

Paper No.: 12

Paper Title: FOOD PACKAGING TECHNOLOGY

Module – 01: Introduction to food packaging

1. INTRODUCTION

In today's world, packaging is universal and important too. It surrounds, enhances and protects the goods we buy, from processing and manufacturing through handling and storage to the final consumer. Without packaging, materials handling would be a difficult, inefficient and costly exercise and modern consumer marketing would be virtually impossible. 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 package depends on the nature, uniqueness and value of the product besides the prevailing social practices and legislation.

The selection of a packaging, storage and distribution system will depend on existing economic ability, production and distribution efficiency, retailing pattern, consumer preferences and ecological aspects.

Despite the importance and key role which packaging plays, it is often regarded as a necessary evil or an unnecessary cost. Furthermore, in the view of many consumers packaging is, at best, somewhat unnecessary and at worst, a serious waste of resources and an environmental threat. Such an opinion arises because the functions which packaging has to do are either unknown or not considered fully. By the time most consumers come into contact with a package, its job in many cases is almost over, so it is understandable that the view that excessive packaging has been used has gained some belief.

The Packaging Institute International defines packaging as the enclosure of products, items or packages in a wrapped pouch, bag, box, cup, tray, can, tube, bottle or other container form to perform one or more of the following functions: containment; protection and/or preservation; communications; and utility or performance. If the device or container performs one or more of these functions it is considered a package.

2. FUNCTIONS OF PACKAGING

The functions of a package are “to preserve the quality and freshness of food, to add appeal to the food to attract consumers, and to facilitate its storage and distribution.” The basic functions required of a package can be grouped under five major categories.

2.1 To Contain the Product

The primary function of any package is to contain the food and facilitate handling, storage, and distribution all the way from the manufacturer to the ultimate user or even the time the rest portion is utilized by the consumer. However, there are usually various levels of packaging. A primary package is one that comes into direct contact with the contained product, e.g., metal cans, glass jars, and plastic pouches. By law, a primary package must not yield any substance that may be injurious to the health of the consumer. Further development to facilitate handling is to bundle a series of primary packages together, and this lead to the concept of secondary packages. Examples of secondary package is corrugated box in which tins of apple juice are packed. As methods of handling and transportation have become more sophisticated, these secondary packages are often palletized and secured by strapping with metal or, more commonly, by shrink- or stretch-wrapped film to give yet another level of packaging, i.e tertiary packaging. In turn, these pallet loads may be packed into large metal containers, i.e., quaternary packaging for transportation over long distances by air, land, or sea. The secondary, tertiary and quaternary packaging is also known as packing. The following are basic functions during containing.

- a. Adequate size and shape (trays to support biscuits in package)
- b. Proper constructional features. No leakage, spillage, diffusion, i.e. loss prevention.
- c. Package: Must contain the commodity in natural form (chips packed in Pillow pack, prevent damage)
- d. No subsequent damage after packaging during handling transportation and storage.
- e. Optimum compatibility (nontoxic, non soluble with product, No physical, chemical or biochemical changes/alteration, i.e. inert to the product.)
- f. Containment or agglomeration - Small objects are typically grouped together in one package for reasons of efficiency. For example, a single box of 1000 pencils requires less physical handling than 1000 single pencils. Liquids, powders, and granules need containment.

2.2 To Protect the Product

One of the most important functions of any container is to protect the product contained against any form of loss, damage, deterioration, spoilage, or contamination that might be encountered throughout the distribution chain. Packaging can prevent physical damage, e.g., bruising caused by vibration shocks during transportation or stacking in a warehouse. Proper packaging will also prevent material loss, e.g., potatoes from a weak sack or juice from a

leaky can. Packaging can also protect products against moisture loss or gain, dust, and light, which causes deterioration of some light-sensitive products. It can also protect the package contents against temperature fluctuations in the transit of chilled and frozen foods. Packaging can also be used to control the availability of oxygen to fruits and vegetables and to protect against loss of flavor or fragrance and help products retain their nutritional value. Proper packaging may also protect the product against microbial spoilage by bacteria, yeasts, and molds. It can also protect against microbiological spoilage of stored products due to rodents and insects.

Packaging protects the product against damages which may be due to different hazards viz.

(a) Mechanical, (b) Environmental (c) Microbial & Biochemical and (d) Social

Table 1: Hazard, damage and protection of packaging materials

Sr. No	Storage	Hazard	Damage	Protection
I	Handling and transportation	Drop, shunting, shocks, vibrations, stack load, compression etc.	Breakage, loss of shape, dusting, seepage	Cushioning, blocking.
II	Storage	Stack load, compression, Attack by rodents and insects	Crushing, distortion, sticking, spillage, contamination, spoilage	Adequate compression strength of package. resistance and repulsiveness to insects
III	Environment during storage	Biological or otherwise	Contamination	Toughness of packaging material (to resist penetration).
	transportation and distribution	High/low humidity moisture/water.	Physical, chemical and biological deterioration due to loss/gain of moisture	Efficiency of closure providing. Water vapour barrier properties. Package desiccant etc.
		O ₂	Oxidative rancidity	O ₂ BARRIER VACUUM – O ₂ N ₂ /CO ₂ flushing

				packaging in impermeable package
		Light U.V. rays	Vitamin Destruction, Off flavour development, Oxidative rancidity, Bleaching of pigments	Use of opaque or dark coloured packaging material.
	Storage	Temperature	Change of state, Increase of moisture ingress Increased rate of deterioration	Heat insulation Use of poor conductor Use of reflective insulation
		Time	Gradual and slow changes occur and staling and other deteriorative changes occur	Early/immediate marketing (FIFO) Proper schedule of dispatching order providing Heat insulation Use of Barrier material

Barrier protection - A barrier from oxygen, water vapor, dust, etc., is often required. Permeation is a critical factor in design. Some packages contain desiccants or Oxygen absorbers to help extend shelf life. Modified atmospheres or controlled atmospheres are also maintained in some food packages. Keeping the contents clean, fresh, and safe for the intended shelf life is a primary function of the package.

2.3 Medium of information

An important function of any food package is to identify the product and its origin; to inform the consumer how to use the contents; to provide any other information needed or required; and very importantly, to attract the user and encourage purchase of the product. Package design has been an important and constantly evolving phenomenon for many years. Marketing communications and graphic design are applied to the surface of the package and

in many cases the point of sale/display. The information a package can convey to the consumer may include the following:

1. Product manufacturing and best before dates
2. Proper storage conditions
3. Instructions for use
4. Size and number of servings or portions per pack
5. Nutritional information per serving
6. Manufacturer's name and address
7. Cost
8. Suggested recipes
9. Country of origin
10. Information transmission - Packages and labels communicate how to use, transport, recycle, or dispose of the package or product.

2.4 Means of minimizing costs:

An important factor often overlooked is that packaging actually reduces costs for the consumer. Packaging reduces food costs by reducing the cost of processing. Foods can be processed where they are grown, waste is treated at the processing plant, and shipping weights are reduced, thereby lowering the cost of transportation. The handling of packages in quantity is important for the economics of bulk storage, warehousing, transport, and distribution. Proper packaging facilitates efficient and mechanized handling, distribution, and marketing of products, thus reducing the high labour costs that would have to be absorbed into the price of the product. Thus, packaging not merely contains the product, but it is a process of bringing goods from the production point to the point of use in a most beneficial manner. This involves all aspects of handling, storage, preservation, distribution, advertising, sales promotion, preparation and various other facts of industry.

2.5 Means of selling product:

The packaging and labels can be used by marketers to encourage potential buyers to purchase the product. Packaging is often referred to as the "silent salesman." Robertson (1992) concisely summarized the multifunction of packaging when he stated that "a package must protect what it sells and sell what it protects." Packages can have features which add convenience in distribution, handling, display, sale, opening, reclosing, use, and reuse.

According to Jelen (1985), primary packages should have the following characteristics to facilitate the sale of products:

1. Aesthetic appeal
2. Non toxic
3. Transparent
4. Lightweight
5. Tamper evident
6. Easy to pick up and handle
7. Easy to fit into cupboards, shelves, refrigerators, etc.
8. Easy to open and dispense from
9. Easy to reclose
10. Returnable, recyclable, or reusable
11. Safe and presents no hazards in the way of broken glass or sharp jagged metal edges
12. Display the product
13. Glamorize: Create an illusion of something very precious, by decoration, embossing techniques and exotic closures, but it should not deceive the people.

The desirable polyfunctional properties of packaging materials are summarized in Table 2.

Table 2: Functional Requirements of Packaging Materials

No.	Functional Property	Specific Factors
1	Gas permeability	O ₂ , CO ₂ , N ₂ , H ₂ O vapor
2	Protection against environmental factors	Light, odor, microorganisms, moisture
3	Mechanical properties	Weight, elasticity, heat-sealability, mechanical sealability, strength (tensile, tear, impact, bursting)
4	Reactivity with food	Grease, acid, water, color
5	Marketing-related properties	Attractiveness, printability, cost
6	Convenience	Disposability, repeated use, resealability, secondary use
7	Aroma	Aroma compound barrier property

Source: Jelen, P. 1985. Food packaging technology. In *Introduction to Food Processing*, Reston Publishing, Reston, VA, pp. 249–266.

3. OTHER FUNCTIONS OF A PACKAGE:

1. **Dispensing:** Product not used all at once, remove a portion, without destroying/damaging the remaining product/container.
2. **Preserve:** Remaining product in container-Protection and preserve it for extended/desired period.
3. **Measuring / Portion control:** Single serving or single dosage package has a precise amount of contents to control usage. Bulk commodities (such as salt) can be divided into packages that are a more suitable size for individual households. It also aids the control of inventory: selling sealed one-liter-bottles of milk, rather than having people bring their own bottles to fill themselves.
4. **Security** - Packaging can play an important role in reducing the security risks of transport. Packages can be made with improved tamper resistance to deter tampering and also can have tamper-evident features to help indicate tampering. Packages can be engineered to help reduce the risks of package pilferage: Some package constructions are more resistant to pilferage and some have pilfer indicating seals. Packages may include authentication seals to help indicate that the package and contents are not counterfeit. Packages also can include anti-theft devices, such as dye-packs, RFID tags, or electronic article surveillance tags, that can be activated or detected by devices at exit points and require specialized tools to deactivate. Using packaging in this way is a means of loss prevention.

4. PACKAGING TYPES:

4.1 Terms used:

- **Package:** It cuts contact between material and outside influences. Package material comes in direct contact with the product (Packaging).
- **Pack:** Secondary container. **Packing material never comes in contact with product.**
- **Packing:** Number of containers/packages put together in big container is called packing.

Packaging may be looked at as several different types. For example a **transport package** or **distribution package** is the package form used to ship, store, and handle the product or inner packages. Some identify a **consumer package** as one which is directed toward a consumer or household. It is sometimes convenient to categorize packages by layer or function: "primary", secondary", etc.

1. **Primary packaging** is the material that first envelops the product and holds it. This usually is the smallest unit of distribution or use and is the package which is in direct contact with the contents (viz. butter in parchment paper).
2. **Secondary packaging** is outside the primary packaging – perhaps used to group primary packages together (viz. paper board pack containing butter wrapped in veg. parchment paper).
3. **Tertiary packaging** is used for bulk handling, warehouse storage and transport shipping. The most common form is a palletized unit load that packs tightly into containers (viz. Boxes containing 20-25 or 50 butter packs are put together).

These broad categories can be somewhat arbitrary. For example, depending on the use, a shrink wrap can be primary packaging when applied directly to the product, secondary packaging when combining smaller packages, and tertiary packaging on some distribution packs.

Table 3: Differences between packaging and packing

No.	Packaging	Packing
1	Comes in direct contact with the product	Never in direct contact
2	Called primary packaging material	Secondary / Tertiary / Quaternary
3	Should be food grade, non-toxic, tasteless, odourless, lowest possible migration	No strict requirements
4	Packaging- a must e.g. Ice cream party pack, Bulk pack, Ghee	May be done/may not be done. Packaging then packing e.g. CFB, cartons, etc. Bulk biscuit packs.
5	Materials used: Plastics / glass / metal / treated paper or their combination	CFB / Plastic board boxes, wood, metal, etc. Shrink/ stretch wrapping
6	Objectives: Mainly to contain, carry, protect. Help in selling, legal aspects, marketing / sale, technical, transportation	Mainly ease in transportation and protection of packages
7	Generally attractive. Not a must: Biscuits & rolls in a pack. E.g Kellogs flakes, toffee. The exposed portion must be attractive.	Generally not attractive. But if retail pack, secondary packing exposed to consumers then attractive: Butter carton
8	Recycled material never used.	Much preferred.

9	Selection of packaging material: Physico-chemical properties of product are considered.	Generally stress / strength properties puncture resistance / burst strength, folding endurance, environmental factors considered.
10	Keeping quality is determined by packaging material.	Generally not so.
11	Single unit packaging.	Generally multi unit packaging. Sometimes single unit also. Butter carton, Bag in box. Here packing materials should be more attractive / effective than packaging material.

Reasons for selecting a particular style/type of packaging are vast and varied, numerous and changing. Product and packaging are becoming so interdependent that one cannot separate/consider one without another. Greatest part of food is spent in some form of package.

5. REQUIREMENTS FOR PRODUCING SUCCESSFUL PACKAGE:

Some sets of facts are necessary to be known for producing a successful package (mainly related to product - package interaction and transportation):

5.1 Facts about the product:

- a. The nature of the product, the material from which it is made and the manner in which it can deteriorate.
- b. Its size and shape.
- c. Its weight and density: eg. Powder – Bulk Density, size of tins
- d. Its weakness-which parts will break, move about, become bent or scratch or abrase the box easily.
- e. Its strengths: which part will withstand loads or pressures and which might be suitable for loading the product in the pack.
- f. The effect of moisture and temperature changes on the product and whether it will absorb moisture or corrode.
- g. Compatibility: whether the product is likely to be affected by any of the possible packaging materials, which items can be packed together, with protection if necessary and which items must not be packed together under any circumstances.

- h. How far stripping down may be carried out to reduce the package size to a minimum such that the customer can handle them.

5.2 Facts about the transport hazards:

- a. The type of transport-road, rail, sea or air.
- b. The degree of control over the transport. Is it private or public transport?
- c. The form of transport- bulk, freight container, unitized load, postal, passenger train, etc.
- d. The mechanical conditions and duration of storage (manufacturer → State Distributor → District Distributor ... Taluka / City → Retailer. The longer the journey or handling more strength is required in packaging & packing materials leading to higher cost).
- e. The nature and intensity of mechanical and climatic hazards in transport, storage, retailing and use. Packaging / packing material has to withstand wide range of temperatures and relative humidity
- f. Whether handling aids are available for loading and off-loading at all points between maker and user. (Viz. Lifts, Trolleys, Slip conveyers etc.)
- g. The importance of minimum volume in relation to transport costs. Over packaging must be prevented.

5.2.1 Hazards may be:

- a. Mechanical: Impact (vertical, horizontal), stationary package impacted by another, vibration, compression, Racking or deformation, piercing, puncturing, tearing etc.
- b. Climatic hazard: (High / low temperature / pressure) light, liquid/water (fresh / polluted), dust, and water vapour, R.H.
- c. Biological: (Microorganisms, fungi, moulds, bacteria, beetles, moths, flies, ants, termites, mites, rodents (rats and mice), birds.

5.2.2 Contamination by other goods:

- By materials of adjacent packs
- By leaking contents of adjacent packs
- Radioactivity.

6. CONCLUSION

Knowledge of the functions of packaging and the environments where it has to perform will lead to the optimization of package design and the development of real, cost-effective packaging.

Reference:

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