Review Article

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Development of Innovative Orally Fast Disintegrating Film Dosage Forms: A Review

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ABSTRACT

Over the past few decades, there has been an increased interest for innovative drug delivery systems to improve safety, efficacy and patient compliance, thereby increasing the product patent life cycle. The discovery and development of new chemical entities is not only an expensive but also time consuming affair. Hence the pharmaceutical industries are focusing on the design and development of innovative drug delivery systems for existing drugs. One such delivery system is the fast disintegrating oral film, which has gained popularity among pediatric and geriatric patients. This fast disintegrating film with many potential benefits of a fast disintegrating tablet but devoid of friability and risk of choking is more acceptable to pediatric and geriatric patients. Formulation of fast disintegrating film can be achieved by various techniques, but common methods of preparation include spraying and casting. These film forming techniques use hydrophilic film former in combination with suitable excipients, which allow the film to disintegrate or dissolve quickly in the mouth within a few seconds without the administration of water. In view of the advantages of the fast disintegrating films over the fast disintegrating tablets and other dosage forms, it has the potential for commercial exploitation. The oral film dosage form not only has certain advantages of other fast disintegrating systems but also satisfies the unmet needs of the market. The present review emphasizes on the potential benefits, design and development of robust, stable, and innovative orally fast- disintegrating films and their future scenarios on a global market as a pharmaceutical dosage form.

KEYWORDS: Fast disintegrating oral film; innovative drug delivery; patented technologies; disintegrating systems; dosage forms.

Introduction

There is a growing demand for novel dosage forms to cater to the needs of the pediatric and geriatric population. In order to assist or satisfy these patients, several fast disintegrating drug delivery systems have been developed and marketed. However, such fast disintegrating solid preparations suffer from certain major drawbacks including fear of choking/swallowing, fragility and friability and requirement of specialized and expensive packaging (Slowson et al., 1985; Doheny et al., 1993). In order to overcome such drawbacks and satisfy the needs of the market, intraoral film has been developed. This quick disintegrating film can be provided in various packages convenient for use, especially for children and elders. Various bioadhesive mucosal dosage forms have been formulated which include adhesive tablets, gels, ointments, patches and, more recently, the use of polymeric films for buccal delivery, known as mouth disintegrating films (Malke et al.,2007).

Fast Disintegrating Oral Films (FDOFs)

These are thin, flexible, elegant films of various sizes and shapes, typically the size of a postage stamp meant to be placed on patient's tongue. They rapidly disintegrate/disperse and release the drug when they come in contact with saliva (Vondrak et al., 2008).

The Potential Benefits of FDOFs

- Large surface area promotes rapid disintegration and dissolution in the mouth cavity
- Due to its flexible and less fragile nature, there is ease of transportation, storage and consumer handling
- Ease of administration to patients who are mentally ill, disabled or non-cooperative
- Precision in the administered dose.
- Good mouth feel
- Offers water nil therapy
- Rapid absorption, faster action and improved bioavailability
- Improved patient compliance
- Enhance the product life cycle
- Good stability

Benefits of FDOFs Over the Fast Disintegrating Tablets

- Provide a larger effective surface area for disintegration

- No friability loss
- Requires less expensive processing and packaging materials
- No fear of choking
- Requires less excipients
- Less time consuming process
- More elegant
- More economical

Major limitations of this dosage forms are, low dose loading capacity and limited taste masking options. Drawback of the film can be minimized by formulating an edible film which can adjust more dosage and bitterness of the drug can be masked by different taste masking processes (Habib et al., 2000).

Biopharmaceutical Consideration of FDOFs

Before designing a new dosage form, the biopharmaceutical factors need to be considered. Fast disintegrating oral films quickly disintegrate, facilitating the absorption of drug from the mouth, pharynx and esophagus through the oral mucosa (Kaushik et al., 2004). Factors like age, nature of the oral cavity, and blood flow to oral cavity should be considered. Distribution of drug depends on tissue permeability, perfusion rate, binding of drug to tissue, drug interaction etc. The duration and intensity of action depends on the rate of drug removal from the body or site of action. The pharmacodyanamic performance of the dosage form is affected by different factors like age, sex and health of the patient.

Drug Incorporation to FDOFs

There is no restriction to incorporate any therapeutic agent to this drug delivery system but the agents which have lower doses and need a quicker onset of the action are most preferable and are depicted in Table 1. Several classes of drugs can be formulated as mouth disintegrating films including antiulcer, antiasthmatics, antitussives, expectorants, antihistaminics and NSAIDs. The proportion of fast disintegrating systems gets approved by different regulatory bodies for their therapeutic use, as shown in Figure 1.

Ideal Characteristics of Drug Candidate for FDOFs

- The incorporating APIs should have a low dose of up to 40 mg
- Drugs with low molecular weight are preferable
- The drug should posses pleasant taste
- The drug should have good solubility and stability both in water and saliva
- It should be partially unionized at the pH of buccal cavity
- It should have the ability to permeate oral mucosal tissue

TABLE1

Most preferable therapeutic agents for fast disintegrating oral films.

MEDICAMENTS	DOSE(in mg)
Chloropheneramine maleate	4
Brompheneramine maleate	4
Dexchlorpheniramine	2
Dexbrompheniramine	2
Triprolidine hydrochloride	2.5
Acrivastine	8
Azatadine maleate	1
Loratidine	10
Phenylephrine hydrochloride	10
Dextromethorphan hydrochloride	10-20
Famotidine	10
Nicotine	2

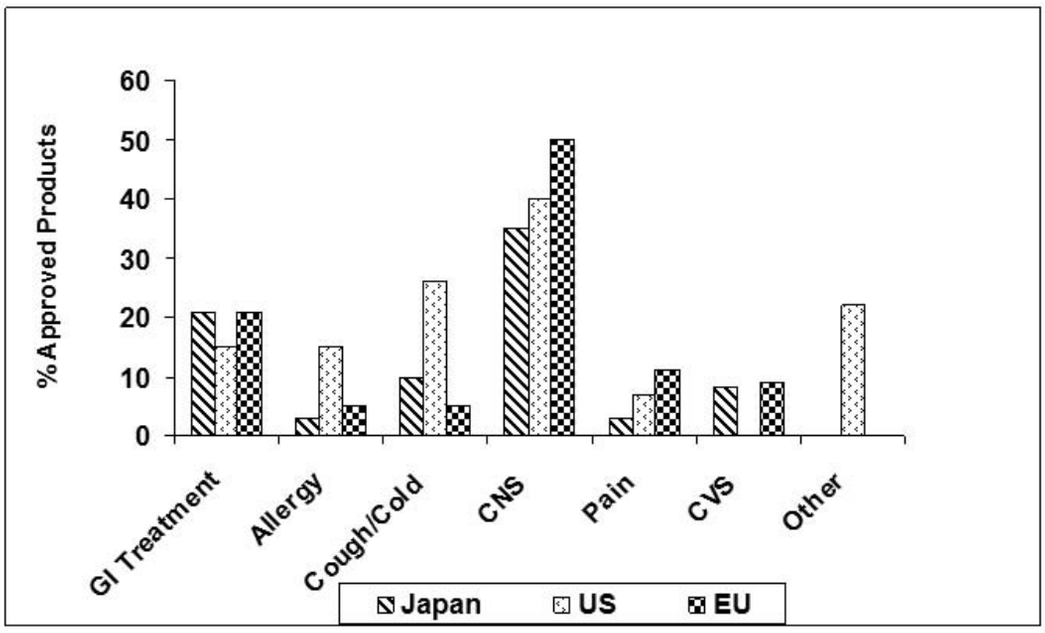

Fig. 1. Approved status of fast disintegrating therapeutics.

Formulation of FDOFs

A typical composition of fast disintegrating oral films formulation should contain the following excipients: (Vollmer et al., 2006)

- Drug 25 %
- water-soluble polymers 40 - 50 %
- Plasticizers 0 - 20 %
- Fillers, color, flavors etc. 0 - 40 %

Different Excipients are used to Formulate the FDOFs

The formulation of fast disintegrating oral film involves the intricate application of aesthetic and performance characteristics like fast disintegrating, taste-masking, physical appearance, mouth feel etc. In the preparation of oral film, the selection of the film forming the polymer is very important and is the major non active ingredient. Important adjuvants include

- Film formers
- Stabilizing and thickening agents
- Plasticizers
- Surfactants
- Saliva stimulating agents
- Cooling agents
- Solvent system
- Organoleptic agents

Film formers

These contribute a platform to the dosage form. Depending on the nature of the film former, physicochemical properties of the film can be modified. The obtained film should be tough enough so that there will not be any damage while handling or during transportation. The robustness of the film mainly depends on the type of polymer and the amount in the formulation. Mostly aqueous polymers are used as film formers (Pareek et al., 2003). Some widely used film formers are hydroxyl propyl methyl cellulose (HPMC) of different grades, hydroxypropyl cellulose (HPC), polyvinyl alcohol (PVA), polyvinyl pyrrolidine (PVP), sodium alginate, sodium carboxy methyl cellulose (sodium CMC) and polyethylene glycol, and pullunan (Kulkarni et al., 2010; Corniello, 2006).

Stabilizing and thickening agents

The stabilizing and thickening agents are employed for the improvement of viscosity and consistency of dispersion or solution of the strip preparation. Natural gums as Xanthum gum, locust bean gum, carragenan and cellulosic derivatives can be used in concentrations up to 5% w/w as stabilizing and thickening agents.

Plasticizers

Plasticizers impart strength, flexibility and gloss to the finished film product (Pareek et al., 2003). The concentration of plasticizer should be optimized along with the film formers and other excipients to get a good, elegant film. Commonly preferred plasticizers are phthalate esters, phosphate esters, esters of oleate, adipate, sebacate, stearates, polyethylene glycol (Dinge and Nagarsenker, 2008), triacetin, dimethyl phthalate etc.

Surfactants

Surfactants are used to enhance the wettability of the film. Mostly nonionic surfactants are preferred like polyoxyethylene alkyl ethers (Brij), and polyoxyethylene sorbitan fattyacid esters (Tween) (Zerbe et al., 2004).

Saliva stimulating agents

The purpose of using saliva stimulation agents is to increase the rate of production of saliva which aids in the faster disintegration of the rapid disintegrating strip formulations. They stimulate secretion of saliva, thus indirectly helping in the quick disintegration and dissolution of the film. The agents which are most commonly used are citric acid, lactic acid, maleic acid, ascorbic acid etc.

Cooling agents

Cooling agents like monomethyl succinate, WS3, WS23 and Utracoll II can be added in the formulation for improvement of flavor strength and enhancement of the mouth feel of the product.

Solvent system

The solvent system may affect the surface texture and disintegration time of the film. Aqueous, organic, or a combination of both can be used as the solvent system.

Organoleptic agents

As the dosage form disintegrates in the mouth, it must have a pleasant taste and cooling sensation to the mouth. Organoleptics like sweeteners, flavors and colors are added so that the product can be better accepted. The most commonly used are mannitol, aspartame, sodium saccharin, thaumatin I and II, etc. The artificial sweeteners can be classified as 1st generation (saccharin, cyclamate, aspartame) or 2nd generation (acesulfame-K, sucralose, alitame, neotame).

The flavors used should be compatible with the other ingredients. Vanilla, chocolate, coffee, orange, peppermint flavors are preferred. (Robert et al., 2006). The amount of flavor needed to mask the taste depends on the flavor type and its strength. Colors are selected to match with flavors for better acceptability. Water soluble dyes are commonly used.

Technologies for development of FDOFs

A combination of different techniques such as rolling method solvent casting, solvent spraying, hot-melt extrusion, and solid dispersion extrusion are used for manufacturing fast disintegrating oral films. Among them, casting and spraying techniques are simple, reproducible and successful processes to develop the films.

Rolling Method

In this method, a solution or suspension of drug with film forming polymer is prepared and subjected to the roller. The solution or suspension should have specific rheological consideration. The solvent is mainly water and a mixture of water and alcohol. The film is dried on the rollers and cut to the desired dimensions (Arya et al., 2010) as shown in Figure 2.

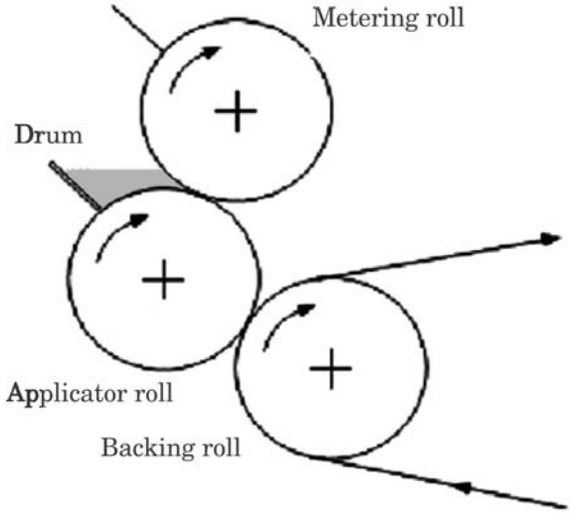

Fig. 2. Three roller coating film forming unit.

Solvent Casting technique

In this process the film forming agents are soaked in a suitable solvent overnight. Other excipients along with the drug are added and mixed well in the solution. The liquid is poured over a suitable casting mould, generally a petridish, to get a film of desired thickness (Robert et al., 2006). The selection of solvent essentially depends on the API to be incorporated into the film. The physiological properties of the API like shear sensitivity, heat sensitivity, the polymorphic form of the API employed, and compatibility of the API with solvent and film based excipients are studied critically. The predominant factors to be considered are liquid rheology, desired mass to be casted and uniformity of the drug content. Solvent systems in the preparation of solution or suspension should be selected carefully and more preferably from ICH class 3 solvent lists. The clearance or tolerance between the roller and the substrate determines the required thickness of the film. Heating processes can be used to assist the complete dissolution of materials. Mixing may cause the formation of air bubbles and their entrapment during the solution preparation. Air entrapment may tend to produce non-uniform films. Deaeration step is imperative to get a uniform film which may be achieved by vacuum assisted machines as shown in Figure 3 (Dixit and Puthli, 2009). Another important aspect, i.e. moisture contents in the solution, can cause changes in the mechanical properties of the films such as flexibility, tensile strength, folding endurance, Young's modulus, elongation, etc. Mahesh et al. (2010) formulated levocetirizine hydrochloride oral film with pullulan polymer using solvent casting method. The optimized films of levocetirizine dihydrochloride were obtained which satisfied all the requirements of an ideal fast disintegrating oral film.

Semisolid casting

In the semisolid preparation water soluble polymers are added and to this preparation, acid insoluble polymer (e.g. cellulose acetate phthalate, cellulose acetate butyrate) which is prepared by ammonium and sodium hydroxide, and then the surplus amount of plasticizer form a gel which is casted (Arya et al., 2010).

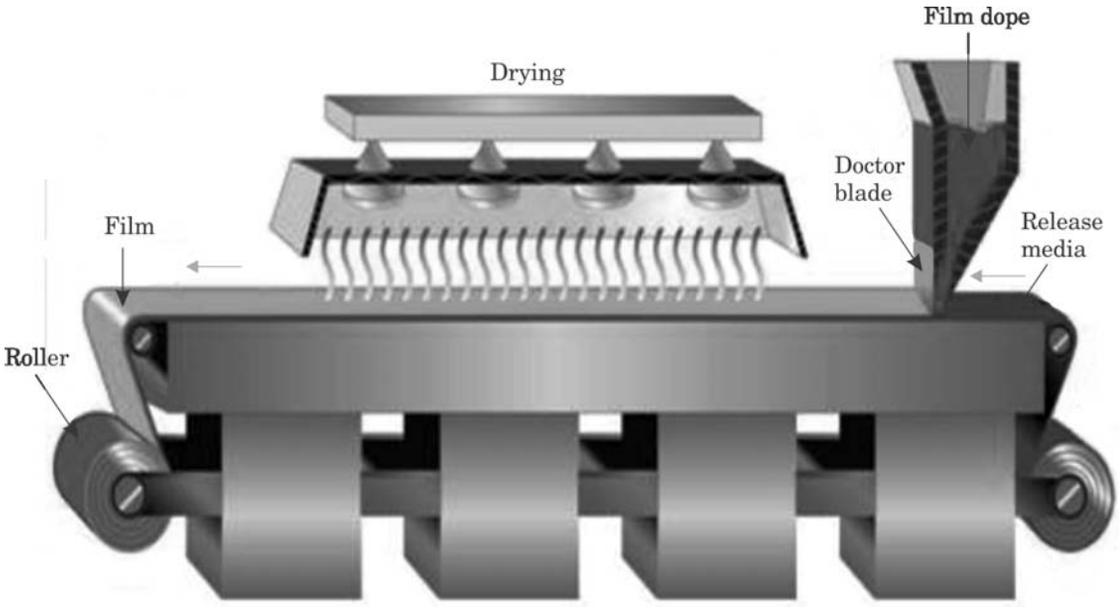

Fig. 3. Solvent casting technique.

Hot Melt Extrusion

Hot melt extrusion is commonly used to prepare granules, sustained release tablets, and transdermal and transmucosal drug delivery systems. This technique involves shaping a polymer into a film via the heating process rather than through the conventional solvent casting method. In this method, API and other ingredients are mixed in a dry state, then subjected to the heating process and then extruded out in molten state (Cilurzo et al., 2008). These processes are without involvement of any solvent systems. The molten mass thus formed is used to cast the film. The films are further cooled and cut to desired size. This process is not suitable for the thermolabile APIs, due to the use of very high temperature. A critical step is the casting and drying process. Optimization of speed of casting and drying time are important from the commercial scale output. This process includes lower temperature and shorter residence times of the drug carrier mix, absences of organic solvents, continuous operation possibilities, minimum product wastage, good control of operating parameters and possibilities to scale up. Cilurzo et al. successfully formulated piroxicam film with maltodextrin plasticized by glycerin employing the hot melt extrusion method.

Solid Dispersion Extrusion

In this method, immiscible components are extruded with drug and then solid dispersions are prepared. Finally, the solid dispersions are shaped into films by means of dies.

Spray technique

A solvent system containing film former and other exicipients are sprayed or coated on suitable carrier material, dried and peeled off to get the film. The carrier materials used for film are glass, non-siliconized kraft paper or polyethylene film etc.

Evaluation of FDOFs

Fast disintegrating oral films are evaluated for the following parameters

- Thickness of the film
- Disintegration time
- Dissolution time
- Folding endurance
- pH
- Percentage of moisture uptake
- Percentage of moisture content
- Tensile strength of the film
- Surface roughness
- Morphology study
- Swelling property
- Tack test/ Dryness test
- Percent elongation
- Young's modulus
- Transparency
- Contact angle
- Linear expansion coefficient in water

Thickness measurement

Thickness of the film is measured using a dial gauge tester. Thickness at different points is measured from which the average thickness of the FDOF is determined (Gavaskar et al., 2010).

Disintegration time

It is the time at which the film begins to break down when brought into contact with water. It can be determined by keeping a film of desired size in a Petri dish containing water and noting the time it takes to break down.

Dissolution time

It is defined as the time at which not less than 80% of the tested film is dissolved in aqueous media. It can be done by both *in vitro* and *in vivo* methods. *In vitro* dissolution time can be determined by keeping the desired piece of film in a Petri dish containing water and noting the time required to dissolve at least 80% of the film. *In vivo* dissolving time of film is studied by selecting groups of volunteers of different aged. The films of desired size should be kept in their oral cavity till they completely dissolve without any residue left in mouth and *in vivo* dissolving time of film is noted (Vishwakarma et al., 2011).

Measurement of folding endurance

In order to carry out the endurance study, the strip of film is repeatedly folded at the same place until it breaks. The number of times the film is folded at the same place prior to breaking gives the folding endurance (Khurana et al., 2000).

pH

pH measurement is carried out by keeping the film in contact with distilled water, and after 1 hour, the pH of the solution or dispersion is measured (Khurana et al., 2000).

Moisture uptake

The test is done by keeping previously weighed films in desiccators at a particular temperature and relative humidity. After three days, the film is taken out and reweighed to determine the percentage of moisture uptake. Percentage of moisture uptake can be calculated as follows (Saxena et al., 2006).

Percentage of moisture uptake =

$$\frac{\text{Final weight} - \text{Initial weight}}{\text{Initial weight}} \times 100$$

Moisture content

Previously weighed films are stored in a desiccator for 24 hours. The final weight is noted when there is no further change in the weight of individual film (Saxena et al. 2006). Percentage of moisture content can be calculated as follows,

Percentage of moisture content =

$$\frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

Tensile strength

Tensile strength is the maximum stress applied to a point at which the strip specimen breaks. Tensile strength of the film is determined by using a tensile testing machine like the Instron or Monsanto tester. It is calculated by the applied load at rupture divided by the cross-sectional area of the strip as given in the equation below.

Tensile strength =

$$\frac{\text{Load Failure} \times 100}{\text{Strip thickness} \times \text{Strip Width}}$$

Surface roughness

The surface roughness of the film is determined by using a Profilimeter. Other parameters like elongation, Young's Modulation, bending length and tear resistance of the film can be studied.

Morphology Study

The morphology of the film is studied using scanning electron microscopy (SEM) at a definite magnification. (Mashru et al., 2005)

Swelling Property

Film swelling studies are conducted using a simulated saliva solution. Each film sample is weighed and placed in a preweighed stainless steel wire mesh. The mesh containing film sample is submerged into a 15 ml medium in a plastic container. An increase in the weight of the film was determined at preset time intervals until a constant weight was observed (Peh et al., 1999).

Degree of swelling property is calculated by following formula,

Swelling Index (SI) = $(W_t - W_o) / W_o$

Where W_t is the weight of the film at time "t" and

W_o= weight of the film at t = 0.

Tack test/ Dryness test

About eight stages of film drying process have been identified and they are set to touch, dust free, tack free (surface dry), dry-to-touch, dry hard, dry through (dry to handle), dry to recoat and dry print free. All these tests are primarily used for paint films. Tack is the tenacity with which the strip adheres to an accessory that has been pressed into contact with the strip (Gavaskar et al., 2010).

Percent elongation

On application of stress, a strip sample stretches and this is referred to as strain. Strain is basically the deformation of strip divided by original dimension of the sample. Generally, elongation of strip increases with increasing concentrations of plasticizer (Dhire et al., 2011).

Percentage of Elongation =

$$\frac{\text{Increase in length of strip}}{\text{Initial length of strip}} \times 100$$

Young's Modulus

Elastic modulus or Young's modulus is the measure of stiffness of the strip. It is represented as the ratio of applied stress over strain in the region of elastic deformation as follows: (Rathi et al., 2011).

Young's Modulus =

$$\frac{\text{Slope} \times 100}{\text{Strip thickness} \times \text{Cross head speed}}$$

Transparency

The transparency of the films can be determined using a simple UV spectrophotometer. The film samples are cut into rectangles and placed on the internal side of the spectrophotometer cell. This determines the transmittance of films at 600nm (Bhyan et al., 2011). The transparency of the film is calculated as:

$$\text{Transparency} = (\log T_{600})/b = -\varepsilon c$$

Where T_{600} is the transmittance at 600 nm, b is the film thickness (mm) and c is concentration.

Contact Angle

Contact angle measurements are performed at room temperature with a goniometer (AB Lorentz and Wettre, Germany). A drop of distilled water is placed on the surface of the dry film. Images of the water droplets are recorded within 10 seconds of deposition by a digital camera. The digital pictures are analyzed for contact angle determination using image software (Rathi et al., 2011)

Linear Expansion Coefficient in Water

The film is immersed in water. The specimen is taken at 2, 4, 6, 8, 10, 15, 30 and 60 seconds, and the size of the side length is measured. It is calculated as (Siddiqui et al., 2011):

$$L\% = \frac{L_1 \times L_0}{L_0} \times 100$$

Where

L_1 =side length after immersion

L_0 = side length before immersion

Technologies Involved in FDOFs

XGel

XGel film manufacturing methods and technology, a great revolutionary product developed by BioProgress is offering a vibrant alternative available to the pharmaceutical industry. XGel film provides unique product benefits for healthcare and pharmaceutical products. It is a non-animal derived product, suitable for vegetarians and continuous production processing provides an economic and competitive manufacturing platform. XGel film can be taste masked, coloured, and layered, whilst also having the ability to incorporate active pharmaceutical ingredients. The XGel film systems can be made to encapsulate any oral dosage form, and can be soluble in either cold or hot water. XGel film is comprised of a range of different water-soluble

polymers, specifically optimized for the intended use. All of the XGEL ingredients are well known and generally regarded as safe (GRAS).

Soluleaves

Soluleaves is applied to flavour-release products such as mouth fresheners, confectionery and vitamin products. This technology can be used to efficiently deliver both active ingredients such as OTC prescription drugs and nutraceuticals to the oral cavity, in a pleasant and easily portable form. On contact with saliva, the designed film dissolved rapidly and quickly releases the active ingredients and flavours. Edible films, formulated based on this concept, arean excellent delivery method for a large number of products requiring fast release in mouth. In view of pharmaceutical applications, this method of administration is especially useful for paediatric or geriatric patients who may have difficulty swallowing conventional tablets or capsules. This dosage form can be used for cough/cold, gastrointestinal and pain therapeutic areas as well as delivering nutritional products. Muco-adhesive soluleaves films can also be designed to adhere to mucous membrane and allow slow release of the active ingredient.

Wafertab

Patented 'Wafertab' is a wafer, employed as a drug delivery system that uses a unique process to prepare drug-loaded thin films which can be used in topical or oral application. Active ingredients are incorporated into the film after casting. The system provides rapid dissolution and release of active pharmaceutical agents when the strip comes into contact with the salivary secretions inside the buccal cavity. The wafertab filmstrip can be flavoured for improved taste masking. The wafertab system lends itself to many possibilities for innovative product design, enabling multiple films with different actives to be bonded together. Wafertab can be prepared in a variety of shapes and sizes and is an ideal method for the delivery of therapeutic agents, which desire fast release or for use by patients who have swallowing difficulty.

Foamburst

Foamburst, a special variant of the soluleaves, which got a new patent granted in 2004, is a capsule form made of foamed film. An inert gas is blown into the film during production, resulting in a film with a honeycombed structure. To produce specific taste-burst characteristics or deliver active drugs, the voids in the film may be gas-filled, empty or filled with other materials. The designed light honeycombed structure results in capsules that dissolve rapidly, causing a melt-in-the mouth sensation.

Micap

Micap plc signed an option agreement in 2004 to combine its expertise in micro encapsulation technology with the BioProgress water-soluble films. The developments will be aimed at providing new delivery mechanisms for the $1.4 bn global market for smoking cessation products (SCPs).

Various products of FDOFs available in the global market and their ingredients and applications are exemplified in Table 2, whereas in the Table 3 the patents of FDOFs dosage form and their related informations are depicted.

TABLE 2

Marketed products of fast disintegrating oral films.

Product Category	Ingredients	Applications
Energy boosters	Caffeine, green tea extract and guarana	The product maintains the energy levels
Detoxification strip	Green tea extract which is high in polyphenols and rich in anti-oxidants	Wound healing, regulating body, temperature, blood sugar and promoting a healthy digestion
Male vitality strip	Maca root extract and Siberian ginseng extract, herbs which enhance libido, Cinnamint flavor.	Aphrodisiac
Appetite suppressant	fucus vesiculous and guarana extract, garcinia cambogia	Cambogia helps to reduce the food intake by suppressing appetite.
Vitamins and food supplements	Various vitamins, minerals and supplements	It is useful for the people who do not like to pop up the tablets or soluble supplements
Breath freshener strip, (Antibacterial strip)	Contain mint flavor and antibacterial agent, cetylpyridinium chloride	Mouth freshener
Saliva promoting strips	Fruit acid extracts, range of flavors	It is used in the dry mouth as a side effect of the other medications
Labtec GmbH Ondansetron Rapidfilm®	Ondansetron 4 mg and 8 mg	Prevention of chemotherapy, postoperative and radiation-induced nausea and vomiting.
Donezepil Rapidfilm	Donepezil Hydrochloride 5 mg and 10 mg	Treatment of mild to moderately severe dementia of the Alzheimer's type.
Paladinabs (Bioenvelop) Smoking cessation	Nicotine	To reduce the smoking habit
Multivitamin for kids and adults	B6, B12, C; D3 for kids, D3 for adults	Multi vitamin supplement
Teeth whitening	----------	Lifestyle improvement product
Food supplements	Benzocaine,Caffeine, Melatonin, MentholOmega, Hoodia, Protein,Vinpocetine	Nutraceuticals
Natural products	Ginseng, Guarana	Aphrodisiac, Appetite reducer
Chloraseptic® Relief Strips™	Benzocaine 3 mg, BHT, corn starch, erythritol, FD&C Red 40, hydroxypropyl methylcellulose, malic acid, menthol, monoammonium glycyrrhizinate, cherry flavors, polyethylene oxide, sucralose	Occasional minor irritation, pain, sore throat and sore mouth

TABLE 3
Patents on fast disintegrating oral films.

Title	United States Patent	Issued	Inventors
Film comprising nitroglycerin	20100215774	August 26, 2010	Maibach, Todd
Fast disintegrating orally consumable films containing a taste masking agent	7,648,712	January 19, 2010	Bess; William S (Edison, NJ),Kulkarni; Neema (Randolph, NJ), Ambike; Suhas H. (West Hill, CA), Ramsay; Michael P. (Ajax, CA)
Oral fast disintegrating film for erectile dysfunction bioactive Agents	2009/0047330	Feb. 19,2009	Ramesh, Bangalore
Disintegratable ilms for diagnostic devices	7,470,397	Dec.30,2008	William G. Meathrel, Nathan A. Meyer, Scott, D. Barnhart, Cathy M. Moritz, Andrew P. Full, Susan R. Newsom, Mary Robertson
Thin film strips	7,241,411	Jul.10,2007	Craig J. Berry, Walter klauser
Flavored film	7,132,113	Nov.7,2006	Horst G. Zerbe, Fadia Al- Khalil
Fast disintegrating orally consumable film	7,025,983	Apr.11,2006	Sau Hung Spence Leung,Robert S. Leone, Lori D. Kumar, Neema Kulkarni, Albert F. Sorg
Process for manufacturing thin film strips	6,824,829	Nov. 30,2004	Craig J. Berry, Walter klauser
Fast disintegrating film for oral administration of drugs	2004/0208931	Oct.21,2004	David R.Friend, Aaron W. Levine, Kerrie L. Ziegler, Emmanuel Manna
Method for producing film type dosage	6,800,329	Oct. 5,2004	Michael Horstmann Wolfgang Laux, Horst Dzekan, Katja Zinndorf

Packaging

A variety of options in packaging are available for fast disintegrating oral films. Single packaging is mandatory for films which are pharmaceutical products; an aluminium pouch is the most commonly used packaging system. APR-Labtec has developed the rapid card, a proprietary and patented innovative packaging system which is specifically designed for rapid films. The rapid card is exactly the same size as a credit card and holds three rapid films on each side. Every dose can be taken out individually, allowing the patient to carry six single, packaged doses of his medication in his purse or wallet and have it readily available (Vollmer et al., 2006). Another packing system, Core-Peel®, is developed by Amcor Flexibles and is gaining popularity in the field of packaging of fast disintegrating oral films.

Conclusion

The demand for fast disintegrating film technology is rapidly growing to create a new tomorrow, as a revolutionary and an innovative dosage forms for all age groups, specifically pediatric, geriatric patients and patients with swallowing difficulties. A number of active ingredients including over the counter (OTC) products, prescription drugs and neutraceuticals, can be incorporated into this innovative oral film dosage form. They combine the greater stability of a solid dosage form and the good applicability of a liquid and thus bridge the gap between two ideas, incorporating positive elements from both solid and liquid dosage forms into an elegant, stable and innovative dosage form. A few companies are actively engaged in development of this fast pace, oral thin film technology, which allows brand extension for products and a good tool for product life cycle management for increasing the patent life of existing products. It can give rise to confectionary products and also can be used for refreshing breath. As per Technology Catalyst International an international agency, fast disintegrating oral film formulation is growing exponentially and the market forecast for this dosage form hold great promise of a billion dollar business for the pharmaceutical industry. Research and development persons believe that during the next 5-10 years because of the immediate release and ease of processing, fast disintegrating oral films would draw the attention of pharmaceutical industry in a big way.

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