UNIT 14 PACKAGING PROCESS AND MACHINERY

Structure

14.0 OBJECTIVES

After reading this unit, you should be able to:

- describe about the packaging systems for the transportation of fresh or chilled fruits and vegetables;
- explain the mechanism of various packaging systems for processed food products;
- discuss about the manufacturing processes of different packaging materials; and
- define the machinery, techniques and processes used for packaging processed food products.

14.1 INTRODUCTION

In India, the processed food industry requires primarily the technology in three areas. These are food preparation, packaging and techniques that allow the extension of shelf life of food products. Moreover, the constant research work in the field of food technology has made it possible to develop newer products which require different packagings. At the same time, there has been continuous effort by the industries as well as Government to promote the exports of processed food products. Exportable products require different packagings in terms of durability, higher strength properties, attractiveness and also shelf life.

In order to meet the requirement of export market, there has been enormous development of packaging technology in terms of newer materials, systems and machinery. These developments have not only made it possible to compete with the International brand but also made a position on the shelf of super markets.

Moreover, the newer system of packagings have made the products available throughout the year by enhancing the shelf life. At the same time, there has

been enormous development in the packaging machinery also. The newer types of packaging machinery accelerated the productivity with high accuracy and low wastage.

On the other hand, the conversion technology of packaging materials resulted in the availability of various options for processing technology. This technology enabled to manufacture newer types of packaging materials having high barrier properties in order to improve the shelf life of processed foods and higher impact strength to withstand shock and vibrations during handling, storage and transportation. This conversion processes also enhance the productivity with low energy inputs and reduce the cost of packaging materials.

However, there is a constant need to upgrade the existing processing machinery by way of incorporating newer techniques and systems so that the Indian food products and packages could become globally competitive.

14.2 PACKAGING OF FRESH/CHILLED FRUITS AND VEGETABLES

Fresh or chilled (at 4^0C temperature) fruits and vegetables are basically living tissues, high in water content and diverse in terms of morphology, composition and physiology. The package design depends on the requirement of the produce within the frame work of handling and marketing system. The main causes of deterioration in fresh produce are metabolic changes, mechanical injury and attack by pests and diseases. Though, there are variety of packages but there is no rigid rule that a particular material or style is to be followed for a particular type of fruits and vegetables.

I. Product characteristics of fresh produce

i) Highly perishable in nature and are very easily affected by the climatic conditions, distribution hazards and microbial decay.

ii) Respiration process of fresh produce releases oxygen and carbon dioxide. Rapid respiration results in fast ripening or aging of the produce.

iii) Loss in moisture of fresh fruits and vegetables during storage and transportation resulting into drying causing wilting, shrivelling and loss of rigidity. In addition, there will also be loss in weight.

iv) Appearance of microorganisms like bacteria and mould.

v) Very low temperature causes chilling injury which damages the delicate tissues of fresh produce and thus restrict the shelf life.

vi) Changes in colour, texture, odour and flavours.

II. Requirement of package design

a) Pre-cooling

Pre-cooling of fresh fruits and vegetables after harvesting is required to slow down the enzymatic and respiratory activity, minimize susceptibility to micro organisms and to reduce water loss and ethylene production. Pre-cooling helps in removing the field heat prior to storage. The different methods of pre cooling are forced air cooling, vacuum cooling and hydro cooling.

b) Ventilation

The package should be provided with proper ventilation holes during transportation. Cold air is constantly circulated through the container to remove the heat transmitted during the cooling process.

c) Mechanical damage

The package should have adequate impact strength to withstand the shock and vibration which occur during handling, storage and transportation resulting into mechanical injury of fruits and vegetables. In addition, the fresh or chilled produce will have bruising affect during transit due to vibration.

III. Packaging materials

The packages for fresh fruits and vegetables can be classified as:

A) Consumer/ Retail packs

B) Transport/ Bulk packs

A) Consumer or retail package

Consumer packages are small in size designed to hold half dozen or one dozen fruit or ½ kg to 1 kg vegetables. There are many types of consumer packs used for the packaging of fresh fruits and vegetables. The selection for the type of consumer pack depends on marketing characteristics of the product. The most commonly used packages are listed below:

i) Flexible plastic film: Plastic pouches made of LDPE, PVC or PP are used for the packaging of horticultural produce.

ii) Trays with overwrap: The trays used are usually made of moulded pulp tray or thermoformed plastic materials like EPS, PVC and PP. The produce is placed in individual cavities so that abrasion and brushing is avoided. Transparent LLDPE based cling films are used to wrap the trays. The films are semi permeable and allow exchange of gases for respiration of the product.

iii) Plastic punnets: Punnets made from either PET or PVC are food grade, odourless and light in weight. These are also amenable to stacking during storage.

iv) Plastic net bag: The plastic net bags have feature to stretch and accommodate all sizes and shapes of produces. These nets are generally made of HDPE or PA (Polyamide).

v) Foam sleeve: This is a tubular film made of polyethylene foam available in different colours, diameters and lengths. It is hygienic, non-toxic and odourless. This could be easily slipped over the individual fruit in a snug fit form.

vi) Shrink wrap: This is one of the latest trend to shrink wrap the individual produce. This pack restricts the moisture loss. In addition, it provides see through property. The films most commonly used are LDPE or LLDPE.

B) Transport packs

The normal size of transport package is between 15 to 20 kg which is suitable to carry by hand. Transport packages can be broadly classified as follows:

(a) Rigid containers:

i) Bamboo basket: Bamboo baskets are widely used even today as transport pack for domestic market. These are available in various shapes, sizes and designs but they do not have the rigidity and stackability during long distance transport.

ii) Wooden box or container: The conventional baskets are replaced by wooden box. However, the use of wooden boxes are discouraged now a days as they directly promote deforestation.

iii) Plastic crates: Crates made of HDPE or PP have got high impact strength. In addition, these are reusable, amendable to withstand journey by different mode of transportation and also provide good stackability during storage and transportation.

iv) Solid fibre board: These materials have got very limited application.

v) Corrugated fibre board boxes: The boxes are widely used as shipping containers for fresh produce because of numerous advantages over wooden boxes.

vi) Plastic corrugated box: These are usually made of HDPE or PP. HDPF have got light impact strength and low degradation by Ultra Violet radiation while polypropylene has a better scratch resistance.

(b) Flexible containers:

Sacks made of either plastic, jute or paper could be used for the packaging of horticultural produce. This facilitates breathing of fresh produce and have also got high stackability during storage and transportation.

IV. New trend

Modified atmosphere packaging (MAP) is a system involving the removal of air from the packages and replacing with a single or mixture of gases. The gas mixture used depends on the type of the produce.

The MAP system is a dynamic one where respiration and permeation occur simultaneously. Factors affecting both of these must be considered when designing a package. The selection of a film or combination of more than one film (laminates) depends on the expected transpiration and respiration rate of the produce.

Check Your Progress Exercise 1

Note: a) Use the space below for your answer.
b) Compare your answers with those given at the end of the unit.

1. What are the important characteristics of fresh fruits and vegetables?

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2. What are the different packaging options for fresh fruits and vegetables?

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3. Explain the new trend of packaging for the enhancement of shelf life for fresh fruits and vegetables.

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14.3 PACKAGING OF FROZEN FOODS

Freezing is considered to be one of the most important technique for the preservation of food products. This technique is mostly employed for the preservation of fresh fruits and vegetables. At low temperature, both microbial growth rate and metabolic activity of foods are reduced by a factor of 1/2 to 1/3 for each 10°C drop in temperature.

Frozen fruits and vegetables should be stored nearly at –16°C to maintain the superior quality. Storing frozen foods at temperatures higher than –16°C increases the rate of deterioration and reduces their shelf life. Fruits and vegetables of high quality and good nutritional value can be achieved under frozen conditions. However, these are primarily based on the following aspects.

a) Physical and chemical changes which take place during freezing process

b) The effect of freezing on fruit and vegetable tissues

c) Food spoilage microbiology

I. Critical factors of frozen food

During freezing operation fruits and vegetables undergo certain physical and chemical changes which affect their quality. Under physical changes, the following critical aspects are to be considered.

i) Moisture is lost as ice crystals evaporate from the surface of the product, producing freeze burn – a grainy, brownish spot where the tissues become dry and tough.

ii) This freeze-dried surface area is prone to development of off flavour.

iii) Freezing of fruits and vegetables consequences into freezing of water resulting into rupturing of cell walls. The texture of the produce, when thawed, becomes much softer as compared to raw produce. This kind of physical change is generally found in vegetables like tomato, which become mushy and watery. However, this type of change is less noticeable in high starch vegetables such as peas, corn and beans.

Similarly, some chemical changes also occur in fresh fruits and vegetables during freezing. The important critical factors to be considered are:

i) Development of brown colour and loss of vitamin C due to enzymatic reactions. In order to prevent this reaction, there is a need to inactivate the enzymes by blanching. This process also helps in destroying the microorganisms present on the surface of fruits and vegetables.

ii) The development of rancid oxidative flavours is another chemical change that takes place through contact of the frozen product with air.

Most of frozen fruits maintain high quality for 8 to 12 months. Unsweetened fruits lose quality faster than those packed in sugar syrup as sugar itself acts as a preservative. Similarly, most of frozen vegetables maintain a high quality for 12 to 18 months at –16°C or lower. Longer storage of frozen fruits and vegetables may not be unfit for consumption but the quality of produce is reduced drastically.

II. Requirement of packaging

Considering the critical factors responsible for the physical and chemical changes of produce that occur due to freezing, the packaging materials should have the following properties to meet the requirement.

i) The packaging materials should have high moisture barrier property so that the material could be used as wrapper to prevent “freeze burn”.

ii) Frozen foods also require the packaging material with high oxygen barrier property so that the products could be wrapped to prevent the development of oxidative rancid flavour.

iii) The packaging materials should have light barrier property so that the effect of UV light in the oxidative reaction could be minimised.

iv) The material should have good printability and heat seal property.

v) The packaging materials should also have low temperature resistance so that wrapped product could be freezed at low temperature without having any crackness on the materials.

III. Types of packaging materials and packages

Frozen fruits and vegetables are normally subjected to blanching or sealing process to destroy the enzymes. Subsequently, they are packed prior to freezing operation. In general, there are two types of packages namely dry pack and tray pack.

a) Dry pack

This is the method used to pack the blanched and drained vegetables into containers or freezer bags. The vegetables like broccoli, pack tightly in the freezer bag by arranging the heads and stems in alternate manner so that there should not be any air inside the bag. This kind of bag is normally made from either low density polyethylene (LDPE) or PVDC coated plastic film, 3 layered laminate structures with PET/Al-foil/Polyethylene or five layered coextruded multilayered plastic film (PE/Tie/ Nylon/ Tie/ PE). These type of packaging materials have high impact strength, low temperature resistance and moisture barrier. These packages can be subjected to freezing at a temperature of –16°C or below.

b) Tray pack

This type of packages, where the trays are made of collapsible corrugated fibre board, are made from either 3 ply or 5 ply. However, top layer of the board is coated with plastic film to provide water proof property. This kind of board is converted into tuck-n-type tray by means of die-cut machine. However, one single layer LDPE film is spread on the tray so that the produce may not have direct contact on the inner surface of the board. The blanched and drained vegetables are then placed on the tray. As an alternative, the plastic bag filled with blanched and drained vegetables can further be packed into collapsible tray.

IV. Properties of packs

i) Tray pack can be more attractive by way printing on the surface as compared to dry pack.

ii) While freezing, tray pack may not be deformed as the package will have adequate strength. But there is a possibility of deformation or appearance of wrinkles on the products during freezing.

iii) Dry packs are cheep as they are made from either single or multilayered flexible packaging materials.

iv) Dry pack made of plastic bag should have good heat seal property whereas the tray pack should have high compression strength.

v) In both the cases, the selection of flexible packaging material is very important as the materials should have low temperature resistance.

V. New developments

i) Aluminium tray

Tray can be made from aluminium sheet instead of paper board. This type of package can be stored at even –40°C without any damage to the tray. Moreover, the oxygen barrier property is excellent and prevention of freezer burn is good.

ii) Plastic tray

Plastic tray made of HDPE is extremely used as transport package for the storage of fruits during freezing. However, the individual fruit is washed properly, packed in plastic bag with sugar syrup, heat sealed and then stored in plastic tray for freezing.

VI. Application

The following fruits and vegetables are normally available in frozen form.

A) Fruits **:** Apples, apricots, peaches, straw berries, pine apples, citrus fruits, etc.

B) Vegetables **:** Beans, carrots, cauliflower, peas, potatoes, pumpkin, spinach and other green vegetables.

Check Your Progress Exercise 2

Note: a) Use the space below for your answer.
b) Compare your answers with those given at the end of the unit.

1. What changes could occur during freezing of fruits and vegetables?

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2. Write down the important critical factors to be considered for frozen foods.

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3. Discuss the important requirements of packaging of frozen foods.

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4. Mention two most important types of packages used for frozen foods.

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14.4 PACKAGING OF DEHYDRATED FRUITS AND VEGETABLES

Dehydration of fruits and vegetables or removal of water from fruits and vegetables is the simplest techniques of food preservation. There are number of products which are available in the dehydrated form, for example raisin, mushrooms, apples etc.

The drying process has to be controlled so as to avoid common problems such as tissue shrinkage, browing and heat damage, case harding, loss of rehydrability or solubility and loss of flavour volatiles. Many a times, the dehydrated product is subjected to agglomeration or instantanization for better solubility and quality.

I. Product characteristics

i) Highly moisture sensitive and tends to absorb moisture resulting into stickiness.

ii) Changes in colour, texture and odour during storage.

iii) Susceptible to microbial spoilage due to the appearance of fungal growth on the surface.

iv) Certain products are oxygen sensitive resulting into rancidity which affects the taste of products.

II. Packaging requirement

i) Air tight package

The package could be made of high moisture barrier plastic films like coextruded plastic film, polyester/ polyethylene laminate, etc. The package should be air tight in the form of either pillow pouch, made in FFS machine, or 3 sides sealed pouch.

ii) Plastic containers

The plastic containers made of either PET blow moulded HDPE could be used.

iii) Vacuum package

The dehydrated fruits and vegetables could be packed in plastic pillow pouch and then subjected to vacuumisation. The vacuum pack will help to avoid oxidation rancidity and also protect the product from moisture absorption. Thus, the shelf life of product will be enhanced. The plastic

pouch could be made either from laminate made of aluminium foil/polyethylene or polyester/ polyethylene.

iv) Gas package

To enhance the shelf life a product can be packed by creating a vacuum and flushing with inert gas in a container. As an alternative, laminated plastic pouch could be vaccumised, gas flushed and sealed in automatic FFS machine.

v) Pouch in box

The vacuum pouch of dehydrated products could further be packed into composite can and sealed at top to make it air tight. In some cases, the vacuum pouch could to be packed in either carton made from duplex board or 3 ply microflutted (E flute) corrugated fibre board box.

14.5 MANUFACTURING OF PACKAGING MATERIALS

14.5.1 Glass Containers

I. Composition

The main constituent of glass are sand, lime stone and soda ash. The sand used is known as silica or glass sand. Silica sand is melted at the first stage of making glass where soda ash helps it to melt with greater ease. Glass made with the glass sand and soda only is partly soluble in water. When crushed lime stone is added, the resistance of glass to water increases greatly. There are few other chemicals that are added to these three main ingredients to make the glass container stronger and cleaner or coloured as may be required.

In some cases, arsenic, selenium and cobalt oxides in proper proportion are added to make clear glass. The green or brownish shade in glass comes from the impurities in natural sand, mainly iron.

Boron from borax is added to glass to make the container stronger and to increase its resistance to acids. This chemical also reduces the thermal expansion of the glass.

Colours are added to glass by adding small quantities of chromium, cobalt, iron and other colourants depending on the colour required.

For amber (brown) glass, carbon and sulphide are added. Depending upon the qualities and the colour, raw materials are mixed in requisite proportions.

II. Manufacturing process

Depending upon the requirement of type and colour of glass containers to be manufactured, the raw materials are weighed, mixed thoroughly and fed into a glass melting furnace by maintaining a temperature of about 2700°F (1560°C). The melted glass is then passed into the refining chamber of the furnace. Impurities are retained in the melting chamber and the purified

glasses are passed through a channel in the furnace called “Throat”. The molten glass passing through the ‘throat’, enters into the refining zone of the furnace where some bubbles, normally escaped through the throat, are allowed to be fined or eliminated and then it enters to the gob feeder. At the precise position, just above the forming machine, the glass is allowed to leave the furnace through a cylindrical hole in the bottom of the feeder and the stream of glass is cut off to a predetermined diameter and length of shears to form a gob. The gob falls into a blank mould, usually made of cast iron, to be shaped into a parison or semifinished container. It is then transferred into a second mould, called finished mould, whose internal cavity is accurately machined to correspond to the desired external shape of the container. The glass container as it emerges from the finished mould has a temperature about 800°C but it cools and hardens quickly. It is then immediately transferred to a tunnel like annealing with planned heating zones to cool slowly. This gradual and regulated cooling of the container eliminates the internal stresses and as it emerges from the other end of the lehr. Then the glass containers are inspected for any faults or defects before packed into corrugated fibre board boxes for the despatch to the user industries.

14.5.2 Metal Cans/Open Top Cans

The tin plate is purchased in the form of sheets either locally or imported. Depending up on the requirement the thickness of tinplate used varies from 0.006” to 0.012”. The following steps are used for the decoration and the manufacturing of tin plate (Figure 14.1).

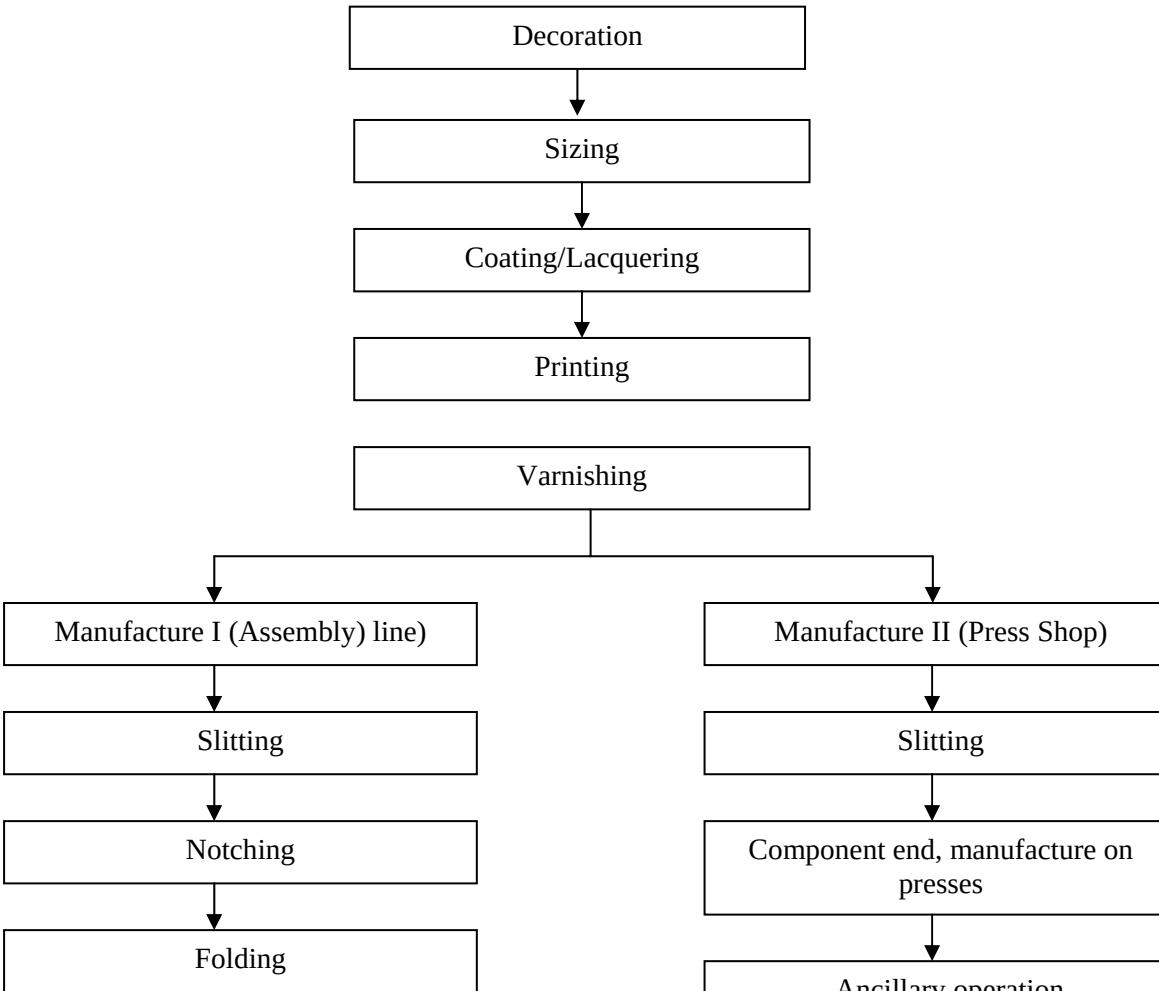

Figure 14.1: Flow diagram of decorated tin plate manufacturing

Though, the plastic containers are constantly replacing tin plate containers in many areas, even though, tin plate containers are continued to be an ideal packaging material for processed food due to the following advantages:

i) They are strong enough to protect the contents during handling and transportation.

ii) The materials are light enough for commercial handling.

iii) They can be readily fabricated into desired sizes.

iv) They are impervious to air and water.

v) They are capable of being heated for sterilization. These containers can with stand the internal pressures during processing of the food.

vi) The materials are not harmful or toxic to their contents.

vii) They can be easily printed for good market appeal.

viii) They can be manufactured at very high speed.

ix) The processed food has got maximum shelf life of 12 months in tin plate containers as compared to any other packaging material.

14.5.3 Plastic Materials

A) Plastic rigid container

Different manufacturing processes are involved in the production of plastic containers by using thermoplastic materials.

a) Blow moulding process

In this process, the thermoplastic materials are extruded in the form of pipe (it is called as parasite) through an annular die (directed downwards) and then blowing it inside the cavity of a closed mould with the help of compressed air to assume the shape of the cavity. Depending on the die, the plastic containers of different capacities, sizes and shapes are manufactured. This method has got most of the major advantages over extrusion and injection techniques and is used to produce thermoplastic hollow ware like bottles.

b) Extrusion blow moulding

Basic parts of this machine are the extruder, die head, mould, clamping unit, blow pin and new blowing unit and control system.

At the first stage, extrusion of the parison is accomplished with a heated, hollow barrel in which a rotating screw conveys solid feed material, compresses and melts it and finally pumps the melt through a tubing die to form the parison. The actual shape and design of the screw

is dependent on the theological properties of the plastic materials. Hence, for different types of polymers, different screws are used.

After the plastic has been melted at a low temperature to maintain high melt strength the vertically extruded tube supports itself and then the plastic melt is fed into an extrusion head. For polyethylene, die head with programmable mandrels can be used.

c) Stretch blow moulding process

This method differs from the conventional blow moulding. In that the parison is "Biaxially Oriented" to impart much superior mechanical properties to the blow moulding containers. This process has the following sequence:

- Formation of a parison by injection moulding or by extrusion
- Longitudinal stretching of the parison
- Radial orientation while blowing the parison into the mould
- Ejection

This process can be continuous or in two stages. In the 2-stage process, perform is moulded first and then subsequently reheated, stretched and blown in a secondary operation. Mineral water bottles made of PET are manufactured by using this technique.

d) Injection blow moulding

It is almost same as stretch blow moulding. A parison is injection moulded over a core pin and the threaded neck is formed. The core pin can be shaped so that the plastic can be thin and thick at different points to produce an acceptable bottle. The injection-moulded perform is then transferred to a blow station where the core pin opens and allows air to blow a bottle into the shape of the blow mould. This method is quite popular in advanced countries for moulding small bottles up to 250 ml capacity. In India, injection blow moulding method is yet to be used.

e) Co-extrusion blow moulding

This method can only be accomplished through the multilayer combination of resins to produce co-extruded bottles. This system includes additional extruders and head system where the plastic is brought in at different points and layered to form a parison and follow the same process of blow moulding technique.

The polymeric materials like polystyrene (PS), high density polyethylene (HDPE), polypropylene (PP), polycarbonate (PC), etc., are normally used to manufacture the rigid containers by using the injection blow moulding process.

f) Compression moulding

The science of compression moulding, particularly thermosetting plastics and rubber, is well established. The use of this technique is very rare for processing thermoplastics because of longer moulding cycles involved. In principle, this technique involves the following steps

i) Filling the heated female mould cavity with the moulding powder.
ii) Pressing the powder with the male mould into shape after a breathing stroke.

iii) Maintaining the desired temperature and pressure over a length of time.
iv) Cooling the mould to a minimum possible temperature.
v) Ejection of the article.

B) Plastic films

The thermoplastic polymeric materials are also used to make the flexible plastic films having thickness from 8 to 250 microns. Plastic films are manufactured mainly by two methods, i.e. blown film co extrusion process and cast film co extrusion process.

In case of blown film coextrusion process, the extrusion machine used with either 3 or 5 extruders. However, single extruder machine can also be used to make plastic film by using blown techniques. In this process, polymeric material of single or multiple type is blended and fed into separate hopper, subjected to melt with separate melt channels and then passed through one die that is bonded to form single web of multilayer co extruded plastic film. Now a days, blown film coextrusion process has become very popular as this technique provides plastic films higher impact strength, barrier properties and high seal strength.

In cast film co-extrusion process, the individual layers are combined in multilayer adapters and distributed across the width of a cast film die. Now a days, multilayer co-extruded plastic sheets are being produced by using this technique. This kind of cast plastic sheet has got wide application in manufacturing of thermoformed containers, used extensively for the packaging of processed food products.

Check Your Progress Exercise 3

Note: a) Use the space below for your answer.
b) Compare your answers with those given at the end of the unit.

1. What are the constituents of glass?

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2. Indicate the steps followed for the manufacturing of glass.

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3. What are the important steps followed for the manufacturing of metal containers?

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4. What is called parasite in blow moulding process of plastics? What are the sequences in the stretch blow moulding process?

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14.6 ASEPTIC PACKAGING

Aseptic packaging can be defined as a procedure consisting of sterilization of the packaging materials or container, filling of a commercially sterile product in a sterile environment and producing containers which are hermetically sealed so that recontamination or reinfection is prevented. This results in a product which is shelf stable under ambient conditions. The term ‘aseptic’ is derived from the Greek word ‘Septices’ and implies the absence or exclusion of any unwanted organisms from the product, package or other specific areas. The term ‘hermetic’ is used to indicate suitable mechanical properties to prevent the passage of microorganisms and gas or vapour into or from the container.

I. Steps followed in aseptic system

Aseptic processing comprises the following:

a) Sterilization of the product before filling

b) Sterilization of the packaging material or container before filling operation

c) Filling the product into the sterile package by maintaining the aseptic condition

a) Sterilization of product

The product sterilization is carried out by in-process or on-line sterilization which is popularly known as the ultra high temperature (UHT) or high temperature short time (HTST) depending upon the product treatment. The essential difference between the sterilization through autoclave, i.e., conventional canning method, and on-line UHT treatment is that in canning, the sterilization is done after the product is packed, whereas in UHT method, the sterilization is done prior to

packaging. Normally, the sterilization temperature is maintained at 133–135°C for 3 to 5 seconds under HTST/UHT method to make the product sterile. However, there may be slight variation in temperature and duration depending on the type of product.

b) Sterilzation of packaging materials and equipment

Different kind of sterilizing agents like heat, chemicals and radiation are used alone or in combination for sterilization of aseptic equipment and packaging materials.

i) Heat

Initially, product supply lines and fillers are commonly sterilized by moist heat in the form of hot water or saturated stream under pressure. 'Dry heat' in the form of superheated steam or hot air may also be used to sterilize equipment. However, due to the relatively high dry heat resistance of bacterial endospores, the time-temperature requirements for dry heat sterilization is high. Systems enjoying moist heat are frequently sterilized at temperatures ranging from 121–129°C, while 176–232°C is used for sterilization by dry heat.

ii) Hydrogen peroxide

Hydrogen peroxide (H_2O_2) is not an efficient sporicide when used at room temperature. Therefore, most aseptic packaging systems use H_2O_2 (at concentrations of 30 to 50%) as a sterilant for packaging materials followed by hot air (60–125°C) to dissipate residual hydrogen peroxide.

Other chemicals which have been used as sterilents for acid foods include various acids, ethanol, ethylene oxide and peracetic acid.

iii) Radiation

A dose of approximately 1.5 megaradians (MGRAD) Gamma radiation is commonly used to decontaminate containers for acid and acidified foods. Doses required to sterilize containers for use with low acid foods are considerably higher than those required for acid and acidified foods.

Ultraviolet (UV-C) light has been used to decontaminate food contact surfaces. The low penetration and problems associated with shadowing limit the use of UV-C for aseptic systems packaging of low acid foods.

c) Filling of the product under aseptic condition

Once the product has been brought to the sterilization temperature, it flows into holding tube. The tube provides the required residence time at the sterilization temperature. No external heating of holding tube should take place.

A deaerator is used to remove air from the product processed and packed aseptically. The deaerator generally consists of a vessel in which the product is exposed to a vacuum on a continuous flow.

The sterilized product is accumulated in an aseptic surge tank prior to packaging. The product is pumped into the surge tank and is removed

by maintaining a positive pressure in the tank with sterile air or other sterile gas.

Aseptic packaging system has been introduced in India by Tetrapack Company and marketing the different process food in tetra packs. The most commonly system is followed by Tetra pack, called as Tetra classic aseptic (TCA) system. The packages produced have a tetra hedronal shape. The ratio of packaging material to packaged product is a very favourable one, i.e., the amount of packaging material needed to package the volume of food is small.

Similarly, the TBA/3 (Tetrabrik Aseptic) system was introduced into the Indian market in the beginning of 1970. The containers produced are 'brick shaped' and easier and more efficient to handle during storage and distribution.

The tetrabrik packages are brik like shape and made of six layers of packaging materials. Composition of Tetrapack Aseptic carton is given below (Figure 14.2). The 6 layers in the brick provide total protection to the packaged product.

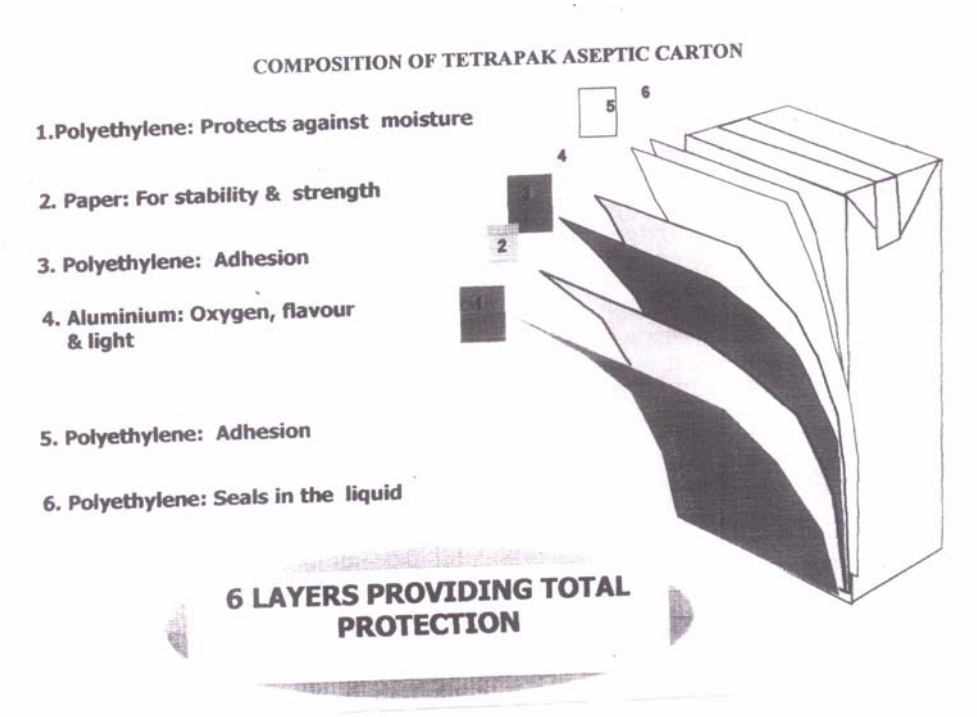

Figure 14.2: Composition of tetrapack aseptic carton

A number of processed food products which are liquid or semi solid in nature, are available in the aseptic packages. The common products aspeticall packed are fresh milk and flavoured milk, fruit juices, yougurt, vegetable oil, chocolate milk, Milk curd, cream.

II. Types of aseptic packages

A variety of consumer packages may be filled aseptically as listed below:

i) Carton box

ii) Bags and pouches

iii) Cups and Trays – Polypropylene based multilayered materials with EVOH barrier materials are used.

iv) Glass bottles and Jars

Check Your Progress Exercise 4

Note: a) Use the space below for your answer.
b) Compare your answers with those given at the end of the unit.

1. Define aseptic packaging system?

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2. What are the steps followed in this technique?

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3. How do you sterilize the product under this process?

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4. Describe the different sterilizing agents for packaging materials.

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5. Give examples of types of aseptic packaging.

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6. What are the applications of this technique?

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14.7 VACUUM AND INERT GAS PACKAGING

Vacuum packaging is the simplest and common method of modifying the internal gaseous atmosphere in a pack. The food product is placed in a pack made of a plastic film or laminate of low oxygen permeability. Air is then evacuated and the package is sealed. An evacuated package collapse around the product so that pressure inside is much less than atmosphere.

Similarly, the gas and vacuum package is dealt with the removal of air from the pack and the vacuum space is replaced by a single gas or mixture of gases. The gas mixture used is dependent on the type of product.

I. Vacuum packaging

In this process a vacuum is applied to remove the air from a preformed flexible pouche, containing the processed food product and then sealing it. The plastic film used should have low oxygen permeability under good vacuum condition, the oxygen level is reduced to less than 1%.

The main significance behind this technique is to extend the shelf life of processed food product. The processed foods having high content of fat like deep fried potato or banana chips, namkeen, bhujia, roasted peanut, roasted ground nut, etc., become rancid due to reaction with oxygen present in container. Due to this fatty foods become bitter in taste and unacceptable to the consumers.

In order to preserve these products, there is a need to evacuate the air from inside the package. However, this technique is most suitable for the products which are powder in from like tea, skimmed milk powder, etc. But this technique is not suitable for granular or flaked or bakery products as the products get crushed due to evacuation of air from the package.

II. Gas packaging

Gas packaging can be achieved by two fundamental methods. One is the replacement of air with a gas or a mixture of gases mechanically. The other is by generating the atmosphere within the package either passively, as in the case of fruits and vegetables, or actively by using suitable atmosphere modifiers such as oxygen absorbents, carbondioxide absorbents or emitters. In general, gas flushing process is usually performed on a form-fill-seal machine. Gas is injected into the package to replace the air. This dilutes the air in the head space surrounding the food product. When most of the air has been replaced, the package is sealed. There is a limit to the efficiency of the system since replacement of air in the package is accomplished by dilution. Typical residual oxygen levels in gas flushed packs are 2-5% oxygen. Inert gas like nitrogen is also used to flush the packages.

In case of fresh fruits and vegetables, the atmosphere inside the package is modified passively. Fruits and vegetables continue to respire even after harvest. That means, the produce consumes oxygen and produce carbon dioxide and water vapour. If the respiration characteristics of the commodity can be accurately matched to the permeability of the film used for packaging, then a favourable modified atmosphere can be created passively within the package and an equilibrium concentration of oxygen and carbondioxide is established. Equilibrium modified atmosphere (EMA) containing 2.5 per cent oxygen and 3.8 per cent carbon dioxide could delay the maturation process and softening of the vegetables, reduces chlorophyll degradation, microbial spoilage and enzymatic browning.

Under active packaging, the package containing food products where certain additives are incorporated either in the packaging film or within packaging container to modify the head space atmosphere. Different additives are added to the package to act as oxygen absorbant, carbon dioxide absorbant or scavenger, ethylene absorbant and ethanol vapour generator, etc. This is relatively a new technology and presently quite expensive.

14.8 FORM-FILL AND SEAL EQUIPMENT

Over the years, the form-fill-seal machine has gained popularity and acceptance for packaging of commodities. This particular equipment is suitable for flexible packaging materials and as well as semi rigid packaging materials. The machine operates with either one or two ebs of films which are transported vertically and horizontally. This machine helps to form a package from packaging material and allows to fill the package with the product. Then there is a provision to seal the package and make it ready for transport. Due to this fact, this particular packaging machine is also considered as system packaging.

There are two types of form-fill-seal machines which have got extensive application for the packaging of processed food products.

i) Vertical form-fill-seal machine.
ii) Horizontal form-fill-seal machine.

i) Vertical form-fill-seal machines

This particular machine performs different operations like film formation, back seal production and making top and bottom cross seal simultaneously. The film is fed from a roll and the operations are as follows:

a) Form-fill-tube

Film formation starts at the forming shoulder. In this process, the flat film passes over the shoulder to form a round tube shape with sides overlapping each other. In some cases, machine uses a metal tube to maintain the shape. The back seal could be formed either as LAP, FOLD OVER or FIN to make the basic shape of the pouch or package.

b) Heat seal along back

Once the tubular shape has been formed, the overlapping edges of the flexible packaging materials are sealed. This is normally done with the help of a pair of heated jaws which come together and press the overlap edges of film to make the back or centre seal. In most of the cases, the impulse seal is used for certain film types while other methods such as hot air or high frequency are also used. This machine creates the longitudinal seal that is generally centered on the back of the bag formed at the front of the forming tube.

c) Cross seal formation

Once the tube has been formed with back or centre seal, cross sealing and filling takes place. The bottom of the pouch is then sealed with the help of heating elements in the horizontal jaws and then the seal is cut at the middle and allow to drop the filled package freely. In this case, the horizontal seal where one part act as top seal of the bottom pouch and the other part will be the bottom seal of the subsequent pouch and the operation thus continuous.

Vertical form-fill-seal machines are particularly suited for material that drop freely on its own weight. These are fed by fillers that are normally positioned at the top of the machine. Fillers are (i) gravimetric where a cup is filled, levelled and discharged to the pouch or (ii) auger filler where product volume is measured by the number of revolution of a screw within the tube or (iii) weight fillers based on a scale system where precise quantities by weight are accumulated and released to the bag machine. Edible oil, milk, sugar, cereals, pan masala, spices, tea powder, etc., are packed by this machine.

ii) Horizontal form-fill-seal machine

This type of machine is extensively used for the packaging of processed food products. In this machine, the flexible film is moved horizontally through the machine which form or folds it into a simple ‘V’ shape. Once ‘V’ shape is formed, proportional heat control dies make the side seals and the pouches or bags are separated. Horizontal film advancement is intermittent or continuous. This machine has a control device based on electromechanical, electronic or micro processor. Products like chocolates and other confectionery items, sauces, salt, sugar, tomato ketchup, pickles, etc., could be packed by using the machine.

Types of pouches / package formed

By using the form-fill-seal (FFS) machine either vertical or horizontal, the flexible pouches could be made in the form of pillow pouch, 3-side seal pouch or 4 side seal pouch. A single web is used to form pillow pouch or 3 sides seal pouch either by vertical or horizontal FFS machine. In case of pillow pouch, there will be one centre seal at back and two seals, i.e., one at top and the other at bottom. But two numbers of independent web can also be used to make 4 sides seal pouch in this machine. Figure 14.3 illustrates a form-fill-seal machine.

Figure 14.3: A form-fill-seal machine

Check Your Progress Exercise 1

Note: a) Use the space below for your answer.
b) Compare your answers with those given at the end of the unit.

1. What do you mean by vacuum packaging?

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2. What are the steps followed for gas packaging?

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3. How many types of FFS machines are available in India?

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4. What are the applications of FFS machine for processed food packaging?

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5. Fill up the following gaps:

   i) In Vertical FFS machine, the fillers are _____ , _____ and _____.

   ii) In vacuum packaging, the oxygen level is reduced to_____.

   iii) EMA contains _____ oxygen and _____ carbon dioxide.

   iv) In active packaging, normally _____ and _____ are used to absorb oxygen and ethylene.

   v) In gas flushing technique, inert gas _____ and _____ are normally used.

14.9 LET US SUM UP

Food products either in fresh or processed form available in the market are consumed by the human beings. There has been constant growth in production of fresh fruits and vegetables but unfortunately, it is not distributed in proper manner across the country. This is mainly due to improper handling and storage mechanisms and also inadequate packaging. In addition, there could also be other reasons like improper infrastructure facilities and transportation. As the fresh produce is highly perishable in nature and continue to respire there is special requirement of its packaging. Similarly, chilled and frozen foods have different packaging requirements.

Aseptic packaging has got extensive application in the packaging of fruit juices for longer shelf life. The foods which have got high fat content, require modern packaging systems like vacuum and gas packaging to enhance the shelf life of these products in consumer pack. Dehydrated fruits and vegetables have got special requirement of packaging which has also been covered in this unit.

For any packaging system, packaging machinery plays an important role. In fact, good and effective machinery has made possible to pack processed food products without much loss in their quality. Form-fill-seal machine is considered to be one of the important machine for system packaging of variety of food products like powders, granules and pastes.

You have also understood the manufacturing processes for the production of important packaging materials like glass bottles, tin plate containers, plastic films and plastic containers which are normally considered as primary packaging materials. These materials have got wide application in the packaging of processed food products.

In short, you have learnt the important packaging materials, their manufacturing process, packaging systems and machinery in this unit.

14.10 KEY WORDS

Annealing : Regulated way of cooling an article to eliminate internal stress and thus breakage.

Throat : The channel of the furnace through which the molten glass is passed away.

Parasite : The thermoplastic material when extruded in the form of pipe under blow moulding process, is called parasite.

HTST : High temperature short time. This is the latest technique of sterilization of food products where the microbes are completely killed within short period of time.

Freeze burn : During freezing moisture is lost from the surface of the product, the product tissue becomes dry and tough brownish and a grainy spot occurs on the surface.

Parison : A semi finished container or a blank mould made of cast iron, used normally prior to sent the gob into finished mould.

Gob : A stream of glass cut off to a predetermined diameter and length of sheats to form a gob.

TBA : Tetrabrick aseptic system which was introduced in Indian market by Tetrapak Company in the year of 1970.

TCA : Tetra classic aseptic system. This system produces the package of hedronal shape.

EMA : Equilibrium modified atmosphere containing 2.5% oxygen and 3.8% carbon dioxide, it can delay the maturation process and the softening of vegetables, microbial spoilage and enzymatic browning.

14.11 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress Exercise 1

Your answers should include the following points:

1.
   - Highly perishable in nature.
   - Changes in colour, texture, odour and flavours.
   - Apearance of micro-organisms like moulds.
   - Damages of delicate tissues due to chilling injury.
   - Loss in moisture causing loss in weight.

2
   - Consumer package:

     Flexible plastic film, plastic punnets, plastic net bag, foam sleeve, plastic crate, shrink wrap, etc.

   - Transport Package:

     - Bamboo basket, wooden box, corrugated fibre board box.
     - Plastic crate, solid fibre board, plastic corrugated box.
     - Jute sacks, plastic woven sacks, multi wall paper sacks.

3. Modified atmosphere packaging where the atmospheric gas mixture is modified inside the package by considering the requirement of fresh fruits and vegetables. The shelf life of fresh fruits and vegetables increases to a great extent in this packaging.

Check Your Progress Exercise 2

Your answers should include the following points:

1.
   - Physical and chemical changes.
   - The effect on tissue of fruits and vegetables.
   - Food spoilage microbiology.

2. i) Physical changes that occur are

     - Freezer burn – a grainy, brownish spot on the surface, tissue becomes dry and tough.
     - Development of off flavour.
     - Changes in texture as the cell wall ruptures due to the formation of ice crystal during freezing.

   ii) Chemical changes that occur are

     - Development of brown colour due to enzymatic browning.
     - Loss of vitamin C.
     - Development of oxidative rancid flavour on the frozen foods.

3.
   - High moisture barrier property
   - Barrier property to avoid oxidative rancidity.

- Light barrier property to control the oxidative rancidity.
- Low temperature resistance.

4.
- Dry packs – LDPE, PVDC coated plastic film, Five layered coextruded plastic film (PE/Tie/Nylon/Tie/PE)
- Tray packs – made of aluminium sheets, plastic corrugated board, 3 ply or 5 ply corrugated fibre board sheet.

Check Your Progress Exercise 3

Your answers should include the following points:

1.
- The main constituents are sand, lime stone and soda ash.
- Other ingredients like arsenic, selenium and cobalt oxides are added to make clear glass.
- Boron is added to make the glass strong.
- Carbon and sulphides are added to make amber (brown) coloured glass.

2.
- Raw materials are mixed and fed into melting furnace at (1482°C).
- Melted glass is passed into refining chamber of furnace and then to form a gob.
- Gob passes through a parison and then to a finished mould at a temperature of 800^0C to form the glass container.
- Finally, the glass container cools and hardens quickly.

3.
- **Decoration Sizing** – Coating/ Lacquering → printing → varnishing.
- **Assembly Section** – Slitting → Notching → Folding → Soldering/ Cementing.
- **Press Shop** – Slitting → Component end → Ancillary operation.

4.
- Thermoplastic material extruded in the form of pipe is called parasite.
- Formation of a parison by injection moulding or extrusion process and then stretching the parison.
- Radial orientation while blowing the parison into mould.
- Ejection.

Check Your Progress Exercise 4

Your answers should include the following points:

1. Aseptic packaging is a system by which the commercially sterile products are packed in sterilized containers and the filling operations are also held in sterilized environment.

2.
- Sterilization of the product before filling.
- Sterilization of packaging materials or containers before filling operation.
- Filling of the product into the sterile package by maintaining the aseptic condition.

3. Products are sterilized by means of UHT method where a temperature of –135°C for 3 to 5 seconds are maintained. However, there may be slight variation in temperature and duration depending upon the type of product.

4. • Moist heat at 121–129°C and dry heat at 176–232°C.
   • Hydrogen peroxide at 30 to 50% concentration.
   • Radiation

5. • Carton box
   • Bags and pouches
   • Cups and trays.
   • Bottles and jars.
6. • Fresh milk and flavoured milk
   • Fruit juices
   • Vegetables oil
   • Cream
   • Chocholate milk

Check Your Progress Exercise 5

Your answers should include the following points:

1. Vacuum packaging is a technique by which all the air inside the package is evacuated resulting into collapsing of package around the product so that pressure inside the package is much less than the atmosphere.

2. Replacement of air from inside the package → inert gas or mixture of gases are injected mechanically → package is sealed.

3. • Vertical Form – Fill-Seal machine
   • Horizontal Form – Fill- Seal machine

4. • Vertical FFS Machine.
   • Edible oil, sugar, spices, ghee, pan masala, milk, fruit juices, hydrogenated fat etc.
   • Horizontal FFS Machine.
   • Confectionery, Sauces, Pickles, Tomato ketchup etc.

5. • Gravimetric, augar and weight fillers
   • 1%
   • 2.5% and 3.8%
   • oxygen seavanger and ethylene absorbant
   • Nitrogen and carbondioxide

14.12 SOME USEFUL BOOKS

1. Bikales Norbert M, Moulding of Plastics (1971) WILEY-Interscience, a division of John Wiley & Sons, Inc, New York.

2. Modern Food Packaging (1998) Indian Institute of Packaging, E-2, MIDC Area, Chakala, Andheri (East), Mumbai.

3. Packaging Technology educational volumes, (Set-A) (2001) Indian Institute of Packaging, E-2, MIDC Area, Chakala, Andheri (East), Mumbai.