

A review on pharmaceutical packaging materials

Pranali S Satkar

Kasturi Shikshan Sanstha's College of Pharmacy Shikrapur, Pune, India

Abstract

Packaging is an important component in the development of various drug formulation in pharmaceutical industry. Pharmaceutical package is an integral part which protect the Pharmaceutical product. Maintain the quality of pharmaceuticals during storage, transportation, delivery, sale is assured by quality of the product. Containment, convenience and compliance for a product during Storage, carriage, display and until the product is consumed. the stability of drug solid, liquid, gel or paste form depend on packaging material to protect drug from chemical degradation.

Pharmaceutical packaging is classified into primary, secondary and tertiary level. Primary packaging is closely protect the product. Primary package is in direct control with the pharmaceutical formulation. Secondary packaging used for branding and display of the product. Tertiary package is the outer package of secondary packaging and used for transportation purpose. Material used for packaging purpose such as Glass, plastic, rubber metal etc. Packaging maintains the integrity of product like providing presentation, protection, identification, information against physical damage, loss of content and unwanted component of the environment such as oxygen, water vapors and light. Packaging is designed to contain a product so that it is unable to interact with the environment factor. Pharmaceutical packaging has important role to transform the formulation into an attractive and marketable product. This review article focused on the types of packaging, packaging material and function of packaging.

Keywords: pharmaceutical packaging, materials, plastic, glass

Introduction

Packaging is the science, art and technology of enclosing or protecting product for distribution, storage, sale, and use. Packaging is important for offering the goods safe and securely to the consumer. Packaging is a coordinated system used for preparing goods for containment, protection, transport, handling, distribution, and sells. Pharmaceutical packaging look into the issue like child safety, patient compliance, tampering and diversion of product. Packaging provide the protection against environmental condition like physical, chemical and biological hazard. Pharmaceutical Packaging provide the blood and blood product, lifesaving drugs, medical device, medical treatment and new product like nutraceuticals. Packaging play a important role in communicating the image and identity of a company. In many countries it is fully integrated into government, business, institutional, industrial and personal use. The external image of the package give the clear information about the product like route of administration, storage condition, batch number, expiry date, manufacture name, address, license number New ideas of dynamic packaging, intelligent packaging, and nanotechnology offers arrangement which a play a vital part to improve or observing food quality ^[1].

Characteristics of Packaging Material

1. It must be a non –toxic
2. It must be a FDA approved
3. It must be not reactive with the product
4. Material must be protect the preparation from environmental condition
5. It must be not impart to the odor or taste to the product

Types of Packaging

There are three types of packaging

1. **Primary packaging:** In the primary packaging the packaging is direct contact with the product ^[2]. it is the smallest unit of distribution and uses. Its main purpose to protect or preserve, contain and inform the consumer. Example- Container, syringe, Ampoules, Vials, Closure, Strip packaging, Blister packaging
2. **Secondary packaging:** Secondary packaging is the exterior packaging of the primary packaging that group packages. Examples- paper and boards, cartoon
3. **Tertiary packaging:** Tertiary packaging is used to protect not only the product but also primary and secondary packaging. it is used for bulk handling, warehouse storage and shipping of the product. Example- Cardboard boxes.

Types of containers which are used as primary packaging are as follows

Primary package for liquid orals is

Well-closed containers: These types of containers protect the product from contamination, foreign particles and loss during transportation, distribution, sale etc ^[1].

Air tight container: These types of containers protect the drugs from environmental hazards. If these containers are intended to be opened on more than one occasions then they remain airtight after closure.

Single dose container: This type of container use for single dose of drug. For e.g. vials or ampoules, glass

Multi dose containers: This type of container contain two or more doses and they withdraw at various interval. e.g.: vials

Light resistant containers: These containers protect the drug from UV light. These container does allow to pass the

UV radiation. E.g.: Amber colored glass containers.



Fig 1

Primary Package for Solid Dosage Forms

Strip package

In this package the contents are sealed in a packet. The package is made up of two layers of film or laminated material. A strip package contains many pockets and each pocket contains single dose of drug. [1] this packaging mainly used for the tablets and capsule. Material used for strip package -: cellophane, polyester, polyethylene.

Blister package

It is made up of base layer with cavities called Blister [3]. It provides excellent protection from environmental condition then strip package. Cavities made up of plastic and aluminum and lid which is made up of aluminum and paper foil. Cavity contain the product and lid seals the product in the package Material used in blister packaging; polyvinyl chloride, polypropylene, polyethylene, polyvenylenedene chloride



Fig 2

Primary package for semi solid dosage forms

Semi solid dosage forms contain ointments, creams and pastes. The containers used for semisolid dosage forms like collapsible tubes and plastic containers. Other type of products is also available in market for e.g Pressurized products. These types of products the package made up of stainless steel, aluminum [2].

Pressurized package expel the product through a valve.

Types of Packaging Material

1. Glass
2. Plastic
3. Metal
4. Rubber

1. Glass

These need to be chemically inert, impermeable, strong and rigid proving FDA clearance. glass widely used as a drug packaging material.glass composed of sand, soda ash, limestone and cullet.

Advantages

- They are transparent
- They are non-reactive
- They can easily labelled
- Economical
- Superior protective qualities
- Available in a wide variety of sizes & shapes

Disadvantages

- Glass is easily broken
- Heavy weight

Types of Glass

- Type I – Borosilicate Glass
- Type II – Treated Soda-lime glass
- Type III – Regular Soda-Lime Glass
- Type NP – General Purpose Soda-Lime Glass.

1. Type I (Borosilicate glass)

- Highly resistant and chemically inert glass.
- Alkali's and earth cations of glass are replaced by boron and/or aluminum and zinc
- It is used to contain strong acids & alkalis as well as all types of solvents.
- It has high melting point and can withstand high temperature
- Primary constituents: SiO_2 -80%, Al_2O_3 -2%, Na_2O , CaO -6%
- Eg: pyrex, borosil
- Uses: Laboratory glass apparatus, for water for injection

2. Type II-Treated soda-lime glass

These are more chemically inert than Type I glass. Type II containers are made of soda-lime glass that has been de-alkalized or treated to remove surface alkali.

The glass surface is de-alkalized by "Sulfur treatment" which prevents blooming/weathering from bottles [4].

Thus sulfur treatment neutralizes the alkaline oxides on the surface and thus rendering the glass more chemically resistant

Uses: For alkali sensitive products, Infusion fluids, blood, & plasma, large volume container.

3. Type III- Regular soda lime glass

Untreated soda lime glass with average chemical resistance [4]. It is cheapest in quality. This type of glass not suitable for alkali sensitive product.

Primary constituents: SiO_2 , Na_2O , CaO .

Uses: Topical use, for oral use, not for ampoules [5].

4. Type NP- General Purpose soda lime glass

It is made up of soda lime glass used for oral and topical application. It has lowest hydraulic resistance.It is suitable for solid liquid semisolid and not for parental.

5. Coloured Glass

Colored glass is used for light sensitive product which does not allow the UV rays to pass through it. Colored glass should not used for parental preparation.

2. Plastic

Plastic used for packaging pharmaceutical product. These packages are extremely resistance to breakage and leakage.

Advantages

1. low in cost
2. It is unbreakable
3. It is available in various size and shape.
4. It has good protection power.
5. Ease for transportation.
6. It is light in weight.

Disadvantages

1. Plastic contain certain disadvantages like interaction, adsorption, absorption, lightness so it has poor physical stability.
2. Main disadvantages is permeation. The atmospheric gases, vapors or liquid from environment easily migrate into plastic container.

Types of Plastics

There are two types plastic material: 1- Thermoplastic type
2- Thermosetting type

1. **Thermoplastic type**- This plastic can be softened by heating and harden by cooling. e.g: Polyethylene, Polypropylene, PVC, Polystyrene, Nylon etc.
2. **Thermosetting type**:- when heated they become flexible but they do not become liquid. e.g: Urea formaldehyde, phenol formaldehyde, Melamine formaldehyde.
 1. **Polyethylene**: polyethylene used as a polymer. It is used as high and low density polyethylene. High density polyethylene provide protection against moisture but poor protection against oxygen and environmental gases. Properties -Stiffness, strength, resistance to chemical. Low density polyethylene prefer plastic for squeeze bottles. Properties- Ease of processing, barrier to moisture, flexibility.
 2. **Polypropylene (PP)**: Polypropylene has good resistance to heat sterilization. It has good resistance to cracking when flexed. It has melting point of 170c which is higher than polyethylene. It is suitable for boilable packages and products needed to be sterilized. Brittleness at low temperature is major disadvantages of polypropylene. It has excellent resistance to strong acids and alkalis. It is suitable for closures, tablet container, and intravenous bottles.
 3. **Polyvinyl Chloride (PVC)**: It has high clarity and oxygen barrier. It can be made softer and flexible by incorporation of plasticizer. The heat stability of PVC is very poor and its melting point is 160c. PVC used for making container used for blood and blood component, bypass sets etc [2].
 4. **Polystyrene**: It is made from petroleum. Rigid, crystal clear plastic and non-biodegradable. Not useful for liquid products. Polystyrene has high water vapor transmission and gaseous permeability also they are easily stretchable and breakable. Polystyrene is combined with rubber and acrylic compound to increase their strength and quality..Base on the composition these are classified as intermediate impact, high impact and super impact packing.

3. Metals

Metals are used for construction of container. The metals used for aluminum, tin plated steel, stainless steel, tin and lead.

Advantages

- Metal holders are solid, generally unbreakable opaque [5].
- Resistance to chemical attack.
- Labels can printed directly on their surface
- They are impermeable to light, moisture, and gases
- They are strong.

Disadvantages

- They are expensive
- This are costly metal among tin, lead, aluminum, & press.
- They react with certain drug or chemicals and produce toxic product.

Aluminium

Aluminum is commonly used because of its light weight. They are attractive in nature. Thickest aluminum is used for rigid container such as aerosols cans and tubes for effervescent tablets. Thinnest aluminum is used in flexible foil that are component of laminated packaging material.

Advantages

- Aluminum tube offer shipment cost of the product is less because of their light weight.
- They provide attractiveness of tin at somewhat lower cost.

Disadvantages

- As a result of corrosion process H₂ may evolve
- Any substance that react with the oxide coating can cause corrosion [6].

Uses: Aluminum ointment tubes, Screw capes.

4. Tin

It is most expensive metal as compared to other metal. It is resistance to chemical attack **Uses**- Tin container are used for food like milk powder container are coated with tin. Currently some eye ointment still packaged in pure tin ointment tubes.

5. Iron-

Advantages

Iron is not used for pharmaceutical packaging, large quantities of tin combines the strength of steel with corrosion resistance of tin.

Use: fabrication of milk containers, screw caps and aerosol cans, creation of drain holders [5]

6. Lead

Advantages

Lead has lowest cost of all metals used in pharmaceutical containers. It is soft in nature.

Disadvantages

Lead never be used alone for anything taken internally because of the risk lead poison. **Use:** with internal linings lead tubes used for products such as chloride tooth paste.

Rubber

Natural elastic comprises of long chain polymers of isoprene units connected together within the cis portion. Its most important source is the tree Heave Brazilians from which latex, containing 30 to 40% of rubber in colloidal suspension, exudes when shallow cuts are made within the bark

- a. **Butyl rubber:** These are co polymer of isobutylene with 1-3% of butadiene ^[6].

Advantages

- Permeability to water vapor
- Water absorption is very low
- They are relatively cheaper as compared to other synthetic rubbers.

Disadvantages

- Slow decomposition takes place above 130°C
- Oil and solvent resistance is not very good.

b. Nitrile rubber

Advantages: Oil resistant due to the polar nitrile group. Heat resistant.

Disadvantage: Absorption of bactericide and leaching of extractives are considerable.

- c. **Chloroprene rubber:** These are polymers of 1:4 chloroprene.

Advantages

- This rubber is oil resistant.
- Heat stability is good

d. Silicon rubbers

Advantages

- Heat resistance (up to 2500c)
- Extremely low absorption and permeability of water ^[6].
- Poor tensile strength.

Disadvantage: They are very expensive

Function of Packaging

1. **Product identification-** packaging helps to identify the product ^[7]
2. **Product protection-** packaging helps to protect the product from environmental condition, breakage and leakage. It protect the container from moisture, temperature, humidity.
3. **Product promotion-** packaging used for promotional and attracting the attention of the people ^[7].
4. **Marketing-** Packaging and labels helps to encourage potential buyers to the purchase of product. Graphic design and marketing communication are applied to the surface of package and the point of sale display
5. **Convenience-** Packages can have features that add convenience in handling, distribution, opening, closing use, sale, display, reuse, re-closing and dispensing.

Conclusion

Pharmaceutical packaging is important technique in pharmaceutical industries. Packaging of the pharmaceutical products is very important to its stability, acceptance to patient, transport, etc. Packaging provide the valuable information to the patient. Packaging play important role for

the protection of the pharmaceutical product. Now a days eco-friendly packaging are used which are biodegradable in nature. This review article focused on the material used for the packaging and types of packaging.

References

1. Recent Advancement in pharmaceutical packaging: Mohd Sohail Ali*, Talath Fatima, Syed Abdul Mubeen, Mohd Abdul Khale1, Dr. Abdul Mannan, 1Deccan school of pharmacy, Hyderabad, T.S. India International Journal of pharmacy and pharmaceutical research
2. A Review on Pharmaceutical Packaging Material Praveen Nasa* Department of Pharmaceutical Education & Research, Bhagat Phool Singh Mahila Vishwavidyalaya, Bhainswal Kalan (Sonipat), India. World Journal of Pharmaceutical Research. Volume 3, Issue 5, 344-368.
3. Recent Trends in Pharmaceutical Packaging: A Review Mehta Kunal C*, D. Akhilesh and B. Shyam Kumar Shree Devi College of Pharmacy, Airport Road, Mangalore, Karnataka, India International journal of Pharmaceutical and Chemical Sciences.
4. Pharmaceutical Packaging: Current Trends and Future Original Article Vikas Pareek*, Dr. Alok Khunteta 1.Lal Bahadur Shastri College of Pharmacy, Rajasthan University of Health Sciences, Government of Rajasthan, 2.Professor: Lal Bahadur Shastri College of Pharmacy Registrar: Rajasthan Pharmacy Council. Email: Vikaspareek@yahoo.com International Journal of Pharmacy and Pharmaceutical Sciences.
5. Pharmaceutical Packaging Technology: A Brief Outline puja saha, Rumpa das, Pratik swarup das, https://www.researchgate.net/journal/0975234X_Research_Journal_of_Pharmaceutical_Dosage_Forms_and_Technology.
6. Pharmaceutical Packaging Technology Lukesh Pegu1, Pankaj Chasta1, Mr. Kaushal K. Chandrul2 1Pharmacy Graduate, 2Faculty of Researcher and Development 1,2 Pharmacy Department, Mewar University, Chittorgarh, Rajasthan, India International Journal of Trend in Scientific Research and Development (IJTSRD) Volume: 3 | Issue: 3 | Mar-Apr 2019 www.ijtsrd.com e-ISSN: 2456 – 6470.
7. Pharmaceutical packaging – SlideShare <https://www.slideshare.net/mobile>