UNIT 9 PACKAGING - MATERIALS, PROCESS AND MACHINERY

Structure

9.0 OBJECTIVES

After reading this unit, we should be able to:

- state the meaning of packaging and list its functions
- describe the various types of packaging materials used for fluid milk
- explain the processes used for packaging fluid milk and
- identify the machineries used for packaging fluid milk

9.1 INTRODUCTION

Packaging is a tool that is used to contain the product, protect the product from environmental hazards and help in marketing the product. Most of the containers in the market today are used to protect a specific quantity of product during procurement, storage, distribution and retail sales, although several are also designed for bulk supply. The quality of the individual container depends on the nature, characteristics and value of the product besides the prevailing social practices and legislation.

9.2 PACKAGING MATERIALS USED FOR FLUID MILK

Milk has been packaged in several types of containers across the globe. The general requirements of a milk-packaging container are as follows:

- It must be tamper proof, so that it is protected against fraudulent practices between the time of packaging and consumption.
- It must be of such a size that the capacity always relates to the keeping quality of the product and that its contents correspond to the consumer's daily requirements.
- It must be clean and attractive.

A container of good quality must prevent post-processing contamination from bacterial sources. It should be such that all indirect or direct chemical change in the milk should be prevented. The package should be of such materials that their constituents do not get transmitted into milk. It should also be resistant to the cleaning materials used in the dairy.

It may either be used once (single-use) or may be returned to the processing factory for reuse.

i. Single-use Packaging Materials

These are also classified as flexible packaging. They, as the name suggests, are used to package milk once and are discarded after removing the product. The consumer is responsible for disposing off the packages. They have been in the news in recent times due to the difficulty in their disposal and their role in environmental pollution.

Plastic pouches: Flexible plastic material can be made into pouch packs. As they are not self-supporting, they generally need some secondary packaging. The advantages offered by the plastic packages are:

- good barrier properties
- visibility of the contents
- light weight (thus reducing the cost of transportation)
- single-service, thus eliminating the need for return, washing and sanitation
- easy to carry
- economical and
- can be made more attractive.

The most commonly used plastic material for pouches is polyethylene (PE). There are several types of polyethylene available and are characterized by their density. These are low density (LDPE – 0.91-0.925 g/cm^3), medium density (MDPE – 0.926-0.941 g/cm^3) and high density (HDPE – 0.942-0.970 g/cm^3). The material has good moisture barrier properties, but poor oxygen barrier characters. HDPE is the least permeable to moisture. PE is suitable both for rigid and flexible packaging, though for some applications, it must be combined with an oxygen barrier.

Flexible pouches are also made from a derivative of polyvinyl chloride (PVC) in the plasticised form (PPVC). It contains plasticisers to render it flexible and stabilizers to prevent thermal and UV light degradation of the product. However, there has been some controversy regarding its toxicity owing to the high chloride content and additives present.

The use of plastic pouches eliminates noise in the milk bottling plants and during delivery, and also reduces water pollution caused by milk residues and detergents used in the bottle washing process. However, they have the disadvantage of poor recyclability and hence, their disposal is a problem.

Carton: The history of the beverage carton is closely associated to the development of milk distribution. The first carton was patented in 1915 in the USA as a 'folded

blank box'. Cartons generally have a square or rectangular cross-section. Tetrahydral and other shapes are also seen, though rarely. These are manufactured by well-developed systems. They are high-technology packaging formats and need well-trained operators to ensure efficient filling of the product. The serving size is also important while designing the package. A 200- or 250 ml single serve packet may be marketed with a straw and if a multiserve (say, one litre), some sort of reclosable feature should be provided. These kinds of packaging materials are normally used for long-life products that need not be refrigerated during storage.

The form-and-fill types of cartons are normally used for liquid milk. They are normally received as rolls of heat-sealable packaging material. The material is laminated paper, consisting of duplex kraft paper coated with PE inside and wax outside. A sandwiched layer of thin aluminium foil between an outer kraft paper and inner PE coating is also prevalent.

The advantages of carton packaging are as follow:

- Lightweight and compact shape, thus increasing distribution efficiency
- Made from renewable raw material (wooden fibre)
- Hygienic
- One way containers, so no need for cleaning before or after filling operation, hence decreasing water and detergent usage
- Recyclable
- Easy to dispose

The distinct disadvantage also is the felling of trees for making the raw material. However, it is a renewable source and can be regenerated with the help of strict laws and effective management. In the forests of Scandinavia and North America, from where the raw material is procured, for every tree cut, three new trees have to be planted.

Paper and paper-based Materials: Several kinds of paper-based materials are used in the form of wrappers, cartons, boxes, bags and cups, while boards are used as cartons and boxes. These materials are made of bleached or unbleached kraft paper, grease-proof paper, vegetable parchment paper, glassine paper, wax-coated paper, plastic-coated paper, straight or corrugated paper boards, solid fibre boards, liner boards and box boards. While boxes and cartons are used generally for packaging products other than fluid milk, they may sometimes be useful in constructing the outer casing material (secondary packaging) for long distance transportation of flexible pouches.

ii. Multiple-use Packaging Materials

Of the possible pack types, bottles are the most commonly used multiuse packages. They can be made of glass and plastic. Metal bottles have also recently emerged for specialist markets, but they are rare and expensive.

Glass: Glass containers come in the form of bottles, jars, jugs and tumblers. They may be plain and transparent or coloured and opaque. While the plain glass bottle provides the advantage of direct viewing of the product contained in it, it has the disadvantage of exposing the milk to ultra violet rays that deteriorate it. Glass has many virtues, but also has several disadvantages that limit its use as a packaging material for milk.

Advantages of glass:

- Strong, inert material
- Good closure and decorative options

- Raw materials easily available
- Recycling possible
- Excellent gas and water barrier properties
- Quality image
- Product compatibility
- Good internal pressure resistance
- Reuse opportunity

Disadvantages of glass:

- Heavy
- Brittle

Despite its disadvantages, the older generation of consumers still thinks of glass as the best option for packaging milk.

Plastic: Plastic bottles for milk generally are made with ribs to add strength. This additional tenacity is needed for withstanding the vacuum on filling machines, for resisting the lateral forces that act within the pack and during transit. Plastic bottles for milk are common in the developed countries and are yet to catch up in India. Plastic has the distinct disadvantage of making recycling difficult.

Plastic bottles may be manufactured from PVC, HDPE or polyethylene terephthalate (PET). Of these, the first two are generally considered together because of the type of moulding machines they are made on and the type of bottle that can be made. They have the following disadvantages:

- Poor oxygen barrier properties in polyethylene
- Less clarity than PET, though not very apparent
- PVC is brittle (specially at low temperatures) and breaks on impact

PET occurs in three physical forms (amorphous, orientated and crystalline), which are exploited to manufacture a wide range of packaging materials. PET bottles are made in two steps. The first is to make a 'perform', which is in the shape of a test tube with the actual neck of the bottle at the end that is open. The second step involves the stretching and moulding of this into the finished shape of the bottle.

The advantages are:

- Light, strong and impact resistant
- Can be made temperature-stable by suitable heat treatment

iii. Materials used for bulk supply

Milk is packaged for bulk and institutional supplies in cans made of stainless steel or aluminium and of capacity of 20 L or 40 L. These are robust and offer excellent product protection. However, there is little opportunity to differentiate one product from the other and branding/labelling is the only alternative.

PET containers are also used in the Western countries, but they require some form of separate strap or handle. Milk is also sold to cafes and caterers in the western countries in large 22 or 40 litre packs in the form of bag-in-box. The short life of fluid milk allows the bag to be produced from PE in two layers, each of 50 micrometers thickness.

Check Your Progress 1

1. Define packaging.

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2. Why is it necessary to package a food?

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3. What are the advantages of glass for packaging fluid milk?

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4. Which materials are used for packaging milk in single use containers?

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9.3 PROCESSES FOR PACKAGING FLUID MILK

i. Processes for single-use packaging

The pouch-filling machine is an integral part of a modern fluid milk plant. Several types of plastic materials are used in forming the pouches. The material generally comes in the form of rolls, which are loaded onto the machine. The layer of plastic is folded vertically and sealed. A horizontal sealer seals the bottom of the pouch. Simultaneously, milk from an overhead float tank is siphoned into the formed cylinder. It is then again horizontally sealed at the top and cut off to form a pouch filled with milk. These machines come with adjustable filling heads capable of filling several volumes of milk as the need be.

ii. Processes for Multiple-use Packaging

The filling of milk in glass bottles was an important operation in the fluid milk factory till recent times when the sachet-packing systems gained popularity for several reasons. However, inspite of the weight of the bottle and the problems regarding the return and cleaning of bottles before refilling, it has several advantages such as ease of cleaning and ease of visual detection of spoilage and impurities.

The bottle-filling process is a cycle of events that follow one another. Clean bottles are filled in the bottle-filling machine and capped (generally with aluminium foil caps). The filled bottles are stacked in crates and sent for cold storage/refrigeration. The crates of empty bottles, after selling the product are returned to the factory. The crates are emptied and cleaned separately. The bottles go to the bottle washer, where the broken/chipped bottles are discarded and the clean, disinfected bottles are returned to the bottle-filling machine.

Bottles require the following properties: The shape of the bottle should be such that it facilitates easy cleaning and allows brushes and jets (of water and detergents) to act on the entire inner surface. The neck of the bottle should be joined to the body smoothly with no sharp and protruding angle. The base should

be concave so that the sediments and residues collect in the center of the bottle rather than on the periphery, thus making cleaning easier.

The resistance of the bottle to shocks is influenced by shape, consistency of quality and the thickness of the glass. The bottles should also be able to resist the high internal pressures and temperatures created during in-bottle sterilization.

Optical defects such as irregularities in the composition of glass, presence of air bubbles, deformations and coarseness in the surface or extraneous matter in the glass also decrease the resistance to mechanical and thermal shocks.

The capacity of the bottle should be constant and consistent and should match with the capacity of the filling machine. The most common volumes in the market are one litre, 500 ml and 200 ml.

iii. Processes for Bulk Supply

The milk for bulk supply is generally processed and filled in containers manually. These may be cans of PET containers. Bulk milk is also sometimes supplied in small tankers or vans fitted with SS tanks.

In the modern dairying countries where the bag-in-box-type of containers is used, the bags, which have a separate bung with a flexible tube attached, are supplied to the producers. The dairy owners use semi-automatic filling machines to fill directly into the box. When delivered to the caterers the filled box fits into a custom-built refrigeration unit with a prefitted, simple on-off tap. The tube on the bag is fed around the tap and cut off to open the bag and permit the product to be dispensed.

iv. Processes for Long-life Milk

Long-life milk is that milk from which most of the spoilage bacteria are removed so that the milk could be stored for a longer period than normal milk. Specific processes such as bactofugation, microfiltration, ultra-pasteurisation and ultra-high-temperature (UHT) processing help to increase the shelf life of milk.

Bactofugation is a method by which the bacteria in the milk are removed by centrifugation. This uses the theory that bacteria have higher density than milk and thus will separate out into the outer orbit during centrifugation and can be removed after the process. The bacteria-rich portion is separately sterilized and added to the centrifugally sterilized bulk of the milk. Any packaging systems for fluid milk packaging may be employed to pack and market the product. However, the packaging system has to be clean and the seals preferably hermetic, in order to avoid recontamination during packaging and storage.

Microfiltration is a non-thermal, pre-pasteurization step that can extend the shelf life of milk up to 45 days. The microfiltration process uses a ceramic filter membrane to remove spoilage bacteria from milk, thus extending shelf life. Because it is a non-thermal process, milk is less susceptible to heat-related sensory defects with a 90-day shelf life. Packaging systems that prevail for fluid milk packaging may be used to pack and sell the product.

Aseptic packaging is a technology wherein the product and package are separately sterilized, and the product is then filled into the package and the package sealed in a sterile environment. The product is commercially sterile (meaning that any pathogenic or other spoilage microorganisms have been destroyed) and shelf stable (does not require refrigeration or freezing). Containers for aseptic filling have traditionally been aluminum cans, high-barrier pouches and multi-layer, foil barrier boxes. Aseptic packaging using flexible materials is also employed where extended shelf life is required. Many aseptic packaging systems are based on form-fill-seal

technologies that eliminate the need to ship preformed containers to the processor. That is, the processor procures the packaging material in the form of rolls or stacks and they are formed (shaped) during the filling process.

Plastic materials used in aseptic packaging of milk products are polyethylene, polypropylene, polystyrene as tubes, bottles or plastic film laminates with paperboard or aluminum in the form of cartons. High-pressure steam is used to sterilize product lines and hydrogen peroxide with heat of UV radiation for container materials. The popular commercial systems available for aseptic packaging of milk are Tetra Pak, Tetra Brick, Brick Pack, Combi Block, Pure Pak, Hind Pak, etc. Tetra Pak/ Tetra Brick packs are used to pack UHT-treated milk into pre-sterilized package in aseptic conditions. The first aseptic carton was the 'Tetra Classic'. It was made from a roll of packaging material that had been sterilized in hydrogen peroxide, formed into a tube, filled with liquid, sealed transversely and cut into tetrahedron-shaped containers. Tetra Pak uses paperboard laminated with 10m LDPE from outside and 70-75m LDPE from inside. The Tetra Brick uses aluminum foil of 7-9m in addition to above laminates. The machinery needed for this system is very expensive.

Ultra-pasteurized products are produced under slightly less extreme conditions than aseptic processing. However, heat processing and clean packaging still play important roles. Ultra-pasteurized milk beverages are usually packaged in barrier-coated paperboard cartons, or HDPE or PET bottles. To prevent light degradation, PET bottles, which are clear as compared to HDPE bottles that are opaque, can be tinted and/or covered with full-body labels. A window in the label allows consumers to see the product.

Ultra-pasteurized bottles include a hermetic foil seal on the bottle mouth. This prevents contamination and enables the product to achieve a 90-day refrigerated shelf life. Some processors who want to obtain a slightly longer shelf life than the standard 14 days, but do not want to ultra-pasteurize the milk, may opt for an intermediate thermal process referred to as higher-heat-shorter-time. The shorter heat exposure can leave the milk free from the sensory defects associated with aseptic and ultra-pasteurization temperatures. The refrigerated shelf life for such products is about 30 days.

Check Your Progress 2

1. What are the required properties of a glass bottle to be filled by a filling-machine?

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2. What is the principle behind long life milk?

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3. What is aseptic packaging?

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9.4 MACHINERY INVOLVED IN PACKAGING FLUID MILK

i. Machinery for single-use packaging

The machinery for single-use packaging involves a pouch-filling machine besides the normal milk handling equipments that are necessary. The available machines normally pack one litre, 500 ml and 200 ml capacity pouches. The packaging material coming out of a roll is suitably sterilized before it is shaped into a chute and sealed vertically to form a pipe. It is then sealed horizontally and a preset quantity of milk is filled from an overhead tank. The pouch is then again sealed horizontally to contain the milk before being cut and stacked manually into crates. The crates are stored in the cold room till marketing.

ii. Machinery for Multiple-use Packaging

Bottles, being reusable are returned to the dairy every morning and evening after the market supply and are washed and sterilized in bottle-washers before filling. The most common among bottles being glass, we shall be discussing here, the processes dealing with glass bottle-washing and filling only. The bottle washing operation takes care of pre-rinsing, washing, rinsing and sanitizing the bottles. The clean bottles are then passed onto the filling machine where they are filled to preset volumes before capping, crating, cold storage and distribution.

iii. Machinery for Bulk Supply

Bulk supply to hotels, cafes, hospitals and other institutions is generally done in cans in India. These are filled manually and therefore, the process does not require the elaborate machinery that is needed for retail packaging of milk. They can be filled directly from the outlet point of the pasteuriser or from a holding tank provided after the pasteurising equipment.

In the case of bag-in-box type of packages that are used in the western countries, the purchase of a filling machine depends on several factors. These include (a) whether the packing is to be retailed as per volume or weight, (b) the product needs to be aseptically packaged or not, (c) the process needs to be fully automatic or not, among others.

iv. Machinery for Long-life Milk

The machinery needed for filling and packaging long-life milk is very expensive. Ultra-High-Temperature (UHT) processing and packaging of milk are employed to increase its shelf life.

Check Your Progress 3

1. Differentiate between machinery needed for bulk and retail packaging of milk.

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2. Why is more advantageous to use a single use package in terms of infrastructure needed?

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9.5 LET US SUM UP

Packaging is used to hold a product, to protect it from spoilage and for its easy marketing. Fluid milk is packaged for retail sale in different types of containers that may be of the single-use or the multi-use type. Single use containers may be plastic pouches or cardboard cartons. Glass or plastic bottles are normally used as multi-use packages. Milk for bulk supply is normally packaged in cans. Long-life milk such as bactofuged, ultra-pasteurised or UHT-treated milk needs superior cleaning efficiencies and/or elaborate packaging systems. Different kinds of machineries are needed for packaging, depending on the type of package. The type of machinery used in India is a bottle washer and filler for a plant supplying bottled milk and a pouch filling or form-and-fill carton packaging machine for milk supplied in single-use package.

9.6 KEY WORDS

Packaging : Packaging is used to hold he product, to protect it from spoilage and damage and to make it easy to market it.

Single-use packaging material : A material in which a product can be filled only once. It is discarded after opening and removing the product.

Multi-use packaging material : A packaging material, which can be used repeatedly after adequate cleaning and sanitisation.

Bulk packaging : System that is used to package large quantities of the product (as opposed to retail quantities). These are normally used to canteens, hotels, hospitals, schools etc.

Long-life milk : Milk, which has been given such processing and packaging as to reduce the bacterial load of the milk. The keeping quality of the milk is thus increased.

9.7 SOME USEFUL BOOKS

De, S. 1980. Outlines of Dairy Technology. Oxford University Press. Delhi.

Edgar, S. 1995. Milk and Dairy Product Technology. Marcel Dekker, Inc. New York, Basel, Hong Kong.

Giles, G.A. (Ed.). 1999. Handbook of Beverage Packaging. Sheffield Academic Press. CRC Press. Canada, USA.

Robinson, R.K. (Ed.). 1994. Modern Dairy Technology. Vol. 1 and 2. Chapman and Hall. London, Glasgow, New York.

Walstra, P., Guerts, T.J., Noomen, A., Jellema, A. and van Boekel, M.A.J.S. 1999. Dairy Technology. 1999. Marcel Dekker, Inc. New York, Basel.

9.8 ANSWERS TO CHECK YOUR PROGRESS

Your answer should include the following points:

Check Your Progress 1

1) i. The meaning of packaging

   ii. Its importance in producing and selling food products

2) i. Include what happens if the food is not packaged with reference to the
   - keeping quality
   - market value
   - popularity

3) i. List the merits of glass.

4) i. List and explain in brief the different materials used for single-use packages.

Check Your Progress 2

1) i. List the qualities needed in a glass bottle that is to be washed and filled by machine and their importance.

2) i. What happens if milk is stored for a long time without proper processing treatment

   ii. How the life of milk increases with proper processing

   iii. How proper packaging helps to increase keeping quality of milk

3) i. Define and explain aseptic packaging. It should also state how it differs from normal packaging in terms of life of milk.

Check Your Progress 3

1) i. Point out the differences in machinery needed in each system in terms of cost, ease of use and technical expertise needed for operation.

2) i. Cumbersome process of returning used packages

   ii. Their cleaning (need for more machines)

   iii. Accounting

   iv. Spoilage/breakage