Food Processing and Preservation

Once food is harvested, it begins to deteriorate immediately due to the following factors:

- ***micro-organisms (yeast, mould, bacteria);***
- ***intrinsic enzymes;***
- ***temperature;***
- ***moisture; and***
- ***insects and vermin.***

Because of the risk of spoilage, much of food is processed in some way to increase its availability.

A food is considered preserved once it is stabilized with respect to safety and quality.

No type of food processing can transform poor quality raw materials into good ones.

It can only increase the product's shelf life.

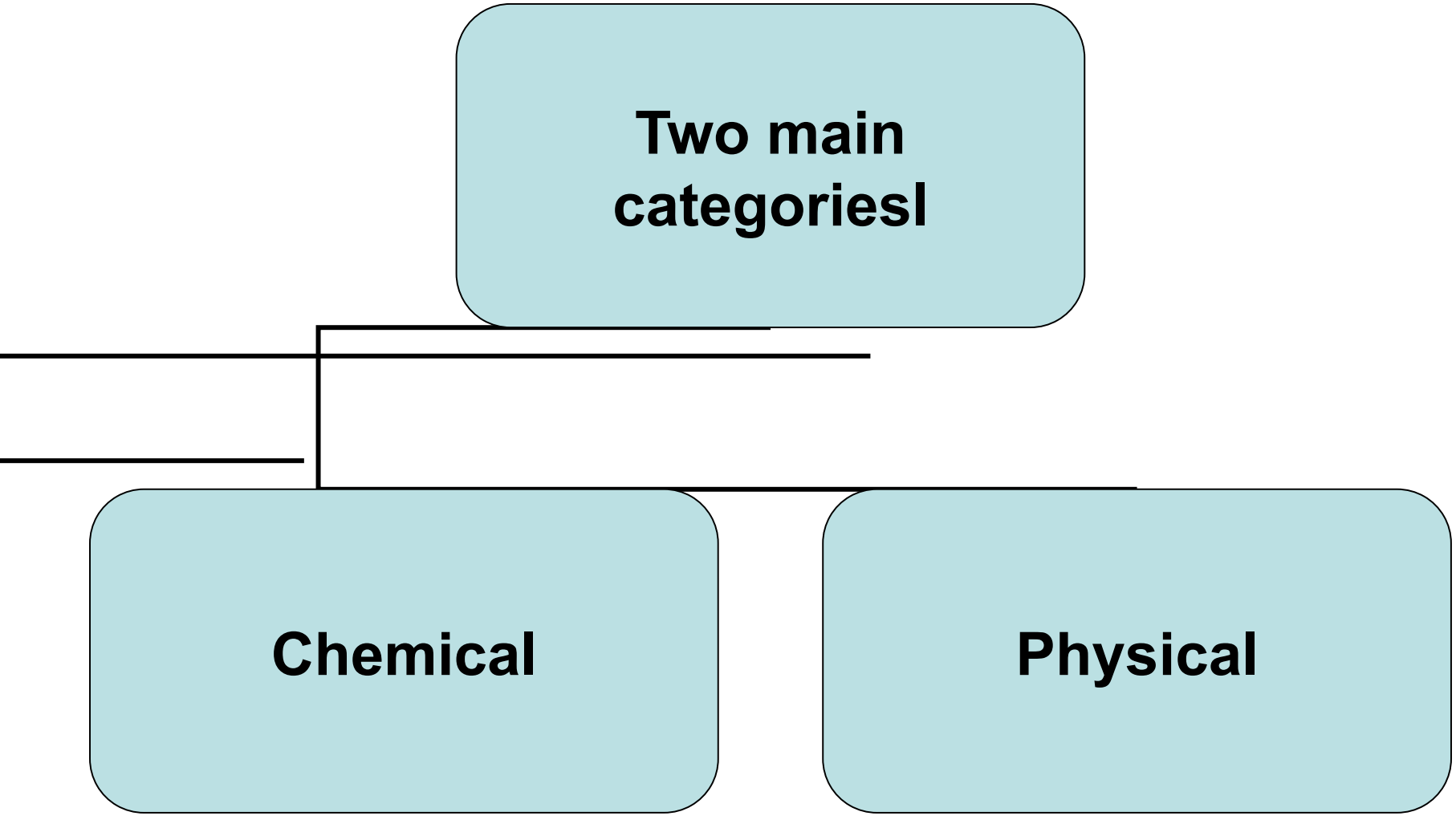
To ensure that product meets high standards:

- *use the highest quality raw ingredients;*
- *establish good processing techniques-and follow them; and*
- *maintain an appropriate product environment after processing.*

Not all processing methods are applied to foods to achieve preservation.

Some are also used to change or stabilize food texturally.

Processing Methods



Chemical Processing Methods

- Intermediate Moisture Foods (IMF)
- Water Activity (aw)
- Addition of Chemicals
- PH Control

Intermediate Moisture Foods (IMF)

- Binding the water that's present preserves intermediate moisture foods-for example, cookies, cake and bread. This reduces the availability of the water for deteriorative reactions.
- Water is immobilized by adding permissible humectant additives such as glycerol, glycols, sorbitol, sugars and salts.
- Generally, IMFs possess water activities that range from 0.6 to 0.85. This enables the food to be stable at room temperature, because the growth of most micro-organisms is inhibited at these levels.

Water Activity (aw)

- It is the *availability* of water for microbial, enzymatic, or chemical activity that determines the shelf life of foods. This water availability is measured as water activity (aw).

Water activity is measured on a scale of 0 to 1, where 0 indicates no water and 1 indicates all water. Food spoilage micro-organisms, in general, are inhibited in food where the water activity is below 0.6. However, if the pH of the food is less than 4.6, micro-organisms are inhibited when the water activity is below 0.85.

ADDITION OF CHEMICALS

The addition of some chemicals inhibits microbial growth in foods.

These chemicals include not only those classified as preservatives. Salt, sugars, wood smoke and some spices also inhibit the growth of micro-organisms. For more information on chemical preservatives.

pH Control

Almost every food, with the exception of egg whites and soda crackers, has a pH value of less than 7.

Foods can be broadly categorized on the basis of their pH as high acid, acid, medium acid or low acid.

Examples of each category include:

- high acid (3.7) : apples, lemons, raspberries
- acid (3.7 to 4.6) : oranges, olives, tomatoes (some)
- medium acid (4.6 to 5.3) : bread, cheese, carrots
- low acid (over 5.3) : meat, fish, most vegetables

Most micro-organisms grow best in the pH range of 6.5 to 7.5.

Yeasts and moulds are capable of growing over a much broader pH range than bacteria.

Few pathogens will grow below pH 4.0.

Physical Processing Methods

- Sterilization
- (Retorting)
- Pasteurization
- Blanching
- Microwaving
- Frying
- Refrigeration
- Freezing
- Irradiation
- Evaporation
- Dehydration
- Emulsions
- Homogenization
- Extrusion

Sterilization

- Sterilization destroys all pathogenic and spoilage micro-organisms in foods and inactivates enzymes by heating.
- All canned foods are sterilized in a retort (a large pressure cooker).
- This process enables food to have a shelf life of more than two years.

Foods that have a pH of more than 4.6, such as meat and most vegetables, must undergo severe heating conditions to destroy all pathogens.

These foods are heated under pressure to 121°C for varying times.

Severe conditions are applied to ensure that *Clostridium botulinum* spores are destroyed during processing.

The spores are destroyed by heat or are inhibited at pH values of less than 4.6.

Therefore, a food with a pH of less than 4.6 that is packaged anaerobically.

Pasteurization

- **Pasteurization is the process of heating a food-usually a liquid-to or below its boiling point for a defined period of time.**

- **The purpose is to destroy all pathogens, reduce the number of bacteria, inactivate enzymes and extend the shelf life of a food product.**

Foods with a pH of less than 4.6, such as milk and spaghetti sauce, can be pasteurized.

Permanent stability-that is, shelf life of about two years-is obtained with foods that can withstand prolonged heating, such as bottled juices.

There is a greater loss of flavour from foods that are exposed to a longer time-temperature relationship. Therefore, temporary stability (that is, limited shelf life) is only obtained with some foods where prolonged heating would destroy its quality.

These foods, such as milk, usually require subsequent refrigeration.

"High temperature short time" (HTST) and "ultra high temperature" (UHT) processes have been developed to retain a food's texture and flavour quality parameters.

Blanching

- **Blanching is a slight heat treatment, using hot water or steam, that is applied mostly to vegetables before canning or freezing.**

  Blanching is used before freezing to inactivate enzymes present that cause deteriorative reactions to foods during frozen storage.

- **These reactions include colour and texture changes, off-flavours and a decrease in nutritional value.**

Blanching is used before canning for different reasons, because enzymes will inevitably be destroyed during canning.

Blanching induces a vacuum in canned goods, and it's also used to control the fill into containers (for example, spinach).

Microwaving

- **Microwave ovens are rarely used for processing large quantities of food. They are mainly of interest when the products such as frozen foods are used..**

Microwave ovens use electromagnetic radiation to excite water molecules in food. The actual waves penetrate only about 10 inches from the source of the radiation. Within the food, the waves only penetrate 3 4 to 1 inch on all sides. As a result, the actual ovens must be limited in size. Heat is produced within the food by the friction of water molecules, which spreads to the centre of the food by conduction.

Small portions are cooked rapidly in microwave ovens. As the quantity of food increases, however, the efficiency is lost.

Frying

- **Frying involves cooking in hot oil. Because of the big difference between the temperature of the oil and the food, as well as the small size of the food pieces, cooking is completed in a relatively short time- anywhere from 20 seconds to six minutes.**

Fried foods are known for their characteristic crispy outer surface as well as their high fat content.

The fat that is absorbed by the food product varies from 10 percent to 40 percent, depending on the time the food is immersed in the oil.

Continuous fryers are often used in the food industry.

Refrigeration

- **Refrigerators should be set to below 4°C to control the growth of micro-organisms in foods.**
- **This lowered temperature also reduces the respiration rate of fruits and vegetables, which retards reactions that promote spoilage.**

Refrigeration is generally used to:

- reduce spoilage during distribution of perishable foods;
- increase the holding period between harvesting and processing; and
- extend the storage life of commercially processed foods.

Not all foods benefit from cold temperatures.

For example, bananas turn black and bread goes stale when refrigerated

Freezing

- While many home freezers are held at -10°C, commercial freezers are under -18°C. At this temperature, the growth of micro-organisms is almost stopped. Deteriorative microbial reactions will still occur, but over a much longer time.

- In addition, deteriorative enzymatic reactions will still take place during frozen storage. Uncooked fruits and vegetables must be blanched before freezing to prevent these reactions.

During freezing, the water in food forms ice crystals. The rate of this phenomenon has a big impact on the quality of frozen foods:

- **Slow freezing (e.g. home freezer)**
- **- large ice crystals formed, which puncture cell walls**
- **- cellular fluid released**
- **- results in shrunken appearance of thawed food**

- **Rapid freezing (e.g. blast freezer)**
- **- small, numerous ice crystals formed**
- **- no change to cell structure**

The shelf life of frozen foods is largely dependent on storage conditions.

Under ideal conditions, frozen foods can have a shelf life of one year.

However, if foods are continuously exposed to warmer temperatures, such as the opening and closing of freezer doors, then heat shock occurs.

Heat shock is when ice melts and re-forms into larger ice crystals. The best example is ice cream, which has a gritty texture if large ice crystals have developed.

Irradiation

- **Irradiation is the controversial process of applying low doses of gamma radiation to food products.**

Irradiation is generally used for:

- **prevent sprouting in potatoes and onions;**
- **control insect infestation of wheat flour and**
- **reduce the microbial load of ground spices.**

If irradiation becomes more widespread among various other food products, it is expected to replace fumigation, ensure hygienic quality and reduce the dependence on refrigeration.

Batch vs. Continuous Processing

- **Food is processed in either discrete batches or a continuous system.**

- **Generally, batch systems are used to produce small quantities of food, whereas larger volumes are required for continuous systems.**

Advantages of Batch Processing	Advantages of Continuous Processing
Greater flexibility to change product formulation and rates	Lower operation and labour costs
Lower equipment costs	Less floor space required
Easier operation and control	Greater product uniformity

Evaporation

- Evaporation is the partial removal of water from liquid foods by boiling. When the operation is done under vacuum, boiling is avoided and the food's flavour qualities are retained.

- Some of the foods that have undergone evaporation are evaporated milk, tomato paste and juice concentrates.

This process is carried out for three main reasons:

- to reduce the weight and, therefore,
- reduce storage and transport costs;
- to preserve foods by decreasing the water activity and increasing the solids content; and
- to provide consumers with convenient foods.

Dehydration

- Dehydration-or drying-is the nearly complete removal of water from solid foods.
- One of the oldest methods of food preservation, it was traditionally carried out by the sun.
- This application is used for the same reasons that liquid foods undergo evaporation-preservation, convenience and cost savings.
- Dried soup mixes, dried fruit, powdered milk and spices are just a few examples of dehydrated foods.

Spray drying and freeze drying are two drying methods used widely today.

Spray drying is when a liquid food is atomized into a fine, dry powder.

Examples include natural and artificial flavours and milk powders.

Freeze drying involves first freezing the food and then driving off the ice, leaving a high quality, porous dried food such as instant coffee.

Emulsions

- An emulsion is a system containing two liquid phases that don't mix, where one phase (disperse phase) is distributed throughout the other phase

- (continuous phase) in the form of very small droplets.

Generally there are two types of emulsions:

oil in water (O/W)

water in oil (W/O)

An example of an O/W emulsion is salad dressing,
and
an example of a W/O emulsion is butter.

Homogenization

- **Homogenization is used to stabilize an emulsion. More specifically, it is the reduction in size and the increase in number of droplets of the dispersed phase by the application of intense shearing forces.**

- **Generally, homogenization is applied to change the functional properties or improve the texture of emulsions. For example, most fluid milk sold at the retail level is homogenized to improve its stability, and most caramel fillings are homogenized to increase their smoothness**

Extrusion

- Extrusion is the process in which a food is compressed and worked to form a semi-solid mass. This mass is then forced through a restricted opening, or die, to create a desired texture or shape.

- The purpose of this application is simply to provide a greater variety of textured foods to consumers.

- Food may also be cooked while extruded.
- This is referrred to as extrustion cooking or hot extrusion.

- Some extruded food products are licorice, puffed wheat and cornflakes.

Hurdle or Combination Processing

- **Hurdle technology is a concept that was developed to address the consumer demand for more natural, fresh-like foods. It is a way for food processors to employ only mild preservation techniques to their food products.**

- **The idea is to use deliberate low-level combinations of existing and novel preservation techniques ("hurdles") to eliminate the growth of micro-organisms. Lower-intensity individual methods can be used because of the collective effect of the combined methods.**

Some of the more common hurdles include:

- pasteurization;
- water activity (aw);
- salt;
- blanching;
- freezing; modified atmosphere packaging (MAP);
- pH;
- preservatives;
- refrigeration; and
- irradiation.

Some micro-organisms present will be able to survive the individual treatments applied. However, no microorganism will be able to overcome all of the combined hurdles.

Thus the food is stable and safe.

The only way to ensure that the correct combination of hurdle technologies is used is to make sure that a qualified resource conducts quality and safety shelf-life studies.

Examples of hurdle processing can be found in traditional and recently developed foods, such as yogurt and prepackaged fresh salads.

The hurdles employed in yogurt manufacture include low temperatures, high acid and competitive microbial flora.

Those used to prepare prepackaged fresh salads include low temperatures and modified atmospheres.

The End