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An Overview of Oral Thin Film Drug Delivery Systems with Fast Dissolving Films

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Abstract: Fast-dissolving oral thin films (OTFs), rather than tablets, are the product of choice for many pharmaceutical businesses. The benefits of tablets (precise dose, simple administration) and liquid dosage forms (easily swallowed, quick bioavailability) are all present in films. Four out of five patients, according to statistics, prefer orally disintegrating dose forms over traditional solid oral dosage forms. Children, the elderly, people who are bedridden, people who are emetic, and those who have CNS illnesses have trouble swallowing or digesting solid dose forms. Many of these individuals refuse to take solid dose forms because they are afraid of choking. OTFs are immediately moistened by saliva when put on the tongue's tip or base. Because of this, OTFs quickly hydrate before dissolving or disintegrating to release the drug for local or systemic absorption. This technology offers a solid foundation for the creation of patent-compliant items and for extending the patent protection of currently available goods. Fast-dissolving oral thin films can be used for a variety of purposes, including gastroprotective and sublingual delivery systems in addition to buccal fast-dissolving systems. This study emphasizes the composition, detailing the numerous natural and synthetic polymer kinds, diverse manufacturing processes, packaging materials, and assessment tests for OTFs.

Keywords: Oral thin films, bioavailability, absorption, manufacturing, fast dissolving.

1. Introduction

To replace traditional dosage forms, fast-dissolving drug delivery devices were originally created in the late 1970s. These methods use solid dose forms that swiftly break down and dissolve in the mouth without the use of water. Orally dissolving tablets (ODTs) and oral thin films (OTFs) are examples of quick-dissolving drug delivery technologies. ODTs are described as "a solid dosage form containing medicinal substances which disintegrates rapidly, usually within a matter of seconds, when placed upon the tongue" by the Centre for Drug Evaluation and Research (CDER). OTFs are described by the US Food and Drug Administration (USFDA) as "a thin, flexible, non-friable polymeric film strip containing one or more dispersed active pharmaceutical ingredients that is intended to be placed on the tongue for rapid disintegration or dissolution in the saliva prior to swallowing for delivery into the gastrointestinal tract." OTFs are becoming more and more popular as generic pharmaceuticals. Zuplenz (ondansetron hydrochloride, 4 mg, 8 mg), the first prescription OTF, received approval in 2010. Fast after the first permission came Suboxone (Buprenorphine and Naloxone). Four out of five patients, according to statistics, prefer orally dissolving dose forms over traditional solid oral dosages.

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These elements have been (and will continue to be) a driving force behind the expansion of ODT and OTF medication products, along with convenience and compliance benefits. The numerous polymer kinds, production processes, and oral film assessment tests are highlighted in this overview. (1,3,4)

Preparation of oral thin films that dissolve quickly is necessary.

Children, the elderly, people who are bedridden, people who are emetic, and those who have CNS illnesses have trouble swallowing or digesting solid dose forms. Many of these individuals refuse to take solid dose forms because they are afraid of choking. Choking fears are common, even with ODTs, which can be dangerous. ODTs can be replaced by a fast-dissolving oral thin film drug delivery device. OTFs are immediately moistened by saliva when put on the tongue's tip or floor. Because of this, OTFs quickly hydrate before dissolving or disintegrating to release the drug for local or systemic absorption. ODTs are brittle and might crack when being handled or transported. The development of oral thin film drug delivery methods that dissolve quickly is the result. (2)

Advantages of OTF

01. Ease of administration for individuals who are mentally ill and noncompliant.
02. Useful when quick action is necessary, such as in cases of motion sickness, allergic reaction, coughing, or asthma.
03. Has a wide range of uses in pharmaceuticals, Rx Prescriptions, OTC drugs, and dietary supplements for treating pain, cough/cold, gastro-oesophageal reflux illness, erectile dysfunction, sleep problems, etc.
04. No water is required for the administration and hence suitable during travelling.
05. As saliva travels down into the stomach, several medications are absorbed from the mouth, throat, and oesophagus, increasing their bioavailability.
06. By providing a high surface area and dissolving quickly, it may provide increased bioavailability for medications that are poorly water-soluble.
07. Little to no aftertaste is left in the mouth after ingestion.
08. Has the capacity to offer liquid medicine benefits as a solid formulation.
09. Adaptable to existing processing and packaging machinery.
10. Cost-effective.
11. Provides precise dosage in comparison to liquids.
12. Excellent chemical stability is provided.
13. Free from the necessity of measuring, which is a crucial flaw with liquids.
14. Offers product differentiation and market expansion.
15. May be created and released in 12 to 16 months, which improves the length of the product development life cycle.

Disadvantages of OTF

01. Maintaining dose consistency is challenging.
02. Only pharmaceutical active substances with low doses may be included. According to research, the active pharmaceutical ingredient (API) concentration level can be increased by up to 50% weight-for-weight.
03. Wants pricey packaging.
04. OTFs disintegrate fast, making dosage interruption difficult.
05. There are no formal OTFs listed in any pharmacopoeia.

Formula for Oral Thin Films That Dissolve Quickly.

Mechanical qualities, flavour masking, quick dissolving, physical appearance, and tongue feel are all considered during formulation. Oral thin films that dissolve quickly typically have an area between 5 and 20 cm^2. APIs can be added in doses of up to 30 mg. All excipients used should be designated as generally recognized as safe (GRAS) and utilized in accordance with the Inactive Ingredients Limit from a regulatory perspective. (5,9)

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Active pharmaceutical ingredients (APIs)

Active pharmaceutical ingredients with large doses are not appropriate candidates for inclusion into fast dissolving oral thin films because the size of the thin films must be small enough to be readily put on the tongue. Fast-dissolving oral thin films should have the ideal properties of APIs.

1. Small dosage
2. Acceptableness
3. Lighter than usual molecule
4. Saliva stability and solubility

APIs that are water soluble exist in dissolved form or as solid solutions, and uniform distribution is not an issue. To achieve an appropriate level of drug content homogeneity, however, water insoluble APIs must be dispersed uniformly. Water-insoluble APIs can also be added in the form of milled, micronized, nanocrystals, or microcapsules for quick dissolution and to retain the film's smooth texture.

Those medications with a bitter or unpleasant taste may make the patient feel queasy because the thin film formulation is intended to be applied on the tongue.

As a result, different flavour masking strategies for the medicine were applied, such as coating with polymers, inclusion complexation with cyclodextrins, microencapsulation, and complexation with ion-exchange resins. (6,12)

Film forming polymers

The film forming polymers utilized must be water soluble since the film formulation quickly disintegrates and dissolves in the oral cavity. To create the appropriate film, which must be strong enough to prevent damage during handling or transit and exhibit quick disintegration in the mouth, the polymers can be employed alone or in combination with others. The kind and quantity of polymer employed in the formulation affects how resistant the film is. By increasing the molecular weight of the polymer film bases, the polymers' time to disintegrate is lengthened. Since polymers and APIs together make up the majority of the film formulation, their relative proportions to one another are determined by two factors:

a) A matrix incorporating APIs and other excipients with appropriate mechanical and viscoelastic qualities must have a minimum percent weight-weight concentration of polymer.

b) The required viscosity controls the % w/v concentration of polymer in solution to be cast as film. In order to prevent suspended materials from settling and to create a spreadable, smooth layer, the viscosity should be optimal. (8,10)

Ideal properties of polymers

1. Non-harmful
2. Not upsetting
3. Bland
4. Pleasant mouth feel
5. Should be consistent for a long time
6. Must not change the excipients' or active medicinal ingredient's characteristics.
7. Affordable
8. It ought to be wettable and spreadable.
9. Should not delay the film's time to degrade
10. Must have maximum tensile and peel strength

Organic polymers

1. Polysaccharides in gum.

Sodium alginate, gum Arabic, and -carrageenan are a few examples of possible gum polysaccharides for film production. They can be combined with others to offer primary film structure and properties for quick dissolving.

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Advantages
a) The addition of these can enhance the breakdown of films in the mouth.
b) The reduction in tensile strength is merely marginal.

2. Gelatin.
Gelatin is a combination of pure protein fractions made from animal collagen that have undergone partial acid hydrolysis (type A gelatin) or partial alkaline hydrolysis (type B gelatin). Gelatin is made by thermally denaturing collagen that has been extracted from fish skins, bones, and animal skins. It generates a viscous solution of randomly coiled polypeptide chains and is easily soluble in water over 40 degrees Celsius. Due to their higher amino acid content, mammalian gelatins are more thermostable and have superior physical characteristics than the majority of fish gelatins. The characteristics of gelatin and its capacity to make films are closely correlated with its molecular weight, i.e., the greater the average molecular weight, the higher the quality of the film. The molecular weight distribution mostly relies on the degree of collagen fiber cross-linking and the extraction technique utilized. 20–30% gelatin, 10–30% plasticizer (glycerin or sorbitol), and 40–70% water can be used to create gelatin films, which can then be dried.

Gelatin films' benefits
a) dissolve quickly
b) are great taste carriers
c) give a smooth tongue feel

3. Pullulan
As a biopolymer, pullulan. It is a neutral, linear polysaccharide made up of (1–6) linked maltotriose residues that is water soluble. It is a fungus called Aureobasidium pullulan that produces the exopolysaccharide from starch. Pullulanase, which selectively hydrolyzes the (1–6) linkage in pullulan and transforms the polysaccharide into maltotriose, was discovered by Bender and Wallenfels. Pullulan has a small number of randomly dispersed maltotetraose subunits, according to research by Catley and colleagues. A linear amylase chain is broken regularly by the (1–6) linkage in pullulan. Pullulan's distinctive film forming properties are the result of the structural flexibility provided by this unique pattern of linking. The deionized version of pullulan, known as pullulan PI-20 grade, has an average molecular weight of 2,00,000 daltons and good film forming characteristics.

Advantages of pullulan
a) It does not absorb moisture.
b) It is resistant to oxygen. Pullulan films' resistance to oxygen permeability makes them ideal for preserving food's rapidly oxidized lipids and vitamins. Pullulan films have a 9 times stronger oxygen barrier than gelatin films of the same thickness and a 300 times stronger oxygen barrier than HPMC films.
c) polysaccharide that is biodegradable and compatible with blood
d) It is non-toxic, has a structure without branches, as opposed to gum arabic, and produces significantly stronger films.
e) It dissolves readily in both cold and hot water to produce a clear, viscous solution.
f) Additionally, it has strong adhesive and film-forming skills.
g) It is a non-ionic compound that is neither immunogenic, mutagenic, or carcinogenic.
h) Pullulan films have anti-static, elastic, and thermally stable qualities.
i) Compression moulding may be created using pullulan films.
j) Pullulan films are clear, extremely water soluble, flavourless, odourless, and bendable.

4. Starch
The main source of stored carbohydrates in plant tubers and seed endosperm, where it appears as granules, is starch. Millions of amylopectin molecules and smaller amylase molecules make up each granule. The ability of starch to form films is due to amylose.

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Advantages of Starch
a) Its biodegradability
b) Transparency or translucent nature
c) Their bland flavour, taste, and color

Lycoat
Lycoat, a brand-new granular hydroxypropyl starch polymer made from pea starch, was created specifically for oral thin films that dissolve quickly. The company that makes it is Roquette Pharma.
Advantages of Lycoat
a) Lycoat quickly disperses in cold water without lump development.
b) Without the need of an additional film forming agent, it may be utilized alone as a film forming polymer to create fast-dissolving oral thin films with high functioning.
c) Its flavour is unremarkable.
d) Without the use of organic solvents, it creates films.
e) APIs can either be loaded as crystals or solubilized in an organic solvent.

5. Maltodextrin
Maltodextrin is a polymer of nutritious saccharides that is not sweet.
Starch undergoes partial hydrolysis to create it. D-glucose units are linked in chains of varying lengths to form maltodextrin. The main glyosidic connection that connects the glucose units is a 1–4 bond. Typically, maltodextrin is made up of a variety of chains that range in length from 3 to 19 glucose units. Maltodextrins are categorized according to their DE (dextrose equivalent), which ranges from 3 to 20. Shorter glucose chains, more sweetness, and greater solubility are all associated with higher DE values. Maltodextrin is utilized between 2-10% w/w, which reduces its DE value and increases the toughness of the film.

Synthetic polymers
1.HPMC, or hydroxypropyl methylcellulose
Partially O-methylated and O-(2-hydroxy propylated) cellulose makes up HPMC, also known as Hypromellose. Concentrations of 2-20% w/w are utilized for film-forming solutions, depending on the viscosity grades. Due to their low viscosity, lower grades of HPMC, such as HPMC E3, E5, and E15, are particularly suited for film formation. Aqueous solvent is utilized with lower grades. To enhance certain film qualities, additives are used. Numerous researches have been conducted to look at how additives affect the physico-chemical characteristics of HPMC films. Due to their significant hydrophobic characteristics, lipids including waxes, triglycerides (tristearin), and fatty acids (stearic acid, palmitic acid) reduce water affinity and moisture transport.

Advantages of HPMC
a) It has great acceptance and good film-forming capabilities.
b) In aqueous solutions, HPMC produces clear, durable, and flexible films.

2. PVA, or polyvinyl alcohol
The synthetic, water-soluble polymer known as poly (vinyl alcohol) (PVA), also known as a polyhydroxy polymer, is made commercially by hydrolysing poly (vinyl acetate) (PVAc). PVA is often plasticized to increase its deformability by low molecular compounds, which are primarily polar groups and associate with the hydroxyl groups of the PVA chain (with or without the help of water) to establish hydrogen bonds. PVA offers several benefits. For example, it is great in forming films and emulsifying substances. PVA has good oxygen and scent barrier qualities, is odourless and nontoxic, has a high tensile strength, is sufficiently flexible, and has a high biodegradability.

Advantages of PVA
a) Excellent film-forming and emulsifying abilities are possessed by PVA.
b) It is resistant to grease and oil.

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c) PVA is non-toxic and odourless.
d) PVA has excellent oxygen and odour barrier qualities.
e) PVA has a sufficient tensile strength and flexibility.
f) Excellent biodegradability.

3. Polyethylene oxide (PEO)
A synthetic polyether is polyethylene oxide. It comes in a huge variety of molecular weights. Typically, film formation uses a 3-5% w/w solution.

Advantages of PEO
a) PEO melts at a high temperature.
b) Its structural soundness is good.
c) Low glass transition temperature describes it.
d) It is biocompatible and low-toxic.
e) It has an excellent film-forming capability and is very hydrophilic.

4. PVP, or polyvinyl pyrrolidone
Radical polymerization of N-vinyl pyrrolidone in 2-propanol produces soluble polyvinyl pyrrolidone. Povidone is the USP name for the pharmaceutical-grade soluble PVP preparations. Products containing soluble PVP are sold under the trade name Kollidon®. The PVP range consists of goods with various K-values. The average molecular weight and the K-value are related. It is determined using the relative viscosity of water and is an element of the trade name.

Advantages of PVP
a) Most solvents, including water, and PVP are easily soluble in them.
b) PVP has excellent ability to make films.
c) It has the capacity to combine with insoluble APIs to produce a water-soluble complex, which can increase their solubility and rate of release.
d) It is both chemically inert and non-toxic.
e) It is pH-stable, temperature-resistant, and colorless.
f) The films are shiny, firm, and clear.

Plasticizers

Plasticizers work by lowering the polymer's glass transition temperature, which increases the film's flexibility and decreases its brittleness. Plasticizers also lessen brittleness and increase tensile strength. The solvent and polymer used should be compatible with the plasticizer. The tensile strength of the polymers is also improved by plasticizers. Some of the most widely used plasticizers are glycerol, propylene glycol, low molecular weight polyethylene glycols, citrate derivatives as tributyl citrate and triethyl citrate, triacetin, and castor oil. Film can peel, split, and fracture when plasticizer is used excessively or inappropriately. Some plasticizers can have an impact on how quickly the medicine is absorbed. The plasticizer should give the film a lifetime of flexibility. There are two processes that cause plasticization:
Both internal and external plasticization include the addition of a physically active plasticizer. Internal plasticization involves the chemical interaction of molecular groups inside the polymer itself. The ideal method of plasticization is external plasticization since it avoids interactions between chemicals in the product. With the use of plasticizers containing hydroxyl, such as polyethylene glycol, propylene glycol, glycerol, and polyols, cellulosic hydrophilic polymers were readily made plastic. In contrast, citric acid and phthalic acid esters were used to plasticize less hydrophilic cellulose polymers. While diethylene glycol may be used for both hydroxylpropyl methyl cellulose and polyvinyl alcohol films, glycerol is a superior plasticizer for polyvinyl alcohol. (11,12)

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Surfactants

Surfactants function as wetting or dispersion agents to swiftly breakdown the film and release the API. The two most often used surfactants are polysorbates and sodium lauryl sulfate. Poloxamer 407, one of the most significant surfactants, is a wetting, solubilizing, and dispersion agent. Fast-dissolving films were developed and tested by Aditya D. et al. to administer Triclosan to the oral cavity. It employed film-forming substances such xanthan gum, xylitol, and HPMC. It was looked into if Poloxamer 407 and hydroxypropyl-cyclodextrin (HP-CD) may increase Triclosan's solubility. The films' in vitro antibacterial activity and dissolving characteristics were assessed. In comparison to films containing HP-CD, films containing Poloxamer 407 shown a higher in vitro dissolving profile and in vitro antibacterial activity. Additionally, human volunteers were used to assess how adding eugenol affected how Poloxamer 407-containing films performed in vivo. Eugenol-containing films increased viewer acceptance in terms of flavor masking and mouth refreshing without affecting in vivo dissolving time. (14,15,16)

Sweetening agents

The oral thin films that dissolve quickly are made more palatable by the application of both natural and artificial sweeteners. Sucrose, dextrose, fructose, glucose, and maltose are all types of sweeteners. When compared to sucrose and dextrose, fructose's sweetness is more quickly tasted in the tongue. Since fructose has a sweeter flavor than sorbitol and mannitol, it is frequently employed. You may combine polyhydric alcohols like sorbitol, mannitol, isomalt, and maltitol since they also have a pleasant mouthfeel and a cooling effect. Additionally, less cancer-causing and without a harsh aftertaste, polyhydric alcohols. Except for xylitol and maltitol (both of which have sweetness similar to sucrose), the majority of polyols have a sweetness imparting characteristic that is less than half that of sucrose. In the case of diabetic individuals, the use of natural sugars in such preparations needs to be limited. Artificial sweeteners are increasingly widely used in food and medicinal preparations as a result. The first generation of artificial sweeteners consists of saccharin and aspartame. These have been shown to be carcinogenic and are prohibited in several nations. Research is being conducted to determine the level of carcinogenicity. (7)

Saliva stimulants

Saliva stimulating substances speed up the production of saliva and aid in the formulations' quicker breakdown. Generally speaking, saliva stimulating substances may be made from food-grade acids. Some of the substances that stimulate saliva include tartaric acid, ascorbic acid, lactic acid, malic acid, and citric acid. Citric acid is the most popular and often used of them. You can use these alone or together. By comparing the amounts of resting flow with stimulated flow at the same time and under the same conditions, salivation stimulation may be determined. (3)

Superdisintegrants

When added to a formulation, Superdisintegrants provide rapid disintegration as a result of the synergistic effects of swelling and water absorption. Superdisintegrants take in water and swell, which increases the system's dispersibility and speeds up disintegration and breakdown. Disintegration requires a strong contact with water. Swelling, wicking, deformation, or combinations of any of these may be the mechanism of disintegration. (9)

Coloured substances

Up to 1% weight per weight can be used for FD&C-approved colouring agents, EU color, natural colouring agents, or pigments.

FD&C Yellow was employed as a colouring ingredient in the composition of the nicotine orally disintegrating film. In the creation of the Ondansetron Rapid Film, titanium dioxide served as a colouring ingredient.

Flavoured substances

The sort of medicine to be included determines the taste choice. The initial flavor, which is noticed in the first few seconds after the dosage form is ingested, and the after taste of the formulation, which lasts for at least roughly 10 minutes, determine whether a person would accept an oral disintegrating or dissolving formulation.

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You can use flavor individually or in combination. In the formulation, tastes should preferably be included up to 10% by weight. As taste enhancers, menthol, chloroform, and certain salts are employed. They add their own flavor and odour and have a little numbing impact on the taste-related sensory receptors.

2. FABRICATION METHODS

Vapor casting

The most popular technique for producing oral thin films that dissolve quickly is this one. The equipment for the solvent casting process is shown in Figure 1.

Steps
1. Water dissolves water soluble polymers.
2. Under high shear, more excipients and APIs are dissolved in aqueous solution.
3. The two liquids are mixed to create a homogeneous, viscous solution.
4. Deaeration of the solution and transfer to the casting station where film is created using a solution is 30-120 c release liner in thickness.

Knife-over-roll, reverse roll, slot-die, gravure cylinder, and Mayer rod coating are examples of film coating processes.
1. An oven is used to dry cast film
2. Cut dried films into the required shape
3. The film product is examined for required characteristics
4. The final examination is completed
5. The product is delivered for packing

Despite the fact that different thicknesses can be used to accommodate API loading and dissolving requirements, 12-100 m is the ideal final film thickness. It is recommended that the ICH Class III solvents list be utilized to choose the solvents used to manufacture oral thin films.

Process variables

1. 20 to 90 °C for mixing
2. Time for agitation: 40 to 120 minutes
3. 1000–2000 RPM for rotation
4. 80 litres/hour flow rate when defoaming
5. Casting wait time: 2 to 8 minutes
6. Temperature range for drying: 50–130 °C

Advantages

1. The technique is economical
2. Preferable to hot melt extrusion because it avoids exposing API to high temperatures, which might lead to the deterioration of heat-sensitive APIs.
3. Films are clearer and have improved thickness consistency.
4. Movies have a beautiful shine
5. Films don't have flaws like die lines.
6. Films are adaptable and have excellent physical characteristics.

Disadvantages

1. Water or a volatile solvent must be soluble in the polymer.
2. It is necessary to create a stable solution with a manageable viscosity.
3. It must be feasible to create a homogenous film and release it from the casting support.

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Hot melt extrusion

Steps

1. By combining API and excipients, the mass is created at a regulated temperature and steering speed.
2. The extruder melts the mixture.
3. Within a drying tunnel, the film is covered and cured.
4. Then, slitting is completed.
5. The films are puffed, sealed, and punched.

Process parameters

a) 15 rpm for the screw
b) 650 to 1 150 °C for processing
c) A 650° C extrudate temperature
d) 200 m final film thickness

Advantages

1. No use of water or solvents
2. Less stages in the processing
3. An improved substitute for medicines that are poorly soluble
4. Requires less energy than high shear techniques
5. Greater uniformity of dispersion due to vigorous mixing and agitation

Disadvantages

1. The usage of high temperatures can cause thermal damage.
2. The polymer's flow characteristics are crucial for processing.

3. DRYING OF FILMS

Drying aids in keeping the film's inside temperature low overall. The inside of the film may not reach the temperature at which the API degrades, even though the film surfaces are exposed to it. The API does not deteriorate as a result of this temperature differential. The films are dried for no more than 10 minutes. The temperature difference between the environment and the film matrix after drying the films at 80° C for 10 minutes is roughly 5° C. This indicates that after drying for 10 minutes, the film's inside temperature is 5° C lower than the exposure temperature outside. Drying periods of 4-6 minutes are frequently adequate. The films can be dried at high air temperatures without damaging heat-sensitive APIs because of the temperature differential between the environment and the film matrix. When enough of the volatile liquid has evaporated, further heating causes the liquid to diffuse evenly across the film. The elements are ideally fixed into a consistent distribution across the movie, and the movie's ultimate form is established. Rapid formation of a viscoelastic solid may be desirable. After the viscoelastic film has formed, there may still be trace quantities of water present, but drying the film further won't change its desirable heterogeneity. The final film is created by further drying. (3)

4. PACKAGING

The fast-dissolving dosage forms must be protected throughout production and storage using expensive packaging, specialized processing, and particular care. Single packing must be used. The most popular type of packaging is an aluminum bag. The Rapid card, a unique and patented packaging solution created by APR-Labtec, is specifically made for the Rapid films. Three films may be stored on each side of the Rapid card, which is the same size as a credit card. You can take each dosage on its own.

The chosen material needs to meet the requirements listed below:

1.It must not react with the product, for one.
2. It must shield the preparation from the elements.
3. The FDA must approve it.

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4. It needs to be tamper-proof.
5. It must not be harmful.

5. CONCLUSION

As opposed to tablets, several pharmaceutical companies are now producing oral thin films that dissolve quickly. The benefits of tablets (precise dose, simple administration) and liquid dosage forms (easily swallowed, quick bioavailability) are combined in films. OTFs are a new, innovative drug delivery method that are crucial in emergency circumstances when quick action is necessary. They fill a demand by enabling children, the elderly, and the general public to discreetly take their prescriptions whenever and wherever they are needed. This technology offers a solid foundation for the creation of patent-compliant items and for extending the patent protection of currently available goods. Fast-dissolving oral thin films can be used for a variety of purposes, including sublingual and gastro-retentive delivery systems in addition to buccal fast-dissolving systems. Future uses might involve employing laminated multilayer films to combine incompatible active medicinal components into a single product. The incompatible active medicinal components may be separated by an inactive film layer. Thin films can include active medicinal components with high transmucosal flux rates for gradual dissolution into buccal or sublingual areas. It is also possible to integrate medications coated with controlled release polymers. There is a lot of room for more research in this area even though this technology is the subject of substantial study.

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