.
   - **Applications:** Water softening, removal of impurities in chemical solutions.
2. **Crystallization:**

- **Description:** Formation of solid crystals from a homogeneous solution.
- **Applications:** Purification of chemicals, production of sugar and salt.

Biological Methods:

1. **Fermentation:**

    - **Description:** Use of microorganisms to convert sugars into alcohols, gases, or acids.
    - **Applications:** Production of ethanol, lactic acid, and antibiotics.

2. **Ultrafiltration:**

    - **Description:** Uses semi-permeable membranes to separate components based on size.
    - **Applications:** Protein concentration, wastewater treatment, and dairy processing