

Module 8

Impact of processing on nutrition

Module coverage

Topic	Sub-topics covered	Learning objectives
8) Impact of processing on nutrition	• Food processing basics. • Types of food processing (minimal, moderate, extensive). • Importance of food processing –Benefits, adverse effects. • Effect of processing on nutrients. • Strategies to minimize nutrient loss during processing.	✓ Understand the different types of food processing and their implications. ✓ Learn about the effects of processing on macronutrients, micronutrients, and phytochemicals. ✓ Identify the potential formation of harmful compounds during processing ✓ Develop strategies to minimize nutrient loss and maximize the nutritional value of processed foods.

Food processing basics

Food processing is the transformation of raw agricultural products into food for human consumption.^[94]

- It involves a variety of techniques, including:^[1]

- Cleaning
- Peelings
- Milling
- Cooling
- Freezing
- Canning
- Fermentation
- Drying
- Smoking
- Irradiation
- Extrusion
- Modified/Controlled atmosphere

- Food processing can make food safer to eat by killing harmful bacteria and viruses.
- It can extend the shelf life of food, making it available all year round.
- It can improve the nutritional value of food by adding vitamins and minerals.
- It can make food more convenient to prepare and eat.

- The goal of food processing is to improve the safety, quality, and shelf life of food.

Types of food processing

Various levels of food processing and their examples:

Minimal Processing	Moderate Processing	Extensive Processing
Limited alteration of raw products.	Employs intermediate techniques to enhance shelf-life and safety.	Involves significant physical or chemical transformation.
Washing, cleaning, trimming, peeling, and cutting.	Pasteurization, blanching, and freezing.	Baking, milling, extrusion, and refining.
Examples: fresh fruits, and pre-cut vegetables.	Processed milk, and frozen vegetables.	Bread, breakfast cereals, and snack foods.

Advantages of food processing



Increased Food Safety:

- Processes such as pasteurization, canning, and irradiation eliminate harmful bacteria and pathogens, significantly reducing the risk of foodborne illnesses.

Extended Shelf Life:

- Techniques such as drying, freezing, and canning preserve food, preventing spoilage and allowing for longer storage. This reduces food waste.

Enhanced food availability:

- Processing enables the transportation and storage of food over long distances, making a wider variety of foods available year-round, regardless of seasonality or geographical location.

Improved convenience:

- Processed foods, such as ready-to-eat meals and pre-cut vegetables, save time and effort in food preparation, catering to busy lifestyles.

Nutritional Enhancement:

- Food processing enables the fortification of foods with essential vitamins and minerals, thereby addressing nutritional deficiencies and enhancing public health.

Reduced Food Waste:

- By extending shelf life, and by processing foods that would otherwise be discarded, food processing helps to reduce overall food waste.

Adverse effects of food processing



Adverse Effects

- Food processing can lead to nutrient loss.
- Adding unhealthy ingredients, such as high salt, high sugar, and high fat, can affect the daily intake value.

Effect of processing on nutrients

- Different types of processing can have different effects on nutrients. For example, heating can destroy vitamins, while milling can remove fiber.
- Processing can also lead to the formation of harmful compounds, such as acrylamide.

Strategies to minimize nutrient loss during processing

- Use minimal processing techniques.
- Process food at low temperatures.
- Use appropriate packaging materials.
- Add nutrients back to processed foods via fortification.

True retention value

Nutrient retention refers to the ability of a country or region to maintain and preserve essential nutrients in the food supply chain, from production to consumption, minimizing losses and waste. [96]

Determination of true retention during cooking.

True retention (TR) values for all vitamins were calculated using the following formula [1]

$$\text{TR(\%)} = \frac{\text{Nutrient content per g of cooked food} \times \text{g of food after cooking}}{\text{Nutrient content per g of raw food} \times \text{g of food before cooking}} \times 100$$

Impact of processing on macronutrients



Impact of processing on carbohydrates

- **Loss of Dietary fiber:** Refining grains removes the bran and germ, reducing fiber content, which may be added back as part of food processing
- **Starch gelatinization:** Increases digestibility but reduces resistant starch.
- **Sugars addition:** Extensive processing often incorporates high levels of added sugars.

Impact of processing on fats

- **Oxidation:** Leads to the formation of rancid flavours and potentially harmful lipid oxidation products.
- **Trans Fats Formation:** Hydrogenation can produce trans fats, associated with cardiovascular risks.
- **Nutrient Addition:** Some processed fats are fortified with essential fatty acids.

Impact of processing on protein

- **Denaturation:** High-temperature treatments can alter the structural integrity of protein, reducing functionality
- **Digestibility:** Some processing methods, such as hydrolysis, improve digestibility.
- **Other losses in by-products:** Significant protein losses can occur during whey separation in dairy processing.

Impact of processing on micronutrients



Impact of processing on vitamins

- Vitamins are sensitive to heat, light, and oxygen.
- Processing techniques like de-husking can lead to loss of B vitamins present in the outer layer of the grains.
- Processing can lead to significant vitamin loss. For example, boiling can destroy up to 90% of vitamin C.

Impact of processing on minerals

- Minerals are generally more stable than vitamins.
- However, processing can still lead to some mineral loss. For example, milling can remove minerals from grains.

Strategies to minimize nutrient loss during processing



Gentle Processing Techniques

- **High-Pressure Processing (HPP):** Uses pressure instead of heat to inactivate microorganisms, preserving vitamins and flavours better than traditional heat treatments.^[99]
- **Pulsed Electric Field (PEF) processing:** Applies short bursts of electricity to disrupt cell membranes, reducing microbial load with minimal heat damage.^[100]
- **Microwave processing:** Offers faster heating and shorter processing times, reducing nutrient degradation.

Optimized Heat Treatments

- **High-Temperature Short-Time (HTST) pasteurization:** Minimizes heat exposure while still effectively killing pathogens.
- **Aseptic processing:** Sterilizes food and packaging separately before combining them in a sterile environment, reducing the need for harsh heat treatments.^[101]

Controlled Atmosphere Storage

- **Modified Atmosphere Packaging (MAP):** Alters the gas composition within packaging to slow down spoilage and maintain nutrient content.
- **Controlled Atmosphere Storage (CAS):** Regulates temperature, humidity, and gas composition in storage facilities to extend the shelf life of fresh produce.

Source: 99) https://www.researchgate.net/publication/350134327_High-Pressure_Processing_Principle_Applications_Impact_and_Future_Prospective

100) <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/pulsed-electric-field>.

101) <https://www.sciencedirect.com/science/article/abs/pii/S0958694621001242>

Strategies to minimize nutrient loss during processing



Enzyme Inactivation:

- **Blanching:** Briefly heating vegetables or fruits to inactivate enzymes that can degrade nutrients during storage.
- **Fortification and Enrichment:** Adding essential vitamins and minerals back into processed foods to compensate for losses incurred during processing or to enhance their nutritional value.

Innovative Drying Techniques

- **Freeze-drying:** Removes moisture at low temperatures, preserving heat-sensitive nutrients and flavours.
- **Spray Drying:** Converts liquids into powders by spraying them into a hot gas stream, offering rapid drying with minimal nutrient loss.

Other Important Improvements in Food Processing:

- **Clean Label Processing:** Focus on using natural ingredients and minimal processing to create healthier and more appealing products.
- **Sustainable Processing:** Reducing energy and water consumption, minimizing waste, and utilizing eco-friendly packaging.

Conclusion



- Food processing methods, such as frying, baking, canning, freezing, and fermentation, can have significant effects on the nutrient retention of foods.
- Some nutrients, especially water-soluble vitamins such as vitamin C and B-complex, are more susceptible to degradation by heat, light, oxygen, and leaching than others.
- Food processing can also alter the structure and bioavailability of food components, such as phytochemicals and dietary fiber, which may influence their health benefits.
- Some processing methods, such as blanching, can reduce nutrient losses by inactivating enzymes and microorganisms that cause spoilage.
- Other methods, such as fermentation, can increase the content or bioavailability of some nutrients, such as vitamin K and B12.
- The effects of food processing on nutrient retention depend on various factors, such as the type and quality of the raw material, the processing conditions, the storage time and temperature, and the cooking method.
- To optimize nutrient retention in processed foods, it is recommended to use fresh and high-quality raw materials, apply mild heat treatment, minimize exposure to light and oxygen, avoid excessive washing or soaking, and use cooking liquids for sauces or soups.

Suggested read: <https://www.sciencedirect.com/referencework/9780122270550/encyclopedia-of-food-sciences-and-nutrition>

Module 9

Nutrition Labelling