UNIT 2 PACKAGING MATERIALS

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2.0 OBJECTIVES
After reading this unit, you will be able to:
• describe different packaging materials;
• state the functional properties of these materials;
• differentiate amongst important plastic packaging films;
• explain some uses of packaging materials; and
• select suitable packaging material for your specific requirement.

2.1 INTRODUCTION
All the packages are developed from some basic packaging materials, which may be flexible, semi-rigid or rigid in nature. These are not selected at random. These materials have certain physical, chemical and functional properties which make them suitable for particular types of uses. The packaging requirements of a particular product are matched with the functional properties offered by a particular packaging material. Further, packaging requirements of retail packaging are different from that of bulk packaging for the same product. Hence, you should have the basic knowledge of the various packaging materials to examine its suitability for a specific type of food packaging. In this unit, we shall discuss some important packaging materials.

2.2 TYPES OF PACKAGING MATERIALS
Depending on the hardness, the packaging materials are of three types:


ii) Semi-rigid packaging materials: Paperboard/cardboard/containers, PET and PVC containers, Aluminum containers, Molded containers.
2.3 FLEXIBLE PACKAGING MATERIALS

You can fold these materials in any manner as per your packaging needs. Their final shape conforms to the enclosed material. Generally, these packaging materials are used for retail individual or family packs as wrappers, pouches, preformed bags etc. Presently, plastic films are most widely used flexible packaging materials. You might have felt some differences in these films. These are of several types and differ in their physical, chemical and functional properties. Here, we shall discuss some of the important flexible packaging materials which are in general used for the packaging of meat and meat products.

2.3.1 Plastic Films

(i) Cellophane was the first commercial flexible film. It is a natural plastic film derived from bleached pulp which is treated with acid and alkali and then plasticized to get cellophane. It can be suitably coated on one side to impart various functional properties. This is a low cost film. Various types of this film bear letter designation on the basis of its properties e.g.,

- C - coloured
- M - moisture proof
- S - heat sealable
- T - transparent
- D - demi (one side) coated

Thus, MST cellophane refers to a film which is moisture proof, heat sealable and transparent. Earlier, nitrocellulose coated cellophane was very much in use for the packaging of fresh meat in developed countries, where its coated side was kept away from meat.

(ii) Polyethylene (PE) is the most commonly used plastic film of these days due to low cost, easy availability and unique properties. It is obtained by polymerization of ethylene. Low density polyethylene (LDPE) is prepared at a very high atmospheric pressure at about 150-200°C, whereas high density polyethylene (HDPE) is prepared at comparatively low atmospheric pressure and temperature. These grades of the film have different functional properties but chemically there is no difference. Polyethylene is a tasteless, odourless and non-toxic film. These properties make it highly suitable for packaging food items. You can safely use this film upto a temperature of 70°C. It starts softening at 90°C and melts at 100°C. It does not rupture immediately, rather it will first stretch to some extent. It has the unique property of sealability of itself by the application of heat.

Low density polyethylene (LDPE) film is transparent to translucent, highly flexible and has comparatively low permeability to water vapours, but it is fairly permeable to oxygen, carbon dioxide or odours. HDPE film is translucent to opaque and comparatively less permeable to water vapours and gases. It is fairly oil and grease resistant as compared to LDPE. You might have noticed black or yellow polyethylene pouches and bags being used by the butchers. These are used and recycled plastic films. Polyethylene and other plastic films thrown here and there are collected by the scavengers. These are purchased by the plastic factory owners and converted into coloured bags after adding dyes. These are not fit for packing any food item because they contain synthetic dye (colour), which on prolonged use may cause cancer.
(iii) Polypropylene (PP) is another plastic film which is also in general use. It has a good gloss, high flex strength and resistance. It softens at a temperature of 150°C, so it can be used to pack food products at moderately high temperature. It is also sometimes used for packaging those raw meat products which are subjected to heat treatment or cooked in the pack itself at a later stage. The film is readily heat sealable and has low water vapour permeability. It also shows a good resistance to oil and grease. It is used in making laminates also.

(iv) Polyamide usually called Nylon film in the trade is inert, heat resistant and has excellent mechanical properties. Nylon-6 is a tasteless and odourless film and thus ideal for use in the packaging of fresh and processed foods. It can be sterilized by steam. It is used for making laminates of good inertness and low permeability. It has excellent gas barrier properties.

(v) Polyester film is also inert and has excellent strength. It is widely used in lamination as outer, abrasion resistance layer for food pouches. Polyethylene terephthalate (PET), a polyester of importance is sold in United States of America by the name of Mylar. Mylar is highly resistant to high temperature and can be handled in thin gauges. That's why it is used in lamination with aluminum foil.

(vi) Polyvinyl chloride is a plasticized film for packaging. This film has low folding endurance. So its use has declined these days.

Saran is produced with vinyl chloride. This is clear, non-toxic, almost impervious to gas transmission and has very low water vapour transmission rate. This is used for meat and meat product.

You may also note that ionomer is an ideal bonding agent between two or more packaging films in the making of a laminate. It has good seal property and resistance to oil as well as grease.

Many thermoplastic films such as PE, PP etc. act as shrink film. These are used for wrapping large and uneven cuts of fresh meat and dressed poultry. The meat cuts are over wrapped with this film and passed through hot air tunnel or dipped in hot water (90°C) for few seconds. The film almost shrinks to the size of the meat cuts. These shrink films give neat appearance and contour tight package. The packaged products can be stored under freezer temperature as these films can withstand very low temperature even to -45°C.

In modern packaging, laminate is a popular term. It is a combination of different flexible packaging materials such as plastic, paper or foil bonded together by heat or adhesive forming a composite structure of uniform thickness and flexibility.

For example – Polyester/PE, Paper/Aluminum foil/PE

These laminates provide required functional properties, heat sealability and improve barrier properties. Now technology is much more developed and produces a composite film in one pass, no bonding between separate films is needed for a composite film. This is known as coextruded film. Here two or more polymers from a common dye are extruded to come out as a single layer. Thereby the cost of the composite structure and the thickness of the film are reduced.

For example –

LDPE/ HDPE/ LDPE
LDPE/ LDPE
LDPE/ HDPE.
2.3.2 Aluminum Foil

Plain aluminum foil is used for packaging food products. Thin gauge aluminum foil with pin holes are generally laminated to paper or plastic film with bonding agent to make suitable laminates. These laminates are used to package food products requiring protection against light, water vapour and gases especially dehydrated cooked meat. One distinct advantage of using aluminum foil as the outer layer of a laminate is that it provides a very good base for colourful and decorative printing.

2.3.3 Paper

Glassine is smooth, dense, transparent or semi-transparent paper manufactured primarily from chemical wood pulps. It has good resistance to grease and air. A plasticizer may be added to make the paper still more soft and machinable.

It may be waxed, lacquered or laminated to be impervious to the transmission of moisture vapour. This is used for wrapping fatty cuts and bacon.

Parchment paper has good grease resistance and high wet strength. These papers are sometimes used to wrapping bacon and other fatty cuts of meat.

Following are different terms used in trade:

Frozen foods paper is a type of high moisture and water vapour resistant paper used for inner liners in frozen food packaging; usually specially treated glassine or bleached chemical wood papers, waxed papers, or plain or coated vegetable parchment paper; pliable and strong to resist cracking at freezing temperatures and for high wet strength.

Meat wrapping paper is a specially treated odourless and tasteless paper that resists meat juices, fat and greases, and is easy to remove from any kind of meat.

Delicatessen paper is used as an inner wrap for meats and for soft foods to retain the moisture in the food and to prevent the outer wrapper from becoming water - or grease-soaked. It is made from bleached chemical wood pulp and may be given a dry paraffin wax treatment of about 10 to 20 - per cent of the weight of the paper.

2.4 SEMI-RIGID PACKAGING MATERIALS

A semi-rigid container is intended to maintain a definite form or shape and is not influenced by the bulk of the contents.

Paper board sheets are cut, folded into desired form and glued. Corners can be made stronger. The material can be made as set up paper board boxes or folding carton or tray as per the demand. It provides convenience, strength and good product protection.

PET (polyethylene terephthalate) and PVC plastic sheets can be moulded in shape, size and colour to suit specific product requirements. PET bottles and containers are extremely clear, virtually unbreakable and very light weight. They are ideal for the packaging of pickled meat products. They provide enhanced visual appeal to the products.

Plain aluminum foil of higher gauge either alone or in combination with paper or plastic foils can be pressure formed into desired shapes to serve as semi-rigid containers for various types of food products.

Moulded pulp containers are the cheapest packaging for the shell eggs. They allow wholesale trading of eggs along with the tray.
2.5 RIGID PACKAGING MATERIALS

Glass containers are very old and versatile packages for food packaging. Glass has many unique properties to our advantage. It is chemically inert and is an excellent barrier to solids, liquids and gases. It can be molded in various shapes and sizes and also allows excellent product visibility. Glass bottles are used for packaging meat pickles etc. The main drawbacks of glass containers are the risk of breakage and comparatively heavy weight.

Metal cans are primarily used for commercially sterilized food products. Iron sheet used-for making can has very thin tin coating on either side. It is generally applied to check rusting and corrosion of metal cans on long term storage. To make the metal can more suitable for food application, a further very thin coating of enamel or lacquer is applied to the tin. For canning of meat products, a sulphur-resistant lacquer is preferred to check black discolouration of the product. Can bodies are soldered or welded. The product is hermatically (air tight) sealed in the can.

Rigid thermoformed plastic containers are made by exposing the plastic sheet to heat and forming into various shapes either individual pieces or in combination. The plastic used in the thermoformed trays are high density polyethylene, polypropylene or polyvinyl chloride. In developed countries, thermoformed polystyrene foam trays are used for containing fresh meat pieces or chunks which is then overwrapped with low density polyethylene.

Fibreboard containers, wooden boxes and plastic crates are used as wholesale or shipping containers. You will learn more about them in the next unit. You will also see and identify various packaging material in your practical classes.

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Fig.2.1: Moulded pulp egg tray

Fig.2.2: Thermoforming Cups for unit packs
You have already studied some of the properties of the different packaging materials under the heading of flexible, rigid and semi-rigid packaging material. Here some more physico-chemical properties of some popular packaging films are given in the following table along with those properties.

Table 2.1: Some physico-chemical properties of packaging films

<table>
<thead>
<tr>
<th>Film</th>
<th>Density/ specific gravity</th>
<th>Clarity</th>
<th>Tensile strength kg/cm²</th>
<th>Elongation (g/100gauge)</th>
<th>Tear resistance (g/100gauge)</th>
<th>Heat seal range (°C)</th>
<th>WVTR (g/m²/24 hr at 38°C and 90% RH)</th>
<th>GTR (O²) (cc/100 gauge/m²/24 hr at NTP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (low density)</td>
<td>0.910-0.925</td>
<td>Transparent to translucent</td>
<td>80-240</td>
<td>220-600</td>
<td>100-400</td>
<td>120-175</td>
<td>20</td>
<td>4000-12500</td>
</tr>
<tr>
<td>Polyethylene (high density)</td>
<td>0.941-0.965</td>
<td>Translucent to opaque</td>
<td>200-350</td>
<td>50-400</td>
<td>50-300</td>
<td>135-155</td>
<td>5-10</td>
<td>500-4000</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>0.88-0.90</td>
<td>Transparent</td>
<td>300-400</td>
<td>200-500</td>
<td>40-300</td>
<td>160-200</td>
<td>7-10</td>
<td>1200-6500</td>
</tr>
<tr>
<td>PVDC/Saran</td>
<td>1.65-1.7</td>
<td>Transparent</td>
<td>500-800</td>
<td>40-80</td>
<td>10-20</td>
<td>135-150</td>
<td>2-5</td>
<td>10-25</td>
</tr>
<tr>
<td>Polyamide (nylon)</td>
<td>1.13-1.14</td>
<td>Transparent to translucent</td>
<td>700-1000</td>
<td>250-500</td>
<td>50-150</td>
<td>175-250</td>
<td>Very high</td>
<td>25-100</td>
</tr>
<tr>
<td>Polyester</td>
<td>1.15-1.39</td>
<td>Transparent</td>
<td>750-1500</td>
<td>70-120</td>
<td>15-75</td>
<td>135-200</td>
<td>15</td>
<td>50-125</td>
</tr>
<tr>
<td>Polystyrene</td>
<td>1.05</td>
<td>Transparent</td>
<td>350-500</td>
<td>10-50</td>
<td>5-20</td>
<td>120-160</td>
<td>&gt;100</td>
<td>2500-7500</td>
</tr>
<tr>
<td>Cellophane (polycoated)</td>
<td>1.25</td>
<td>Transparent to translucent</td>
<td>15.15</td>
<td>2-10</td>
<td>110-150</td>
<td>&gt;20</td>
<td>5-10</td>
<td></td>
</tr>
</tbody>
</table>
Table 2.2: Individual polymer materials, common abbreviation and associated properties

<table>
<thead>
<tr>
<th>Polymer materials</th>
<th>Abbreviations</th>
<th>Associated properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low density polyethylene</td>
<td>LDPE</td>
<td>Sealability, formability, moisture barrier, low cost</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>PP</td>
<td>Moisture barrier, thermal resistance, dimensional stability</td>
</tr>
<tr>
<td>Polyesters</td>
<td>PET</td>
<td>Mechanical resistance, heat resistance, medium O₂ barrier</td>
</tr>
<tr>
<td>Polyamides</td>
<td>PA</td>
<td>Mechanical strength, O₂ barrier (moisture sensitive), formability</td>
</tr>
<tr>
<td>Polyvinylidene chloride</td>
<td>PVDC</td>
<td>High O₂ barrier (moisture stable), grease and fat barrier</td>
</tr>
<tr>
<td>High density polyethylene</td>
<td>HDPE</td>
<td>More gas impermeable than LDPE, low cost, strong, reduced clarity</td>
</tr>
<tr>
<td>Polyvinyl chloride</td>
<td>PVC</td>
<td>Versatile, shrink properties, sparkling clear, low cost</td>
</tr>
<tr>
<td>Polystyrene</td>
<td>PS</td>
<td>Excellent clarity, low cost, readily thermoformed and injection moulded</td>
</tr>
<tr>
<td>Ionomer</td>
<td></td>
<td>Heat sealability, produce films of unusual toughness and clarity</td>
</tr>
</tbody>
</table>


Check Your Progress

1) Fill in the blanks

   i) Polyethylene can be safely used upto a temperature of ___________ °C.

   ii) Aluminum foil provides a good base for _________________ to enhance marketing prospects of a product.

   iii) Polyamide film is called _________________ in the packaging trade.

   iv) Parchment paper wrapping is especially suitable for meat cuts with more _________________

   v) PET bottles are extensively used for packaging of _________________

2) Answer in True or False

   i) Cellophane is an environment-friendly packaging film.

   ii) Polyethylene film is chemically inert.

   iii) Glass bottles allow gases to pass through them.

   iv) PVC film is brittle in nature.
v) Use of black polyethylene bags is not desirable for packaging meat and meat products.

3) What do you mean by shrink film?

4) What is the main difference between laminate and coextruded film?

2.7 LET US SUM UP

Food packages are developed from different packaging materials which are classified into three types - flexible, semi-rigid and rigid. Functional properties of these packaging materials make them suitable for a particular use. Packaging materials are formed into various sizes and shapes depending upon their utility, for a particular food product. Flexible packaging materials may be plastic films - cellophane, LDPE, HDPE, PP, Nylon, polyester, PVC or aluminum foil, paper etc. Semi-rigid packaging materials may be set-up paper board cartons or aluminum foil, PET bottles or moulded pulp containers. Rigid packages are made from glass, metal, wood, fibre board etc. We have discussed some of the salient features of these packaging materials in this unit. This discussion will be helpful in understanding the uses of these packaging materials in the next two units.

2.8 KEY WORDS

Bag : A bag or pouch is a container made from flexible packaging material and has one sealed end.

Bottles : Bottles are containers with rounded neck which is narrower than body.

Elongation : It indicates the length to which the film can be stretched by using a pulling force. It is expressed in percentage.

Film : A film is a very thin flexible plastic sheeting.

GTR : It is gas transmission rate which is the quantity of any gas passed through a unit area of a film at fixed time and normal temperature and pressure (NTP).

Jar : Very wide mouth bottles with no appreciable neck.

Plasticizer : Material added during the manufacturing process to increase flexibility. For example, the plasticizer ATBC (acetyl tributyl citrate) used in Saran.

Tear resistance : This is the measurement of the resistance to the propagation of a slight tear in the flexible packaging material.
WVTR : It is water vapour transmission rate which is the quantity of water vapour in grams permeated through one square meter of a film in 24 hours at 38°C and 90% relative humidity (RH).

2.9 SOME USEFUL BOOKS


2.10 ANSWERS TO CHECK YOUR PROGRESS

1) Fill in the blanks:
   (i) 70°C, (ii) decorative printing, (iii) nylon, (iv) fat, (v) meat pickles.

2) True or false:
   (i) True, (ii) True, (iii) False, (iv) True, (v) True.

3) Shrink film is a plastic film which stays stretched at ambient temperature and after passing through the hot air or hot water, shrinks to the size of the product packaged by this film. Thus it gives a neat appearance and contour tight package. For example: Polyethylene, Polypropylene.

4) The main difference between laminate and coextruded film is that laminate is a combination of two or more separate films bonded by heat or adhesive whereas coextruded film is a composite film which is obtained by simultaneous extrusion of two or more plastic resins from a common dye to emerge out as a single layer. So later has better functional properties in spite of a thin film and it is produced in a single pass.