UNIT 10 INTRODUCTION TO FOOD PROCESSING

Structure

10.1 INTRODUCTION

We are all aware that delay in the use of fresh foods alters its freshness, palatability and nutritive value. Therefore, it becomes very important that we transform the fresh raw material and ingredients into wholesome, safe, nutritious and acceptable foods to be used by the consumers throughout the year. This process of transforming fresh raw material into wholesome, safe, nutritious and acceptable foods for the consumers is referred to as *food processing*. Food processing is as old as the human hunger. Thousands of years ago, hunters and gatherers cured meat, dried fruits and berries, and cooked meals for their families. From the simple foods for ancient peoples to the foods created for astronauts, food processing has been intimately linked with human endeavours.

In this unit, we shall study about all the different aspects of processing i.e. its historical developments, what are the basic concepts and principles of food processing and preservation, why is food processing necessary, what are the different food processing techniques to prevent the food from the spoiling agents. Using this knowledge of food processing, we shall then learn about how to transform the food into a more palatable form with a prolonged shelf-life. But, before we learn about processing we need to understand food spoilage and its causes. We begin this unit by first defining food spoilage and discussing the main causes of food spoilage.

Objectives

After studying this unit, you will be able to:

- discuss the concepts and aims of food processing,
- enumerate the historical developments in food processing and preservation,
- identify the factors that are responsible for food spoilage, and
- describe the traditional methods of food preservation and their principles.

10.2 FOOD SPOILAGE AND CAUSES

Foods gradually undergo deterioration or spoilage from the time they are harvested, caught, slaughtered or manufactured. Therefore, delay in the consumption or processing of fresh foods alters its freshness, colour, texture, palatability and nutritive value, organoleptic desirability, aesthetic appeal and safety as you have seen in the

last Unit. Essentially, all foods undergo varying degrees of deterioration during handling and storage. Some foods spoil rapidly, others keep for longer but for a limited period of time. Therefore, spoilage of food refers to *the alterations in foods or the food undergoes some physiological, chemical and biological changes, which renders it inedible or hazardous to eat*. Hence, such food is essential for processing or preservation after it is harvested or slaughtered.

Why and how does the food get spoiled? There are several causes of food spoilage. These include:

- *growth of microorganisms*, such as bacteria, moulds and yeasts, which can spoil food very fast
- a*ction of enzymes,* present in all raw food, promotes chemical changes affecting especially the food texture and flavour
- *atmospheric oxygen* can react with some food components, which may cause rancidity or colour changes (oxidative reaction)
- *damage due to pests (insects, rodents etc),* which account for huge losses in food stocks infestations, and
- *others*: moisture, light, time, temperature (heat and cold), mechanical damage, etc.

At any one time, many forms of spoilage may take place depending upon the food and environmental conditions. Food processing involves the development of preservation techniques to slow down or stop the food spoilage caused by the above factors and finally result in the preservation of food.

In the next section(s), we will learn about the processing concept, principles and methodology.

10.3 FOOD PROCESSING

Food processing, as you learnt earlier, involves the conversion of raw materials and ingredients into an acceptable food product for the consumer. It encompasses every aspect necessary to transport raw materials from the "harvest site" through packaging and merchandising. It involves the application of scientific principles to slow down or stop the natural processes of food decay caused by microorganisms, enzymes in the food or environmental factors such as heat, moisture and sunlight and so preserve the food. Much of this knowledge is known traditionally and put into practice by experience and information handed down through the generations. Food scientists strive to improve the methods of storing, processing and manufacturing food through the scientific understanding of mechanisms involved.

The term 'processing' is very broad and encompasses many techniques. These include primary processing like threshing, dehusking, polishing and grinding in case of food grains and preliminary operations such as cleaning, washing, sorting, grading, peeling, blanching and cutting in case of fruits and vegetables and others to produce secondary processed products like breads, biscuits, confectionery, dehydrated and canned products like jams, jellies, pickles, sauces, frozen meals etc. This diverse range of operations means that the majority of foods are processed in one way or another before being consumed. What are the reasons for processing foods? Well, the reasons for food processing may vary, but the main objectives are discussed in the next section.

10.3.1 Aims of Food Processing

The reasons for food processing may vary, but the main objectives are to:

- preserve the nutritive quality of food by preventing them from spoilage due to microbes and other spoilage agents

- prolong the shelf-life (e.g. preservation). This is because the processed food is usually more stable than the raw food
- enhance the quality (e.g. cooking)
- ensure that food is safe for future consumption
- ensure the availability of many food products throughout the year
- ease for storage, transportation and distribution systems, and
- create employment and to generate additional income.

Food processing, you would have realized, is practiced in some form or the other in most of our homes. Have you ever thought about its origin? How did it start? How did it develop? The next section presents the historical development of food processing. You will find this discussion interesting.

10.3.2 Historical Development of Food Processing

Food processing began thousands of years ago to help people keep food through the lean seasons. Various methods of preserving food have been around for a long time. The processes of smoking, drying (dehydration) and using salt and spices to prevent spoilage have been used for thousands of years. All of these methods were based on desiccation or dehydration. Grains and nuts were the first foods to be dried using the naturally available sunlight and air. Mechanical methods of drying were developed in the late 1700s. Dried foods are popular because they are compact, lightweight and last much longer than the fresh foods. Cheese-making was an accidental discovery, which became established as a method for increasing the longevity of milk.

The process of canning was pioneered in the 1790s when *Nicolas Appert*, a French Confectioner, discovered that the application of heat to food in sealed glass bottles preserved the food from deterioration. *Napoleon-I* gave *Appert* 12,000 Francs to make his invention public. *Napoleon* was highly interested in *Appert's* invention because of its potential to supply food to the armed forces who were many miles away from home. *Appert* published several books for canning and started the canning industry. Around 1806, the French Navy had undertaken successful training of *Appert's* principles on a wide range of foods including meat, vegetables, fruit and milk.

Before 1860, changes in food were explained on the theory of spontaneous generation. *Pasteur* demonstrated that ferments, moulds and some other forms of putrefaction were caused by the presence of microorganisms widely distributed in the environment. Since these microorganisms are the main cause of food spoilage, food preservation depends on rendering conditions unfavourable for their growth.

The evolution of food processing is listed in Box 10.1.

Box 10.1: Evolution of food processing

- 8000 - 7000 B.C.: Mankind first began farming, growing crops and raising animals for food instead of hunting and gathering for food.
- 4000 B.C.: Salt, chemicals in smoke, drying, use of snow and ice were used for storing food for long times.
- 3000 B.C.: Yeast was used to make alcoholic drinks by fermentation.
- 200 A.D.: Bacteria were used to make yogurt by fermentation.
- 1810: *Nicolas Appert* (1752-1841) discovered a way of preserving food in sealed containers. Canning industry is developed from his discovery.
- 1860s: *Louis Pasteur* (1822-95) invented a way of killing harmful microbes in wine and beer.
- 1920s: *Clarence Birdseye* (1886-1956) developed a method of quick freezing food.

Today, food processing allows food from other parts of the world to be transported to our local market, so that we can enjoy a great variety of things to eat all through the year. Let us then study the methods and principles that are involved in the food preservation technique.

10.3.3 Methods and Principles of Food Preservation

Food preservation is one of the oldest technologies used by human beings. The perishable food materials like fruits, vegetables, milk, meat, fish and others deteriorate or decay easily, so quite a lot of such commodities are wasted in various stages of food supply chain unless special methods are used for their preservation. Therefore, the process in which the perishable food materials are given a suitable physical or chemical treatment to prevent their wastage, spoilage and to retain their nutritive value for long periods, is called *food preservation*. The principles of food preservation refer to *the processing techniques that are used to prevent food from spoilage*. The different preservation techniques commonly used today are given in the Table 10.1.

Table 10.1: Methods of food preservation

1) Asepsis, or keeping out microorganisms
2) Removal of microorganisms (filtration, centrifugation, washing, trimming)
3) Maintenance of anaerobic conditions, e.g., in a sealed, evacuated container
4) Drying (drying under the sun, mechanical drying, freeze drying, smoking)
5) Use of high salt or sugar content (sugaring, pickling, curing etc)
6) Use of acids
7) Fermentation
8) Use of low temperatures (refrigeration, chilling, freezing)
9) Use of high temperatures (pasteurization, boiling, canning)
10) Mechanical destruction of microorganisms, e.g., by grinding, high pressure, etc.
11) Chemical preservatives
12) Carbonation
13) Irradiation
14) Combination of the two or more of the above methods.

All food preservation methods listed in Table 10.1 are based upon the general principle of preventing or retarding the causes of spoilage caused by microbial decomposition, enzymatic and non-enzymatic reaction, chemical or oxidative reactions and damage from mechanical causes, insects and rodents etc. The basic principles of the different preservation methods are highlighted next.

Principles of food preservation

The basic principles of food preservation include:

1) *Prevention or delay of microbial decomposition:* This is achieved by*:*
    a) keeping out microorganisms (asepsis).
    b) removal of microorganisms e.g. by filtration.
    c) hindering the growth and activity of microorganisms e.g. by low temperatures, drying, anaerobic conditions or chemicals, and

d) killing the microorganisms e.g. by heat or radiations.

2) *Prevention or delay of self-decomposition of the food.* This is brought about by:

   a) destruction or inactivation of food enzymes e.g. by blanching, and

   b) prevention or delay of chemical reactions e.g. prevention of oxidation by means of an antioxidant.

3) *Prevention of damage* caused by insects, animals and mechanical causes.

Having looked at the various methods of food preservation and the basic principle involved in the section above, we shall move on to section 10.4 where a detail discussion on the traditional methods of food processing is presented. But, before you go on to read about these methods, look up the points to remember listed below. This will help you sum up what you have learnt so far.

POINTS TO REMEMBER

1) Conversion of raw materials and ingredients into acceptable consumer products is referred to as food processing, which comprises of all the steps right from the time the raw materials are procured to the time it arrives on consumer tables, including preservation.
2) Most of the foods we buy are processed in some way or another. These processes help to make the products that are safe, of consistent quality and convenient for the consumers, prolonged shelf-life and available round the year.
3) Food spoilage or deterioration refers to the alterations in the foods or undergoing some physiological, chemical and biological changes, which render the food inedible or hazardous to eat. Food spoilage may affect: safety, nutritional value, organoleptic desirability, aesthetic appeal and change in colour, texture, flavour and other quality attributes of the food.
4) Major causes of food deterioration include: growth of microorganisms (bacteria, yeasts, moulds), activities of food enzymes and other chemicals within the food itself, infestation (by insects, parasites, rodents), oxidation, time, temperature and light, physical stress or abuse.
5) The principles of food preservation refer to the processing techniques that are used to prevent food from spoilage caused by the above agents.
6) The origin of food processing goes all the way back to 8000 B.C. Smoking, drying and salting were some of the most frequently used processes of preservation during ancient period.

Check Your Progress Exercise 1

1) Define food processing and food preservation.

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2) List the major causes of food deterioration/spoilage.

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3) What are the effects of food deterioration?

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4) Mention the major advantages of food processing.

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5) Different preservation techniques commonly used today, include:

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6) What do food manufacturers particularly aim to achieve when they preserve a food? (Choose the correct answer)

i) To improve its vitamin C content.

ii) To extend its shelf life.

iii) To reduce the amount of cooking time it will require.

10.4 TRADITIONAL METHODS OF FOOD PROCESSING

Because food is so important to survival and most foods remain edible for only a brief period of time, people since the earliest ages have experimented with the methods for successful food preservation. Among the products of early food conservation were cheese and butter, raisins, pemmican, sausages, bacon and grains. Therefore, food preservation is one of the oldest technologies used by human beings. Often, in the way of many traditional technologies, the ideas and methods are passed down through the generations, from mother to daughter. Look around and everywhere you will see people processing food, wherein food is being dried, crushed, milled, canned, bottled, cooked and sweetened.

Various methods of preserving food have been around for a long time. The methods like drying, pickling, salting, smoking, canning and freezing have been with us for the times immemorial. But all of these traditional methods are being updated and are in use today in some form. The methodology and principles of some of the preservation methods are discussed here:

- *Asepsis:* Food is a living system and it has natural protection mechanisms in its raw agricultural state. Once removed from the field or protective skin or peel (e.g. banana, coconut, vegetables, shell of nuts, husks of grains etc), it begins to deteriorate. Asepsis deals with the prevention of microbial contamination (keeping out microorganisms) of fresh or processed foods. Packaging of foods is a widely used application of asepsis.

- *Drying:* Drying is the oldest and probably the simplest way of preserving food. It is usually accomplished by the removal of water. Dried foods are preserved because the available moisture level is so low that the microorganisms cannot grow and enzyme activity is controlled. Moisture from food may be removed by a number of methods – drying by the sun's rays and by the modern artificial ones. Grains and nuts were the first foods to be dried under the sun and air. However, sun-drying is a slow process, risk of contamination and spoilage and is limited to climates with a hot sun and a dry atmosphere and to certain fruits such as grapes (raisins), figs, dates, apricots, raw mangoes (*amchur*), pears and

peaches. Vegetables like beans, peas, cabbage, cauliflower, lady finger, garlic, onions, chillies, turmeric and all leafy vegetables can also be dried by sun-drying. Drying of fruits and vegetables involves washing, peeling, preparing and spreading on flat bottom trays and drying under the sun. Fish (bombay duck) and shrimps are dried by exposing them to the sun on the seashore. The word dehydration usually implies *the use of controlled conditions of heating, with the forced circulation of air or artificial drying (mechanical drier)* as compared with the use of sun-drying. Using mechanical driers, fruits, fruit leathers, banana chips, tea, coffee, milk, soups, fish, meat, eggs and vegetables can all be dried year-round. Dried foods are compact and lightweight, do not require refrigeration and last much longer than the fresh foods. Dried foods should be stored in airtight containers to prevent moisture from rehydrating the products and allowing microbial growth.

- *Salting:* Salting, especially of meat, is an ancient preservation technique. Food is treated with salt or a strong salt solution. Due to high concentration of salt, water from the food is tied up and made unavailable for microbial growth and enzyme action and hence, preserves the food. Salt has the following effects: (a) causes high osmotic pressure and hence, plasmolysis (shrinking) of cell (b) dehydrates foods by drawing out and tying up moisture as it dehydrates microbial cells, and (c) ionizes to yield the chloride ion, which is harmful to organisms. Dry salting is used in India for the preparation of tamarind, raw mango, amla, fish and meat. Salted meat and fish can last for years. In meat salting, the prepared meats are soaked in 10% salt-water brine for several weeks. In fish salting, fresh fish are gutted on a cement slope and washed with the water. Coarse salt is then rubbed into their gills, mouth and scales. Layers of fish are alternated with layers of salt and covered with dry matting. They are then left to stand for 3 to 5 days, after which the pile is turned over and left for an additional 3 to 5 days.

- *Sugaring:* Water is withdrawn from the microbial cells when they are placed in a strong sugar solution (about 68%) and thus result in an adverse effect on microorganisms. Therefore, sugars such as glucose or sucrose, owe their effectiveness as preservatives to their ability to make water unavailable to organisms and to their osmotic effect. Examples of food preserved by high sugar concentrations are sweetened condensed milk, fruits in heavy sugar syrup (preserve or murraba), jams, jellies, marmalades and candies. Jam is prepared by boiling the fruit pulp with sufficient quantity of sugar (about 55 % by wt), acid and pectin to a reasonably thick consistency.

- *Pickling:* Pickling was widely used to preserve meats, fruits and vegetables in the past, but today it is used almost exclusively to produce “pickles” or pickled cucumbers or onions and sauces. Pickling uses the salt combined with the acid, such as acetic acid (vinegar). Microorganisms do not grow well in acidic solutions. Some of the fruits and vegetables, which lend themselves to pickling are raw mangoes, limes, amla, ginger, turmeric and green chillies. To make pickles, the fruits or vegetables are washed, cut into halves or quarters, the seeds are removed and then either dry salted or soaked in a 10-15% salt water brine for several days or months, then rinsed and mixed with spices, oils etc. and stored in glass bottles or jars.

- *Fermentation:* In contrast to other preservation methods, multiplication of microorganisms and their metabolic activities are encouraged. In this, microorganisms break down complex organic compounds into simpler substances either in aerobic or anaerobic conditions. The chemicals excreted by the microorganisms cause the preservative effect of fermentation. The principal chemicals involved are the acids (especially, lactic acid) and alcohol. These

inhibit the growth of common pathogenic organisms in foods. Examples of food preserved by fermentation are yogurt, cheese, beer, wine and other alcoholic beverages.

- *Cheese-Making:* Cheese is a way of preserving milk for long periods of time. In this process, the milk in cheese becomes something completely unlike milk, but cheese has its own interesting and delicious properties. Cheese-making is a long and involved process that makes use of bacteria, enzymes and naturally-formed acids to solidify milk proteins and fats and preserve them. Cheese can be stored for months or years.

- *Smoking:* Smoking was known as a method of food preservation at an early date. Foods are exposed to smokes by burning some special kinds of wood. It has two main purposes, adding desired flavouring and preserving. In the earlier times, many households had smokehouses, which were used to smoke beef, ham and bacon. Smoking is still used to preserve fish and meat. Most meat is smoked after curing to aid their preservation. Preservative action is provided by such bactericidal chemicals in the smoke as formaldehyde and creosote, and by the dehydration that occurs in the smokehouse. The smoke is obtained by burning hickory or a similar wood like oak, maple, walnut and mahogany under low breeze/wind.

- *Cold Preservation:* The metabolism of a living tissue is a function of the temperature of the environment. Low temperatures are used to retard chemical reactions and action of food enzymes and slow down or stop growth and activity of microorganisms in the food. Lower the temperature, the slower will be the above natural activities. Freezing and refrigeration are among the oldest methods of preservation. Mechanical ammonia refrigeration systems invented during 1875 allowed development of commercial refrigerated warehousing and freezing. Low temperatures employed can be:

  a) *Cellar storage temperatures (about 15^{o}C):* It is usually used for the storage of surplus foods like root crops, potatoes, onions, apples etc. for limited periods.

  b) *Refrigerator or chilling temperatures (0^{o}C to 5^{o}C):* Foods kept at this temperature slows down the microbial activities and chemical changes resulting in spoilage. Mechanical refrigerator or cold storage is used for this purpose. Examples of this include meats, poultry, eggs, fish, fresh milk and milk products, fruits, vegetables etc. can be preserved for 2-7 days by refrigeration.

  c) *Freezing (–18^{o}C to –40^{o}C):* In freezing, water in food turns into ice and makes unavailable for reactions to occur and for microorganisms to grow. Most perishable foods like poultry, meats, fish, ice-creams, peas, vegetables, juice concentrates etc. can be preserved for several months at this temperature. In vegetables, enzyme action may still produce undesirable effects on flavour and texture during freezing. Heating, like blanching, therefore, must destroy the enzymes before the vegetables are frozen.

- *Heat Preservation:* The process of heating was used centuries before its action was understood. Food is heated up or cooked. Heat kills microorganisms, alters the protein structure and destroys enzyme activity of microorganisms in food. The examples include all forms of cooked food, pasteurization, milk sterilized by UHT (ultra high temperature), canning etc. One of the most important modern applications of the heat principle is the pasteurization of milk. Heat treatment of food can be carried out by the following different ways:

a) *Pasteurization (temperature below 100°C)*

Pasteurization is a heat treatment that kills a part but not all the microorganisms present and usually involves the application of temperatures below 100°C. Milk, for example, is usually heated to 63°C for 30 min or 71°C for 15 seconds or in UHT, 138°C for 2-4 seconds. For example: milk, wine, beer, fruit juices and aerated waters are routinely pasteurized. The heating may be by means of steam, hot water, dry heat or electric currents and the products are cooled promptly after the heat treatment. Pasteurization is usually supplemented by other methods to prolong shelf-life.

b) *Boiling (temperature at 100°C)*

Cooking of rice, vegetables, meat, fish etc. at home is usually done by boiling the food with water and involves a temperature around 100°C.

c) *Canning (temperature above 100°C)*

Canning is the process in which *the foods are heated in hermetically sealed (airtight) jars or cans to a temperature that destroys microorganisms and inactivates enzymes that could be a health hazard or cause the food to spoil.* The vacuum seal formed after heating and cooling in the process ensures that no microorganism can get into the product. The degree of heat and the length of time of heating vary with the type of food and the kinds of microorganisms that are likely to occur in it. High-acid foods such as fruits and tomatoes can be processed or "canned" in boiling water, while low-acid vegetables and meats must be processed in a pressure canner at 121°C (15 psi pressure). Most canning is in 'tin cans' which are made up of tin-coated steel or in glass containers, but increasing use is being made of containers that are partially or wholly of aluminium, plastics such as pouches or solid containers. Examples of food preserved by canning are – all kinds of tinned foods, such as soup, meat, beans, cereal grains, legumes, nuts and other various dried food products such as fruit, coffee, milk, soups, fish, meat and vegetables.

- *Food concentration:* Relatively few liquid foods are preserved by concentration, mainly because of the reduction in water activity (a_w) and development of osmotic pressure which retard the microbial growth and enzymatic reactions. Concentration of food is usually done for many reasons: reduction in volume and weight, reduction in packaging, storage and transport costs, better microbial stability and convenience. Examples of food preserved by concentration are tomato paste, fruit juice concentrate, soup and condensed milk. The main requirement to improve processing of these products is to control the rate of heating to prevent localized burning of the product, particularly when it has become thickened towards the end of boiling.

- *Carbonating:* Carbonated water is *the water in which carbon dioxide gas has been dissolved under pressure*. By eliminating oxygen, carbonated water inhibits bacterial growth. Carbonated beverages (soft drinks), therefore, contain a natural preservative.

- *Use of food additives:* Food additives may be defined as *substances added intentionally to food, generally, in small quantities to improve its appearance, flavour, texture or storage properties*. These may be classified into different broad groups as listed in Table 10.2.

Those food additives, which are specifically added to prevent the deterioration or decomposition of a food, have been referred to as *chemical preservatives*. In food preservation, the added substances may be grouped into two categories. You may recall reading about these in the Food Microbiology and Safety Course, Unit 7. The first one includes the use of sugar, salt, spices, acetic acid (vinegar) and alcohol, and is referred to as *class I preservatives* and is considered to be relatively safe to humans. The second group includes the use of benzoic acid, sulfur dioxide, nitrates and nitrites and a variety of neutralizers, firming agents and bleaching agents and referred to as *class II preservatives* and is considered to be relatively safe to humans, but within the permissible doses prescribed by the Food Regulatory bodies because higher concentrations can be a health hazard. Preservation of foods by the chemicals is effected by interfering with the cell membrane of the microorganism, their enzyme activity and genetic mechanism by acting as antioxidants.

Table 10.2: Food Additives

Preservatives	Sodium benzoate in fruit drinks, potassium meta bisulphate in fruit products, sorbic acid in cheese, sodium and calcium propionates in breads and cakes, nitrates and nitrites in meats.
Antioxidants	Butylated hydroxy anisole (BHA), Butylated hydroxy toluene (BHT), propylgallate (PG), tocopherols in oily or fried foods, Ascorbic acid, SO_2 in fruit products.
Sequestrants (chelating agents)	Polyphosphates, citric acid – to remove elements from the food.
Surface-active agents (emulsifiers)	Lecithin, mono- and di-glycerides and bile acids-to stabilize oil in water.
Stabilizers and thickeners	Gums, gelatin, carboxy methyl cellulose, pectin, egg yolk etc. in jellies, chocolate milk drinks, pie fillings and cake toppings.
Bleaching and maturing agents	Oxides of nitrogen, chlorine dioxide in bleaching and maturing flour.
Food colours	Natural sources: annatto, caramel, carotene, saffron; synthetic sources: coal tar dyes.
Non-nutritive sweeteners	Saccharin, cyclamates etc.
Flavouring agents and flavour enhancers	Monosodium glutamate (MSG), 5'-nucleotides

- *Food Irradiation:* Food irradiation is another sterilizing technique in which the foods are bombarded by high-energy rays called *gamma rays* or by fast-moving electrons to kill bacteria, fungi and insects and in some cases, to delay fruit ripening. It has been used in pasteurizing or sterilizing perishable foods such as meat, fish and fruits and extending their storage lives for long periods. It is also used for sprouting inhibition in onions, potatoes etc. Sterilization can be effected at room temperature and hence, the technique is also called as *cold sterilization* process. A major benefit of irradiation is that it can occur after the food is packaged and sealed. Cobalt - 60 or Cesium - 137 or electrons producing machines are the principal sources of ionizing radiations used for food irradiation. The unit of radiation is in terms of *rads* (and kilorad or megarad). With this we end our discussion on traditional preservation methods. To help you recapitulate, a summary of the salient points is presented under points to remember herewith.

POINTS TO REMEMBER

1) The traditional food preservation methods like drying, pickling, salting, smoking, canning and freezing have been with us from the times immemorial. But all of these methods are being updated and are in use today in some form.
2) Dried foods are preserved, because the available moisture level is so low that microorganisms cannot grow and enzyme activity is controlled.
3) Fruits like grapes (raisins), figs, dates, apricots, raw mango powder (amchur), pears and peaches and vegetables like beans, peas, cabbage, cauliflower, lady finger, garlic, onion, chilli, turmeric, all leafy vegetables and fish can be dried under sun.
4) Dried foods are compact, lightweight, do not require refrigeration and last much longer than fresh foods, retaining wholesomeness.
5) Effects of salt in food preservation include: (i) causes high osmotic pressure and hence shrinking of cell (ii) dehydrates foods by removing moisture and making it unavailable for the microbial cells (iii) ionizes to yield the chlorine ion, which is harmful to organisms.
6) Foods preserved by high sugar concentrations are sweetened condensed milk, preserves, jams, jellies, marmalades and candies.
7) Foods preserved by fermentation are yogurt, curd, cheese, beer, wine and other alcoholic beverages.
8) Cheese-making is a long and involved process that makes use of bacteria, enzymes and naturally formed acids to solidify milk proteins and fat and preserve them.
9) Preservative action of smoking is due to the bactericidal chemicals like formaldehyde and creosote present in the smoke and dehydrating effect.
10) Low temperature preservation of food may be at: (i) Cellar storage temperatures (about 15°C) (ii) Refrigerator or chilling temperatures (0°C to 5°C), and (iii) Freezing temperatures (–18°C to –40°C).
11) High temperature preservation of food may be at (i) Pasteurization temperature (below 100°C) (ii) Boiling temperature (at 100°C), and (iii) Canning temperature (at or above 100°C).
12) Advantages of concentration of foods are: reduction in volume and weight hence, reduction in packaging, storage and transport costs, better microbial stability and convenience.
13) Chemical preservatives are referred to as those food additives, which are specifically added to prevent the deterioration or decomposition of a food.
14) Cobalt - 60 or Cesium - 137 or electrons producing machines are the principal sources of ionizing radiations used for food irradiation.

Check Your Progress Exercise 2

1) State whether the following statements are correct or incorrect. Correct the false statements.

   i) Asepsis deals with killing of microorganisms.

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   ii) Food in its agricultural state has natural protection mechanism from deterioration.

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   iii) Dried foods are more susceptible to microbial spoilage.

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iv) Preservation of food by high sugar and salt solution is based on the principle that water from food is tied up and made unavailable for microbial growth and enzyme action.

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v) The heat developed during the process causes the preservative effect of fermentation.

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vi) Cheese making is a process to preserve the milk into solid form for months and years.

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vii) Smoking is a method of food preservation mainly used for milk and milk products.

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viii) Preservation of food by cold temperature is by killing of spoilage microorganisms and inactivation of enzymes present in the food.

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ix) Pasteurization is the process of heat treatment to kill all the microorganisms present in milk or fruit juice.

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x) In canning preservation, high acid foods are processed at temperature above 100^{o}C.

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xi) Sugar, salt, spices, vinegar and alcohol are considered as class I food preservatives relatively safe to humans.

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xii) Ionizing radiations are measured in terms of Kcal.

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10.5 LET US SUM UP

In this unit we studied about the development and basic fundamentals of food processing. Food processing, we learnt, refers to the transformation of raw materials and ingredients into a more palatable, readily usable form, nutritious and convenience food product with a prolonged shelf-life.

We also identified the several agents or factors responsible for food spoilage in this Unit. To prevent the food from spoilage, we discussed some of the traditional food processing methods like drying, salting, smoking, sugaring, fermentation, use of preservatives and use of heat treatment. In all of these methods discussed, the common basic principle we learnt is to slow down or stop the natural process of food spoilage caused by the various factors and so preserve the food. As a result, availability of food round the year, easy storage, transportation and distribution, retention of nutritive value of the food, creation of employment and generation of additional income are ensured by the technique of food processing.

10.6 GLOSSARY

Acid foods : foods which contain enough acid to result in a pH of 4.5 or lower.

Contaminant : an undesirable substance that is considered to make something impure or dirty.

Curing : a method of food preservation that involves soaking the food in a strong salt solution.

Dhal : deorticated, split products from pulse.

Emulsifier : a substance that is used to prevent the liquids in an emulsion from separating into layers.

Fermentation : it is the transformation of sugars by intentional growth microorganisms (bacteria, yeast or mold).

Food additive : a substance added to food that enhance the palatability or preserve the foods.

Hermetic seal : an absolutely airtight container seal, which prevents reentry of air or microorganisms into packaged foods.

Infestation : invasion by insects and pests.

Pasteurization : a heating process designed to destroy the most heat-resistant pathogenic or disease-causing microorganism in a food product.

Pickling : the practice of adding enough vinegar or lemon juice to a low-acid food to lower its pH to 4.6 or lower.

Preservative : a substance used to prolong the shelf-life of foods or to prevent the spoilage of food.

Rancidity : development of any off or disagreeable flavours in oil or fat due to enzymatic or oxidative reactions.

10.7 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress Exercise 1

1) Food processing refers to the transformation of raw materials and ingredients into wholesome, safe, nutritious, convenience and acceptable food to consumers throughout the year. Food preservation refers to the process in which the perishable food materials are given a suitable physical or chemical treatment to prevent their wastage, spoilage and to retain their nutritive value for long periods.

2) The major causes of food deterioration/spoilage are growth of microorganisms, action of enzyme present in food itself, atmospheric oxygen, pests and insects and others including moisture, light, temperature etc.

3) The effects of food deterioration are spoilage by pathogenic microorganisms, nutrient loss, loss of organoleptic quality (colour, texture, taste, aroma), loss of functionality.

4) The advantages of food processing are many. Processing can prevent food deterioration or spoilage, processing can extend shelf-life (e.g. preservation), processing can enhance quality (e.g. cooking), processing can generate employment, processing ensures the availability of food round the year, safety, convenience and quality food products.

5) asepsis, filtration, centrifugation, washing, trimming, drying and smoking, sugaring, pickling, curing, fermentation, refrigeration, chilling, freezing, pasteurization, boiling, canning, chemical preservatives, carbonation, irradiation and combination of the two or more of the above methods.

6) (ii)

Check Your Progress Exercise 2

1) i) True

ii) True

iii) False. More susceptible to browning etc.

iv) True

v) False. Lactic acid and alcohol excreted by the microorganisms cause the preservative effect.

vi) True

vii) False. Meat, fish and their products preserved through the smoking method.

(viii) False. Low temperatures, retard chemical reactions and action of food enzymes slow down or stop growth and activity of microorganisms in food.

ix) False. Kills part but not all the microorganisms present.

x) False. Low acid foods are processed at temperature above 100^{o}C.

xi) True

xii) False. Measured in rads (and kilorad or megarad).