UNIT 11 FOOD PACKAGING

Structure

11.1 INTRODUCTION

In the previous two units we learnt about the various hygiene and sanitation factors that need to be considered within the food service establishments to ensure safe food for the customers.

In this unit, we will learn about safety of packaged foods. Packaging is a very important part of food production. Proper packaging helps to reduce the amount of wastage, as it can help to preserve and protect the food from spoilage. This becomes more important in developing countries. What kind of packaging is used for what kind of food products? What are the equipments and machinery used in packaging? What is labeling? What are the rules and regulations related to packaging? This unit attempts to answer these questions and other related issues linked with safety of packaged foods.

Objectives

After studying this unit you will be able to:

- outline the importance of packaging,
- identify the types of packaging material used for various food products,
- discuss about the equipments and the machinery used in packaging,
- explain the importance and the types of labeling related to packaging,
- enumerate the rules and regulations related to packaging, and
- describe the environmental issues related with packaging.

11.2 PACKAGING: CONCEPT, SIGNIFICANCE AND FUNCTIONS

As we have already mentioned, packaging is a very important aspect of food production. What is packaging? Packaging means *a coordinated system of preparation of goods (in this case, foods) for shipment, distribution, storage and marketing at optimum costs, compatible with the requirements of the product.* It has a protective role as a means of ensuring safe delivery of the products in sound conditions to the final user at a minimum cost. Packaging becomes even more important when dealing with foods and pharmaceuticals, since a large amount of food products becomes inedible due to spoilage for the want of adequate packaging. Thus, to save the food from spoilage, primary packaging is of utmost importance, especially in developing countries. Packaging includes the art, science and technology used initially and during transportation along with the selling and technical methods and work processes related to the above preparations.

You may be aware of the various materials that are used for the packaging of food products. The packaging material is very crucial in the packaging process. What in your opinion is a packaging material? In simple terms, *any physical material which serves as a covering, wrap or seal for an object or material is a packaging material.* Selection of the kind of packaging and packaging material is based on the type of food that needs to be packaged. It also involves identifying the kind of equipment to be used and to label the package suitably. However, before deciding upon the kind of packaging material to be used, you must remember that the requirements of a package in order to be commercially functional include:

- *It must contain the product.* For example, in case of cold drinks, a bottle meant for 1litre of the drink should be able to hold/contain that quantity of the liquid, as well as, keep them secure until they are used.
- *It must protect the product.* This is the most important function. For example, in case of biscuits, the waxy covering that we see protects them from moisture, dust, as well as, contaminants during distribution and use.
- *It must sell the product.* For example, sweets, which are meant especially for children, must be attractive to look at.
- *It should relate to the cost of the product packed.* Expensive boxes must not be used in products that are not so expensive to help in keeping the cost down.
- *It must be convenient throughout production, storage and distribution.* Fruit juices in tetrapack are easy to open and dispense.

Packaging has evolved over the centuries from nature's packages such as leaves, skin and bark to current high technological ones. There has been substantial development in both material and packaging systems over the last decade or so. These developments have been instrumental in both reducing packaging cost and in the development of novel and minimally processed foods. We shall learn about the different packaging systems later in the unit. But, first let us learn about the significance/relevance of food packaging.

Relevance of food packaging

To understand the relevance of food packaging, it is necessary for us to understand how spoilage reduces the availability of food. In the developing countries like ours, even though nearly 75% of the population is occupied with food production, have you ever wondered why the availability of food is a major problem? The answer to this is due to heavy food spoilage. In our country, about 30% of the food becomes unusable due to its spoilage. To overcome this problem and to increase the availability

of food products, preventing spoilage by the means of good packaging will be an economical and socially desirable step.

We can, therefore, say that packaging and storage prevents scarcity condition during the two harvesting seasons. It is also essential for transporting marketable surplus to the consumption centers. Packaging is essential for food industry for inland and export markets.

Thus you can now see that packaging forms an integral part in the chain of food production, transportation, storage and marketing and has important functions. What are these functions? We learnt earlier that packaging is a means of ensuring safe delivery of goods to the ultimate consumer in sound conditions. So, then the functions of packaging are obvious. Can you list them? A review of these functions are presented herewith. Tally your responses with the functions discussed herewith.

Functions of Packaging

Packaging is a coordinated system of preparing food products for transport, distribution, storage, retailing and use. The major functions of packaging are highlighted in Figure 11.1. These include:

- *To contain the product:* For the packaging to contain the product, it must have the following characteristics:
  - an adequate size to hold the product
  - paper constructural features
  - strong enough to withstand hazards, and
  - useful for distribution and sale
- *To protect the product against:*
  - physical damages during transportation, distribution and storage
  - environmental factors such as dust, humidity and contaminants, and
  - water vapour and oxygen interactions, light rays and heat.
- *To assist in marketing* by aiding in identifying the product and ensuring that it conform to laws, regulations and specifications.
- *To increase shelf-life*
- *To provide for consumer convenience*

Besides the functions mentioned above, the other function of packaging is *to provide facility for ease of usage, dispensing and disposing off.*

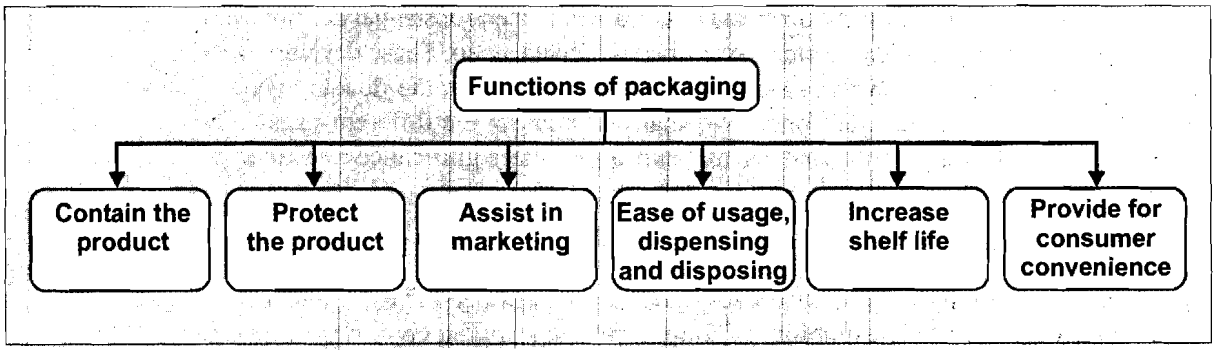

Figure 11.1: Functions of packaging

From our discussion above we have a fairly clear idea as to why we need to package food products. Next, have you ever given a thought as to why a product is packed

in a specific way? For example, why juices, oils etc. are usually packed in tetra pack or for that matter cereals, pulses etc. packed in plastic bags/containers. Well, the selection of packaging material and design is crucial. Let's learn about this aspect.

Package Design

The selection of the packaging material/design is an important aspect in the process of packaging. What are the things you must keep in mind while selecting the design of the packaging material? Let's consider:

The first point is the *product considerations* i.e. what is the material to be packed? The characteristics of the material/product to be packed will actually influence the package design. These characteristics include:

- nature of the state
- deteriorative changes that may occur
- chemical and biological characteristic nature, and
- extent of deteriorations.

The second aspect to be considered is the *external factors.* These are the factors that comprise the external factors of the environment such as:

- physical hazards in handling
- transportation and storage climatic conditions
- relative humidity, and
- temperature

Next, the *properties of packaging materials/forms* to be used must be kept in mind before using it for packaging. These properties are:

- physical and mechanical properties
- performance properties
- availability
- machineability, and
- capacity.

The fourth consideration is *packaging machinery*. The machinery used for packaging should provide ease in:

- sealing, closing and handling, and
- availability, capability, capacity.

Finally, the *marketing aspects* need to be considered. Do you know why we need to look into the marketing aspects? Well this is to ensure the quality of the packaged foods. You may have noticed certain trade marks/codes on the packaged foods. The government regulations, national and international standards and voluntary codes – ecological factors have to be considered before the packaging can be done.

Apart from these, there are certain other marketing considerations that need to be looked into and these include:

- the brand image and style of presentation required for the food
- flexibility to change the size and design of the container, and
- compatability with methods of handling and distribution and with the requirements of retailers.

Check Your Progress Exercise 1

1) Define packaging.

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2) Indicate the relevance of food packaging to developing countries.

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3) Why do we need to package food? Give the functions of packaging.

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4) Explain package design considerations.

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5) Indicate the environmental factors that influence stability of food product.

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Now, that we have learnt about what is food packaging and its concepts and significance, we next, move on to the classification of packaging material.

11.3 CLASSIFICATION OF PACKAGING MATERIALS

You have seen that different food products are packaged in different materials. For example, cold drinks are packed in glass bottles, oil in plastic bottles/cans and milk in tetra packs. Why is that so? You have learnt about the different considerations to be kept in mind for package design above. Well, it must be clear that the packets are chosen according to the characteristics of the product, its properties, shelf-life, its final use etc. Keeping these properties in mind, therefore, the packaging materials can be categorized as either *flexible packages* or *rigid packages*. Flexible packaging types range from bags and bubble wrap to tubes, stand-up pouches and foam cushioning materials. Rigid packaging comprises blisters, bottles, cartridges, trays etc. Let us learn about these different packaging materials.

11.3.1 Flexible Packages

You must have seen packages made of relatively thin materials such as papers, plastics, foils, films and their combinations. These are called flexible packages – *a package capable of being readily deformed by hand, including being bent, flexed or twisted.* Some of the most commonly used flexible packaging materials are described below and illustrated in Figure 11.2.

Figure 11.2: Various flexible packaging

a) *Papers:* The term paper refers to *materials with a grammage less than 225 grams per square meter (g/m²).* Paper has a number of advantages as a food packaging material. The advantages include:

- it can be produced in many grades and can be converted to many different forms, especially boxes or cartons
- it can be recycled and it is biodegradable
- it can be easily combined with other materials to make laminated or coated packs, and
- it can be produced with different degrees of opacity.

Paper pulp is produced from wood chips by acid or alkaline hydrolysis, in which lignin in wood pulp is dissolved and removed by washing to leave cellulose fibres. The major packaging papers are kraft, sulphite, grease proof, glassine, vegetable parchment and waxed papers. Some of these paper packagings are illustrated in Fiugre 11.3. These are made generally on fourdrinier machines in various grammages. Kraft paper (70-300g/m^2) is made by sulphate (alkaline) cooking process, which yields strong and robust papers. Union or bituminized kraft consists of outer kraft papers and inner bitumen which is used as a water-vapour barrier. Examples of uses of paper packaging are highlighted in Table 11.1.

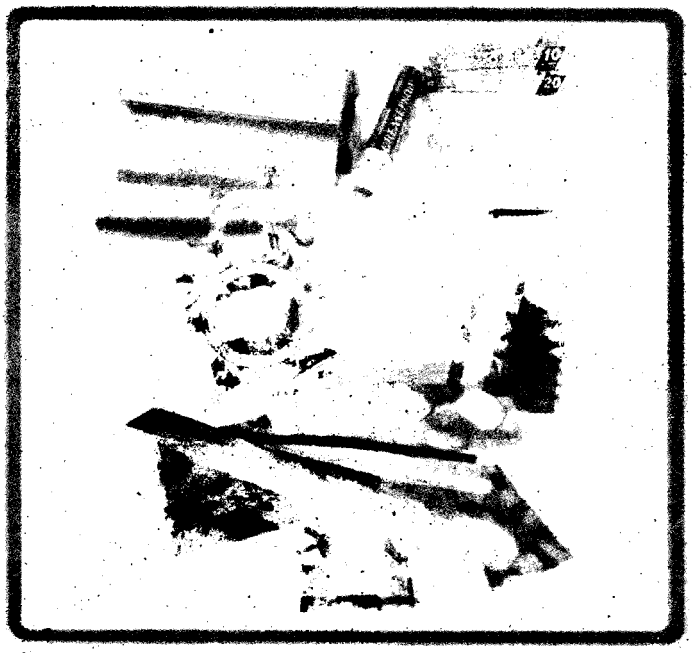

Figure 11.3: Paper packaging

Table 11.1: Examples of uses of paper packaging

Paper	Examples of uses
Kraft	Multi-wall sacks, liners for corrugated boards
Sulphite	Small bags, pouches, waxed papers, labels, foil laminates
Greaseproof	Paper for bakery products, fatty foods
Glassine	Odour resistant and greaseproof bags, wrappers or liners for boxes, suitable for wax coating to make them water resistant- for dry cereals, potato chips, dried soups, cake mixes, coffee, sugar.
Vegetable parchment	High wet strength and grease resistant bags, wrappers or liners for boxes used for meat, fish, fats etc.
Waxed paper (tissue)	Soft wrapping paper for bread, fruits etc.

b) *Paper Board Cartons:* Paperboard is a generic term covering boxboard, clipboard and corrugated or solid fibreboards. Boards are made in a similar way to paper but are thicker to protect foods from mechanical damage. Figure 11.4 illustrates the paper cartons/boards. Different types of boards and their common uses are highlighted in Table 11.2.

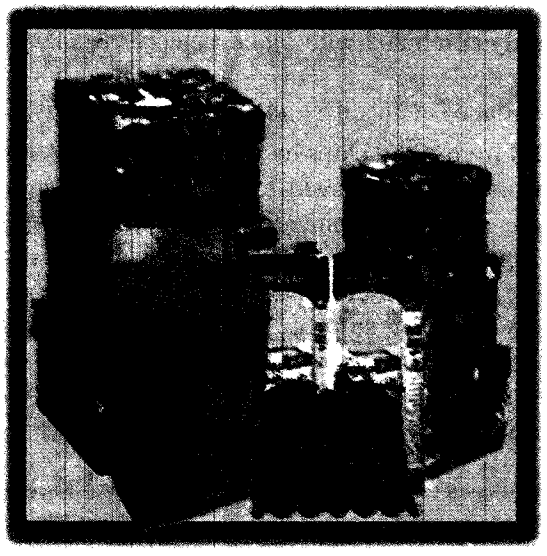

Figure 11.4: Paper cartons

Table 11.2: Different paperboards and their uses

Types of board	Uses
White Board	Ice Creams, chocolates, frozen food cartons
Paper Board (moulded)	Egg tray, tray for fruits
Fibre Board	Juice concentrates, confectionery, nuts
Chip Board	Outer cartons for tea and cereals
Laminated paper board cartons	UHT foods

c) *Plastics and flexible films made from non-fibrous plastic polymers:* Most polymer films are made by extrusion, in which pellets of the polymer are melted and extruded under pressure as a sheet or tube as illustrated in Figure 11.5.

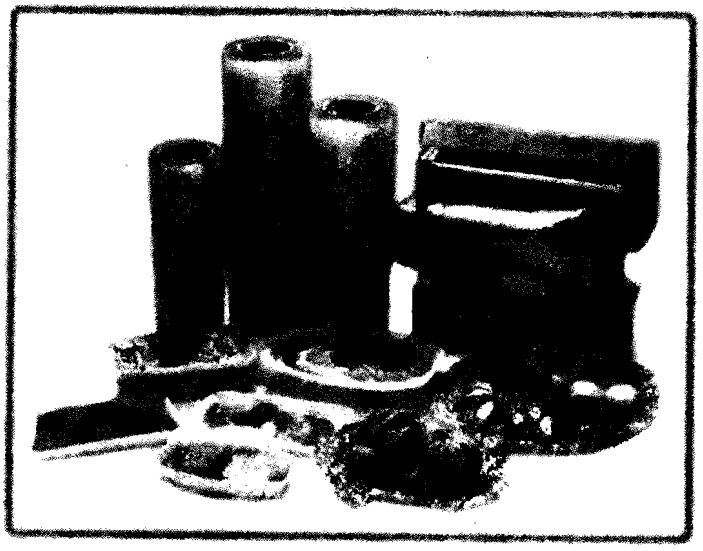

Figure 11.5: Plastic and flexible films

The commonly used plastic film is the plain cellulose, a glossy transparent film which is odourless, tasteless and biodegradable within approximately 100 days. It is normally used for foods that do not require a complete moisture or gas barrier, including fresh bread and some types of confectionary. The other plastic films include:

- *Polyethylene (P)* (Low density polyethylene (LDPE), medium density, linear low-density (LLDPE), high-density polyethylene (HDPE) and ethylene vinyl acetate copolymer): These materials have an excellent sealability, good moisture barrier, low temperature durability and good tear resistance. LDPE is heat sealable, odour free and shrinks when heated. It is less expensive than most films and is therefore widely used – including applications in shrink or stretch-wrapping. HDPE is stronger, thicker, less flexible and more brittle than LDPE. They are however water-proof and chemically resistant and are used instead of multi-wall paper sacks for shipping containers. Generally, polythene is used for packaging processed and fresh meats, cheese etc. High density polyethylene is used in applications such as containers, milk and detergent bottles, bags and industrial wrapping. Low density polyethylene is used for pallet and agricultural film, bags, coatings and containers.
- *Polypropylenes (PP)* (cast PP, Bi-axially oriented PP (BOPP), pearlized PP): Polypropylene is often termed a breathable film. This film is not a good gas barrier, but is used mainly for moisture barrier properties and for temperature resistance in retort or pasteurized packaging. The material has good clarity, high gloss and excellent flexcrack resistance. Packaging material made of polypropylene are used for bottles, jars, crisp packets, biscuit wrappers and boil-in-bag films among many other applications.
- *Polyester (ES)* or *polyethylene terephthalate (PET):* PET is a very strong transparent glossy film, which has good moisture and gas barrier properties. It is commonly used for carbonated drinks and boil-in-bags. Polyester is a transparent exceptionally strong oriented film. It is mainly used for packaging processed meats, cheese, candy and coffee.
- *Uncoated polyvinyl chloride (PVC) and polyvinylidene chloride (PVDC):* PVC and PVDC are closely related plastics that are a part of the group of polymers more commonly known as "vinyl", first developed in the 1930s. Its uses include "film" wrap for meats and water and cooking oil bottles. As a packaging material, PVC is most commonly formed into very thin plastic "film" (such as that used to wrap meat) and as thicker plastic

"sheet," which is molded into some type of rigid container shaped like a "clam shell.". PVDC films are fat resistant and do not melt in contact with hot fats, making it suitable for 'freezer-to-oven' foods. It is also used as a coating for films and bottles to improve the barrier properties. Other common food packaging applications include clear blow-molded bottles and as "coatings" on other types of plastic packaging materials.

- *Nylon (PA) polyamides and polyethylene modifications:* Nylon is a strong transparent film made of two principle polymers (Type 6 and 66) and has a combination of properties which make it suitable for a variety of industrial applications. It can be printed, laminated or extrusion coated. It must be noted that nylon alone is a poor moisture barrier.

d) *Surlyn films:* Surlyn (SU) is a versatile film which is sometimes favoured over polyethylene due to some unique properties such as excellent moisture barrier, high melt strength, good clarity, low temperature sealability and toughness. It is commonly used for packaging processed and fresh meats.

e) *Metallized films:* In metallized films, plastic films such as those of polyester, polyamide and polypropylene are coated with aluminium to enhance the barrier properties towards the passage of water vapour, gaseous volatile ingredients, light, odours and microorganisms. Metallized polyester film is a polyester film with a vacuum deposition of aluminium on one side. It is ideal for a variety of packaging end uses such as processed meat packaging, fish packaging and the packaging of snacks, candy and nuts. Metallized film is less expensive and more flexible than foil laminates which have similar barrier properties and is therefore suitable for high speed filling on form-fill-seal equipment.

f) *Aluminium cans and foils:* You may have seen the coke cans in the market. These are aerosol cans. Aerosol cans are basically two or three piece lacquered tinplate or aluminium cans fitted with a valve through which the product is dispensed. Aluminium cans are commonly used in the food industry in the form of three piece 'sanitary' cans, used to package powders, syrups and cooking oils or two piece cans used for carbonated beverages where the gas pressure supports the container. Figure 11.6 illustrates the aluminium cans.

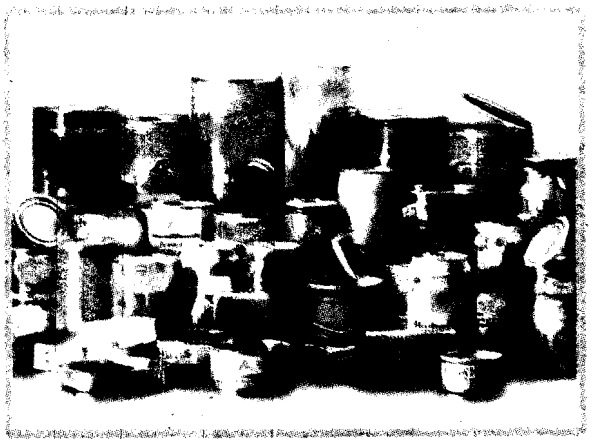

Figure 11.6: Aluminium cans

In addition to its use in can making, aluminium is used for foil wrapper, lids, cups and trays (for frozen and ready foods), laminated pouches, collapsible tubes (for viscous products like tomato puree, garlic paste), barrels etc. Metallic foil of aluminium for food packaging is available in thickness of 0.009 mm, 0.012 mm, 0.015 mm and 0.020 mm. The selection is dictated by the specific needs of the foods to be packed and shelf-life requirements. Aluminium is also used as the barrier material in the laminated films to metallise flexible films.

g) *Composite films (laminate and coextruded):* The plastic films when combined as separate substrate is called a *laminate*. When they are manufactured simultaneously in a singlé operation, it is called a *co-extruded film*. Let us review these composite films in more details.

Laminate films: Laminated films are commonly made by the lamination of two or more films. Commonly used laminate films for food packaging are listed in Table 11.3. Lamination of two or more films improves the barrier properties and/ or mechanical strength of a package. Laminates of nylon-LDPE, nylon-PVdc-LDPE are commonly used for non-respiring products. In such a combination, the nylon provides the strength to the pack, whereas PVdc provides the correct gas and moisture barrier properties and LDPE gives heat reliability.

Table 11.3: Common laminated films used for food packaging

Type of laminate	Typical food applications
Polyvinylidene chloride-coated polypropylene-polyvinylidene chloride coated polypropylene	Crisps, snack foods, confectionery, ice cream, biscuits, chocolate confectionery
Polyvinylidene chloride-coated polypropylene-polyethylene	Bakery products, cheese, confectionery, dried fruit, frozen vegetables
Polypropylene-ethylene vinyl acetate	Modified atmosphere packaged bacon, cheese, cooked meats
Biaxially oriented polypropylene-nylon-polyethylene	Retort pouches
Cellulose-polyethylene cellulose	Pies, crusty bread, bacon, coffee, cooked meats, cheese
Cellulose acetate-paper-foil-polyethylene	Dried soups
Metallised polyester-polyethylene	Coffeee, dried milk, bag-in-box packaging, potato flakes, frozen foods, modified-atmosphere-packaged foods.
Polyethylene terephthalate aluminium propylene	Retort pouches
Polyethylene aluminium paper	Dried soup, dried vegetables, chocolate
Nylon-polyvinylidene chloride-polyethylene-aluminium-polyethylene	Bag-in-box packaging
Nylon-medium density ethylene-butene copolymer	Boil-in-bag packaging

Coextruded films: Coextrusion is *the simultaneous extrusion of two or more layers of different polymers to form a single film*. There are three main groups of polymers which are used in co-extruded films- *olefins* (low density and high density polyethylene and polypropylene), *styrenes* (polystyrene and acrylonitrite-butadiene-styrene) and *polyvinyl chloride polymers*.

Having studied about the different flexible packages let us look at some examples of foods and beverages for which polyethylene-based packaging is used. These are listed herewith:

- fresh fruit and vegetables – film bags, heat-sealed overwrapping film and container liners for bulk transport
- frozen fruit, vegetables, meat, poultry and fish products – film bags and heat-sealed overwrapping films

- cereals – film bags sometimes with carton board outer packaging
- bread and bakery products – film bags
- milk, milk-based drinks, soups, fruit juices, and fruit drinks – HDPE bottles and polyethylene/cartonboard/polyethylene laminate containers
- long-life fruit juices and milk – polyethylene/aluminium/cartonboard/polyethylene laminate containers
- yoghurt and other dairy products – polyethylene/aluminium lidding
- take-away foods and beverages – polyethylene/paperboard/polyethylene laminate containers, and
- coffee – polyethylene/aluminium/polyethylene terephthalate laminate bags.

After a detailed discussion on flexible packages, we move on to the second group of packaging material referred to as *rigid containers*. Not all products can be packed in a flexible packaging. They require firm, rigid packages. What are the different rigid containers that are or can be used? Let's find out.

11.3.2 Rigid Packages

Which products require rigid containers? Products that need to be transported to long distances and the ones that require extra care are packaged in rigid containers or boxes. Figure 11.7 illustrates the rigid packages. Some common rigid containers are enumerated herewith.

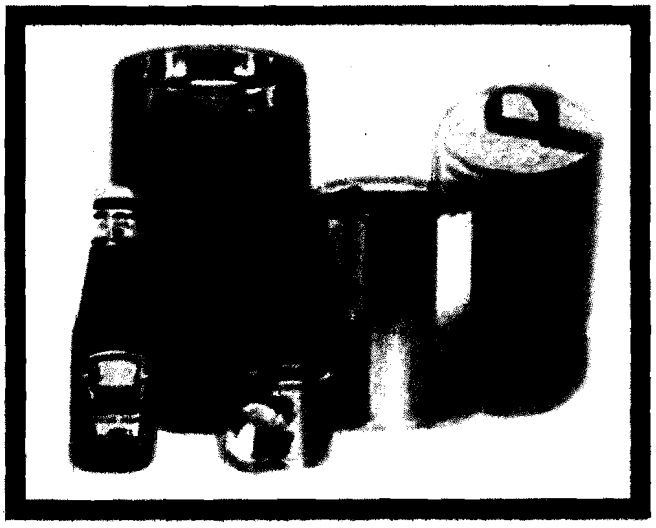

Figure 11.7: Example of rigid packaging

a) *Metal containers:* Tin plate containers are made of steel body coated with tin electrolytically. The coating is applied in various thicknesses to suit the requirement of the food packed.

b) *Aluminium containers:* These are available in various sizes and shapes. These have to be coated initially with lacquers to reduce rusting and chemical interactions.

c) *Chromium steel cans:* These are made of steel body treated on the surface by chromium. These are called as *tin-free-steel can*. These also require lacquers for food applications.

d) *Glass containers:* This is the conventional container used to package a wide variety of food products. Glass bottles, jars are commonly used.

e) *Wooden containers:* Wooden containers have been traditionally used for a range of solid and liquid food products including fruits, vegetables, tea, wines, spirits and

beers. They provide good mechanical protection, good stacking characteristics and a high vertical compression strength-to-weight ratio.

f) *Polypropylene and polyethylene drums, crates and boxes:* These packaging materials have largely replaced wood in many applications and have the benefit of lower costs.

So far we have been introduced to a wide variety of flexible and rigid containers i.e. packaging material commonly used in the food industry or at the home level. These packaging materials are further classified into two main types – retail and/or shipping containers. What is the difference between the two? Let's find out.

11.3.3 Retail or Shipping Containers

You would realize that there are a few packaging material that only contain and protect the contents during transportation and distribution, but have no marketing functions. Such containers are the *shipping containers,* which included traditional packages such as gunnysacks, textile bags, wooden containers and other types such as metal cases, crates, barrels, drums and sacks. Most recently intermediate bulk containers (IBCs), including combi-bins, large boxes made from plastic or corrugated fibre board and large bags made from woven plastic fabric have been introduced to increase handling efficiencies.

On the other hand, *we have containers which protect and advertise the food in convenient quantities for retail sale and home use/storage, we call them retail containers.* Can you give few examples of retail containers from our study of packaging material above. Yes, metal cans, glass bottles, aluminum foils, trays, rigid and semi-rigid plastic tubs, collapsible tubes, paperboard cartons, plastic sachet, wraps and bags are all examples of retail containers.

Check Your Progress Exercise 2

1) How are the packaging materials classified? Which are the important flexible packaging materials?

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2) What are the different plastics used for packaging?

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3) What is the difference between metallized films and aluminium foils?

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4) Indicate the three major types of rigid metal containers.

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11.4 PACKAGING METHODS

We have just discussed that different kinds of products require different packaging materials. Similarly there are different methods of packaging that can be used for the various styles of packing. In this section, we will learn about these various methods of packaging employed in the food industry. The types of packaging include:

1) *Vacuum packaging*

Vacuum packaging, as the name suggests, *is removal of external gases in a container.* It refers to *packaging in containers (rigid or flexible), from which substantially all air has been removed prior to final sealing of the container.* Why is this done? The reason behind this is - to extend shelf life of the product, remove the oxygen present inside so as to protect the contents from its undesirable effects, such as aroma and taste attraction, oxidative rancidity, microbial growth and physical changes and reduce moisture loss.

2) *Gas packaging*

Gas packaging can be defined as *the alteration of the proportional volumes of the gases which comprise a normal atmosphere.* This type of packaging generally falls into two categories:

- *Controlled Atmosphere Packaging (CAP):* CAP means *an active packaging system which continuously maintains the desired atmosphere within the package throughout the shelf-life of the product.* CAP uses an agent to bind or "scavenge" oxygen permeating the package, or a sachet to emit a gas. Basically, CAP refers to a controlled system whereby gases are added or removed to maintain a desired balance. For fresh fruits and vegetables and meat products, the CAP is carried out mostly inside flexible barrier materials. In CAP, the bulk bin or storage vessel is virtually impermeable.
- *Modified Atmosphere Packaging (MAP):* MAP refers to *enclosing a product in some type of barrier, and modifying the atmosphere either by drawing a vacuum or filling with a gas mix.* It is a system in which the atmosphere of a package of food is modified so that its composition is different from air but the atmosphere may change over time due to the permeability of the packaging material or the respiration of the food. Modified atmosphere packaging includes any of the following:
  - reduction in the proportion of oxygen
  - total replacement of oxygen, and
  - an increase in the proportion of other gases, such as carbon dioxide or nitrogen.

  MAP involves the modification of the head space gas in a package in order to prolong the shelf life of the product it contains. The success of MAP depends on the packer's ability to correctly prepare the product and to control the concentrations of head space gas within the desired limits.

  Gas packaging with nitrogen or carbon dioxide is a better method of removal of oxygen since there is no negative pressure and susceptibility to puncture. The advantages of gas packaging include: a) extended shelf life by controlling oxidation by displaying the oxygen with carbon dioxide and nitrogen, inhibiting bacterial growth of normal aerobic spoilage organisms b) retain moisture – by preventing the product from drying out by containing the moisture in the package, and c) preventing crushing of soft products.

3) *Aseptic packaging:* Aseptic packaging is the process, whereby the food and packages are sterilized separately and filled in an aseptic atmosphere. Examples are fruit pulps in bags, beverages in pouches and cartons.

4) *Thermal processing:* This is processing food products of high moisture content in situ, in rigid or flexible containers. Processing in tinplate, aluminium containers and more recently in flexible multi-layer pouches and bags are examples of this type of processing.

5) *Minimally processed food packaging:* Foods intended for easy preparation by removing inedible portions and cuts can be packed in suitable packages to extend their storage life. For such products, minimally processed food method is used. *The concept is based on the application of the lightest possible treatment that yields a fresh-like, convenient, safe and high quality product.*

   Minimal processing of vegetables is a state-of-the-art technology by which a variety of tropical, sub-tropical and temperate vegetables can be made available in trimmed and cut forms, prepackaged with fresh/fresh-like sensory attributes. Although minimal processing is still improving, many new high quality products have already been marketed. Radio-frequency heating (RF-heating) at 27.12 MHz for instance has been used for several types of foods, in particular for post-baking of biscuits and cereals, drying of foods and thawing of frozen products. Heat is created inside the food item mainly via its electric conductivity. Few examples *of minimal processing treatments* are:

   - modified atmosphere packaging
   - aseptic processing
   - high pressure treatment
   - high temperature short time heating (HTST)
   - sous-vide processing, and
   - very fast heat transfer technologies.

6) *Bag-in-Box Packaging:* This denotes the concept of inclusion of a flexible pouch/bag inside a rigid container such as a carton, box or drum. The bag material for chemical and biological deterioration decides the efficiency of the containers. Aseptic packaging in bag-in-box is extensively carried out for processed fruit products.

7) *Active Packaging:* It employs a packaging material that interacts with the internal gas environment to extend the shelf-life of a food. Such new technologies continuously modify the gas environment (and may interact with the surface of the food) by removing gases from or adding gases to the headspace inside a package. Active packaging involves interaction between the packaging material itself and the internal atmosphere of food product. New techniques involve active packaging plus MAP. Active packaging encompasses the following broad-spectrum functions, including:

   * Antimicrobial
   * Carbon dioxide controllers
   * Ethylene controllers
   * Flavour enhancers
   * Microwave susceptors
   * Time-temperature indicators
   * Moisture Control
   * Odour generators
   * Oxygen-permeable films
   * Oxygen enhancers
   * Oxygen generators
   * Tamper-evident labels

Table 11.4 presents some areas of atmosphere control in which active packaging is being successfully used.

Table 11.4: Uses of active packaging

Active packaging system	Applications
Oxygen scavenging	Most foods
Carbon dioxide production	Most foods affected by moulds
Water vapour removal	Dried and mould-sensitive foods
Ethylene removal	Horticultural produce
Ethanol release	Baked foods (where permitted)

Other systems of active packaging which are either already available or could soon be seen in the market place include:

- sachets containing iron powder and calcium hydroxide which scavenge both oxygen and carbon dioxide. These sachets are used to extend the shelf life of ground coffee.
- film containing microbial inhibitors. Other inhibitors being investigated include metal ions and salts of propionic acid.
- specially fabricated films to absorb flavours and odours or, conversely, to release them into the package.

As you have already seen, there are different methods of packaging. These methods involve various equipment and machinery. Certainly, you would like to know about these machineries and how they function? Well it is not within the preview of this unit to go into the detail functioning of these machineries, but certainly we would like to orient you to the different machineries used for packaging at the industry level. Here is a list for your information.

The various machines used for packaging operations include:

i) Sealing machines hot bar, impulse and induction

ii) Form-fill-seal (FFS) machines for automatic packaging

iii) Box sealing, strapping and closing machines

iv) Aseptic/Thermal processing machines

v) Printing, coding and marketing machines

vi) Shrink wrapping, vacuum and gas packaging machines

vii) Materials handling equipment.

With a comprehensive knowledge about types and methods of packaging, next we move on to study about the moisture sorption properties of food, which you would realize is an important aspect in packaging.

11.5 MOISTURE SORPTION PROPERTIES OF FOODS AND SELECTION OF PACKAGING MATERIALS

You must have noticed that food spoilage takes place at a much faster rate during the rainy season. Have you ever wondered why this happens? This is because all foods are sensitive to moisture interchanges. Moisture can have different effects on different foods. While some foods such as bread, cakes and fresh produce lose moisture and desiccate, other foods such as biscuits, cereals and grains absorb water vapour from the atmosphere. The Equilibrium Relative Humidity (ERH) of the food product and the external relative humidity (RH %) of the atmosphere to which the food is exposed dictate this interchange. What do we mean by equilibrium relative humidity? ERH is *an expression of the amount of free water vapour present on*

a product, both at its surface and within its structure. Numerically, ERH of a food divide by 100 equals "Water Activity". You may recall reading about this earlier in Unit 3, where we learnt about moisture as one of the factors which influence the growth of microorganisms. We learnt that water activity can be represented by the following equation:

$$\text{Water Activity } (a_w) = \frac{\text{Equilibrium Relative Humidity}}{100}$$

In definition, water activity, expressed as the percent equilibrium humidity (%ERH) divided by 100 is unexciting. *In practice, it is really a measure of free water in a food sample, as opposed to bound water.* Both water activity and ERH as you may have realized by now, are practically the same measurement expressed in a slightly different way. You must understand that water activity is different than the water content in foods. *Water content, when referring to a solid material, is an expression of the percentage of the materials weight which is water (both in liquid or gaseous phase), usually referred to as percent moisture content.*

The reason why water activity merits closer attention is that it influences the shelf life of a food product. Water activity affects microorganism survival and reproduction, enzyme and chemical reaction. While temperature, pH and several other factors can influence if and how fast organisms will grow in a product, water activity may be the most important factor in controlling spoilage.

The ERH of a food product can determine the extent of deteriorative damage that may be caused. Table 11.5 gives the effect of ERH on various foods.

Table 11.5: Effect of ERH on food

At ERH below 20-25%	:	Water molecules are strongly bound with the food solids and are not available for chemical and biological deterioration.
Up-to an ERH of 65 to 70%	:	Water molecules are somewhat loosely bound and mobile leading to some chemical deteriorative reactions
At ERH higher than 70%	:	The products become soft and soggy and microorganisms can grow.

The curve representing the relationship of the moisture content and ERH (or water activity) at a particular temperature is known as *"moisture sorption isotherm"* of the food product. Figure 11.8 illustrates the sorption isotherm curve.

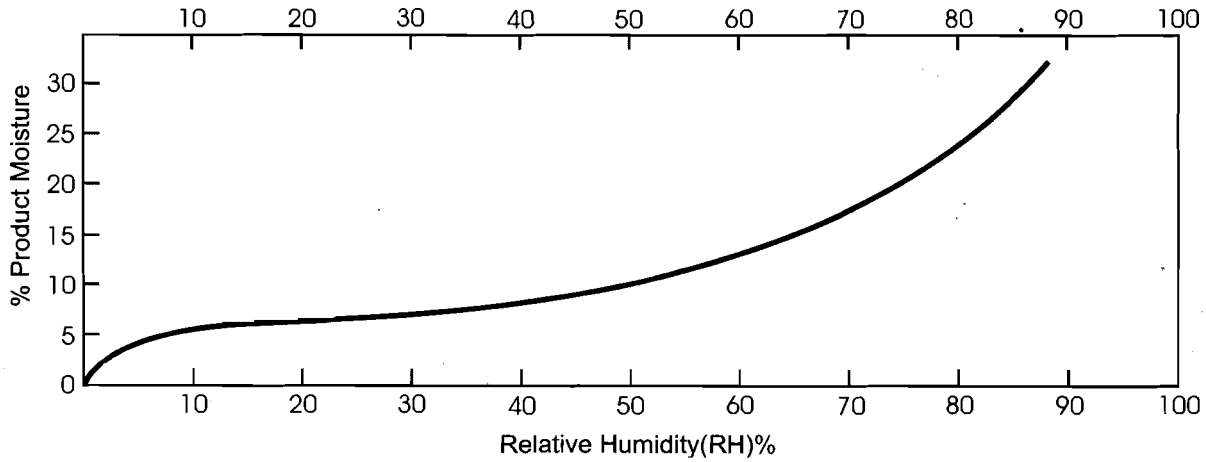

Figure 11.8: Sorption isotherm curve

Let us understand the sorption behaviour of the food in more details. A portion of the total water content present in food is strongly bound to specific sites and does

not act as a solvent (medium capable of dissolving another substance). These sites include the hydroxyl groups of polysaccharides, the carbonyl and amino groups of proteins, and others on which water can be held by hydrogen bonding, by ion-dipole bonds, or by other strong interactions. *The binding action is referred to as the sorption behaviour of the food.* The most successful method for studying the sorption properties of water in food products has been the preparation of "Sorption Isotherms," or curves relating the partial pressure of water in the food to its water content at constant temperature. The same practice is followed to study curves relating water activity under equilibrium conditions to water content.

You must be wondering how the moisture content of a food product can be related to the packaging procedure? Since the moisture content influences the rate of spoilage of a product, it is very important to choose the packaging material wisely. The moisture permeability of the material should be kept in mind while selecting the material.

Different packaging materials including *aluminium foils* below 0.025 mm have finite permeability. This depends on the permeate-permeant systems, thickness, temperature and relative humidity. *Polyethylene* and *polypropylenes* have good water vapour barrier property, but poor barrier properties to oxygen, other gases and volatile and aroma substances found in foodstuffs.

Polyethylene terephthalate (PET), nylon and ethylene-vinyl alcohol films have outstanding barrier properties to gases and vapours, but these do not provide good sealable function. Hence, these are combined with heat-sealable plastics.

Metallized plastics, especially PET has excellent barrier properties and is relatively less sensitive to creasing and folding.

Based on the permissible moisture content pick-up or loss of a food product, a packaging material construction can be selected to provide the required shelf-life under use conditions. This depends on the weight of the product packed, permeability characteristics of the packaging materials and external conditions.

For predominantly moisture sensitive food products, shelf life could be predicted fairly accurately by the above indicated parameters. However, for oxygen and aroma sensitive food products, the selection depends on the effectiveness of the protective layer (web).

Check Your Progress Exercise 3

1) Differentiate between vacuum and gas packaging.

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2) What are controlled and modified atmosphere packages?

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3) List the functions and applications of active packaging.

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4) Define moisture sorption isotherm.

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5) What is shelf-life? What are the parameters that are necessary to predict the shelf-life of a moisture sensitive food?

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We have just learnt about moisture sorption properties of foods and selection of packaging materials. Geared with this knowledge, let us next focus on another important aspect of packaging, i.e. interactions between packaging and foods – the toxicity hazards and the environmental concerns and safety issues related to packaging.

11.6 INTERACTIONS BETWEEN PACKAGING AND FOODS – TOXICITY HAZARDS

Toxicological effects of interactions between food and packaging materials and also the effect of such interactions on the shelf-life and sensory quality of the food are extremely complex. The main aspects that are being intensively studied are:

- lacquers and coatings for metal containers to prevent interaction of food acids, anthocyanins, sulphur compounds and other components with steel, tin or aluminium
- the migration of plasticisers, pigments, metal ions and other components of plastic packaging into foods
- the migration of oils from foods into plastics, and
- the interaction of the package and food under different processing conditions.

We already know that packaging keeps food fresher for long and protects it from contamination. We have already studied about the different packaging material in common use. Plastics (polythelene, PVC, polypropelenes etc.) with high barrier properties, we learnt in sub-section 11.3.1, are used to adequately protect food either from external influences (oxygen, water vapour) or from loss of flavours. PVC is manufactured by polymerizing vinyl chloride monomer (VCM). To increase the heat- and light-aging resistance of PVC, stabilizers are introduced. Different plasticizers (phthalic and phosphoric acids, etc.) are added to give it elasticity. These stabilizers, plasticizers and other substances including residual monomers, low-molecular-weight polymers (oligomers) and any additives or other substances used in the formulations or the manufacturing process, may migrate from polyethylene plastics to foodstuffs. The quantities of substances that migrate from polyethylene plastics into the foods and beverages with which they come into contact depend largely on the type of food or beverage, the temperature during contact and the contact time. Migration into liquid foods will be higher than that into more solid foodstuffs, particularly dry foods. With all plastic types, migration increases with temperature and time of contact. Hydrophobic substances, such as oligomers and the antioxidants, have a tendency to migrate into fatty foods, whereas, hydrophilic substances, such as anti-static agents, have a tendency to migrate into high-moisture foods. Polyethylene plastics are not generally used in applications in which there is high-temperature contact with foodstuffs because of their relatively low melting point ranges, but they are used as packaging for a wide range of water-based and fat-containing foods and beverages.

PVC is approved for use as the film to wrap fresh red meats because it allows enough air to go through the package to make the meat pigments "bloom" bright red. In order to be preserved, meat and fish are sometimes pre-packaged in plastic films and then irradiated to avoid microbial recontamination. Low doses of irradiation do not present a toxicological risk or affect the nutritional value of food. Furthermore, irradiation kills all types of pathogens and could with time replace chemical treatments. However, depending on the nature of the film used and the specific conditions of irradiation, the packaging material can change, and plastics components (plasticizers, monomers, stabilizers, etc.), some of which are known to have adverse effects on humans, can get into the food. For example, low doses of Bisphenol-A (BPA), a chemical widely used in plastic food containers, baby bottles, cans, toys and dental sealants can migrate from the plastic into food, thereby causing health concern. New research suggests that it could be a contributing factor to the development of breast cancer in women. Similarly, there are also some indications of possible migration of VCM, stabilizers, and plasticizers (dioctyladipate (DOA) and acetyltributylcitrate (ATBC)) from plasticized polyvinylchloride (PVC) and polyvinylidene chloride (PVDC)/ PVC (Saran) films into food/water.

Migration of functional additives from plastics into foodstuffs is also a phenomenon of prime importance. It can result in a loss of food quality (e.g. off-flavour) and/or food safety problems. Film packaging additives have a particularly high affinity for fatty foodstuffs with which they are in direct contact.

Another concern is that plastic wraps contain endocrine disrupters, which can mimic or interfere with hormones in the body. What do we mean by *endocrine disrupters?* Endocrine disrupters, are chemical substances, sometimes called environmental oestrogens, both from natural sources and man made, that if present in the body at the right concentration and at the right time, can adversely effect hormone balance or disrupt normal function in the organs that hormones regulate. These endocrine disrupters can interfere with the synthesis, secretion, transport, binding, action, or elimination of natural hormones in the body that are responsible for the maintenance of homeostasis (normal cell metabolism), reproduction, development, and/or behaviour. They can cause breast cancer, birth defects, low sperm count and mental problems. While evidence continues to accumulate that disrupters have an effect on animals, scientists are in heated debate about its meaning for humans.

A number of concerns have been raised by environmentalists, public health groups, and government agencies about the adverse impacts associated with the manufacture, use and disposal of PVC and PVDC products. These impacts include:

- The carcinogenicity of PVC and vinyl chloride monomer, one of the raw materials used to manufacture PVC.
- The migration of carcinogenic compounds and endocrine disrupters out of PVC and PVDC products and into foods packaged in these materials.
- Acid rain problems arising from the incineration of chlorinated compounds (such as PVC).
- PVC's role as a contaminant undermining the recycling of polyethylene terephthalate (PET), a resin commonly used to make soda bottles.
- The possible link between dioxin generation and PVC disposal and manufacture. Dioxin, you have already learnt earlier, is one of the most deadly substances.

All the above aspects pose a threat to the safety of the food and the health of consumers. The on-going research in the field of packaging will definitely give the consumers foods, which are safe in the near future.

Other than the toxicological aspects related to packaging, another issue which needs consideration is the use of packaging materials which are biodegradable, economical

and safe. Also, the packaging material must be eco-friendly so that they do not pose any environmental threat related to their disposal and waste management. So let us in the next section, have a look at the biodegradable materials and environmental issues.

11.7 BIODEGRADABLE MATERIALS AND ENVIRONMENTAL ISSUES

We all know that certain packaging materials have posed a serious threat to our environment. Therefore there is a great deal of concern over the packaging materials on the environmental issues. It is generally contended that packaging contributes to pollution and is a major waste of the earth's resources.

Although 'over-packaging' is to be avoided, in general, packaging saves more than it costs. However, efforts have to be made to reduce the amount of packaging material or change the packaging pattern. This would help in solving to a great extent, the litter and waste due to packaging. In addition, there is a considerable cost saving also.

Another approach is to encourage returnable packaging and if possible and economical, this should be implemented. One example of returnable packaging is the glass bottles that are used for cold drinks.

The solid waste management of packaging materials falls into – recycling, reuse or degradability. Let us understand these concepts.

Recycling: You must have heard of recycling as one of the major methods of conservation of any resource. What really is recycling? *It means the use of discarded package to produce new packaging.* Since a long time, paper and paperboard, glass and aluminium have been recycled for packaging applications. Currently, the main problem is that of plastic materials. The different plastics used such as PE, Polystyrene, PVC, Polyester etc. are very different from each other in their properties and cannot be used in the form of a mixture for making films or rigid containers.

Mixed plastic waste can be scheduled and used for non-packaging applications such as building and construction of roads and also as a soil re-conditioner.

The consumer should be educated to segregate recyclable materials from other, collect as one lot and dispose it off. You must have seen this being practiced in many big institutions and should be further encouraged in smaller places too.

In this connection, Bureau of Indian Standards has formulated FS: 14534: Guidelines for recycling of plastics and IS: 14535: Recycled plastics for the manufacturing of product designation. The defined symbols or numbers designated for various plastics are:

- PET (Polyethylene terephthalate)
- HDPE (High density polyethylene)
- V (Vinyl, polyvinyl chloride)
- LDPE (Low density polyethylene)
- PP (Poly propylene)
- PS (Poly styrene)
- Others (such as poly carbonate).

Degradation of packages can be either through biological agents or light (photo degradation). Biodegradable materials are degraded completely by microorganisms in a composting process to natural compounds and biomass.

Biodegradable polymeric materials such as poly lactic acid, poly hydroxyl alkanoates and starch modification find applications as coatings, films, wraps and other containers.

Another method used for the protection of the environment is the use of edible films such as cellulose and its derivatives and proteins from plant or animal sources for food packaging. Edible packaging is thin layers of edible materials coated on a food item or pre-formed on or between food ingredients. These can be consumed along with the food and thus are environment-friendly. Such eco-friendly packaging must have the following criteria:

- to provide hygienic and healthy foodstuffs
- reduction in pollution load
- efficient use of non-renewable energy sources
- to pressure agri-forest resources, land and water, and
- recyclability leading to recovery of energy.

The concern over environmental pollution from packaging material has led to research into edible or biodegradable films for general food packaging and films that can be used to coat fresh fruits to control the rate of respiration. Examples are corn zein, wheat gluten, soy protein, peanut protein, cottonseed protein, casein, milk whey protein, alginates and collagen.

Check Your Progress Exercise 4

1) What are the different toxicity hazards related to packaging and foods?

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2) What are biodegradable packaging materials?

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3) Indicate the eco-code marking for plastics.

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You must have noticed that now-a-days our markets are flushed with a myriad of packaged products. Development of new products and their introduction to the vast market is a never-ending process. In reference to this continuing developmental process, labeling of packaged products and coding becomes an absolute necessity. We will learn about the labeling and coding process of packaged foods, next.

11.8 LABELING REQUIREMENTS AND BAR CODING

After the food is packaged, it is very important to tell the customer about the product that is present in the package. This can be achieved by the method of labeling. What is labeling? Food labeling is *the primary means of communication between the producer and the seller of food on one hand and the purchaser and consumer on the other*. One would then wonder what needs to be communicated through the means of a label? By label *we mean a slip of paper or any other material (such as tag, brand, mark, pictorial or other descriptive method) on which the legend and design concerning the product is printed, stenciled, marked, embossed or impressed on.* This is then affixed to a container/article containing the product. Have you ever looked at a label on a food product? What information does it contain? Labels on packages are required to indicate the necessary details regarding quantity, active ingredients and the manufacturers' name and address, as well as, the manufacturing and expiry dates as shown in Figure 11.9. You would notice that various materials are used for labeling such as paper, foil, plastics and transfer labels.

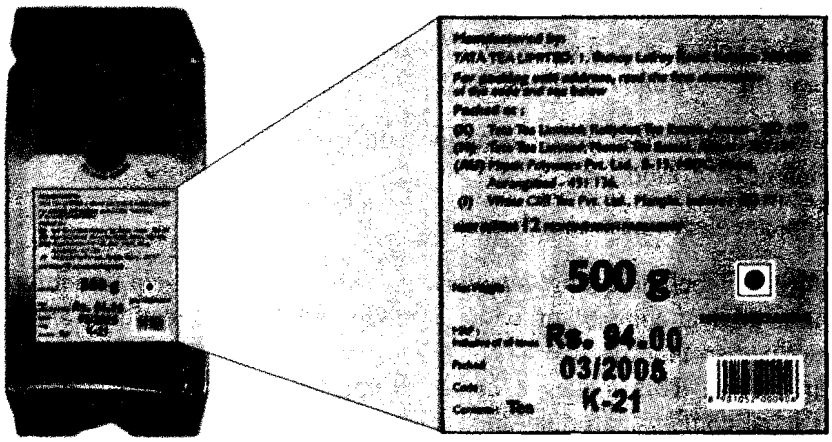

Figure 11.9: A food label

Mandatory labeling requirements of prepackaged foods indicate that every package of food shall carry the following information on the label:

1) Name of the food
2) List of ingredients
3) Declaration of food additives
4) Name and address of manufacturing units/importer
5) Country of origin
6) Net contents and drained weight Lot/Code/Batch identification
7) Date of manufacture or packing
8) Date marking i.e. Expiry date and Best Before Date
9) Instructions for use

The Gazette of India stipulates that all food products packed should have a label indicating whether it is totally vegetarian or not. A green dot, as indicated in Figure 10.9, contained in a green square indicates vegetarian origin, whereas, a brown dot in a brown square denotes that the product or ingredients are non-vegetarian. Apart from these, the Gazette of India stipulates certain additional mandatory requirements on packaged food items. These include:

— *Quantitative labeling of ingredients* (for example, special emphasis on the presence of one or more valuable and/or characterizing ingredients, emphasis on the low content of one or more ingredients etc.)

— *Irradiated foods* symbol (the use of the international food irradiation symbol, as shown in Figure 11.10, shall be in close proximity to the name or brand of the food).

Figure 11.10: Symbol for irradiated foods

While on the topic of food labeling, we need to focus on yet another aspect which is nutrition labeling and nutrition claims.

11.8.1 Nutrition Labeling and Nutrition Claims

Nutrition labeling is *a description of the nutrient content of a food and is intended to guide the consumer in food selection.* It consists of two components:

- nutrient declaration, which means a standardized statement or listing of the nutrient content of a food, and
- supplementary nutrition information.

The nutrition label indicating *nutritional facts* is designed to help find information fast and make general comparison without making a lot of calculations. The *serving size* is prescribed so that the size of one serving will be the same for different brands of the same food. This makes it easier to compare different products. The *dietary values* label contains information regarding overall diet. Figure 11.11 illustrates the nutrition label.

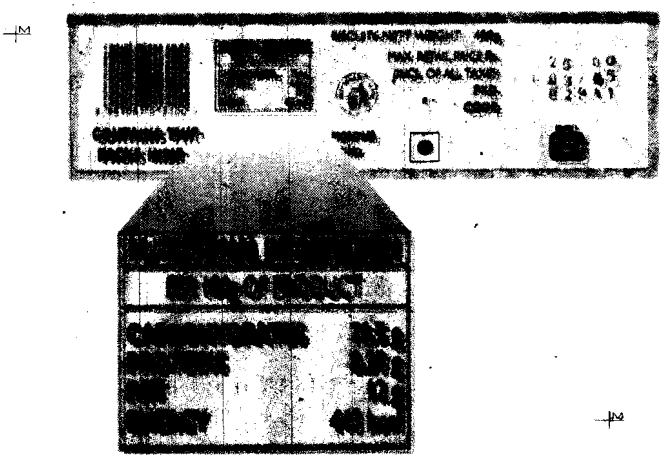

Figure 11.11: Nutrition label

Nutrition claims, on the other hand, means *any representation which states, suggests or implies that a food has a particular nutritional properties including but not limited to the energy value and to the content of protein, fat and carbohydrates, as well as, the content of vitamins and minerals.* The following do not constitute nutrition claims:

- the mention of substances in the list of ingredients
- the mention of nutrients as a mandatory part of nutrition labeling, and
- quantitative or qualitative declaration of certain nutrients or ingredients on the label if required by national legislation

From labeling we move on to the other concept i.e. coding of food products. What do we mean by coding? Let us find out.

11.8.2 Coding of Food Products

Coding denotes *assignment of numerical, alphabetical or symbolic identifying makes to containers, packaging material or articles to provide information concerning the qualities of the contents or containers or date, plant or line in which manufactured.*

A common form of coding the packaged food is through bar coding. Look at Figure 11.12 which highlights a bar code.

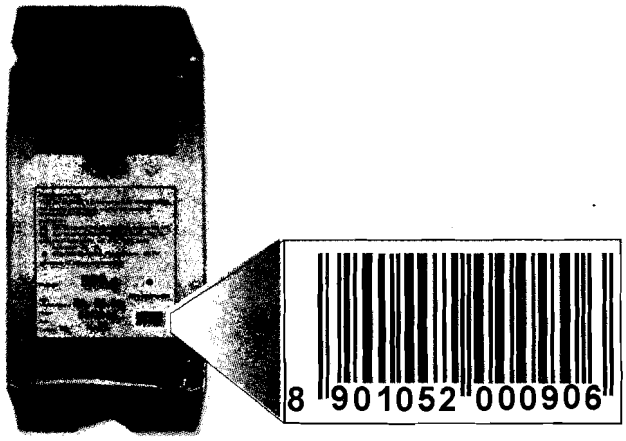

Figure 11.12: Bar coding

Many food products, specially the ones available in supermarkets have code depicting various vertical lines made on them as indicated in Figure 11.12. *This is called the Universal Product Code (UPC)* or the bar code. A bar code is *a series of bars and spaces arranged according to the encodation rules of a particular specification in order to represent data.* Its purpose is to represent information in a form that is machine-readable. The bar codes are printed on consumer packs for laser reading at retail checkouts. This makes the process much easier and faster and avoids the need for individual price labeling of packs and allows itemized bills to be produced for customers.

A bar code symbology is a set of rules discussing the way bar and spaces have to be organized to encode data characteristics. The major symbols are code 39, Interleaned Of Fine (ITF), code 128 and European Article Numbering (EAN) and Universal Products Code (UPC).

The codes are printed as labels on packages and are read by decoding devices. Bar coding technology is used extensively in the supply chain of goods ready for shipment and as a means of inventory control. For example, corrugated board shipping containers are bar coded to inform the carrier about the destination. A manufacturer's code is printed on to the containers to identify the factory, the production line and the shift during which the product was made.

Besides labeling, packaging laws and regulations have also been laid down by the government. We shall review them in the next section.

11.9 PACKAGING LAWS AND REGULATIONS

The standards concerning the hygiene and safety affects are of most important in food packaging. It is very important to maintain the standards when it comes to food products for the sake of consumer health and safety. There are norms and laws laid

down by the government for the process of food production, as well as, packaging. You must have heard about some of them or seen them on the labels of food products. The regulations on packaging that govern food products in the country are enumerated next. A detailed discussion on these regulations and legislations will be presented in Unit 14.

1) *Standard Weights and Measures Act (SWMA) 1976 and the Standards of Weight and Measures (Packaged Commodities) Rule, 1977*

This is applicable to all commodities including foods. The emphasis is on quantity and value declaration to facilitate value comparisons and protect consumer interests. The standard specifies quantities to be packed, expressions to be avoided and size of type depending on the size of the panel in a package. It is mandatory.

2) *Prevention of Food Adulteration Act, 1954 and the Prevention of Food Adulteration Rules, 1955*

This is basically intended to protect consumers health and safety. The labeling rules are very elaborate and applicable to all packaged foods. The declarations include product name, net quantity, month and year of manufacture and additives incorporated and ingredients mandatory for internal trade.

3) *Fruit Products Order, 1955*

This is concerned with fruit and vegetable products including beverages, syrups etc. The objective is mainly to regulate the quality and hygiene of these products. It also specifies the type of packages that can be used for various fruit and vegetable products. All labels should be approved by the authority and should carry the license number allotted. This is mandatory for export and internal trade.

4) *Meat Food Products Order, 1973*

This order is similar to FPO and regulates the licensing and labeling of meat products. It also specifies the type of packages that can be used for various meat products. All labels have to be approved by the licensing authority and number should be declared on the label. This is mandatory.

5) *Agmark Rules*

Agricultural products such as nuts, ghee, honey, pulses, spices and condiments, vegetable oils etc. are covered for their quality parameters. The Agmark rules also specify the type of packages that can be used and labeling declarations that have to be given. It is voluntary for internal trade and compulsory for export of modified products.

6) *Bureau of Indian Standards (BIS)*

The BIS has formulated specifications for packaging materials, packages and components. Also, it specifies the types of packaging materials that can be used for various types of food products. These specifications are voluntary for most of the foods, but are compulsory for certain items like food colours and packaged drinking water.

Check Your Progress Exercise 5

1) Why is a food label required?

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2) What is a nutrition label?

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3) How are vegetarian and non-vegetarian foods labeled?

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4) Mention the different regulations that govern food packaging.

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5) What does PFA mean? What is its relevance in packaging of food products?

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6) Indicate the BIS specifications on safety evaluation of plastic materials.

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11.10 LET US SUM UP

In this unit, we studied the importance of packaging and the various aspects associated with it. Packaging, we learnt, requires proper selection of material, based on the type and the final use of the product. We also learnt about the labeling of packets, equipments used and the rules and regulations that must be considered while packaging.

Another aspect dealt within this unit was biodegradable materials and environmental issues. As you know, packaging wastes can be a serious hazard to the environment. To avoid this, various new materials are being studied and introduced.

11.11 GLOSSARY

Aseptic packaging : process of sterilizing separately food and package and filling in a clean-air atmosphere.

Bag-in-box : a package comprising a carton containing a bag which closely fits the carton and contains the product.

Barrier	:	a material that retards the transmission of water vapour, gases and volatile materials. "Barrier" means a safety factor of a physical, biological, or chemical nature which inhibits or minimizes the growth of microorganisms including those which may be infectious or toxigenic.
Box	:	a rigid container having closed faces.
Can, composite	:	a rigid container with the body made of fibreboard and one or both ends of metal, plastic and other material.
Carton	:	folding boxes generally made from boxboard, for merchandizing consumer quantities of products.
Collapsible tube	:	a container for pastes usually made from a malleable metal or plastic.
Corrugated board	:	a material comprising one or more sheets of fluted paper stuck between flat sheets of paper.
Critical moisture	:	the moisture content at which physical or chemical deterioration occurs to a degree sufficient to render the food unusable, insoluble or unpalatable.
Film	:	unsupported, basically organic, non-fibrous, thin flexible material of a thickness not exceeding 250 μm.
Gauge	:	a method of indicating the thickness of a film, 100 gauge = 25 micron = 0.025 mm.
Label	:	a slip affixed to a container or article and on which is printed the legend and design concerning the food product.
Lacquer	:	a type of coating, applied in liquid form, which dries by evaporation. It is synonymous with enamel.
Packaging	:	a coordinated system of preparation of goods for shipment, distribution, storage and merchandizing at optimum costs compatible with the requirements of the product.
Packing	:	selection and application or use of exterior shipping container and assembling of packaged items.
Shelf-life	:	the length of time that a container or a material in a container will remain in a soluble or acceptable condition under specified conditions of storage.
Shrink Packaging	:	producing a package by shrinking plastic film over the object or objects to be packaged.
Shrink wrapping	:	a process in which a package is wrapped in a thermoplastic film which is then heated so that the film shrinks to closely fit the package.
Stretch wrapping	:	a process in which a package is wrapped in a thermoplastic film which is pulled tightly around the package. The film may be formulated to

Tin-free-Steel	:	electronically chrome-coated steel. The layer consists of chromium – chromium oxide.
Tinplate	:	sheet steel, usually of special formula and temper, coated on both sides with a controlled thickness of pure tin.
Tray	:	an open topped container typically made from carton board or corrugated board and supplied to the user as a flat blank or pre-glued and folded.
Virgin material	:	a material or liquid that has not been subjected to use or processing other than that required for its original manufacturer.

11.12 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress Exercise 1

1) Packaging means a coordinated system of preparation of goods for shipment, distribution, storage and marketing at optimum costs, compatible with the requirements of the product.

2) In the developing countries, a lot of food becomes unusable due to its spoilage. To overcome this problem and to increase the availability of food products, all along the years, preventing spoilage by the means of good packaging will be an economical and socially desirable step.

3) We need to package food to prevent spoilage, increase the availability of food products and transporting marketable surplus to the consumption centers. The functions of packaging are to contain the product, protect the product, assist in marketing and to provide facility for ease of usage, dispensing and disposing off.

4) Package design considerations are product considerations, external factors, packaging materials / forms, packaging machinery, package design / prototypes, marketing aspects and government regulations.

5) The environmental factors that influence the stability of food product are physical hazards in handling, transportation and storage, climatic conditions, relative humidity and temperature.

Check Your Progress Exercise 2

1) The packaging materials are classified as flexible and rigid packages. Some important flexible packaging materials are papers, plastics, metallized films, aluminium foils and composite films.

2) The different plastic materials that are used for packaging are polyethylene, polypropylene, polyester, uncoated polyvinyl chloride and polyvinylidene chloride.

3) Metallized films are plastic films such as those of polyester, polyamide and polypropylene are coated with aluminium to enhance the barrier properties towards the passage of water vapour, gaseous volatile ingredients and light.

   Aluminium foils are metallic foil of aluminium for food packaging is available in thickness of 0.009 mm, 0.012 mm, 0.015 mm and 0.020 mm.

4) The three major types of rigid metal containers are:

- Metal containers: Tin plate containers are made of steel body coated with tin electrolytically. The coating is applied in various thicknesses to suit the requirement of the food packed.
- Aluminium containers: These are available in various sizes and shapes. These have to be coated initially with lacquers to reduce rusting and chemical interactions.
- Chromium steel cans: These are made of steel body treated on the surface by chromium. These are called as tin-free-steel can. These also require lacquers for food applications.

Check Your Progress Exercise 3

1) Vacuum packaging is removal of external gases in a container to remove the oxygen present inside so as to protect the contents from its undesirable effects, such as aroma and taste attraction, microbial growth and physical changes. While gas packaging with nitrogen or carbon dioxide is a better method of removal of oxygen since there is no negative pressure and susceptibility to puncture.

2) Enclosing of a food product in an atmosphere inside a container by attaining the gas concentrations to optimum linear is called CAP. For fresh fruits and vegetables and meat products, the CAP is carried out mostly inside flexible barrier materials. On the other hand, when the gaseous atmosphere is modified, that is, the concentration of the gases oxygen, carbon dioxide etc. are altered, it is called MAP. The packages intended for MAP should be a good barrier to water vapour and gases.

3) The functions of active packaging are antimicrobial, moisture control, carbon dioxide controllers, odor generators, ethylene controllers, oxygen-permeable films, flavor enhancers, oxygen enhancers, microwave susceptors, oxygen generators, time-temperature indicators and tamper-evident labels. Tha applications of active packaging include its use in various foods, foods that are affected by moulds, dried and mould-sensitive foods, horticultural produce and baked foods.

4) The curve representing the relationship of the moisture content and ERH at a particular temperature is known as moisture sorption isotherm.

5) The shelf-life of a product is the period of time during which a perishable food undergoes no physical, chemical, microbiological or nutritive value changes. The parameters that are necessary to predict the shelf-life of moisture-sensitive foods are the weight of the product packed, permeability characteristics of the packaging materials, and external conditions.

Check Your Progress Exercise 4

1) The different toxicity hazards related with packaging and foods are migration of additives to foodstuffs, loss of food quality, food safety problems and endocrine disrupters which interfere with the functioning of hormones in the body.

2) Biodegradable materials are degraded completely by microorganisms in a composting process to natural compounds and biomass. Biodegradable polymeric materials are polylactic acid, poly hydroxyl alkanoates and starch modification.

3) The eco-code marking for plastics is as follows:

- PET (Polyethylene terephthalate)
- HDPE (High density polyethylene)
- V (Vinyl, polyvinyl chloride)

- LDPE (Low density polyethylene)
- PP (Poly propylene)
- PS (Poly styrene)
- Others (such as poly carbonate).

Check Your Progress Exercise 5

1) Labels on packages are required to indicate the necessary details regarding quantity, active ingredients and the manufacturers' name and address as well as the manufacturing and expiration dates.

2) The food label indicating nutritional facts is a nutrition label designed to help find information about nutrient content of foods and is intended to guide consumers in food selection.

3) A green dot contained in a green square indicates vegetarian food whereas a brown dot in a brown square denotes non-vegetarian food.

4) The different regulations that govern food packaging are:
   - Standard Weights and Measures Act (SWMA) 1976 and the Standards of Weight and Measures (Packaged Commodities) Rule, 1977
   - Prevention of Food Adulteration Act, 1954 and the Prevention of Food Adulteration Rules, 1955
   - Fruit Products order, 1955
   - Meat Food Products Order 1973
   - Agmark Rules
   - Bureau of Indian Standards (BIS)

5) PFA is basically intended to protect consumers' health and safety. The labeling rules within this Act are very elaborate and applicable to all packaged foods. The declarations include product name, net quantity, month and year of manufacture and additives incorporated and ingredients mandatory for internal trade.

6) The BIS has formulated voluntary specifications for packaging materials, packages and components. According to BIS specifications, different plastic materials that are used for food packaging such as polyethylenes, polypropylenes, polystyrenes and various others and plastic coatings have to conform to "positive list of ingredients" and "global migration limits".