SECTION THREE

FOOD TECHNOLOGY
MODULE 9

FOOD PROCESSING TECHNOLOGIES

Objectives of the module

By the end of the module, participants should be able to:
(a) Explain the reasons for processing food.
(b) List the main processing methods that can be used to preserve food.
(c) Explain the purpose of packaging
(d) List the different types of packaging available
(e) Describe the properties of each type of packaging available.
9 FOOD PROCESSING TECHNOLOGIES

9.1 REASONS FOR PROCESSING OF FOOD

Food is processed to make and/or keep it safe for human consumption for as long a period as possible, without extensively impairing its nutritional content and maintaining its quality and sensory properties. Foods are processed in order to:

- ensure their microbiological safety
- inhibit chemical, microbiological and biochemical spoilage
- maintain the quality, including shelf-life and sensory qualities
- develop new products

Factors that affect the microbiological, chemical and biochemical safety of foods have to be controlled. These factors include:

- Growth and activities of microorganisms
- Activities of natural food enzymes
- Insects, parasites and rodents
- Temperature (heat and cold), moisture and dryness
- Air, more particularly oxygen
- Light
- Time
The above factors often do not work alone in nature and may be beneficial to the food up to certain levels. Many of the factors, when exerting a negative influence on food safety, are discussed in other modules in more details.

### 9.2 PRINCIPLES OF FOOD PRESERVATION

The basic principles for food preservation are the control of microorganisms, the control of chemical and biochemical reactions and naturally occurring negative components in foods.

#### 9.2.1 Control of microorganisms, enzymes and other deteriorative reactions

A number of food processing technologies are used to control microorganisms and other reactions:

- Temperature management
- Drying
- Addition of acid, sugar, salt and smoke
- Exclusion of oxygen
- Use of chemicals
- Radiation

### 9.3. FOOD PROCESSING TECHNOLOGIES

The reasons for processing of foods and the various principles of food preservation are combined in food processing technologies, which aim at the ultimate production of safe and wholesome foods. The most important technologies are discussed in more detail below.

#### 9.3.1 Pre-processing operations

Food raw materials must be of good quality, ripe, free from extraneous
matter and undamaged. A good product cannot be manufactured from damaged or spoilt raw materials. Pre-processing operations consist of:

• **Sorting** that is the separation of material based on one of its characteristics (example colour sorting)
• **Grading** that is the assessment of number of attributes to obtain indication of good quality foods
• **Cleaning** or the removal of contaminated materials to leave surfaces suitable for further processing
• **Separating** using centrifugal forces and other methods such as filtration and expression
• **Size reduction** of food particles
• **Mixing** consisting of bringing together different components of foods or ingredients

**Peeling** that is the removal of peel or outer skins.

### 9.3.2 Heat processing

Heat is usually applied to preserve foods, as it kills microorganisms, destroys enzymes, cooks the food and changes the sensory properties. Heat is applied in different ways.

<table>
<thead>
<tr>
<th>Examples</th>
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</thead>
<tbody>
<tr>
<td>• Blanching</td>
</tr>
<tr>
<td>• Pasteurisation</td>
</tr>
<tr>
<td>• Cooking</td>
</tr>
<tr>
<td>• Baking</td>
</tr>
<tr>
<td>• Sterilisation</td>
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</table>
**Blanching**
Blanching is a short time, high temperature treatment carried out to

- destroy enzymes in vegetables and some fruits before further processing,
- reduce the number of microorganisms
- soften the tissue

Factors influencing blanching time are

- type of fruit or vegetable
- size of the pieces of food
- blanching temperature
- method of heating

**(2) Pasteurisation**
Pasteurisation is the application of heat below 100 °C. This method kills most but not all of the pathogenic and spoilage organisms in foods. Pasteurisation conditions used are

- **HTST**: High Temperature Short Time
  
  72 °C for at least 15 seconds

- **LHT**: Low Temperature Long Time or holding
  
  65.6 °C for 30 minutes
Method of pateurisation

The products are heated by steam, hot water, dry heat, or electric current, then cooled promptly to about 10 °C. Pasteurisation can be applied to milk, sauces, juices, cream, and wine.

Heating at about 100oC is sufficient to kill everything except bacterial spores.

100 ° C is obtained by
- boiling a liquid food
- by immersion of container of food in boiling water
- by simmering-gentle boiling about 100 °C

(3) Baking and roasting

Baking and roasting is cooking of food using dry heat. Heating temperatures are high but internal food temperature may be slightly below 100 °C.

Roasting - applies to meats, nuts and vegetables
Baking – applies to flour-based foods or fruits

<table>
<thead>
<tr>
<th>Primary purpose</th>
<th>To change the structure/sensory properties of the food</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary purpose</td>
<td>Preservation by destruction of micro-organisms and reduction of the water activity at the surface of the food.</td>
</tr>
</tbody>
</table>

Additives and other ingredients are used to add flavour and develop characteristics, which are special to such products.

(4) Frying
Frying utilises oil or fat to transfer heat to a raw or cooked food product.

During frying,
- the food is cooked,
- chemical changes impart flavour and texture characteristics and the product loses a certain amount of water

Depending on the level of water loss, the food may be shelf stable or need refrigeration for shelf life. Here also, the external temperature is high whereas the temperature inside the food is not more than 100 °C.

Heating above 100 °C is obtained by means of steam under pressure in sterilisers or retorts. The temperature in the retort increases with rising steam pressure.

<table>
<thead>
<tr>
<th>Pressure Level</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>At sea level</td>
<td>100 °C</td>
</tr>
<tr>
<td>With 5 lb</td>
<td>109 °C</td>
</tr>
<tr>
<td>10 lb pressure</td>
<td>115.5 °C</td>
</tr>
<tr>
<td>15 lb pressure</td>
<td>121.1 °C</td>
</tr>
</tbody>
</table>

(5) **Ultra Heat Treatment (UHT)**
This is a type of sterilisation, which involves heating a liquid to a very high temperature for a very short time. Milk is heated to 132.2 °C by use of steam injection for a few seconds. This milk can be kept unopened for up to six months.

(6) **Canning**
Canning is a heat treatment of foods in hermetically sealed containers (tin coated steel cans, glass or aluminium containers, plastic
pouches). The aim is not complete sterilisation but rather to kill all micro organisms that could spoil food under normal conditions of storage.

Time and Temperature relationship. With high retort temperatures, shorter times are used. The process varies with the acidity of foods, the sauces used, the sizes and shapes of the cans, and the initial food temperatures.

Loosely packed foods in liquid require less heat than solidly packed ones. Acid foods require less heat than those nearer neutrality. Foods such as artichokes cannot withstand high temperatures and are acidified and processed at lower temperatures.

Sterilisation can be done in two ways

- The food is sterilised and placed in a container in aseptic conditions
- The food is placed in a container first, then sterilised
In both canning and bottling, the product is placed in a hermetically sealed container to prevent re-entry of and thus recontamination by microorganisms.

(7) Cold processing
Cold processing is the removal of heat from a product. In foods, cooling and freezing slow down enzymatic, chemical and microbial activities and can be used for preservation. This method is essential for some food items such as ice cream. Methods of cold processing include chilling, cook chilling and freezing.

Chilling

Chilling or cold storage temperatures are above freezing temperatures but usually less than 5 °C

Important considerations in chilling storage are:

Temperature
The lower the temperature, the higher is the cost. Although most foods will keep best at temperatures just above freezing point, they are not necessarily stored at this temperature unless required.

Relative Humidity (RH)
Optimal level varies with the foods stored and with environmental factors. A too low relative humidity may lead to a loss of moisture and hence loss in weight, wilting and softening of fruits and vegetables. High relative humidity may cause growth of spoilage microorganisms

<table>
<thead>
<tr>
<th>Near saturation RH</th>
<th>bacteria growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-92 % RH</td>
<td>development of yeast</td>
</tr>
<tr>
<td>85-90 % RH</td>
<td>development of moulds</td>
</tr>
</tbody>
</table>
Ventilation

Ventilation or control of air velocities is important to maintain a uniform relative humidity in the storage room and to remove odours. The rate of air circulation affects the rate of drying foods. Poor ventilation may give rise to local areas of high humidity leading to microbial decomposition.

Cook-Chill products are usually dishes that are cooked, rapidly chilled and stored at low temperatures. These foods should be reheated prior to consumption.

Freezing

Freezing is the process of lowering temperature of food to below the its freezing resulting in reduced reaction time and lowered water activity. Freezing has little effect on flavour, nutritional value and colour but may damage the texture due to large ice crystal formation during slow freezing.

Methods used are:

1. Direct immersion of the food or packaged food in a refrigerant (freezing of fish in brine)
2. Indirect contact with refrigerant at –17.8 to –45.6 °C
3. Air blast freezing where frigid air of –17.8 to –34.4 °C is blown across materials being frozen
4. Plate freezing where the food is placed between two plates which make contact with the food’s surface

Since freezing does not completely stops enzymatic action, fruits and vegetables are blanched (dipping in boiling water for a short time), prior to freezing.

(8) Dehydration (evaporation and drying)
Drying of food is the reduction of its water content to such a level that microorganisms cannot grow. Chemical reactions, such as browning may still occur causing deterioration of quality. Sun drying requires little equipment for the drying process. Other methods used include oven drying, hot air beds, spray drying, and drum drying. Evaporation (concentration) is often used to reduce the amount of water before drying, but it can also be used to manufacture products with specific characteristics.

(9) Addition of salt, acids, sugar and smoke

Salting
At high concentrations, salt preserves the food through reduction in water activity and control of microbial growth. Salt also adds flavour.

<table>
<thead>
<tr>
<th>Uses of salt</th>
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</thead>
<tbody>
<tr>
<td>Basic flavouring agent</td>
</tr>
<tr>
<td>Flavouring agent and preservative in meat</td>
</tr>
<tr>
<td>Flavouring ingredient and curing agent in cheese</td>
</tr>
<tr>
<td>Flavouring agent in butter</td>
</tr>
<tr>
<td>For control of fermentation processes</td>
</tr>
<tr>
<td>In brine storage of cucumbers and other vegetables</td>
</tr>
<tr>
<td>In brine storage of citrus peel before further storage</td>
</tr>
<tr>
<td>For temporary storage of cut fruits</td>
</tr>
<tr>
<td>Fish preservation</td>
</tr>
</tbody>
</table>
Addition of acids
Acids are usually added to enhance flavour, to reduce the pH (preservative effect) and to create specific products, such as fermented foods.

**Acids used in foods**

- Citric acid (also lemon juice)
- Tartaric acid
- Lactic acid
- Malic acid
- Acetic acid (also vinegar)
- Phosphoric acid

Addition of sugar
Sugar is a common ingredient in many foods.

Sugar at concentrations of 40 % or more, aids in the preservation of products such as jellies, jams, condensed milks, candies and grapefruits. A sugar concentration of about 60% in finished or processed products generally ensures preservation. Sugar addition followed by evaporation will lower the water activity to about 0.848
aw. However at this level, mould and osmophile yeast can still grow on the product.

For jam preparation, fresh or pre-cooked fruits are boiled in a solution of cane or beet sugar until sufficient water has evaporated giving a mixture that will set to a gel on cooling. Gel formation is dependent on the presence of pectin, a carbohydrate of the fruit. At a pH of 3.2 to 3.4 and in the presence of a high concentration of sugar, pectin can form a viscous semi-solid. Other sugar preserves from fruits are marmalade, jelly and fruit paste.

Addition of smoke
Smoking is a traditional food preservation method. Presently the sensory properties of smoke are also sought. Smoke can be added to foods by
- burning wood and letting the smoke soak into the product or
- adding the flavour as a liquid to the surface of the product

**Effects of smoke**

- Drying
- Developing and fixing of colour of lean portions
- Tenderising action from proteolytic activity of enzymes, supported by the higher temperatures
- Producing desirable finish or gloss on skin
- Imparting desirable flavour
- Imparting fat antioxidants
- Impregnating outer portion of meat with components with a preserving action
- Reducing microbial level of meat
Use of food additives
Additives may be added intentionally for five main reasons:

1. **To control food texture.** Emulsifiers, stabilizers, and thickeners give food an even texture and help keep ingredients and flavours blended in the product. Lecithin, mono and diglycerides, guar gum and carrageenan are examples of such additives. Emulsifiers are also used to keep peanuts and oil from separating.

2. **To improve flavour and colour.** Natural and artificial colours and flavours enhance the appearance and taste of certain foods. Examples include: Aspartame; FD&C Red No 40, Monosodium glutamate (MSG).

3. **To improve nutritional value.** When nutrients are added to foods to replace those that are lost during processing, these foods are said to be enriched. Vitamins and minerals, as well as fibre, are often added to enrich foods. Many of the B vitamins are lost as whole wheat flour is being refined into white flour, so these are added back to enrich the flour. Vitamins A and D are added to fortify milk.

4. **To maintain freshness and safety.**
Preservatives prevent spoilage of foods by controlling or preventing growth and survival of microbial agents. Preservatives include: citric acid, sulfites, calcium propionate and sodium nitrite.
Antioxidants, such as vitamin E, BHA and BHT are added to fats and oils to prevent rancidity. They also are used in baked goods, cereals, processed foods, and salad dressing to prevent spoiling and discoloration.

5. **To help foods rise and to control the acid-base balance of food.**
Leavening agents cause baked goods, such as bread, to rise. Other additives, such as yeast and sodium bicarbonate, help control the acidity and alkalinity of foods and hence the flavour, taste, and colour.

**Irradiation**

Food can be irradiated to render it safe and to maintain its quality.

The food is exposed to ionising radiation, either from **gamma rays** or an **electron beam**. The rays pass through the food just like microwaves in a microwave oven, but the food doesn't heat up.

**Gamma rays** are a form of radiation that shares some characteristics with microwaves, but in a more concentrated form.

**Electron beams** are formed from electricity and do not need radioactive material to work.

At low doses, irradiation extends shelf life of products.

At higher doses, this process kills insects, moulds, bacteria and other potentially harmful microorganisms.
9.5 INTRODUCTION TO PACKAGING

Packaging is necessary to impart visual identification to food products, to maintain the beneficial effects of food processing, that is to prevent recontamination of the food and to preserve its sensory properties.

<table>
<thead>
<tr>
<th>Uses of packaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>• to contain</td>
</tr>
<tr>
<td>• to protect</td>
</tr>
<tr>
<td>• to communicate</td>
</tr>
<tr>
<td>• to market the produce</td>
</tr>
</tbody>
</table>

Packaging materials Different types of packaging materials are available for packing food products. The characteristics of commonly used materials are listed below.

• **Paper**  
  – Strength; rigidity; opacity; printability.

• **Aluminium foil**  
  – Negligible permeability to water vapour, gases and odours; grease proof, opacity and brilliant appearance; dimensional stability; dead folding characteristics.

• **Cellulose film (coated)**  
  – Strength; attractive appearance; low permeability to water vapour (depending on the type of coating used), gases, odours and greases; printability.

• **Polythene**  
  – Durability; heat-sealability; low permeability to water vapour; good chemical resistance; good low-temperature performance.

• **Rubber hydrochloride**
–Heat-sealability; low permeability to water vapour, gases, odours and greases; chemical resistance.

**Cellulose acetate**
–Strength; rigidity; glossy appearance; printability; dimensional stability.

**Vinylidene chloride**
–Low permeability to water vapour, gases, copolymer odours and greases; chemical resistance; heat-sealability.

**Polyvinyl chloride**
–Resistance to chemicals, oils and greases; heat-sealability.

**Polyethylene terephthalate**
–Strength; durability; dimensional stability; low permeability to gases, odours and greases.

**Tinplate**
Tinplate, a rigid and impervious material, consists of a thin sheet of low carbon steel coated on both sides with a very thin layer of tin. Tin is not completely resistant to corrosion but its rate of reaction with many food materials is considerably slower than that of steel.

### 9.6 CHOICE OF PROCESSING METHODS FOR FRUITS AND VEGETABLES

Practically any fruit, vegetable and animal product can be processed. The rationale for processing the product and the method to be used will depend on the following factors:

1. demand for a particular fruit, vegetable or animal product in the processed form;
2 quality of the raw material and its ability to withstand processing;

3 supply of the raw material;

4 cost of processing.

**ACTIVITY**

A workshop with breakaway groups is provided for, rather than practical work or demonstrations, due to the nature of the information covered in the module. The participants are divided into groups of four. Each group will discuss the problems outlined below.

**Drying of foods**

The following is a process for the drying of sliced cabbage.

```
Cabbage
  Sort
  Clean off outer leaves
  Cut out central stalk
  Slice cabbage
  Wash strips
  Blanch in boiling water (4 minutes)
  Cool
  Spread out
  Dry (@ 60 °C for 12 hours)
  Cool and equilibrate moisture
  Packaging
```

**Problems**

The following problems are identified during drying or in the dried product. Discuss them and identify the possible cause(s) and
1. The dried product has spots and marks.
2. The product has mould growing on it.
3. The product takes long to dry.
4. The dried product looses colour or browns quickly after drying or during storage.

<table>
<thead>
<tr>
<th><strong>Problem</strong></th>
<th><strong>Cause(s)</strong></th>
<th><strong>Solution(s)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Spots and marks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mould growth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long drying time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colour loss/browning</td>
<td></td>
<td></td>
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</tbody>
</table>

**Possible answers**

<table>
<thead>
<tr>
<th><strong>Problem</strong></th>
<th><strong>Cause(s)</strong></th>
<th><strong>Solution(s)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Spots and marks</td>
<td>Raw material not well selected</td>
<td>Use only good material</td>
</tr>
<tr>
<td>Issue</td>
<td>Cause</td>
<td>Solution</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>External contamination with foreign material during or after drying</td>
<td>Prevent contamination through covering during drying (without affecting air movement) and proper packaging</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Insect infestation</td>
<td>Prevent access to insects</td>
</tr>
<tr>
<td>Mould growth</td>
<td>Product not completely dried</td>
<td>Dry product until crisp</td>
</tr>
<tr>
<td></td>
<td>Wet spots on dry product</td>
<td>Equilibrate moisture in dried product</td>
</tr>
<tr>
<td></td>
<td>Dried product got wet</td>
<td>Packaging must prevent moisture uptake; prevent moisture getting to product during storage</td>
</tr>
<tr>
<td>Long drying time</td>
<td>Temperature too low</td>
<td>Moisture movement out of product not fast enough</td>
</tr>
<tr>
<td></td>
<td>Temperature too high</td>
<td>Moisture removed too fast from surface leading to case hardening prevents further fast removal of water</td>
</tr>
<tr>
<td></td>
<td>Humidity of air too high</td>
<td>Facilitate removal of moisture from area surrounding product</td>
</tr>
<tr>
<td></td>
<td>Product spread too thick</td>
<td>Reduce thickness of product layer</td>
</tr>
<tr>
<td>Colour loss/browning</td>
<td>Active enzymes remaining</td>
<td>Improper blanching, increase time and/or temperature</td>
</tr>
<tr>
<td></td>
<td>Too high storage temperature</td>
<td>Reduce temperature</td>
</tr>
</tbody>
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1.2 **Frying of foods**

A packet of potato crisps is opened and the crisps have an unacceptable odour (rancid) and colour (dark brown). Identify the
possible causes of this and how these can be prevented.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Cause(s)</th>
<th>Solution(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off flavour</td>
<td>Abused frying oil</td>
<td>Always use sufficiently fresh and high quality oil</td>
</tr>
</tbody>
</table>

Possible Answers
<table>
<thead>
<tr>
<th>Issue</th>
<th>Reason</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxidised oil</td>
<td>Packaging is too permeable to oxygen; use packaging with higher barrier properties</td>
<td></td>
</tr>
<tr>
<td>Brown colour</td>
<td>Too high frying temperature</td>
<td>Reduce frying temperature</td>
</tr>
<tr>
<td>Potatoes too high in sugars</td>
<td>Buy correctly stored potatoes*</td>
<td></td>
</tr>
</tbody>
</table>

## 2 MATERIAL IN NATIONAL CONTEXT

The following products and processes are linked to specific SADC countries and can be used as examples of specific processing technologies as covered in the training material. Some of the processing technologies used during their manufacture are given in brackets.

1. (Steamed) bread (baking)
2. Mango achar (preprocessing, mixing)
3. Maize, sorghum, millet milling (size reduction)
4. Peanut processing (separating, roasting)
5. Coconut drying and shredding (dehydration, size reduction)
6. Oil processing (separating)
7. Drying of fruits, fish, vegetables, e.g. sundrying of tomatoes (dehydration)
8. Pickling of vegetables (addition of acids)
9. Pineapple processing (separation, pasteurisation)
10. Beverage production, e.g. fruit juices, beer from sweet potatoes, sorghum (addition of acids, natural)
11. Dairy processing, e.g. amazi (addition of natural acids, pasteurisation)
QUESTIONS AND ANSWERS ON THE MODULE

Why is it important to preserve foods?
A: To enable to keep food in a nutritious and safe state for consumption by people who cannot grow their own food and during times when the food is not readily available.

Name three groups of reactions or organisms which can negatively affect the safety of foods.
A: Micro organisms, chemical and biochemical reactions.

Are the influences of the groups mentioned in (ii) always negative? If not, identify at least one product in each group where the reaction has a positive influence on the food.

List at least seven processing methods that can be used to preserve foods.
A: Heating, drying, freezing, sugaring/salting, acidification, smoking, chemicals

Discuss when and how foods can become contaminated with micro organisms.
A: How: during harvesting, slaughtering, preparation for processing, after processing. How: from air, water, hands, surfaces, soil, the outside of the product.

Give an example of a biochemical reaction which can be beneficial to a food, but which will decrease food quality when left to continue too far.
A: Ripening of fruit, aging of meat
Why must raw materials and food products be handled carefully?
A: To prevent damage, loss of moisture, growth of microorganisms, deterioration through chemical and biochemical reactions.

Why are foods cleaned? List at least three methods for cleaning?
A: Foods are cleaned to reduce microbial load and remove foreign material. Cleaning can be done by washing, brushing, steam, high velocity air, vacuum, magnetic removal of metals.

What does separation of foods entail and give an example of each?
A: The removal of a solid from a solid, e.g. skins from fruit or shells from nuts, the removal of solids from liquids or the other way round (filtration of juice or preparation of juice) or removal of air from a liquid (e.g. the removal of air from juice by vacuum).

What is disintegration of foods and give examples?
A: The reduction of large pieces of foods into smaller particles. Examples: milling of grains, pulping of fruit, reduction of oil droplets through high speed mixing, dicing of vegetables, cutting of meat.

Give three examples of mixing of foods.
A: The preparation of dough, the flavouring of milk, the addition of sugar to juice, the beating of egg white.

Name four degrees of heat preservation and explain the differences.
A: Sterilisation (the complete destruction of microorganisms through heat), commercial sterilisation (The destruction of all harmful and other micro organisms to such an extent that any remaining
organisms will not grow during storage), pasteurisation (the destruction of micro organisms through milder heat treatment, such that known pathogens are destroyed and will not grow during subsequent storage, but other harmless micro organisms will spoil food after a certain period of time), blanching (a mild heat treatment applied mostly to fruits and vegetables to destroy enzymes).

**How are heat treatments selected?**

A: By determining the time and temperature combination required to inactivate the most resistant pathogens and spoilage organisms and by determining the heat penetration characteristic of the food.

**Name the three heating mechanisms of foods and explain the difference.**

A: Conduction: heating of food where the heat is transferred from one particle to another in a straight line in solid foods, e.g. meat; convection: heating of food through the movement of the food, e.g. a liquid; radiation: heating of food through transfer of heat by waves.

**Which grain is best suited to make flour and how does its composition influence the baking of bread?**

A: Wheat is the only flour whose protein component, together with the correct amount of water, develops into an elastic network which can hold gas and set in a spongy texture in an oven.

**Which three characteristics influence the suitability of wheat to form bread flour?**

A: The variety of wheat, the protein content of the flour and the milling conditions.

**What is the purpose of the milling process and how is this**
normally done?
A: To separate the wheat endosperm (source of flour) from the germ and the bran and to reduce the endosperm chunks to fine powder. This is achieved by passing the wheat kernels through a series of rollers and sieves. The various streams from different sieves can be combined by the miller to yield different flours.

Name the four ingredients that will produce a basic loaf of bread.
A: Wheat flour; salt; yeast; water.

Which types of leavening agents are used and what are their function(s)?
A: Yeast or chemical agents. They form gas either through fermentation of sugars (yeast) or chemical reactions (chemical agents) which become trapped in the gluten (protein) network and result in the rising of the dough.

Why are other ingredients added to the flour?
A: As food for the yeast, to improve dough formation, to improve dough handling, to retard retrogradation (ageing) of bread

What are the roles of the following ingredients in bread?
  a) Fat or oil
  b) Milk
  c) Other cereal grains

A: a) To improve flavour and to help slow down the staling process
    b) To produce a bread with a softer texture (instead of, or in combination with water)
    c) To produce breads with different tastes and textures
List the three important steps in baking of bread and give a short discussion of each.

A: Mixing: to affect uniform distribution of all ingredients, to introduce air bubbles, to develop the gluten structure; leavening: to allow time for gas formation and fixation, more important in the case of yeast; baking: expansion, coagulation of proteins, gelatinisation of starch, evaporation of water, browning of the crust and flavour development.

Name any two savoury ingredients that may be added to bread.

A: Cheese, fried onions, dried tomatoes, herbs.

Name any two sweet ingredients that may be added to bread.

A: Sugar, cinnamon, dried fruit.

How does frying differ from other heat processing methods?

A: Cooking of product is achieved in a short period of time due to large temperature differences between oil and product as well as small product particle sizes; frying fat or oil is taken up by the product and becomes a significant part of it; the outer layer of the fried product is crisp; the heat transfer medium, i.e. fat, is subject to quality changes (deterioration); mechanical problems of frying large masses of products need to be overcome.

Describe the physical changes which occur in foods during frying.

A: Water evaporates from the product and is partly replaced by oil; the temperature of the product rises to the desired temperature; the surface of the product is dried and heated so that desired browning and crisping can occur; the dimensions of the fried product change; part of the fat is removed from the frying system with the food; the removed fat must be replaced; the product changes in density during frying and either floats or stays submerged.
Which four general factors affect oil uptake in the fried product?
A: Frying temperature, frying time, product (dough) viscosity, fat source.

Which visible changes that may occur in oil, indicate that the oil must be discarded?
A: Discolouration from yellow to brown/black; excessive foaming of the hot oil; excessive smoking of the hot oil; thickening of the oil, i.e. no longer pours easily, but becomes viscous.

List the factors that may lead to oxidation of cooking oils.
A: Presence of oxygen; high frying temperatures; long frying times; repeated heating; presence of moisture; cooking both proteinaceous and starchy foods in the same oil; type of heating method used (e.g. gas or electricity); type of oil used (e.g. sunflower, olive, etc).

Explain the difference between chilling and freezing.
A: Chilling refers to storage of food at temperature above freezing point (usually between −0 °C and 16 °C) whereas freezing is the storage of food below -20°C. Food usually only freezes at −2 °C and not like pure water at 0 °C.

Which of the two methods provides the longer shelf-life?
A: Freezing

Why should raw materials preferably be transported and stored at chilling temperatures, i.e. what are some advantages of chilling?
A: Chilling reduces microbiological and biochemical changes and thus preserves the quality and safety of the food.
What are the most important (principal) requirements of refrigerated storage?
A: Controlled low temperature, air circulation, humidity control.

What is the advantage of freezing?
A: Most deteriorative reactions are stopped or very slow during freezing and thus a frozen food can be preserved without large changes to size, shape, texture, colour and flavour.

Name three changes each which occur during a) chilling and b) freezing, which can influence the quality of the food.
A: Chilling: feeding of animals and growth conditions of plants will influence the keeping quality of meat and fruit respectively, low temperatures can cause refrigeration damage to certain fruits and vegetables, flavours can be exchanged between different foods during storage, fruit and vegetables can loss firmness and crispness, meat can change colour and lose moisture, fats can become rancid.
Freezing: partially frozen food will deteriorate because solutes become concentrated and can, e.g. cause negative colour reactions, ice crystal formation can cause damage to cells and result in high drip loss during thawing, specific foods must be stored at certain freezing temperatures for optimum shelf-life, intermittent thawing and freezing can result in loss of moisture (drying out), loss of texture and even microbial growth, which negatively affects safety and quality of the product.

Name five objectives for using salt in foods.
A: Flavouring ingredient, preservative, texturising agent, active processing ingredient, enhancer of anti-oxidants, quality grading, reduction of freezing point
Name two examples each of natural, fermentation and synthetic acids.
A: Natural: lemon juice, tartaric acid; fermentation: citric acid, vinegar, (lactic acid); synthetic: phosphoric, acetic, (malic).

List ten functions of acids in food processing.
A: Depress sweetness, clarify and stabilize fruit juices, control rate of thermal destruction of micro organisms and enzymes, influence the properties of colloidal systems, scavenge harmful metals, make possible the utilisation of micro organisms and enzymes, improve texture, inversion of sucrose, prevent flavour reversion of edible oils, increase flavour intensity, aid extraction of pectins and pigments, increase effectiveness of benzoate (preservative), stabilise ascorbic acid.

What is the relation between acid level and pH?
A: The higher the acid level, the lower the pH and vice versa

Describe the use of acid in a food product of your choice
A: (Choose product from fruit, vegetables, dairy, meat, soft drink, confectionery, desserts, aspic, baking, etc. See Fundamentals of Food Processing Operations from pp159-166)

List the eight effects of smoking on meat
A: Drying, fixing colour, tenderising action from temperature, creation of gloss or finish, desirable flavour, imparting of antioxidants to the fat, imparting of preservatives to the product, reduction of microbial level.

Name four methods to apply smoke to meat.
A: Through burning of wood (hot smoke), electrostatic deposition, cold smoke and liquid smoke.

List ten general requirements for food containers.
A: Non toxic and compatible with the specific food; sanitary protection; moisture and fat protection; gas and odour protection; light protection; resistance to impact; transparency; tamper-resistant or -evident; ease of opening; pouring features; reseal features; ease of disposal; size, shape and weight limitations; appearance, printability; low cost; special features.

**What is a hermetic closure?**

A: A seal which is absolutely impermeable to gases and vapours or other components, including the seams.

**List the various packaging materials and discuss the features of one of them.**

A: Metals, glass, papers, plastics and films, laminates, edible films.

E.g. glass: chemically inert, breakable, heavy, sensitivity to thermal shock, can be coated.

**What are some benefits of packaging?**

A: Physical protection of the product, convenience, advertising, appealing to the eye, shelf-life extension, prevents recontamination, prevents loss of flavour and colour.
REFERENCES


