Chapter 29: Food Preservation & Packaging

Introduction

- **Food preservation** is the process of treating and handling food to stop or slow down spoilage
  - (loss of quality, edibility or nutritional value)
    - and thus allow for longer storage.

Introduction

- Fresh meat and fish were preserved by putting them in the sun
- Fruits and vegetables were dried in the sun or on an open stove
- Addition of salt and sugar
- Smoking

Causes of Food Spoilage

- **Food spoilage** :When food is spoil it become inedible or hazardous due to the chemical and physical changes that occur within the food

1) Microorganisms
2) Enzymes
3) Non-enzymatic reactions

1- Microorganisms

- Bacteria, yeasts and molds
- However, they have an advantageous roles in food preservation and processing
- Yeast is an essential ingredient in bread and is needed by the brewing industry

1- Microorganisms

- Certain cheeses are ripened by molds while other cheeses are ripened by bacteria
- Production of soy sauce require fermentation by molds
- Buttermilk, yogurt and fermented pickles owe their special desirable flavors to bacterial action

2- Enzymes

- Present in any food that has been living tissue
  - Meat, fish, poultry, chicken, eggs, fruits, veges

- If undesirable enzyme action is not controlled or the enzymes are not destroyed, there will be unwanted chemical changes in the preserved food
  - cutting apples→ it becomes brown
  - Tomato leaves → develops a black scum

Apple browning

Apple brwowning

- When an apple is cut (or bruised), oxygen is introduced into the injured plant tissue

- When oxygen is present in cells, polyphenol oxidase (PPO) enzymes in the chloroplasts rapidly oxidize phenolic compounds naturally present in the apple tissues

Apple browning

- the level of PPO activity and concentration of substrate are varied from fruit to another

- And that’s why some apples seem to brown faster than others

PPO activity

- PPO oxidation activity can be reduced by:
  - Heating
  - Coating wit syrup or sugar(reduce oxygen diffusion)
  - Blanching
  - Add acids like lemon juice (has antioxidant that can lower the oxidation rate)

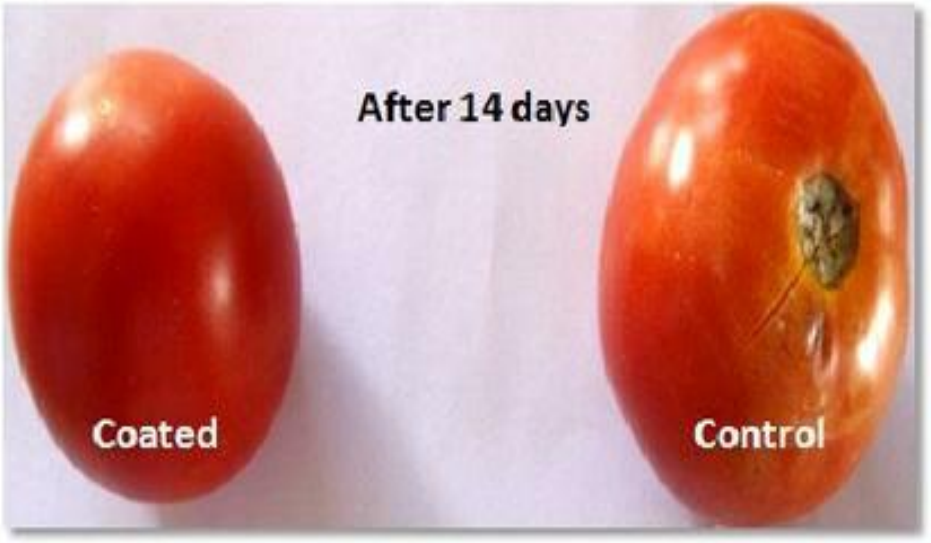
The desirable side of browning !

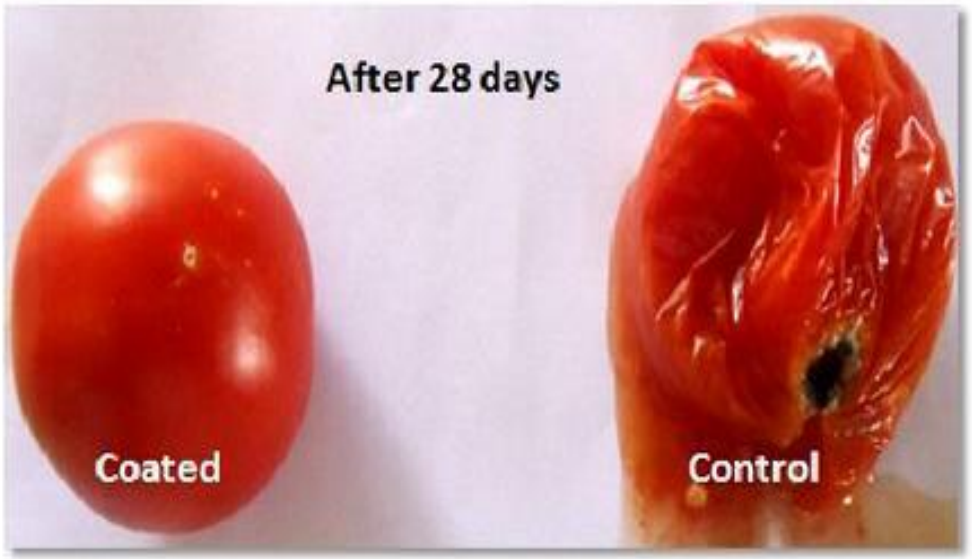
- the familiar brown color of tea, coffee and cocoa is developed by PPO enzymatic browning during product processing.

3- Desiccation, Bruising and Oxidation non enzymatic reactions

- Desiccation is a process of drying as moisture is lost

- Oxidation can be retarded by :
  - appropriate packaging
  - control of environmental conditions
  - addition of antioxidants
- Example : edible coating of fruits and vegetables
  - Moisture barrier
  - Control respiration
  - Reduce post harvest decay





General methods of food preservation

- General principle for all preservation methods is to prevent or retard the causes of spoilage

- When the growth of microorganisms is only **retarded** or **inhibited**, prevention is temporary

- When spoilage organisms are completely destroyed and the food is protected, more permanent preservation is achieved

General methods of food preservation

1. Preservation by temperature control
2. Preservation by moisture control
3. Use of preservatives
4. Preservation by irradiation

Preservation by Temperature Control

- Hot or cold temperature
- Hot temperature → destroy spoilage agents
- Cold temperature → produce an environment unfavorable to microbial growth

Temperature control preservation

- cold temperature
  - Refrigeration and controlled atmosphere packaging
  - Freezing
- Thermal processing
  - Canning
  - Pasteurization

Cold Temperature

- Inhibit the growth of microorganisms
- How much the food remain wholesome varies with the temperature applied, type of the food and the type of packaging
- Main concerns are the growth of psycrophilic and mesophilic pathogens

Refrigeration and Controlled Atmosphere Storage

- Maintenance of food at or below 5c in the refrigerator preserve the food for a few days

- In Cold storage warehouses : the time the food is preserved is longer because the temperature is lower and the humidity is controlled

- Controlled atmosphere storage used to retard ripening or maturation changes that decrease the storage life of fresh produce

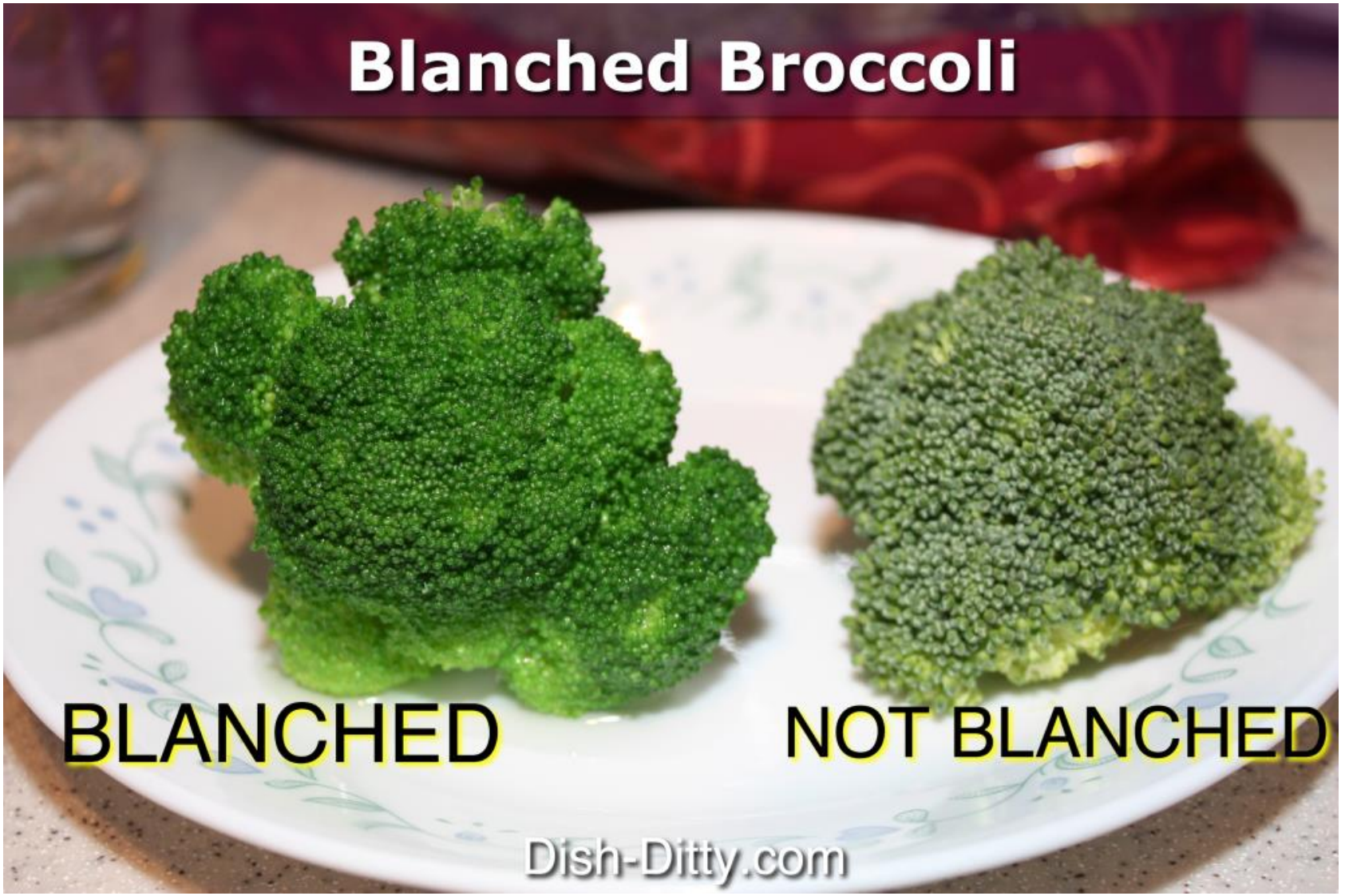
Freezing

- Can preserve food for a longer period
- Freezer should be maintained at no higher than -18C

- Action of the enzymes already present in the tissue is retarded at freezing temperature
  - Except products like vegetables

- Vegetables should be blanched before they are frozen (to destroy the enzymes by heating)

blanching



Thermal Processing

- Destroy both microorganisms and enzymes
- Heating must penetrate all parts of the food
- Bacteria are less readily destroyed than yeasts, molds, enzymes
- Vegetative cells are readily destroyed than spore form

Canning

- Food is preserved by using high temperature and then sealing the container
- **Complete destruction of microorganisms and their spores, as well as enzymes**
- **Retort packages** are flexible packaging for thermoprocessed food
- Require less time for heat penetration (than metal cans), save energy, easier to transport

Pasteurization

- Mild heat treatment that destroy microorganisms that may cause disease but not all microorganism in the product are destroyed
- Milk, fruit juices, eggs that are frozen or dried
- Limited or temporary preservation period than sterilization or canning

Preservation by Moisture Control: Drying

- One of the oldest methods of preservation

- The food is dried in the sun or by air currents and artificial heat until the moisture content of the food is reduced to the level that inhibit the growth of microorganism

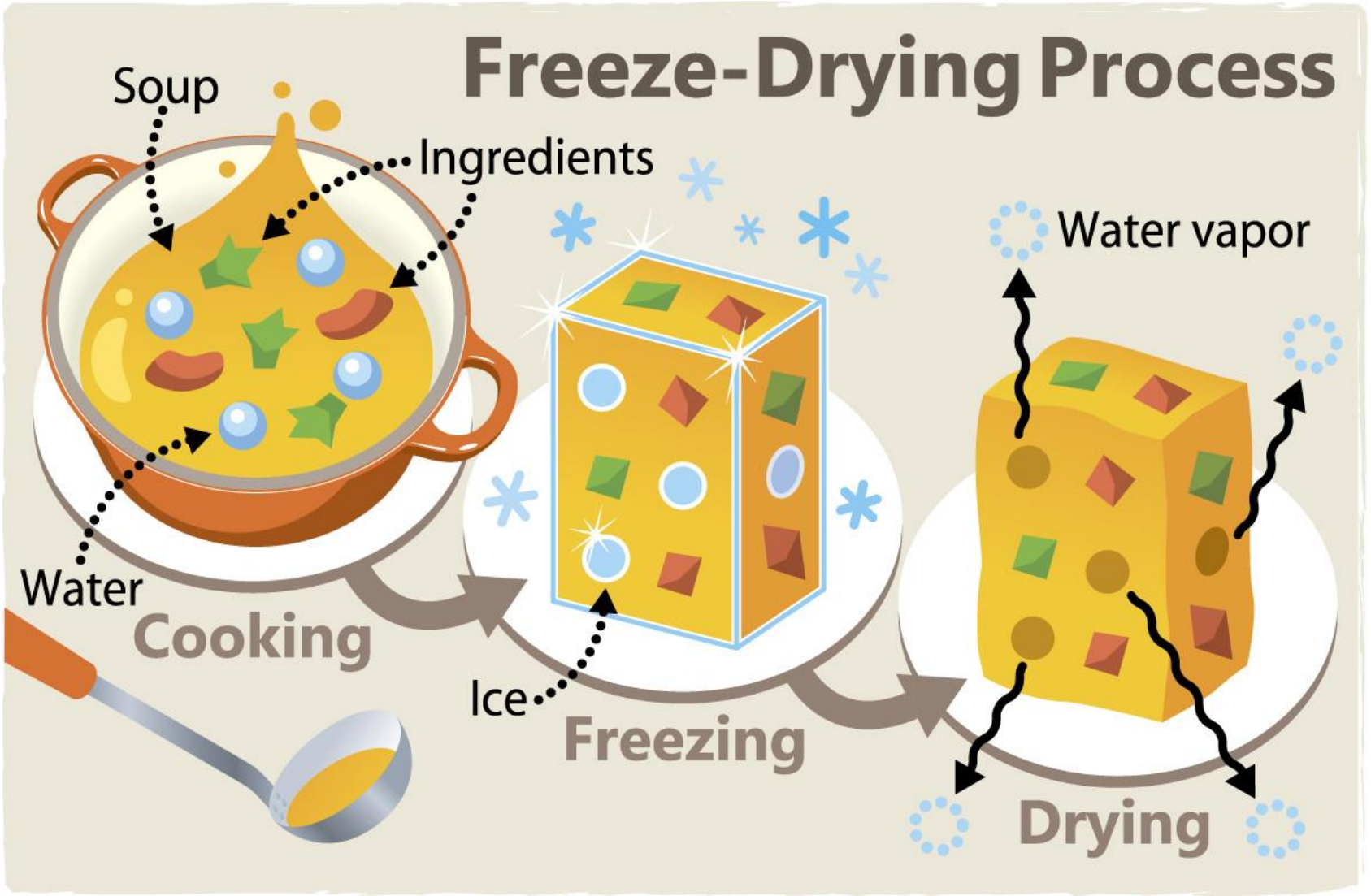
- Some foods can be easily dried at home

Preservation by Moisture Control: Drying

- Drying can be done in the oven, trays placed in the sun
- Vegetables should be blanched before they are dried
- Light colored fruits are of better quality when they are sulfured before drying

Preservation by Moisture Control: Freeze-Drying

- Food product is first frozen, then placed in a vacuum where a small amount of heat is applied
- The ice in the frozen food changes directly to water vapor and is carried away by the circulating heat air
- Moisture content is reduced to 1-8%



Preservation by Moisture Control: Freeze- Drying

- Food product remain frozen through most of the drying period, it does not get warm
- Fresh flavors and texture are better preserved by freeze drying
- Meat, fruit, vegetables

FREEZE-DRIED FOODS

Family-Survival-Planning.com

Preservation by Moisture Control: Freeze- Drying

- Do not need refrigeration
- Light when transport
- Tend to deteriorate with long storage unless they are properly packaged

Use of preservatives

- Inhibit growth of undesirable microorganisms
- Common preservatives (household preservatives) include:
  - Acids
  - Salt
  - Sugar
  - Spices
  - smoke

Use of preservatives

Acids and sugars:

- In pickle vegetables, vinegar (acetic acid) and salt are used
- Acid prevent unwanted microbial growth, desirable flavour substances are produced by the bacteria
- Sugar is used in production and preservation of jam and jellies (bind to the water)

Use of preservatives

- Spices:

- Inhibit bacterial growth to some degree

- Oils of spices inhibit microbial growth more than ground spices
- Ground cinnamon and cloves are more valuable than nutmeg

Use of preservatives

Other preservatives:

- Many preservatives are used as food additives
- They must be tested for safety before being used

Food additives classifications

E100-E199	Colors
E200-E299	Preservatives
E300-E399	Antioxidants
E400-E499	Emulsifiers, stabilizers, Thickeners
E500-E599	Anticaking agents
E600-E699	Flavor Enhancers
E700-E799	Antibiotics
E900-E999	Propellant, glazing agents, humectant, sweeteners
E1000-E1599	Additional chemicals (thickeners, gums)

Food additives : Preservatives

- Examples :
  - Ascorbic acid : antioxidant, ani rancidity in high fat foods
  - Citric acid
  - Sodium benzoate : antimicrobial in beverages
  - Calcium propionate : prevent bread molding
  - Sodium nitrate
  - Tocopherol

Preservation by Irradiation

- Reduce microbial level
- Destroy pathogens
- Extend shelf life
- Remove insect infestation
- It is considered safe by: FDA, USDA, WHO, FAO, International Atomic Energy Agency (IAEA)

Preservation by Irradiation

- CDC expert report that irradiation reduce foodborne illness cases
- More than 40 food products are irradiated in 37 countries
- Called cold pasteurization (destroys organisms without heating the food)
- Sources of radiation allowed for food are gamma rays, beta rays, x-rays

Preservation by Irradiation

- The chemical bonds in the microbial DNA → killing the microbe

- Irradiated food are not radioactive
  - Does not have enough energy to split atoms in the food

One Process:

Multiple Uses

Sprout Inhibition

Onion, Potato, Ginger, Garlic

Quarantine

Fruits

Insect Disinfestation

Cereals, Pulses, Dry Fruits

Shelf-life Extension

Chicken, Meat, Fish

Pathogen Reduction

Spices, Flesh Foods

Preservation by Irradiation

- Consumer acceptance is important for commercial application of food irradiation

Packaging of Food: Functions

1. Protect food from contamination
2. Contain the food
3. Provide information
4. Enable the consumer to heat or cook the food in the package

Packaging of Food: Functions

1- Protection:

- Provide protection from biological, chemical, physical influence that may deteriorate the product
- Chemical changes can be controlled or prevented by the type of packaging
- Minimize the reactions that affect the stability or the shelf life of the food product

Packaging of Food: Functions

- Provide a barrier to water vapor and oxygen (to keep moisture in the food or to prevent moisture from entering the package)

- Permeability of the package to light also affect the stability of the food

- Physical protection help to prevent breakage, crushing and other forms of damage

Packaging of Food: Functions

2- Containment:

- Containers provide ease in handling and convenience
- Large containers result in less environmental waste
- Small containers may result in less food waste

Packaging of Food: Functions

- 3- Marketing and Information:

- Provide information about the product for the consumer
- Food contact nutrition label, package contents, product use, recipes

- Unique codes enable traceability of the product throughout the distribution process

Packaging of Food: Regulatory Requirement

- Compatibility of food and its packaging is a safety issue
- Package is a potential source of chemical substances for the food product

- Packaging materials are considered food additives and require premarket safety evaluation and approved by the FDA

Packaging of Food: Methods of Packaging

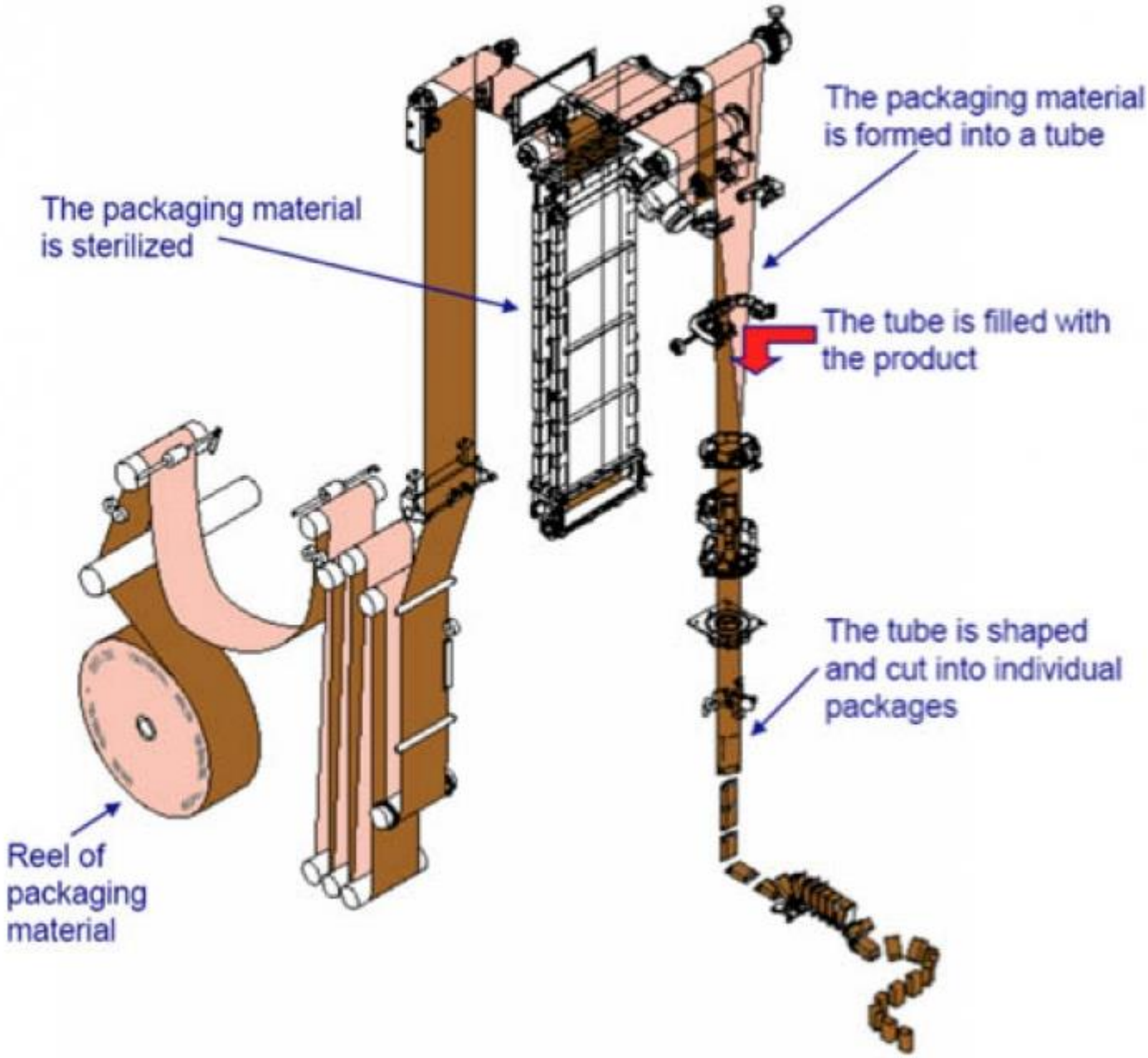
Aseptic Packaging:

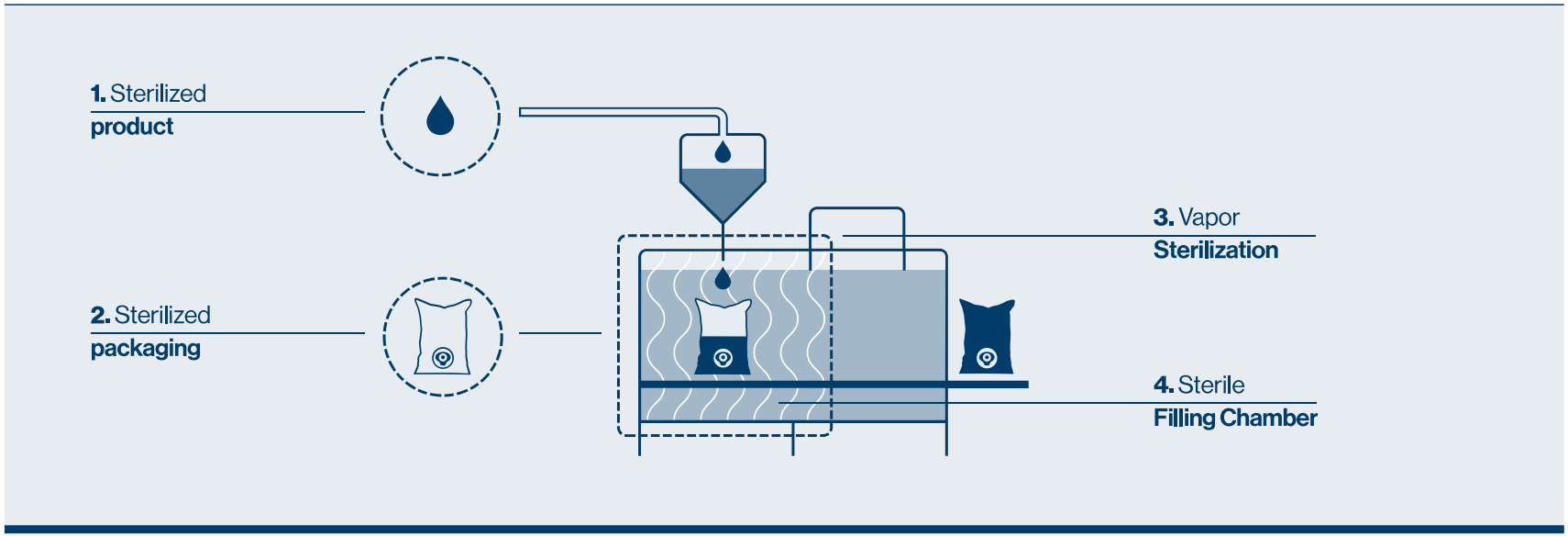
- Involve sterilization of the food product, the package or container, filling the sterilized container with the sterilized food, sealing the container
- Developed in 1940
- To sterilize the packages
  - Heated steam
  - Dry hot air
  - Hydrogen peroxide in combination with heat or ultraviolet light

Packaging of Food: Methods of Packaging

- Food are pumped through heat exchanger →then into a holding tube → then into a cooling section →before being packaged

- Destruction of *Clostridium botulinum* spores must be ensured
- The process is highly automated, efficient and less expensive compared to the conventional canning





Packaging of Food: Methods of Packaging

- Modified Atmosphere Packaging:

- Enclosure of food products in gas-barrier materials in which the gases environment has been changed or modified
  - reduce respiration rate
  - Reduce microbial spoilage
  - retard deterioration due to enzymatic reaction which will extend the product shelf life

Packaging of Food: Methods of Packaging

- The amount of oxygen will be reduced while amount of carbon dioxide and nitrogen are increased

- Applied to fresh cut produce, sandwiches, pasta and sauces, prepared poultry, lunch kit

- Modification of the gas mixture may be accomplished by two different ways: vacuum packaging and gas packaging

Packaging of Food: Methods of Packaging

- Sous vide: under vacuum

- Slow controlled cooking of food in sealed, heat stable pouches or trays, followed by quick chill and cold storage at 0-3^{o}C
- The natural flavors are retained
- Can be reheated in a boiling water bath or in a microwave oven

Packaging of Food: Methods of Packaging

- Major microbial hazard is the potential growth and toxin production of *Clostridium botiulinum*

- HACCP should be applied in the production of Sous vide

Packaging of Food: Packaging Materials

- Should be carefully chosen
- Food flavors can be affected by the type of packaging
- Direct contact of food with packaging → could cause a migration of volatile substances from the package into the food

Packaging of Food: Packaging Materials

- Polyethylene and polypropylene have been implicated in flavor absorption into the plastic

- Glass is chemically inert and does not affect flavor
  - Disadvantages of breakability, cost, transportation

Packaging of Food: Packaging Materials

- Paper and Paperboard:

- Produced from cellulose fibers derived from wood
- Corrugated boxes, milk cartons, folding cartons, bags, sacks, wrapping paper

- Any additives used in processing of paper must be regulated by FDA

Packaging of Food: Packaging Materials

- Plastics:

- Organic polymers with variable chemical compositions and physical properties

- Different fabrication process are used to produce the many types and shapes of both rigid and flexible packages

Plastic Safety issues

- **To reduce your exposure to the chemicals in plastic, use these strategies:**
- Use a paper towel instead of plastic wrap in the microwave.
- Don't microwave food in plastic containers (put food on a plate instead).
- Use safer dishware made from materials like glass or stainless steel.
- Avoid use of plastic containers with the number 3 or 7 on them. Plastics with the number 1 (typically used for water and soda bottles) are single use only. Recycle after use.
- Use tempered glass baby bottles instead of plastic. If you use plastic bottles, don't heat them.
- Store food in glass or Pyrex containers, rather than plastic.
- Discard scratched or worn plastic containers.
- Hand wash plastics to reduce wear and tear.

PLASTIC CONTAINERS

Identification code	Type of plastic	Uses	Risks
	Polyethylene terephthalate (PET)	• Bottles used for bottled water and soft drinks • Jars for products such as peanut butter • Lightweight and "green" wine bottles	No known health hazards.
	High density polyethylene (HDPE)	• Bottles used for milk and cream • Yoghurt cups • Bags that line breakfast cereal packets	No known health hazards.
	Polyvinyl chloride (PVC)	• Shrink and cling wrap • Clear plastic containers for fresh fruit or take-away sandwiches • Some soft drink bottles • The gaskets that form a seal on screw-cap glass jars	Contains plasticisers such as DEHA or phthalates that can leach into food.
	Low density polyethylene (LDPE)	• Take-away containers • Waterproof coating on milk cartons • Bags used for bread and frozen foods • Cling wrap	No known health hazards.
	Polypropylene (PP)	• Bottle caps • Yoghurt and margarine containers • Food storage boxes	No known health hazards.
	Polystyrene (PS)	• Plastic cutlery • Drinking cups and yoghurt cups • Cups for hot coffee (polystyrene foam) • Lightweight trays used by supermarkets to package meat and sometimes vegetables (polystyrene foam)	Researchers have investigated possible health risks from traces of styrene monomer. This risk seems to be low.
	This number is used as a catch-all for any other plastics, one of which is polycarbonate.	• Bottles for sauces and condiments • Babies' feeding bottles and infants' drinking cups • Reusable water bottles for cyclists or bushwalkers	Polycarbonate can release BPA into the food, especially when bottles are washed for reuse.

Packaging of Food: Packaging Materials

- Metals:

- Aluminum, aluminum foil, tinplate

- Aluminum is lightweight, resistant to corrosion, easily recycled

- Tinplate can be recycled, less expensive than aluminum, produced by coating thin sheets of steel in molten tin, useful for sterilized products

tinplate

Packaging of Food: Packaging Materials

- Combination of materials:

- Improve functional properties for food packages

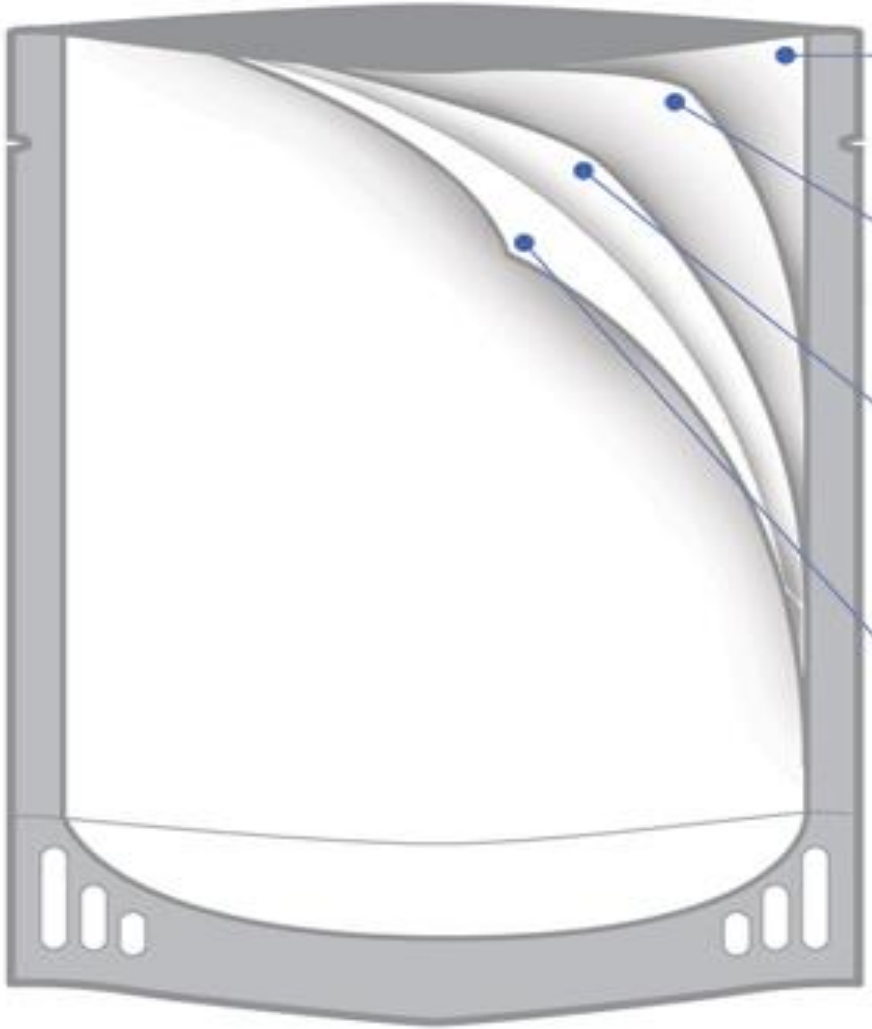
- Containers for aseptic packaging may be fabricated with aluminum foil as a barrier material and a polypropylene or polyethylene as heat sealing and food contact surface

Packaging of Food: Packaging Materials

- These packages act as a barrier to moisture, oxygen, light, microorganisms and have the necessary strength

- Flexible retort pouch consist of three laminated materials held together by adhesives
- Outer layer is polyester, middle layer is aluminum foil and the inner layer is polyolefin

Flexible retort pouch



POLYPROPYLENE
Physical Food Contact Layer
- Heat Seal Surface
- Provides Flexibility and Strength

NYLON
- Abrasion Resistance

ALUMINUM FOIL
Barrier Layer
- Protects from Light, Gases, Odors
- Extends Shelf Life

POLYESTER
Outside Layer
- Excellent Printable Surface
- Provides Strength

Packaging of Food: Packaging Materials

- Retort pouch is thin and permits sterilization temperature to be reached more quickly throughout the content than the traditional can

Packaging of Food: Packaging Materials

- Edible films and coating:

- Edible films is a thin layer of edible material formed on a food as a coating or placed on or between food components

- Edible films and coating are not meant to replace nonedible, synthetic materials for prolonged storage of food

- Can improve overall food quality and extending shelf life

Packaging of Food: Packaging Materials

- Inhibit migration of
  - Moist
  - Oxygen
  - carbon dioxide
  - Aromas
  - Lipids
- carry food ingredients (antioxidants, antimicrobial, flavor) and/or improve mechanical integrity

Packaging of Food: Packaging Materials

- If the product is fresh fruits or vegetables the film should retard moisture loss and allow some permeability of oxygen and carbon dioxide
- Potential edible films include polysaccharides, proteins and a combination of these substances