

## Chapter 04: Unit Operations in Food Processing

### 1. Introduction

Food processing relies on a sequence of operations called **unit operations**, which constitute the basic building blocks of any food industry.

Each processed food product (bread, milk, juice, meat, etc.) results from an organized combination of these operations.

#### Global example:

Milk → heating + cooling + packaging

### 2. Definition

A unit operation is an elementary step in a process that causes a **physical, thermal, or biological modification** of food.

It is characterized by:

- A principle (heat, mechanical force, etc.)
- An objective (preservation, transformation, etc.)
- An effect on quality

### 3. Classification

Unit operations are classified according to the dominant phenomenon (mechanical, thermal, physical, or biological).

We distinguish four main families:

- **Mechanical operations:** grinding, cutting, mixing, homogenization  
They modify size or shape without changing chemical composition.
- **Thermal operations:** pasteurization, sterilization, cooking, blanching  
They use heat to transform or preserve food.
- **Physical operations:** freezing, drying, filtration, centrifugation  
They modify the physical state without major chemical reactions.
- **Biological operations:** fermentation, enzymatic action  
They involve microorganisms or enzymes.

## 4. Mechanical Operations

### 4.1. Definition

Mechanical operations modify the size, shape, or physical structure of food without altering its chemical composition.

### 4.2. Types of Mechanical Operations

## A. Cutting

### 1. Definition

Cutting is a mechanical operation that reduces the size of solid foods using sharp tools (knives, blades, machines).

### 2. Principle

Cutting is based on the application of shear force that separates food tissues into smaller fragments.

This operation increases the surface area of the food.

### 3. Types of foods concerned

Cutting is mainly used for:

- Fruits and vegetables
- Meat and fish
- Some processed products

### 4. Examples

- Cut vegetables (salad, carrots)
- Sliced meat
- Cubed potatoes for frying
- Fruits for fruit salad

### 5. Effects on quality

#### 5.1. Technological quality

- Uniform size → homogeneous cooking
- Facilitates subsequent operations (cooking, drying)

#### 5.2. Nutritional quality

- Exposure to air → oxidation of some vitamins
- Loss of soluble nutrients with juice

#### 5.3. Sensory quality

- Improved presentation
- Easier consumption
- Enzymatic browning (e.g., apple)
- Juice loss → less juicy texture

#### 5.4. Sanitary quality

- Increased contamination risk (surface area increases)
- Facilitates washing and heat treatment

## B. Mixing

**1. Definition**

Mixing is a mechanical operation that combines several ingredients to obtain a homogeneous or semi-homogeneous system.

**2. Principle**

Mixing is based on mechanical movements (agitation, rotation, kneading) that ensure uniform distribution of components.

In some cases, it also induces structural changes.

**3. Types of foods concerned**

- Dough products (bread dough, cake batter)
- Liquid products (yogurt, beverages)
- Solid mixtures (spices, powders)

**4. Examples**

- Bread dough (flour + water + yeast)
- Flavored yogurt
- Spice mixtures
- Sauce preparation

**5. Effects on quality****5.1. Technological quality**

- Product homogeneity
- Uniform distribution of ingredients
- Gluten activation (in dough)

**5.2. Nutritional quality**

- Uniform distribution of nutrients
- Minimal losses (except prolonged exposure to air)

**5.3. Sensory quality**

- Uniform texture
- Improved consistency
- Even distribution of flavors

**5.4. Sanitary quality**

- Risk of contamination if equipment is not clean
- Facilitates uniform heat processing

**C. Homogenization****1. Definition**

Homogenization is a mechanical operation that consists of reducing the size of particles (often fat globules) in order to stabilize an emulsion.

**2. Principle**

The liquid is subjected to high pressure and then passes through a narrow opening, which breaks the globules into very fine particles. This prevents their subsequent aggregation.

### **3. Types of foods concerned**

- Milk and dairy products
- Emulsified beverages
- Sauces (mayonnaise, etc.)

### **4. Examples**

- Homogenized milk
- Creams and sauces
- Milk-based beverages

### **5. Effects on quality**

#### **5.1. Technological quality**

- Emulsion stabilization
- Prevents separation (cream/milk)

#### **5.2. Nutritional quality**

- No significant change in composition
- May influence lipid digestibility

#### **5.3. Sensory quality**

- Finer and more uniform texture
- Improved mouthfeel

#### **5.4. Sanitary quality**

- Uniform distribution of components
- Requires strict control (risk of contamination if poorly performed)

### **6. Advantages**

- Stable product
- Improved texture
- Uniform appearance

### **7. Disadvantages**

- High energy cost
- Requires specific equipment
- Increased sensitivity to oxidation (higher surface area)

## 8. Applied example

### Milk

- Homogenization → smaller fat globules

#### Effects:

- No cream layer formation
- More stable texture

## D. Grinding

### 1. Definition

Grinding is a mechanical operation that consists of reducing the size of solid particles by applying mechanical forces.

### 2. Principle

Grinding is based on the application of compression, impact, or shear forces to break particles into smaller elements.

This size reduction increases the specific surface area of the particles.

### 3. Types of foods concerned

- Cereals (wheat, maize)
- Dry products (spices, coffee)
- Hard solid foods

### 4. Examples

- Wheat grinding → flour
- Ground coffee
- Powdered spices

### 5. Effects on quality

#### 5.1. Technological quality

- Increased surface area
- Facilitates transformations (cooking, extraction)

#### 5.2. Nutritional quality

- Oxidation of nutrients (lipids, vitamins)
- Possible loss of sensitive compounds

### **5.3. Sensory quality**

- Improved texture (fine flour)
- Release of aromas (coffee, spices)

### **5.4. Sanitary quality**

- Risk of contamination (increased surface area)
- Possible microbial growth if moisture is present

### **6. Advantages**

- Facilitates food use
- Improves extraction of compounds
- Produces more homogeneous products

### **7. Disadvantages**

- Rapid oxidation
- Sensitivity to moisture
- Loss of quality if storage is inadequate

## **E. Sieving**

### **1. Definition**

Sieving is a mechanical operation that consists of separating particles according to their size using a sieve.

### **2. Principle**

The product passes through a sieve whose openings allow only fine particles to pass through, while larger ones are retained.

### **3. Types of foods concerned**

- Flours and powders
- Granular products
- Processed cereals

### **4. Examples**

- Sieving of flour
- Separation of grains according to size
- Refining of food powders

## **5. Effects on quality**

### **5.1. Technological quality**

- Uniform particle size
- Improvement of final product quality

### **5.2. Nutritional quality**

- Loss of certain rich fractions (e.g., wheat bran)
- Possible reduction in nutritional value

### **5.3. Sensory quality**

- Finer texture
- More pleasant product

### **5.4. Sanitary quality**

- Removal of impurities
- Improved safety

## **6. Advantages**

- Improves visual quality
- Product uniformity
- Removal of impurities

## **7. Disadvantages**

- Loss of nutritional components
- Additional processing step
- Dependence on sieve size