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Research Article

A REVIEW ON FAST-DISSOLVING ORAL FILM

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A B S T R A C T

Fast-dissolving oral films (OTFs) have emerged as a cutting-edge oral solid dosage form due to their numerous advantages over traditional tablets and capsules. These films dissolve rapidly in the oral cavity, typically within seconds to a minute, enhancing the effectiveness of the active pharmaceutical ingredients (APIs). They require less saliva to dissolve compared to fast-dispersing tablets, ensuring consistent and efficient drug delivery. Additionally, OTFs can be administered without the need for chewing, reducing the risk of choking and making them more user-friendly. Moreover, these films can be taken without water, offering a convenient and discreet way to administer medication anytime, anywhere. Depending on the film's thickness and the choice of the polymer matrix, the release of the medicine can be tailored to be more gradual. When placed on the tongue or in the oral cavity, OTFs can swiftly hydrate, adhere, and dissolve, facilitating rapid local or systemic drug delivery. This quick onset of action can be advantageous for medications that require immediate therapeutic effects. Due to consumer demand for fast-dissolving products over conventional tablets or capsules, OTFs have gained a significant position as an alternative dosage form in the pharmaceutical market. Fast-dissolving oral films represent a modern and patient-friendly alternative to traditional oral solid dosage forms. Their rapid dissolution, ease of administration, and customizable drug release profiles make them a valuable option for improving patient compliance and therapeutic outcomes. As technology and formulation techniques continue to advance, OTFs will likely become even more prevalent in the pharmaceutical industry, offering innovative solutions for drug delivery challenges.

INTRODUCTION

Considering oral administration accounts for over 52% of the market for drug delivery overall, there has been a significant interest in the development of modified-release oral dosage forms. The pharmaceutical industry's sources of drug leads have experienced a notable shift in recent years. However, there are challenges associated with the oral administration of medications, such as the risk of partial active component loss through tablet or capsule crushing and inaccurate liquid administration, which can lead to dose errors, overdosing, or ineffective drug therapy. The screening areas of absorption, distribution, metabolism, and excretion follow the concept of a large chemical space and a narrow target space. Fast-dissolving medication delivery systems are gaining attention as a solution to these problems. In recent years, oral film strips have become popular as a brand-new method of breath freshening[1]. These wafers, resembling gel, disintegrate swiftly in the mouth to release flavour. Many pharmaceutical corporations have been drawn to recent technical breakthroughs to explore new opportunities in this technology to provide quick, accurate dosing, which is expected to improve compliance, especially among young people. Transmucosal methods of drug administration have advanced significantly in recent years because they have the potential to address issues related to oral medication administration. The dose of medicine is swallowed after melting without the use of water or measurement[2]. Since the mouth mucosa is highly vascularized and therefore highly permeable, absorbing drugs through it into the systemic circulation is a desirable strategy. As a result, fast-dissolving films have gained popularity as an oral dosage form for many medications due to their quick disintegration, attributed to their large surface area. Pharmaceutical technologists have developed various mouth-dissolving drug delivery devices to meet these medicinal needs. These films typically dissolve in water at ambient temperature, disintegrate in 30 seconds, and vanish in a minute. The drug's absorption and onset of therapeutic effect occur more quickly the faster it dissolves in the solution. Fast-dissolving films are often made of plasticized hydrocolloids or mixtures of them, which can be laminated through hot-melt extrusion or solvent casting[3]. However, the production of these dosage forms can present challenges, such as foaming during film production caused by material heating or solvent evaporation, flaking during slitting, and cracking during cutting. The films should also be resistant to moisture over

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time. When it comes to ease of handling the formulations, attractive appearance, and ease of usage, the mouth-dissolving film formulation surpasses the liquid dosage form. Due to its pleasant taste and improved tongue feel, oral medicated mouth dissolving film displays increased patient compliance. Scientists are currently facing challenges due to the poor aqueous solubility and lipophilic character of chemical entities. However, due to their lipophilic nature, these medications can be targeted through the mouth, which improves their absorption. The mucosal cavity is greatly preferred due to its abundant blood supply. Fast-dissolving intraoral films[4] (FDF) are non-bulky oral dose forms with several advantages over traditional oral dosage forms. Oral films are receiving greater interest as a brand-new platform for patients. These films are considered a preferred dose form due to their high durability.

To create new dosage forms, pharmacological studies focus on drug simplicity and improving quality of life. Fast-dissolving films enhance oral bioavailability by improving drug solubility and dissolving rate. These films disintegrate rapidly in the oral cavity, allowing for efficient drug delivery. They offer a convenient and patient-friendly administration method, improving patient compliance and adherence. Fast-dissolving films meet the criteria for a viable solid oral dosage form for local drug delivery. Their high surface area facilitates rapid dissolution and absorption of active pharmaceutical ingredients. This leads to improved therapeutic outcomes and treatment efficacy. Fast-dissolving films represent a significant advancement in drug delivery technology. The oral cavity is well-tolerated by patients, with a permeable mucosa and strong blood supply, making it an ideal location for systemic medication administration. Oral transmucosal drug delivery bypasses presystemic elimination in the GI tract and first-pass metabolism. Fast-dissolving films released for mucosal absorption can be formulated to maintain quick-dissolving characteristics for gastrointestinal absorption. Buccal administration is particularly beneficial for compounds with low skin penetration. The membrane coating granules in the top 200 µm layer of the oral mucosa serve as the main barrier to permeability. Depending on the active ingredient, these dosage forms have a shelf life of 2–3 years but are susceptible to moisture[5].

Drug delivery within the oral mucosal cavity can be categorized into three types

I. Sublingual delivery: This involves systemic drug administration through the mucosal membranes lining the floor of the mouth.
II. Buccal delivery: This involves drug administration through the mucosal membranes lining the cheeks.
III. Local delivery: This involves administering drugs directly within the oral cavity.

The Thin Film Delivery System involves drugs being delivered to the systemic circulation through dissolving films or strips. These films disintegrate within 1 minute when placed in the mouth without the need for chewing or water. Users typically place these dissolving films on, under, or along the inside of the cheek for oral medication administration. This method offers an alternative for those with swallowing difficulties and patients experiencing nausea, such as those undergoing chemotherapy. The concept of fast-dissolving dosage forms originated with tablets, and their quick-dissolving properties were achieved through adjustments to the formulation or by using a unique manufacturing process[6]. Fast-dissolving films are gaining popularity as an alternative to fast-dissolving pills, especially for treating patients with obstructions and alleviating their fear of choking. These films are typically composed of plasticized hydrocolloids. However, challenges such as foaming during production, flaking during slitting, and cracking during cutting can arise. Key characteristics for these films include flexibility, appropriate tensile stress, stability to moisture, ease of handling, and non-adherence to packaging materials or fingers. They hold unique advantages over other solid dosage forms due to their thinness and compact size, which encourage patient compliance. An ideal mucoadhesive system should adhere to the site of attachment for several hours, release the drug in a controlled manner, aid in the rate and extent of drug absorption, not irritate or discomfort the patient, not interfere with daily activities like talking or drinking, and offer unidirectional drug release toward the mucosa. The accessibility of these films makes them easy to apply, localize, and remove medication. Many commercially available formulations, such as Listerine PocketPaks™, Ora-film™ (benzocaine), and Theraflu® (various active ingredients), are designed to deliver locally acting medications. Implementing new administration strategies for existing medications can often be less expensive to develop, leading to increased efficacy and bioavailability, as well as reduced dosing frequency to minimize adverse effects.

To achieve effective medication therapy, overcoming several advantages and drawbacks is essential.

Advantages[5,6]

Improved Patient Compliance: Thin and compact design encourages consistent medication adherence.

Quick Dissolution: Rapid disintegration ensures fast drug release and absorption, leading to swift therapeutic effects.

Ease of Administration: Can be used without water or chewing, making them suitable for patients with swallowing issues or nausea.

Localized Drug Delivery: Many formulations target specific areas, enhancing treatment effectiveness.

Cost-Effective Development: Utilizing new administration strategies for existing medications can reduce development costs, increase efficacy, and improve bioavailability.

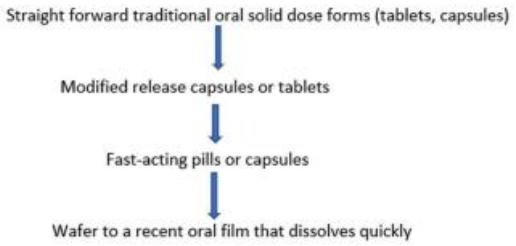
Disadvantages

I. Drugs that become unstable at buccal pH cannot be given.
II. Drugs that irritate the mucosa cannot be given by this route of administration.
III. A medication with a low dose requirement can only be given.
IV. Taste masking is necessary because the majority of medications have a bitter taste

Development of oral Solid dosage form[7]

Currently, there is significant interest in enhancing the oral delivery of medications with poor water solubility. Oral therapy stands out as the most productive field in medication delivery innovation research. The formulation of oral solid dosage has progressed through various stages of development.

To address the critical and pressing issue in drug development, the concept of delayed drug release is being further explored



Composition ofthe mouth-dissolving film[8]

Different additives can affect this process and the structure of a film

API It is possible to provide a range of active pharmacological substances. High-dose medications are challenging to include in the movie due to a restriction on the size of the dosage form. Ideal dynamic voice for oral films pharmaceutical ingredients (APIs) should ideally be strong, highly lipophilic, and less bitter. About 5% w/w to 30% w/w of the dry film is made up of the drug, and up to 10% w/w of the dry film can be made up of multivitamins. Both children and many adults dislike active pharmacological substances that have a bitter taste and/or irritate the mouth and throat.

Ideal characteristics

- The dosage of the drug to be included should be as low as 40 mg.
- Smaller and more moderately sized molecules of drugs are preferable.
- The medication needs to be stable and soluble in saliva and water.
- At the pH of the oral cavity, the medication should be partially unionized.
- The oral mucosa must allow the medication to pass through.

Film-forming polymer

The water-soluble polymers give the films quick disintegration, a pleasant mouthfeel, and mechanical qualities. Brand-new polymers utilized in medicine delivery [38]. By increasing the molecular weight of the polymer film bases, the disintegration rate of the polymers is slowed down. HPMC E-3 and K-3, Methylcellulose A-3, A- 6 and A-15, Pullulan(The creation of pullulan was a logical extension of Hayashibara's original 1883-founded enterprise, which was the manufacture of starch syrup. Hayashibara began marketing Pullulan films in 1982). Carboxymethyl Cellulose Cekol 30, Polyvinylpyrrolidone PVP K-90, Pectin, Gelatin, Sodium alginate, Hydroxypropyl cellulose, Polyvinyl alcohol, Maltodextrins, and Eudragit-RD10 are some of the watersoluble polymers used as film formers. POLYMERIC FILMS are being used in a wider variety of pharmaceutical research, development, and dosage form creation processes. There is currently no coating technique that can compete with film coating in terms of production capacity or cost-effectiveness for coating tablets and other solid dosage forms. A brand-new polymer that forms films is polymerized rosin.

Plasticizer

It has been noted that formulation concerns (plasticizer, etc.,) are significant factors determining the mechanical characteristics of films. To choose an appropriate plasticizer and solvent, preliminary research was done. Plasticizers have also improved the mechanical characteristics of the films, such as their tensile strength and elongation. These qualities might be impacted by variations in their concentration. Glycerol, di-butylphthalide, and polyethylene glycols are the most widely used plasticizers.

Surfactant

Surfactants are employed as solubilizing, wetting, or dispersing agent to dissolve the film quickly and release the active ingredient. The Ostwald–Freundlich equation, which links the drug's small particle size and, if relevant, its amorphous state, to an increased solubility. The important element in determining the pace and degree of absorption is solubility. Benzalkonium chloride, benzethonium chloride, tweens, and sodium lauryl sulfate are a few of the oftenutilized substances. As a solubilizing, wetting, and dispersion agent, poloxamer 407 is one of the most significant surfactants.

Sweetening agent

Sweeteners now play a crucial role in medicinal medicines that are meant to dissolve or disintegrate in the mouth. It is well known that food preferences are heavily influenced by the sweetness of flavour. In these situations, the bitter taste is frequently a major issue. Sucrose, dextrose, fructose, glucose, liquid glucose, and isomaltose are the traditional sources of sweetness. Since many oral-delivery medications have unpleasant properties including bitterness, sourness, saltiness, or inducing oral numbness, taste-masking technologies are crucial for achieving high patient compliance and drug therapy efficiency. The temporal profiles of sweetness show how the perception of sweetness changes over time.

The use of artificial sweeteners in pharmaceutical formulations has grown. The first generation of artificial sweeteners consists of saccharin, cyclamate, and aspartame, while the second generation includes acesulfame-K, sucralose, alitame, and neotame. Making use of flavours and sweets in the formulation is necessary for physical taste masking.

Saliva stimulating agent

Faster dissolution of the fast-dissolving film formulations is facilitated by increased saliva production. Acids that are used to prepare food should therefore be present in the formulations as salivary stimulants. A few examples of salivary stimulants include citric acid, malic acid, lactic acid, ascorbic acid, and tartaric acid, with citric acid being the most popular.

Flavouring agent

You can choose flavouring agents from artificial flavour oils, oleo resins, and extracts made from different plant components like leaves, fruits, and flowers. An unpleasant taste is one the of numerous significant formulation issues that are present with some medications. You can use flavours individually or in combination. Any flavour can be added, including water-soluble menthol extracts, fruit essences such as apple, raspberry, cherry, and pineapple, as well as potent mints such as peppermint, sweet mint, spearmint, wintergreen, cinnamon, and clove. Sour fruit flavours like lemon and

orange can also be added. The type and strength of the flavor determine how much flavour is required to cover up the taste.

Colouring agent

Titanium dioxide is one of the FD and C approved colouring compounds that are used in the production of orally rapid dissolving films, with concentration levels not exceeding 1 per cent (w/w).

METHODS OF PREPARATIONS FOR THE FILM[9,10]

There are several methods employed for the manufacturing of such dosage forms such as casting, spraying, and extrusion. Method of preparation of fast-dissolving films Fast-dissolving films can be prepared by:

a. Solvent casting method
b. Semisolid casting method
c. Hot melt extrusion
d. Solid dispersion extrusion
e. Rolling method.

Solvent casting method

This process involves dissolving the medicine along with various excipients in a suitable solvent while also dissolving water-soluble polymers in the solvent. The two solutions are then combined and agitated. The air bubbles in this solution are subsequently settled by degassing it under a vacuum. The final step is to cast the bubble-free solution into a Petri dish and let it dry. The base of the current film preparation is easily dissolved in saliva without forming insoluble materials, and it has been used in oral care products to treat foul breath.

Advantages

a. Better clarity and thickness uniformity compared to extrusion.
b. The film has a nice shine and is devoid of flaws like die lines.
c. Film has better physical qualities and is more flexible.
d. Although different thicknesses are achievable to suit API loading and dissolving requirements, the recommended finished film thickness is typically 12–100 m.

Disadvantages

a. The polymer needs to be water or a volatile solvent-soluble.
b. It should be possible to generate a stable solution with a suitable minimum solid content and viscosity.
c. It must be feasible to create a homogeneous film and be released from the casting support.

Semisolid casting method

This procedure creates a water-soluble film-forming polymer solution. Then the resultant solution is mixed with an acid-insoluble polymer solution (e.g., cellulose acetate phthalate and cellulose acetate butyrate). The right quantity of plasticizer is then added to create a gel mass. The films or ribbons are then cast using heat-controlled drums from the gel bulk. The films should be between 0.015 and 0.05 inches thick. The ratio of the film-forming polymer to the acid-insoluble polymer should be 1:4.

Hot melt extrusion

This procedure makes use of a hot melt extruder. In this method, a polymer is heated and then shaped into a film. A mixture of dry pharmaceutical materials, including API, is added to the hopper, transported, mixed, and heated before being extruded out in molten form by the extruder. The film is cast using the molten mass that has now solidified. The casting and drying process is a crucial phase. This method has a lot of benefits, such as the possibility of continuous operation, minimal product waste, good control of operating parameters, shorter residence times and lower temperatures for the drug carrier mix, absence of organic solvents, and scalability.

Advantages

a. No solvent or water is required
b. The API's compressibility characteristics might not be significant
c. A superior substitute for drugs that are not easily soluble
d. Greater uniformity of dispersion due to vigorous mixing and agitation
e. Requires less energy than high-shear methods.

Disadvantages

a. Thermal deterioration brought on by the use of high temperatures.
b. The polymer's flow characteristics are crucial for processing.
c. The scarcity of available polymers.
d. No excipient may contain any water or other volatile solvents.

Modern drug delivery methods[11]

By creating a solid dispersion or solid solution, melt extrusion has been employed in the pharmaceutical industry for a variety of goals, including:

I. Enhancing the drug's bioavailability and dissolving rate.
II. Regulating or altering the drug's release.
III. Covering up a drug's unpleasant aftertaste.

Solubility and permeability are the two key factors that affect a drug's bioavailability when taken orally. The introduction of high throughput screening in the drug development process has led to the creation of molecules that are frequently quite large in size, highly lipophilic, and poorly soluble. Scientists have experimented with numerous medicinal interventions to try and solve the solubility problems. The creation of solid dispersions and solid solutions is one of the numerous current technologies available to increase solubility and the rate of dissolution.

Solid dispersion extrusion

When one or more active chemicals are dispersed in an inert carrier in a solid form while amorphous hydrophilic polymers are present, this is referred to as solid dispersion. In this process, medications are dissolved in suitable solvents before being added to the polyethylene glycol melt at a temperature below 70°C. Finally, using dies, solid dispersions are moulded into the films.

Pharmaceutical applications with solid dispersions[12]

Since 2003, more than 80 oral thin film brands have been introduced in North America; however, the market is still

small compared to ODTs. However, the OTF sector is well-positioned in terms of future growth.

Up to 50% of the new drug candidates discovered as a result of high-throughput screening has very low solubility and thus low bioavailability. It can be difficult to produce pharmaceutical products when solubility, dissolution rate, and absorption of medications with low water solubility are problematic. Solid dispersions are a strategy to improve the API's solubility and bioavailability, which is partly accounted for by a decrease in particle size. Based on the drug's solubility in the carrier, solid dispersions can be categorized as molecular or particulate. The words molecular dispersion or solid solution is used when the medicine is disseminated at the molecular level.

Rolling method

In the rolling procedure, a drug-containing solution or suspension is rolled on a carrier. Water and an alcohol-water mixture make up the majority of the solvent. The film is cut into the desired shapes and sizes after it has dried on the rollers. Using a high-shear processor, additional materials, including the active substance, are dissolved in a tiny amount of aqueous solvent. Hydrocolloids that are water soluble are dissolved in water to create a homogeneous viscous solution.

Table 1 Formulation Table

S. No	Components	Concentration
1	API	1–25%
2	Film-forming polymer	45%
3	Surfactant	QS
4	Plasticizer	0–20%
5	Sweetening agent	3–6%
6	Flavouring agent	QS
7	Colouring agent	QS
8	Vehicles	QS
9	Saliva stimulating agent	QS

EVALUATIONS OF THE FILM[13, 14]

Pre-formulation research is required to reach the set objective.

Thickness

It is important to ensure uniformity in the thickness of the film since the thickness of a film directly affects the uniformity of the drug content. In many key areas, it can be measured with a micrometer screw gauge or calibrated digital VernierCalipers. The film should have a thickness between 5 and 200 micrometers.

Table 2 List of pharmacological molecules that can be included in the oral strip is shown in the table

Active pharmaceutical ingredients	Therapeutic action
Loperamide	Anti-diarrheal
Famotidine	Antacid anti-diarrheal
Azatadine maleate	Anti-histaminic
Triprolidine hydrochloride	, Anti-histaminic
Chlorpheniramine maleate	Anti-allergic
Ketofren	Analgesic

Dryness test

It has been determined that there are roughly eight stages in the drying process of a film: 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. The majority of the studies can be meticulously modified to analyze pharmaceutical OFDF even though the tests are generally designed to evaluate paint films. The specifics of how these factors were evaluated can be found elsewhere and are outside the purview of this review. Tack describes how firmly a strip sticks to a piece of material (like paper) after being rubbed on it. For this investigation, there are also instruments available.

Table 3 List of certain polymers that produce films

Synthetic polymer	Natural polymer
Methylcellulose	Starch
Hydroxypropyl cellulose	Pectin
Hydroxyethyl cellulose	Gelatin
Hydroxypropyl methyl cellulose	Xanthan
Polyvinyl alcohol	Pullulan
Kollicoat IR	Maltodextrin
Sodium carboxy methyl cellulose	Sodium Alginate

Weight Variation

From each film formulation, three 2 cm2 films were randomly selected. Films were individually weighed using an automated scale, and Each batch's mean weight was computed.

Surface PH

0.5 ml of phosphate buffer was then used to wet it, and it was left for 30 s. After putting the electrode of the pH meter in touch with the formulation's surface and giving it a minute to equilibrate, the pH was recorded. For each formulation, Average data were provided after the studies were carried out in triplicate.

Folding Endurance

It was discovered by repeatedly folding a film with a constant crosssectional area and thickness until it snapped. The folding endurance value is calculated as the number of folds a film might endure without breaking. This test validates the film's tensile strength.

Uniformity of Drug Content

Consistency in medication content. The drug content of all batches was calculated using random sampling. The phosphate buffer was used to dissolve the FDF (22 cm2). This mixture was filtered before being added to the HPLC. A mean of three measurements was used to determine the drug content.

Percentage Elongation

The following formula is used to compute percentage elongation by measuring the growth in length of the film following the measurement of tensile strength.
Elongation as a Percentage = [L-L0] ×100/L0
L0 was the starting length, while L was the final length.
Film coatings can boost overall film strength, minimizing dust generation and lowering the coefficient of friction in metal chutes thanks to their lower elasticity modulus and stronger tensile fracture strength.

Stability study[15,16]

It describes how important physical stability is for pharmaceutical products as well as how to assess it for tablets, capsules, suspensions, emulsions, solutions, and ointments.
The chosen formulas were packaged in aluminum foil to completely and flawlessly cover the film. After that, they were

kept at 40°C and 75% relative humidity for a month 4–8 weeks in a humid environment, and at certain intervals, their physical characteristics and in vitro drug release were assessed.

Three-monthly stability studies were conducted in the humidity chamber at 35°C and 65% relative humidity for all batches. The films were assessed for their drug content, rate of disintegration, and physical look after three months.

In Vitro Disintegration Time [17]

Three films from each formulation were taken and tested for disintegration by being placed in a Petri dish with a wall height of 1.3 cm and a surface area of 6.3 cm2 that contained a buffer solution with a pH of 6.8. It is noted when the picture started to fall apart. We computed the mean and standard deviation.

In Vitro Dissolution Studies [18]

Using a pH 6.8 phosphate buffer solution, a 3-min in vitro dissolution experiment was conducted on films of selected formulations. Dissolution media was maintained at 37 0.5°C and 50 rpm. Every 30 s, the samples (5 mL) are removed and replaced with new pH 6.8 phosphate buffer solution. After that, 10 mL of the 5 mL samples were diluted in a volumetric flask. Using a U.V. spectrophotometer set to a maximum wavelength of 256 nm (Electro Lab Ltd Dissolution Apparatus used for dissolution investigations), the samples' drug concentration was ascertained. Increased dissolution rate can be attributed to a strongly enhanced surface area of the drug for dissolution.

Ftir [18]

Studying compatibility using FT-IR spectroscopy, IR grade KBr was separately mixed with pure drug and drug coupled with polymers, then transformed into KBr pellets by a hydraulic press and scanned across a range of 4000–400 cm-1.

Xrd [19]

To ascertain the crystallinity of raw medications and drugs included in films, X-ray diffraction was used. For the purpose of analyzing the amorphous/crystalline behaviour of treated medicines, diffraction patterns were acquired.

Studies on Differential Scanning Calorimeter (Dsc) [19]

To ascertain potential interactions between the medication and excipients, DSC experiments were carried out using a Perkin-Elmer DSC-4 system, calibrated using an indium standard.

Film-Forming Capacity

Film-forming capability is a polymer's capacity to create the desired strip. It is divided into categories based on its ability to form strips, such as very poor, poor, average, good, better, and best.

Appearance of Films

Using visual cues such as transparency and semitransparency, the strip's appearance was assessed.

Drug Release Kinetics [20]

The release data were fitted to the following kinetic models to study the mechanism of drug release.

Kinetics of zero order Qt = Q0 + k0t

Where Q0 is the starting dose of the medication in the pharmaceutical dosage form, Qt is the dose at time t, and k0 is a zero-order rate constant.

Initial-order kinetics lnQt = lnQ0 + k1t or Qt = Q0 e-k1t
Where Q0 is the initial concentration of the drug in the solution, Qt is the amount of drug released at time t, and k1 is the first-order release constant. Dissolution efficiency (DE) was proposed by Khan as a useful metric for the assessment of in vitro dissolution data.

In Vitro Microbiological Studies

In vitro, microbiological experiments were conducted to verify that the antibacterial activity was still present after being liberated from the films. For this, the antibacterial activity of the aliquot removed from each film of the formula after 35 min of the in vitro drug release experiment (the time at which films indicate complete dissolving) was assessed. A common bacterium that causes dental plaque and cavities, Streptococcus mutans, is tested for antimicrobial activity. The antimicrobial studies' protocol followed the findings of Jagtapand Karkare's investigation.

Testing For Mechanical Strength

A texture analyzer TX was used to examine the films' mechanical strength [69].

Porosity

The liquid displacement method was used to calculate the porosity of the ChS film and nanocomposite films [30]. An electronic balance machine (W1) was used to measure the weight of each dried film. The dried film was then placed in an ethanol-containing beaker for 24 h, and the weight was recorded as W2. Finally, the film was taken out of the ethanol, and W3 was recorded as the weight of the beaker holding the leftover ethanol. The following formula was used to compute porosity:

% porosity= (W2-W1-W3/W2-W3) 100 [70]

Tensile strength

A load cell-equipped FudohRheometer (JJ, Rheotech, Japan) was used to measure the mechanical characteristics. Two grips that are 1.5 cm apart were used to fix the films, and they are then pulled continuously. The peak stress, or the level at which the films burst, was noted. Three different film samples made using the same formulation were used for three different measurements.
Fracture force/cross-section area equals tensile strength.

APPLICATION OF MOUTH-DISSOLVING FILM [20]

Vaccines

Fast-dissolving buccal films can administer vaccines that are stable at room temperature and easily dissolve in saliva and the mouth. Rotavirus vaccine made in the United States is a fast-dissolving buccal film that is stable at room temperature and makes vaccinations virtually as simple as mouthwash. Improved patient compliance, increased bioavailability, and a decrease in the expenses of handling, administration, and storage are just a few of the benefits that this delivery system offers.

Controlled and sustained release film Chitin and chitosan derivatives, among other polymers, are utilized as excipients in hospital preparations for the sustained-release buccal film.

Taste masking

Fast-dissolving tablets must include taste masking to be successful commercially. Fast-dissolving buccal films dissolve or break down in the patient's mouth, releasing the active substances that come into touch with the taste buds. This quality is therefore crucial for the patient's compliance. By using solvent evaporation and solvent extraction procedures, medications with an unfavourable bitter taste can be microencapsulated into acrylic polymers that are pH sensitive. These polymer microspheres demonstrated quick and complete disintegration as well as effective taste masking.

Orally disintegrating film

Fast-dissolving buccal films are based on a water-soluble polymer that dissolves when ingested. Patients with swallowing issues and patients experiencing nausea, such as those getting chemotherapy, have an alternative thanks to the film's capacity to dissolve quickly without the need for water.

Packaging of Mouth-Dissolving Film

Storage, protection, and stability of the dosage form depend heavily on packing concerns. Barrier films, single pouches, aluminium pouches, blister packaging with multiple units, and foil paper or plastic pouches are among the packaging options for oral thin films. For medications that are particularly moisture-sensitive, barrier films are most frequently used. There is ample room for logos, codes, directions, or other information on primary packaging constructed of a sealing pouch thanks to Labtech GmbH's rapid film technology. The films are created by a laminating process, and the cost of packaging is similar to that of tablets.

MDFs in biopharmaceutical consideration

Before creating a new dosage form, it is important to take biopharmaceutical considerations into account. Fast-dissolving oral films dissolve instantly, making it easier for the medicine to be absorbed through the oral mucosa from the mouth, throat, and oesophagus. Age, the makeup of the mouth cavity, and blood flow there should all be taken into account. Drug distribution is influenced by factors such as tissue permeability, perfusion rate, medication binding to tissue, and drug interactions. The amount of time it takes for the drug to leave your body or reach its target depends on how quickly it leaves. Different characteristics, such as the patient's age, sex, and health, have an impact on the dose form's pharmacodynamic performance. Throughout the trial, adverse occurrences were gathered. Such a decline in food quality might be prevented by edible films and coatings.

TECHNOLOGY

Quick-DISTM

To meet the market's unmet needs, Lavipharm Laboratories Inc. (Lavipharm) has created the perfect intraoral fast-dissolving medication delivery system. The new intraoral medication delivery method, trademarked (TM) Quick-Dis, is a thin, flexible, and quickly dissolving film and is a patented, proprietary technology of Lavipharm. The tongue's top or bottom is where the film is placed. It quickly releases the active ingredient for local and/or systemic absorption while being maintained at the application location. Unit-dose pouches to multipledose blister packages are just a few of the packaging options available for the Quick-Dis medication delivery system. The Quick-Dis TM film, which has a thickness of 2mm, often disintegrates in about 5–10 s after coming into contact with water. This is known as the disintegration time.

Soluleaves

A variety of oral delivery films that can include active substances, colors, and flavors are created using technology. When in contact with saliva, SOLULEAVESTM films can be made to swiftly dissolve, releasing the flavors and active substances.

Wafer tab

This is a medicine delivery device that includes pharmaceutical ingredients in a filmstrip that may be swallowed. When the strip comes into contact with mouth saliva, the system quickly dissolves and releases the active ingredients. To further enhance taste masking, the WAFERTABTM filmstrip can be flavored. Because the active component is properly dosed and integrated into the structure of a pre-fabricated XGELTM film, needless heat and moisture are avoided, potentially improving product stability.

Foam burst

This unique SOLULEAVESTM technology variation involves passing an inert gas through the film as it is being created. As a result, a film is created with a honeycomb structure that quickly dissolves and produces a novel tongue experience. Manufacturers of foods and confections are interested in FOAMBURSTTM as a flavor delivery system.

Xgel

All of Meldex International's film systems and its innovations for ingestible dosage distribution involve film, which is at the core of the company's intellectual property. With its nonanimal origin, religious approval, and suitability for vegetarians, XGELTM film offers special product benefits for healthcare and pharmaceutical products. It is also GMO-free and continuous production processing offers a cost-effective and competitive manufacturing platform. The XGELTM film has the capacity to include active pharmacological compounds and can also be taste-masked, coloured, layered, and have enteric qualities.

CONCLUSION

Both mucoadhesive and Oro dispersible films have been successfully used as effective drug delivery platforms, particularly for proteins and peptides, thanks to the prominent characteristics of oral films, including fast drug absorption, high bioavailability, easy-to-use nature, and avoidance of the first pass effect both in GI tract and in the liver. The development of fabrication techniques, as well as formulation strategies using both natural and synthetic polymers, has advanced oral films significantly for their practical uses. In addition, actives could be enclosed in nanoparticles or inclusion complexes, which are uniformly or unevenly distributed into the oral films produced, not only to nicely enhance the bio adhesion to the targeted oral mucosa but also to sufficiently improve both the solubility and permeability of the corresponding drugs, ultimately resulting in a fully promoted drug absorption and highly enhanced bioavailability. Despite the aforementioned advancements, there are still several obstacles that prevent such alluring oral films from

being widely industrialized and commercialized. Future research must, on the one hand, concentrate on the creation of innovative formulations that increase drug loading rates while simultaneously taking biocompatibility and biodegradability into account. On the other hand, it is necessary to adapt the production techniques now in use to enable the creation of these newly developed oral films with a reduced processing time and increased output.

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