Review Article

A Comprehensive Review on Oral Strips

Inder Kumar*, Vinay Pandit[1]
* Department of Pharmaceutics, Abhilashi University, Mandi (H.P.), India.
[1]Department of Pharmaceutics, Laureate Institute of Pharmacy Kathog, Jwalaji (H.P.), India.
***Corresponding author's E-mail:** inder.93kumar@gmail.com

Received: 16-07-2019; **Revised:** 22-08-2019; **Accepted:** 03-09-2019.

ABSTRACT

Oral Strips is a rising innovation with the quickest beginning of the activity and enhanced patient consistence. Oral strips when setting in the oral cavity break down or disintegrate inside a couple of moments without the admission of water. It enhances the viability of API's and gives better medication arrangement. These formulations are suitable for cold, allergic rhinitis, asthma attacks, CNS disorders where quick on the set of action is required for all the more quickly alleviation. An oral strip offers a substitute stage for molecules that experience first passes digestion. The present article overviews the formulation aspects, manufacturing methods, patent technologies, evaluation parameters, and marketed products.

Keywords: Oral strips, Onset of action, Patent technology.

INTRODUCTION

Over the past few decades, affinity toward pioneering drug delivery systems has majorly increased attempts to ensure effectiveness, safety, and patient suitability. As discovery and development of new chemical entity are a difficult, expensive and time-consuming process, so recent trends are shifting toward designing and developing innovative drug delivery systems for existing drugs. Out of those, the drug delivery system is very renowned among pediatrics and geriatrics is Oral Drug Delivery System. In oral drug delivery system, the Oral Strips gaining the important popularity nowadays because of their fastest onset of action and better patient compliance for pediatrics and geriatrics as well. Oral strips when placed on the tongue they get disintegrate within a second by soaking saliva and release the drug from the dosage form.[1-3]

Oral strips are the alternative to conventional oral dosage forms like capsule, syrups tablets, etc. the technology behind developing the oral strips was the transdermal patch. Hydrophilic polymers play an important role in the preparation of oral strips that rapidly dissolves; release the medication to the systemic circulation via oromucusa. Due to the thin membrane of oromucosa the drug is directly absorbed into the systemic circulation and gives the instantaneous bioavailability and faster onset of action.[4,5]

Advantages of oral strips: [6]

a) It provides the fastest onset of therapeutic action because drug directly goes into the systemic circulation.

b) It provides the ease of administration of pediatrics and geriatrics patients who face the problem of dysphasia.

c) Increased Bioavailability, due to absorption via oro-mucosa which has better permeability properties.

d) No water is required; therefore, it gives a suitable mark for those patients who are traveling.

e) Due to the availability of a larger surface area, it leads to the rapid dissolution of the drug.

f) Oral stripes are more flexible, easily handled storage and transportation.

g) They are available in various size and shapes.

Disadvantages of oral strips: [6]

a) A high dose cannot be incorporated into the strips.

b) Drugs that irritate the oral mucosa and which are unstable at mucosal pH cannot be administrated.

c) Oral strips require a special type of packaging because they are fragile and protect from water.

CRITERIA FOR SELECTION OF DRUG CANDIDATE [7]

1. The drug should have a pleasant taste.
2. A higher dose of the drug is not required. The dose should be minimum 40mg.
3. Stability and solubility of the drug should be good in the water as well as saliva.
4. It should have the ability to pass the oral mucosal tissues
5. Drugs having smaller and moderately molecular weights are selected as candidates.
6. Drugs which partially unionized at oral cavity pH should be selected.

ANATOMICAL AND PHYSIOCHEMICAL OF ORAL MUCOSAL CAVITY

The oral mucosa is composed of an outermost layer of stratified squamous epithelium. Below this lies a basement membrane, a lamina propria followed by the sub-mucosa as the innermost layer. The buccal mucosal site offers a smooth, stable surface with vascular perfusion, as opposed to the sublingual mucosal site, which does not have a stationary mucosal surface. At the point when contrasted with other mucosal regions, the buccal mucosa is more tolerant of potential allergens, with less effect for irreversible harm and moderately brings down enzymatic movement. [8]

Drug ingestion from the buccal pit can happen either by the transcellular course (intercellular course) or para-cell pathway. The oral mucosa is in general intermediate between that of the epidermis and intestinal mucosa in terms of permeability. The wafer quickly dissolves in the oral cavity and the active moiety absorbs via oral mucosa into the blood stream.[9, 10]

TYPES OF ORAL STRIPS

Oral strips are of three types:

1. Flash release strips
2. Mucoadhesive melt away strips
3. Mucoadhesive sustained-release strips

PROPERTIES OF ORAL STRIPS

Types and properties of oral strips are shown in **Table 1**. [11]

Table 1: Types of oral strips and their properties

Properties	Flash release strips	Mucoadhesive melt away strips	Mucoadhesive sustained-release strips
Area (cm^2)	2-8	2-7	2-4
Thickness (μm)	20-70	50-500	50-250
Structure	Single-layer structure	Single or multilayer structure	Multilayer structure
Excipients	Soluble hydrophilic polymer	Soluble hydrophilic polymer	Low or nonsoluble polymers
Drug Phase	Solid solution	A solid solution or suspended drug particles	Suspended or solid solution
Application	Tongue (upper palate)	Gingival or buccal region	Gingival, (another reason in the oral cavity)
Dissolution	60 sec	Dissolution in a few minutes. Forming Gel	8-10hours
Site of Action	Systemic or local	Systemic or local	Systemic or local

Table 2: Composition of the oral strip

S. No.	Composition	Concentration (w/w)	Examples
1	Drug/API	5-30%	Antiemetic, Antiallergic etc.,
2	Water soluble polymer	45%	HPMC E5,E3, pectin, gelatin etc.,
3	Plasticizer	0-20%	Glycerol, polyethylene glycol etc.,
4	Surfactant	Q.S.	Sodium lauryl sulphate, tween etc.,
5	Sweeting agents	3-6%	Saccharin, aspartame etc.,
6	Saliva stimulated agents	2-6%	Citric acid, malic acid, lactic acid
7	Fillers, color, flavors	Q.S.	FD and C color, US FDA approved flavors

API: Active Pharmaceutical Ingredients, HPMC: hydroxyl propyl methyl cellulose, US FDA: United State Food and Drug Administration, Q.S: quantum satis.

STANDARD COMPOSITION OF ORAL STRIPS[12]

The oral strip is a thin film having an area of 1-20cm^2 containing drugs. Not more than 30mg of the drug can be incorporated in a single dose. The composition of an oral strip includes:

- ✓ Drug
- ✓ Water-soluble polymers
- ✓ Plasticizer
- ✓ Surfactants
- ✓ Sweetening agents
- ✓ Saliva stimulating agents
- ✓ Fillers, colors, and flavor.

Table 2 list the composition of oral strips along with ingredients with the example used in the formulation of oral strips.

1. Active Pharmaceutical Ingredients

5-30% w/w of active pharmaceutical ingredients are used for a standard composition of oral strips. Generally, small dose molecules are selected for oral strips. Micronization of APIs is very useful to improve the dissolution of the strip that will lead to fast absorption as well as the instant therapeutic action of the drug. Taste masking agents will be used for masking the itter taste of the drug. Highly lipophilic drugs should be preferred for oral strips. Different categories of drugs are used in the oral strips some of these are antiulcer (e.g. omeprazole) Antiemetic, Antiallergic, antiasthmatics (salbutamol sulfate), antitussives, expectorants, antihistaminics, NSAID'S (e.g. paracetamol, meloxicam, valdecoxib). [13, 14]

2. Water-soluble polymer

The development of the film and the mechanical strength of the film is strongly related to the selection and concentration of the polymers. These polymers can be used alone or in combination with other polymers to increase the mechanical strength and modify the film property. 45% w/w of the concentration of the polymer is used to develop an oral strip. But it can be increased up to 60-65% w/w to attain the desired characteristics.[15] A polymer that is used for formulation the thin strip should have the following properties (**Table 3**).

Table 3: Natural and synthetic polymer commonly used in oral strips

Type of polymer	Example
Natural polymers	Starch polymerized rosin, pullulan, sodium alginate, Pectin, gelatin, and maltodextrins
Synthetic polymers	Polyvinyl alcohol, hydroxypropyl methylcellulose, sodium carboxymethylcellulose, polyvinylpyrrolidone, and hydroxypropyl cellulose

Ideal properties of water-soluble polymers:

- Nontoxic
- Nonirritant
- Should not affect the disintegration time of oral strip
- Should have a moderate half-life
- Should have good spreadability
- Should have maximum tensile and mechanical strength
- Easily affordable
- Nowadays both natural and synthetic polymers are used in the formulation of the oral strip. [16]

3. Plasticizers

Plasticizers play an important role in the formulation of oral strips. By the addition of the plasticizers, the mechanical and tensile strength of the film will be improved. The selection of the plasticizer is dependent on the compatibility with the polymer used and type of solvent that employed. Commonly used plasticizers are polyethylene glycol, glycerol, low molecular weight polyethylene glycol, phthalate derivatives and citrate derivatives like tributyl, triethyl, acetyl citrate and castor oil. 0-20% w/w concentration of plasticizer is commonly used that will help to prevent cracking, splitting and peeling of the strip. [17, 18]

4. Surfactant

Surfactants are used to enhance the solubility and wetting property of the film that will provide quick dissolution and release the medicament within a minute, some of the commonly used surfactants are sodium lauryl sulfate, benzalkonium chloride, and a tween, etc. Poloxamer 407 is the most important surfactant used as solubilizing, wetting and dispersing agent. [19]

5. Sweetening agent

Sweeteners have become one of the important ingredients in the pharmaceutical product to mask the bitter taste of the drug. Both natural and artificial sweeteners are used. Natural sweeteners like sucrose, dextrose, fructose, glucose, liquid glucose and isomaltose etc. and artificial sweeteners like monosaccharide's, disaccharides and polysaccharides such as galactose, glucose, mannose, fructose, xylose, ribose, dextrose, maltose, sucrose, sugar, sorbitol, xylitol, mannitol and soluble saccharin salts, saccharin, cyclamate salts, acesulfame-K, Aspartame, Neotame respectively. Now day's popularity of artificial sweeteners in pharmaceutical formulation increasing day by day. Neotame and alitame have more than 2000 to 8000 times sweetening power than sucrose. [20, 21]

6. Saliva stimulating agent

Saliva stimulating agents are helpful for rapid disintegration of the oral strips because they enhance the rate of production of saliva. Citric acid, malic acid, lactic acid, ascorbic acid, and tartaric acid are some of the examples of salivary stimulant. In the oral strip, 2-6% w/w concentration of salivary stimulant is used alone or in combination. Citric acid is one of the preferable stimulants used in the oral strip. [22]

7. Coloring and flavoring agents

FDC approved natural coloring agents are commonly used. The concentration of the coloring agent should within the limit of 1% w/w.

Flavoring agents are generally added to the formulation to give the flavor and make the formulation attractive towards pediatric patients. The different flavor can be used such as essential oils or water-soluble extract of menthol, intense mint (peppermint, sweet mint,

spearmint,) wintergreen, cinnamon, clove, sour fruit flavor (lemon), fruit essence (apple, raspberry, cherry, pineapple), etc. [23, 24]

CONVENTIONAL APPROACHES FOR MANUFACTURING THE ORAL STRIPS

1. Solvent casting method
2. Semi-solid casting method
3. Hot-melt extrusion
4. Solid dispersion extrusion
5. Rolling method

1. Solvent casting method

Strip forming agent, plasticizer, and saliva stimulating agent are dissolved in distilled water, the solution is then stirred up to 4hurs continuously in a magnetic stirrer at 60 °C and 1000rpm. After that, the solution is kept stand for 1 hour to remove all the air bubbles entrapped. At the same time in a separate container remaining excipients i.e. sweetening agent, disintegrating agent, flavor, and drug are dissolved in distilled water with continuous stirring for 45minutes. Both the solutions are mixed together in a separate container and stir up to 1hour in magnetic stirrer at room temperature and 1000rpm. Standby the solution for 1hour to let the foams settle down. Finally, the solution is cast and dried at 60 °C and cut the strip into the desired size. [25, 26, 27]

Advantages: [28]

a) Great uniformity of the thickness of the strip.

b) More flexible and better physical properties.

c) Defects are very less in the solvent casting method.

Disadvantages: [28]

a) The solubility of the polymer is important in a volatile solvent or water.

b) Viscosity and the minimum solid content of the solution are essential.

2. Semi-solid casting method[29]

1. A solution of water-soluble film-forming polymer is prepared first.
2. The resulting solution is then added to acid-insoluble polymer (cellulose acetate phthalate, cellulose acetate butyrate) solution which can be prepared with ammonium or sodium hydroxide.
3. For obtaining the gel mass exact amount of plasticizer is added.
4. Finally, the obtaining gel is then cast into a strip using a heat controlling drum.
5. The ratio between the acid-insoluble polymer and film-forming polymer should be 1:4. (**Figure 1**)

3. Hot-melt extrusion method

Hot-melt extrusion method is commonly used for the preparation of various dosages form in the pharmaceutical industry like sustained-release tablet, granules, transdermal and transmucosal drug delivery systems. [28] In this method, the drug and polymer are firstly blended in a mixer for 10minutes and plasticizer is added slowly and in the presence of the anti-sticking agent, the mixer is granulated. The prepared granules are dried overnight at room temperature and pass the dried granules in 250µm sieve and standardize. The standardize granules are then poured into the extruder. The speed of the extruder is set to 15 rpm in order to process the granules inside the drum approximately less than 3mintues at 65 °C and then pressed into a cylindrical calendar in order to obtain a strip with a thickness about 200µm. for further testing, the strip is cut into the required size and shape and stored at 25 °C (**Figure 2**). [30, 31]

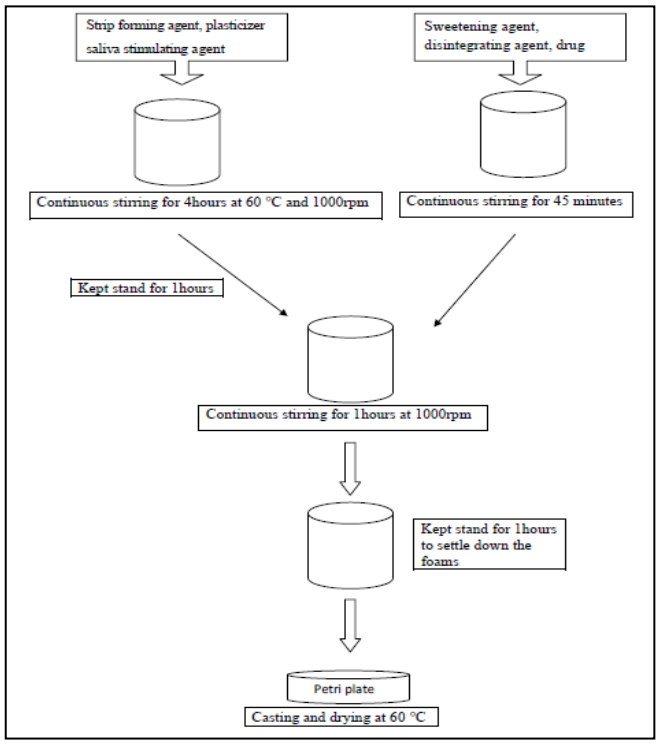

Figure 1: Flow chart of the solid casting method

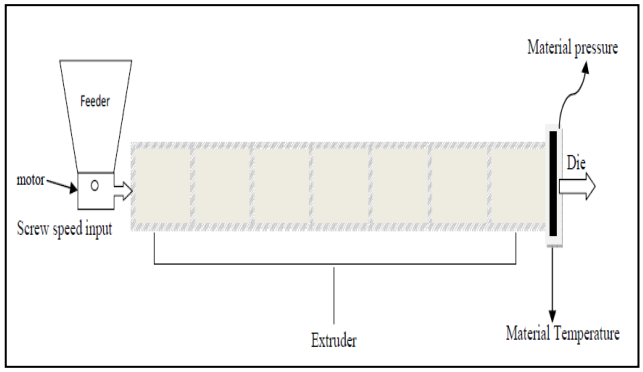

Figure 2: Hot melt extrusion method

Advantages: [28]

I. No water or solvent used.

II. Less processing steps.

III. For poorly soluble drugs it possesses good dispersion mechanism.

IV. Uniform dispersion of the fine particles is more because of intense mixing and agitation.

Disadvantages: [28]

a) The process is thermal so there will be a problem with drug/polymer stability.

b) Flow properties of the polymer are important for processing.

c) Availability of polymer is low.

4. Solid dispersion extrusion

The drug is dissolved in an appropriate liquid solvent. The obtained solution is then added to the pre-melted suitable polymer to form the solid dispersion. Finally obtained solid dispersion is shaped into the strips by using dyes of different size and shapes. [32]

5. Rolling method

In the rolling method, the solution containing drug is prepared in a solvent of water or mixture of water and alcohol. Then the prepared solution or suspension is rolled on a carrier. The strip is dried on the roller. After drying the strip is cut to the desired shape and size (**Fig. 3**). [33]

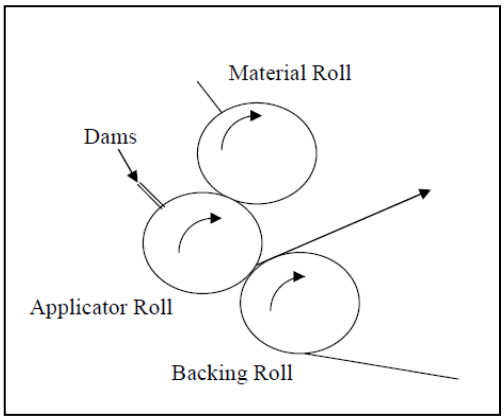

Figure 3: Rolling method

PATENTED APPROACHES FOR MANUFACTURING THE ORAL STRIPS[34-38]

I. XGel

II. Soluleaves

III. Wafertab

IV. Foambrust

V. Micap

I. Xgel

This technology is produced by Bioprogress to produce a newer technology to product manufacturing. Xgel film provides unique product benefits for healthcare and pharmaceutical products: it is non-animal- derived, the film is continuous production processing provides an economic and competitive manufacturing platform.

II. Soluleaves

This technique is used to formulate the quick dissolving films by adding with active ingredient, flavor, and color to fill the pleasant and easy acceptable form.

III. Foam burst

This method gives an effect like the melt in the mouth like sensation because at time of preparation of film gas is blown on the film due to this films gives honeycomb-like structure and this void is empty or filled with other material to acquire the specific test or odor.

IV. Wafertab:

In this system drug load in film after casting. The system provides rapid dissolution and release of actives when the strip comes into contact with saliva in the mouth. The wafertab filmstrip can be flavored for additionally improved taste masking.

V. Micap

Micap plc signed an option agreement in 2004 to combine its expertise in microencapsulation technology with the BioProgress water-soluble films. The aim of this company to make the smoke sensation product.

EVALUATION

Organoleptic Evaluation: The oral strips are evaluated firstly for organoleptic evaluations like color, odor, and taste. [39]

Physical Appearance and Surface Texture: Physical inspection is observed by visual and surface texture is evaluated by touch or feel of the strip. [39]

Thickness: The thickness of the strip is measured by calibrated digital vernier caliper or micrometer screw gauge at different locations. Uniformity in the thickness is very important because it is directly related to the dose of the strip. [40]

Weight Variation: Weight variation of the strip is evaluated by weighed the individual weight of every strip and then the average weight is calculated. The average weight of the strip is then subtracted from the individual strip of the film. A large number of weight variations indicate nonuniform drug content. [41]

Contact Angle: It is measured at room temperature by goniometer (AB Lorentz and Wettre, Germany). A drop dubbed distilled water is placed on the dry strip and images of the water droplet is recorded by the digital camera within 10 sec. Digital images are analyzed by image

1.28 V software (NIH, USA) for angle determination. The contact angle is observed both sides of the drop and average is taken. [42]

Transparency: In transparency test, the strip is cut into a rectangle shape and then placed into the internal side of the UV spectrophotometer cell. The strip is determined at 600 nm transmittance. The transparency of the strip is calculated by the following formula:

$$\text{Transparency} = \frac{(logT600)}{b} = -€c$$

Where b is the thickness of strip (mm), c is the concentration and *T*600 is the transmittance at 600nm. [43]

Moisture Content: Brittleness and friability of the strip are affected by moisture content present in the strip. Karl Fisher Titration method or by the weighing method is used to determine the moisture content. Typically, the pre-weighed strip with a specific size is heated to 100-120C until it attains constant weight. The difference in weight gives the amount of moisture content present in a strip. [44]

Moisture content can be determined by:

$$\%\ \text{moisture content} = \frac{initial\ weight - final\ weight}{initial\ weight} \times 100$$

Dryness/Tack Test: It is the insistence due to which the strip adhered to a piece of paper (an accessory) that has been pressed into contact with the strip. This test is also called the dryness test. Dryness test is helpful to check for dry to handle, dry to print, dry to touch, dry to recoat. [45]

Tensile Strength: The maximum strength applied to a point at which the strip is going to break. Tensile strength is calculated by the maximum strength applied for breakage divided by the thickness of the strip into the width of the strip (cross-section area). [46]

$$\text{Tensile strength} = \frac{maximum\ strength\ applied\ to\ break}{thickness\ of\ strip \times strip\ width}$$

Percentage Elongation: It is calculated by determining the distance traveled by a pointer before the strip break. The formula for percentage elongation is given below:

$$\text{Percentage elongation} = \frac{final\ length - initial\ length}{initial\ length} \times 100$$

As the concentration of plasticizer is increased the percentage elongation of the strip is also increased. [47]

Folding Endurance: Folding endurance is measured by manually. The strip is folded repeatedly at the same place until it broke. The time at which the strip is folded without breaking is called folding endurance value. Generally, 3×2cm diameter strip (an area of 6 m^2) is used for folding endurance. [48]

Young's Modulus: It is also called elastic modulus. It is used to measure the stiffness of the strip. It is calculated by the ratio of applied stress over the stain in the region of elastic deformation.

$$\text{young's modulus} = \frac{slope \times 100}{film\ thickness \times cross\ head\ speed}$$

Harder and brittle strip show high tensile strength and young modulus with small elongation. [49]

Tear Resistance: Tear resistance or tear strength of the strip is that at how well a strip can withstand the effect of tearing. Tear resistance of strip is a complex function of its ultimate strength to rupture. Basically a very low rate of loading 51 mm (2 in.)/min is employed and is designed to measure the force (that is generally found near the onset of tearing) required to tear the specimen is recorded as the tear resistance value in Newton's or pound-force. [50, 51]

Surface pH: The Surface pH of the strip is determined in order to examine the side effects of the strip *in vivo*. The oral strip is firstly placed on the surface of the agar gel (1.5% w/v) and pH is determined using a pH paper. The color change in pH paper is observed and noted. [52]

pH of The Film: The pH of the film is measured by dissolving strip in 2ml distilled water and the pH of that solution is measured by pH meter or pH paper. [53]

***In-vitro* Disintegration Time:** In vitro disintegration time is the time in which the strip breaks when in contact with saliva. As per CDER, the disintegration time of strip is 30 seconds or less. Typically disintegration time of strip is 5 to 30 seconds. [54, 55]

There are two different methods for determining the disintegration time as follows:

Slide Frame Method: One drop of distilled water is pipette out and drop into the strip. After that, the film is a clamp on the side surface and it placed planner on the Petri plate. Time at which the strip is completely dissolved or causing a hole in the strip is the disintegration time of that strip. [56]

Petri Plate Method: The strip is placed on the 2 ml of distilled water in a Petri plate. The time at which the strip is dissolved completely in distilled water is measured. [57]

***In-vitro* Dissolution:** *In-vitro* dissolution, drug release of the strip is determined by standard USP dissolution apparatus Type I (Basket) and type II (paddle). The dissolution medium is selected as per the sink condition and the high dose of API. Mostly used dissolution medium in the oral strip is phosphate buffer pH 6.8 and 0.1N HCl having rotation speed 50 rpm and 37 ± 0.5 °C temperature. After that, the sample is analyzed by using UV visible spectrophotometer. [58, 59]

Content Uniformity: Content uniformity of oral strip is determined for estimating API content in a single strip. Standard methods for all API are given in Standard Pharmacopoeias. The limit of content uniformity is up to 85 - 115%. [60].

Swelling Index: The swelling property of the oral strip is determined in simulated saliva solution. The strip sample is weighed and placed on the stainless steel wire mesh which is already weighed. The mesh is then submerged into the 15 ml medium in a container. The swelling index of the strip is calculated by using the formula:

$$\text{Swelling Index} = \frac{Wt - Wo}{Wo}$$

Where, *Wt* is the weight of the strip at time *t* and *Wo* is the weight of the strip at time zero

Stability Study: Stability study of fast dissolving films is carried out for all the batches according to ICH guidelines. After predetermined time intervals, the films are evaluated for the drug content, disintegration time and physical appearance. [63]

PACKAGING OF FAST DISSOLVING FILM

In the pharmaceutical industry, it is very important that the package selected effectively preserve the integrity of the product. Expensive packaging, specific processing, and special care are required during manufacturing and storage to protect the dosage of other fast dissolving dosage forms. A variety of packaging options are available for fast dissolving films. Single packaging is mandatory for films, which are pharmaceutical products; an aluminum pouch is the most commonly used packaging format. APR-Labtec has developed the Rapid card, a proprietary and patented packaging system, which is specially designed for the Rapid films. The rapid card has the same size as a credit card and holds three raid films on each side. Every dose can be taken out individually. [64, 65]

The material selected must have the following characteristics

a) They must protect the preparation from environmental conditions.

b) They must be FDA approved.

c) They must meet the applicable tamper-resistant requirement

d) They must be non-toxic.

e) They must not be reactive with the product.

f) They must not impart to the product tastes or odors

Foil, paper or plastic pouches

The flexible pouch is a packaging concept capable of providing not only a package that is temper- resistance, but also by the proper selection of material, a package with a high degree of environmental protection. A flexible pouch is usually formed during the product filling operation by either vertical or horizontal forming, filling, or sealing equipment. The pouches can be single pouches or aluminum pouches. [64]

Single pouch and Aluminum pouch

Soluble-film drug delivery pouch is a peelable pouch for “quick dissolve” soluble films with high barrier properties. The pouch is transparent for product display. Using a 2 structure combination allows for one side to be clear and the other to use a cost-effective foil lamination. The foil lamination has essentially zero transmission of both gas and moisture. The package provides a flexible thin-film alternative for nutriceutical and pharmaceutical applications. The single-dose pouch provides both product and dosage protection. The aluminum pouch is the most commonly used pouch. [66]

Blister card with multiple units

The blister container comprises of two segments: the blister, which is the framed cavity that holds the item, and the top stock, which is the material that seals to the blister. The blister package is shaped by warm – softening a sheet of thermoplastic gum and vacuum-drawing the mollified sheet of plastic into a formed shape. Subsequent to cooling the sheet is discharged from the shape and continues to the filling station of the packaging machine. The semi-inflexible blister beforehand shaped is loaded up with the item and lidded with the warmth sealable sponsorship material. The film choice ought to be founded on the level of insurance required. For the most part, the cover stock is made of the aluminum thwart. The material used to shape the cavity is normally a plastic, which can be intended to shield the measurement frame from dampness.[5, 64]

Barrier Films

Many drug preparations are extremely sensitive to moisture and therefore require high barrier films. Several materials may be used to provide moisture protection such as Polychlorotrifluoroethylene (PCTFE) film, Polypropylene. Polypropylene does not stress crack under any conditions. It is an excellent gas and vapor barrier. Lack of clarity is still a drawback. [67, 68]

CONCLUSION

From above, this can be concluded that oral strips have proved to be an innovative drug delivery system for all groups of population of patients with the problem of swallowing. Oral strips have proved to be valuable whenever rapid onset of action is essential like in case of an asthmatic attack, cardiac heart failure and in epilepsy. Oral Strips are used as a good tool to increase the life cycle of the existing product by getting a patent of the same product as fast dissolving oral films. So this technology is growing at a fast pace challenging most of the pharmaceutical companies to develop oral films for a wide range of active pharmaceutical ingredients. A lot of research work is going on and will be started in the near future on fast dissolving oral strips. However, for future growth point of view, the fast-dissolving oral strips sector is well-positioned. It seems that the value of the overall oral thin film market will grow extensively.

Table 4: List of the Marketed Formulation of Oral Strips[5, 69-72]

S. No.	Product/ Brand Name	Manufacturer/ Distributor	Indication/ Uses
1	Diphenhydramine Hydrochloride films	MonoSol RX	Antihistaminic
2	Triaminic Thin Strips®	Novartis Pharmaceuticals	Nasal decongestant
3	Klonopin Wafers	Solvay Pharmaceuticals	Treatment of anxiety
4	Benadryl	Pfizer	Anti-allergic
5	Theraflu	Novartis	A cough suppressant
6	Dextromethorphan fast dissolving films	Hughes medical corporation	Antitussive agent
7	Caffeine films	Dow chemical company	CNS stimulant.
8	Ondansetron Rapid films®	Labtec Pharma	Postoperative nausea and vomiting
9	Suppress®	InnoZen®, Inc.	A cough suppressants
10	Orajel	Del	Mouth ulcer
11	Gas-X	Novartis	Anti flatuating
12	Folic acid-fast Dissolving films	Huges Medical Corporation	Anemia
13	Chloraseptic® Relief strips	Innozen Inc	A minor irritation, pain, and sore throat.
14	Sudafed PE	Wolters Kluwer Health, Inc.	Relieving Congestion
15	Chloraseptic	Prestige	A sore throat
16	Listerine Cool Mint Pocket Paks	Pfizer, Inc.	Mouth Fresheners
17	Zuplenz	MonoSol Rx	Prevent nausea and vomiting caused by cancer drug treatment
18	Ondissolve	Labtec Pharma	Prevent nausea and vomiting
19	Suboxone	MonoSol Rx	Treatment of opioid
20	Setofilm	Labtec Pharma	Nausea and vomiting

REFERENCES

1. Nagar Priyanka, Chauhan Iti, Yasir Mohd, Insights into Polymers: Film Former in Mouth Dissolving Films, Drug Invention Today, 3(12), 2011, 280-289.
2. Gali AK, Fast Dissolving Dosage Forms, International Journal of Pharmaceutical Science Invention, 2(11), 2013, 14-17.
3. Keshari Ankita, Sharma PK, Parvez N, Fast Dissolving Oral Film: A novel and Innovative Drug Delivery System, Int. J. Pharma Sci. Res, 5(3), 2014, 92-95.
4. Thakur Nishi, Bansal Mayank, Sharma Neha, Overview A Novel Approach of Fast Dissolving Films and Their Patients, Advances in Biological Research, 7(2), 2013, 50-58.
5. Arya Arun, Chandra Amrish, Sharma Vijay, Pathak Kamla, Fast Dissolving Oral Films: An Innovative Drug Delivery System and Dosage Form, International Journal of ChemTech Research, 2(1), 2010, 576-583.
6. Heer Deepak, Aggarwal Geeta, Kumar Hari SL, Recent Trends of Fast Dissolving Drug Delivery System- An Overview, The Formulation Technology, 4(1), 2013, 1-9.
7. Patil Pallavi, Shrivastava SK, Fast Dissolving Oral Films: An Innovative Drug Delivery system, International Journal of Science and Research, 3(7), 2014, 2080-2093.
8. Dey Paramita, Ghosh A, Wafer: An Innovative Advancement of Oro-dispersible Films, International Journal of Applied Pharmaceutics, 8(1), 2016, 1-7.
9. Metkari VB, Kulkarni LV, Patil PS, Jadhav PA, Jadhav PH, Yadav PS, Fast Dissolving Film: Novel Drug Delivery System, Journal of Current Pharma Research, 4(3), 2014, 1225-1230.
10. Harris D, Robinson JR, Drug Delivery via the Mucous Membranes of the Oral Cavity, J Pharmaceutical Sci, 81, 1992, 1-10.
11. Jangra Kumar Pradeep, Sharma Sachin, Bala Rajni, Fast Dissolving Oral Films: Novel Way for Oral Drug Delivery, International Journal of Universal Pharmacy and Bio Sciences, 3(1), 2014, 6-29.
12. Bala Rajni, Pawar Pravin, Khanna Sushil, Arora Sandeep, Orally Dissolving Strips: A New Approach to Oral Drug Delivery System, International Journal of Pharmaceutical Investigation, 3(2), 2013, 67-76.
13. Ramesh B, Saravanakumar K, K Jagadish Kumar, Saddham Hussain, A Novel Approach of Fast Dissolving Films: A Review, International Journal of Medicine and Pharmaceutical Research, 2(5), 2014, 816-824.
14. Bekkeri Swathi, Leads of Oral Disintegrating Film over Oral Disintegrating Tablets: A Review, Int. J. Pharma. Sci., 4(2), 2014, 447-453.
15. Irfan Muhammad, Rabel Sumeira, Bukhtar Quratulain, Qadir Imran Muhammad, Jabeen Farhat, Khan Ahmed, Orally Disintegrating Films: A Modern Expansion in Drug Delivery System, Saudi Pharmaceutical Journal, 24, 2016, 537-546.
16. Chauhan I, Yasir M, Nagar P, Insights into Polymers: Film Formers in Mouth Dissolving Films, Drug Invent Today, 3, 2012, 56–73.
17. Parmar Dipika, Patel Upendra, Bhimani Bhavin, Tripathi Aditi, Daslaniya Dhiren, Patel Ghanshyam, Orally Fast Dissolving Films As Dominant Dosage Form For Quick Release, International Journal of Pharmaceutical Research and Bio Science, 1(3), 2012, 27-41.
18. Mahboob Hassan, Bilal Muhammad, Riaz Tehseen, Jamshaid Muhammad, Bashir Irfan, Zulfiqar Saqiba, Oral films: A comprehensive Review, International Current Pharmaceutical Journal, 5(12), 2016, 111-117.

19. Siddiqui Nehal MD, Garg Garima, Sharma PK, A Short Review on A Novel Approach in Oral Fast Dissolving Drug Delivery System and Their Patents, Advances in Biological Research, 5(6), 2011, 291-303.
20. Prakruti M Amin, Gangurde AB, Pranali V Alai, Oral Film Technology: Challenges and Future Scope For Pharmaceutical Industry, International Journal of Pharmacy & Pharmaceutical Research, 3(3), 2015, 183-203.
21. Pandya Ketul, Patel KR, Patel MR, Patel MN, Fast Dissolving Films: A Novel Approach to Oral Drug Delivery, Asian Journal of Pharmaceutical Science & Technology, 3(1), 2013, 25-31.
22. Juluru Sowjanya Naga, Fast Dissolving Oral Films: A Review, International Journal of Advances in Pharmacy Biology and Chemistry, 2(1), 2013, 108-112.
23. Pandya Ketul, Patel KR, Patel MR, Patel MN, Fast Dissolving Films: A Novel Approach to Oral Drug Delivery, International Journal of Pharmacy Teaching & Practices, 4(2), 2013, 655-661.
24. Patil P, Shrivastava SK, Fast Dissolving Oral Films: An Innovative Drug Delivery System, International Journal of Science and Research, 3(7), 2014, 2088-2093.
25. Patil L Swapnil, Mahaparale R Paresh, Shivnikar A Madhavi, Tiwari S Shradha, Pawar V Ketan, Sane N Prashant, Fast Dissolving Films: An Innovative Drug Delivery System, International Journal of Research and Reviews in Pharmacy and Applied Science, 2(3), 482-496.
26. Bhyan Bhupinder, Jangra Sarita, Kaur Mandeep, Singh Harmanpreet, Orally Fast Dissolving Films: Innovations in Formulation and Technology, International Journal of Pharmaceutical Sciences Review and Research, 9(2), 2011, 50-57.
27. U Siemann, Solvent Cast Technology- A Versatile Tool for Thin Film Production, Porgr Colloid Polym Sci, 130, 2005, 1-14.
28. T Nagaraju, R Gowthami, M Rajashekar, S Sandeep, M Mallesham, D Sathish, Y Shravan Kumar, Comprehensive Review on Oral Disintegrating Films, Current Drug Delivery, 10, 2013, 96-108.
29. Kaur Mandeep, Rana AC, Seth Nimrata, Fast Dissolving Films: An Innovative Drug Delivery System, International Journal of Pharmaceutical Research & Allied Sciences, 2(1), 2013, 14-24.
30. Patel Jitendra C, Patel KR, Patel NM, Review on Fast Dissolving Film, International Journal of Advanced Pharmaceutics, 3(1), 2013, 44-50.
31. Patil C Pallavi, Shrivastava SK, S Vaidehi, P Ashwani, Oral Fast Dissolving Drug Delivery System: A Modern Approach for Patient Compliance, International Journal of Drug Regulatory Affairs, 2(2), 2014, 49-60.
32. Mundhe Bhagyashri, Kadam Vaishali, Jadhav Suryakant, Md Zamiruddin, Bharkad Vishavanath, A Short Review on Fast Dissolving Oral Film, World Journal of Pharmacy and Pharmaceutical Sciences, 3(3), 2014, 463-475.
33. Kaushal MR, Patel KJ, Overview: On Oral Strip, J Drug Discoveries Therapeutics, 1(3), 2013, 49-56
34. Thakur Rani Reeta, Narwal Sonia, Orally Disintegrating Preparation: Recent Advancement in Formulation and Technology, Journal of Drug Delivery and Therapeutics, 2(3), 2012, 87-96.
35. Sharma D, Kaur D, Verma S, Singh D, Singh M, Singh G, Fast Dissolving Oral Film Technology: A Recent Tend For An Innovative Oral Drug Delivery System, International Journal of Drug Delivery, 7, 2015, 60-75.
36. Gauri S, Kumar G, Fast Dissolving Drug Delivery and Its Technologies, Pharm Innova, 1(1), 2012, 32-37.
37. Patel JC, Patel KR, Patel NM, Review on Fast Dissolving Film, Int. J. Advanced Pharmaceutics, 3(1), 2013, 44-50.
38. Bhasin RK, Bhasin N, Ghosh PK, Advances in Formulation of Orally Disintegrating Dosage Forms: A Review Article, Indo Global J Pharm Sci, 1(4), 2011, 328-353.
39. Nagendrakumar D, GG Keshavshethi, Mogale Pratibha, Swami Swati, Swami Harshanand, Formulation and Evaluation of Fast Dissolving Oral Films of Metoprolol Succinate, International Journal of Engineering and Applied Sciences, 6(4), 2015, 28-38.
40. K Kumar Ravi, M Sulochana Mercy, Fast Dissolving Film: A Unique Strategy for Drug Delivery, Asian Journal of Pharmaceutical Research, 4(1), 2014, 47-55.
41. Tarjani S Naik, Khale Anubha, Kanekar Hema, Evaluation of Mouth Dissolving Film: Physical and Chemical Methods, Int. J. Pharm Phytopharmacol Res, 4(1), 2014, 62-65.
42. Rathi Varun, Senthil V, Kammili Lavanya, Hans Ritu, A Brief Review on Oral Film Technology, International Journal of Research in Ayurveda & Pharmacy, 2(4), 2011, 1138-1147.
43. Pant Warsha, Badola Ashutosh, Kothiyal Preeti, A Review- Novel Approaches of Orally Fast Dissolving Film for Fast Dissolving Drug Delivery, European Journal of Biomedical and Pharmaceutical Sciences, 3(6), 2016, 220-227.
44. Panda BP, Dey NS, Rao MEB, Development of Innovative Orally Fast Disintegrating Film Dosage Form: A Review, International Journal of Pharmaceutical Sciences & Nanotechnology, 5(2), 2012, 1665-1674.
45. Radhakisan Ravindra Udhan, Chavan Vijayalaxmi, Tribhuvan Nitin, Mouth Dissolving Film and Their Patent: An overview, International Research Journal of Pharmacy, 3(9), 2012, 39-42.
46. Ghodake P Prasanna, Karande M Kailas, Osmani Ali Riyaz, Bhosale R Rohit, Harkare R Bhargav, Kale B Birudev, Mouth Dissolving Films: Innovative Vehicle for Oral Drug Delivery, International Journal of Pharma Research & Review, 2(10), 2013, 41-47.
47. R Gowri, N Narayanan, S Revathy, P Prabhavathy, G Preethy Mol, G Rekha, Melt Mouth Films- An Effective Alternative Drug Delivery System, International Journal of Biological & Pharmaceutical Research, 4(9), 2013, 645-650.
48. Pathan Anjum, Gupta Kumar Mahesh, Jain Kumar Neetesh, Dubey Ankita, Agrawal Ankit, Formulation and Evaluation of Fast Dissolving Oral Film of Promethazine Hydrochloride Using Different Surfactant, Journal of Innovations in Pharmaceuticals and Biological Sciences, 3(1), 2016, 74-84.
49. Rathod S, Surve GD, Phanesekar M, Bhagwan A, Review on Mouth Dissolving Film Technology, International Journal for Pharmaceutical Research Scholars, 3(1), 2014, 635-647.
50. Thakur Smriti, Mouth Dissolving Films: A Review, Int. J. Pharm Bio Sci, 4(1), 2013, 899-908.
51. Dahiya Meenu, Saha Sumit, Shahiwala F, Alisagar, A Review on Mouth Dissolving Films, Current Drug Delivery, 6, 2009, 469-476.
52. Komaragiri SD, Shaik F, Yerram CR, Vardhan V, Amaravathi V, Uttaradi A, Formulation and Characterization of Atenolol Fast Dissolving Films, Indian Journal of Pharmaceutical Science and Research, 2(2), 2012, 58-62.
53. Jadhav D Sandeep, Kalambe N Rahul, Jadhav M Chaten, Tekade W Bharat, Patil R Vijay, Formulation and Evaluation of Fast Dissolving Oral Film of Levocetirizine Dihydrochloride, International Journal of Pharmacy and Pharmaceutical Sciences, 4(1), 2012, 337-341.
54. Bhyan B, Jangra S, Kaur M, Singh H, Orally Fast Dissolving Films: Innovations in Formulation and Technology, Int. J. Pharm. Sci. Rev. Res., 9, 2011, 9–15.
55. Patel RS, Poddar SS, Development and Characterization of Mucoadhesive Buccal Patches of Salbutamol Sulphate, Curr. Drug Deliv., 6, 2009, 140–146.
56. Venkata Anupama M, R Shireesh Kiran, V Uma Maheshwar Rao, P Dileep, D Bhavani, B Madhavi Latha, A Review on Oral Thin Fast Dissolving Films Recent Trend of Dosage Form for Quick Release, Int. J. Pharm Bio Sci, 5(4), 2014, 54-67.

57. Patel Dipal, Patel Mihir, Upadhyay Pratik, Shah Nihar, Shah Shreeraj, A Review on Mouth Dissolving Film, Journal of Pharmaceutical Science and Bioscientific Research, 5(3), 2015, 266-273.

58. Gade R, Aynampudi A, Makineni A, TEGK Murthy, Rao CB, Nama S, Design and Development of Pravastatin Sodium Fast Dissolving Films From Natural Mucilage of Ocimum Bacilicum Seeds, International Journal of Pharma Research and Review, 3(1), 2014, 17-27.

59. Dixit RP, Puthli SP, Oral Strip Technology: Overview and Future Potential, Journal of Controlled Release, 139, 2009, 94-107.

60. Aggarwal Jyoti, Singh Gurpreet, Saini Seema, Rana AC, Fast Dissolving Films: A Novel Approach to Oral Drug Delivery, International Research Journal of Pharmacy, 2(12), 2012, 69-74.

61. Khairnar A, Jain P, Baviskar RD, Development of Mucoadhesive Buccal Patch Containing Aceclofenac: *In-vitro* Evaluation, Int. J. Pharm Tech Res, 1(4), 2009, 34-42.

62. Kulkarni AS, Deokule HA, Mane MS, Ghadge DM, Exploration of Different Polymers for Use in The Formulation of Oral Fast Dissolving Strips, J Current Pharma Res, 2(1), 2010, 33-35.

63. Deshmane SV, Joshi UM, Channawar MA, Design and Characterization of Carbopol-HPMC Based Buccal Compact containing Propranolol Hydrochloride, Ind. J. Pharmaceut. Edu. Res., 44(3), 2010, 67-68.

64. Ketul P, Patel KR, Patel MR, Patel MN, Fast Dissolving Films: A Novel Approach to Oral Drug Delivery, Int. J. Pharm. Teaching & Practices, 4(2), 2013, 655-661.

65. P Lakshmi, J Sreekanth, A Sridharan, Formulation Development of Fast Releasing Oral Thin Films of Levocetirizine Dihydrochloride With Eudragit And Optimization Through Taguchi Orthogonal Experimental Design, Asian J Pharm, 5(2), 2011, 84-92.

66. K Patel, S Soni, R Patel, V Pandya, P Bharadi, Mouth Dissolving Film: A Review, Int. J. Pharm, Res. Sci., 3, 2012, 154-163.

67. S Malke, S Shidhaye, J Desai, V Kadam, Oral Films - Patient Compliant Dosage Form for Pediatrics, The Internet Journal of Pediatrics and Neonatology, 11(2), 2010, 1-7.

68. Vishwakarma DK, Tripathi AK, Yogesh P, Maddheshiya B, Review Article on Mouth Dissolving Film, Journal of Global Pharma Technology, 3(1), 2011, 1-8.

69. Dnyaneshwar HR, Wale KK, Sayyed SF, Chaudhari SR, Orodispersible Film Dosage Form: A Review, World Journal of Pharmaceutical Research, 3(5), 2014, 1093-1111.

70. M Panchal, H Patel, A Bagada, K Vadalia, Formulation and Evaluation of Mouth Dissolving Film of Ropinirole Hydrochloride by Using Pullulan Polymers, Int. J. Pharm. Res. Appl. Sci., 1(3), 2012, 60-72.

71. Bhura N, Sanghvi K, Patel U, Parmar B, Patel D, A Review on Fast Dissolving Film, International Journal of Pharmaceutical Research and BioScience, 1(3), 2012, 66-89.

72. Prabhu Shruti C, Parsekar SD, Shetty A, Monteiro SS, Azharuddin M, Shabaraya AR, A Review on Fast Dissolving Sublingual Films for Systemic Drug Delivery, International Journal of Pharmaceutical and Chemical Sciences, 3(2), 2014, 501-511.

Source of Support: Nil, **Conflict of Interest:** None.