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Fast Disintegrating Oral Films: A Recent Trend of Drug Delivery

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Abstract

Oral fast disintegrating films (OFDF) is an emerging technology brings out "formulations taken without water" with quick onset of action and improved patient compliance. Oral films provide better drug utilization in by-passing the first pass metabolism, enhance drug bioavailability, mask the bitter taste of the drug and do not need water to swallow. OFDF formulations are suitable for cough, cold remedies, sore throat, allergenic conditions, nausea, pain and CNS disorders. Multivitamins, caffeine strips, snoring aid and sleeping aids are also applicable for incorporation in the oral films. The major constraints of OFDF are limited drug aqueous solubility, poor permeability and its high dose. Present article overview the advancement in the oral dosage forms, application, formulation consideration, method of preparation, evaluation, marketed product and patented technologies of oral fast disintegrating films.

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INTRODUCTION

Despite the tremendous advancement in the drug delivery system, oral route is the most preferred route of administration and tablet and capsules are the most preferred dosage form [1-3] but now they experienced several limitations like chocking and swelling discomforts in the geriatric and paediatric patients [4-5]. Among the plethora of avenues explored oral strips gain more attention as it emerging new platform for geriatric and paediatric patients [6-8].

Fast dissolving drug delivery system (FDDS) was introduced in late 1970 as the alternative to

conventional tablet, capsule and syrups especially for the geriatric and paediatric patients suffering from the dysphasia problem [9]. Fast dissolving tablets are the solid dosage form which disintegrates rapidly in the oral cavity without the need of water [10-11]. Some problems are associated with the OFDF like they are sometime difficult to carry, storing and handling (friability and fragility), these are prepared using the expensive lyophilisation method [12-13]. To overcome these problems oral films were developed, which are very popular now a days.

The concept of oral film was come from confectionary industry [4, 9]. Oral films are the recent ultra thin novel formulation of postage stamp size which contains active pharmaceutical ingredients and excipients [14]. Efficacy of API is improved as it dissolves in the oral cavity. Oral films disintegrate rapidly within seconds when it comes in contact with saliva without the need of water [15-16]. Oral fast dissolving films are useful for the geriatric and paediatric patients and also for the patients suffering from emesis, diarrhoea, allergic attacks, cough, mental disorder, bedridden patients etc [17]. Oral films are also used for local effects like local anaesthetics for oral ulcers, toothaches, cold scars and teething. Generally the shelf life of film is 2-3 years it depends on the API added to the film but films are very sensitive to environmental moisture [18].

Salivary gland is present in the oral cavity which secretes saliva [19]. Three salivary glands are present in the oral cavity i.e. parotid, submandibular and sublingual glands. Saliva is relatively less viscous as compared to GI fluids [19-20]. Saliva is mainly water which contains 1% organic and inorganic material. Saliva is a weak buffer and its pH ranges from 5.5-7. The total volume of saliva secreted from the salivary gland is 0.5-2 litres and it is the amount of saliva enough to hydrate oral mucosal dosage form [21-22].

Advantages: [23-25]

1. Oral cavity has large surface area which leads to rapid dissolution and disintegration of the oral dosage form.
2. No risk of chocking
3. OFDF are solid unit dosage form so provide accurate dosing and great precision.
4. Due to pregastric absorption the bioavailability of drug is improved and fewer doses are required which improve the patient compliance.
5. OFDF's does not require water to swallow so it has better acceptability among the dysphagic patients.
6. Provide good mouth feel.
7. Oral films are flexible and less fragile as compared to OFDF's so it can easily transport handled and stored.
8. It avoid first pass metabolism as it directly absorbe from the buccal mucosa and enter into the systamic circulation, side effects and dose are reduced.
9. Fast dissolving films disintegrate immediately with in seconds when placed on tongue without the need of water and release one or more API.
10. Stability of the dosage form is enhanced.

Constraints of oral film: [26-28]

- High dose cannot be incorporated
- Drug should have low dose
- Should have high oral bioavailability
- Oral films have expensive packaging

Special features of oral films: [26-30]

- Ultra thin films
- Available in various size and shape
- Unobstructive
- Rapid release and fast disintegration
- Excellent mucoadhesion

Applications: [28-31]

- Oral films are preferred for local action and also to manage pain, allergies, sleeping difficulty and CNS disorders.

- Dissolvable films are feasable for topical application for wound care as analgesics or antimicrobial agents.
- Oral films are applicable to enhance the bioavailability of poorly bioavailable drugs.
- Taste masking of bitter drugs
- Dissolvable films are loaded with sensitive reagents to allow controlled release when exposed to a biological fluids or to create isolation barriers for seperating multiple reagents to enable a timed reaction with a diagnostic device.

Formulation consideration: [32-33]

From the regulatory prospective all the excipients used in the formulation and development of oral films and they are regarded as safe (GRAS listed) and should be approved for use in oral pharmaceutical dosage forms. The area of oral thin films is 1-20cm² (depend on dose and drug loading containing drug). Overview on different ingredients employed in formulation of fast dissolving films is given in Table 1.

Drug (Active pharmaceutical ingredient): [15] Different type of API can be successfully incorporated in the oral strip technology. Micronized API can improve the texture of the film and also dissolution and uniformity of the oral fast dissolving film. Different molecule can be incorporated into the delivery system. Taste of bitter drug need to be masked for that cyclodextrins or resins can be used; they prevent the direct contact of API with the saliva [34][35][36][37][38][39]. It include cough/cold remedies(antitussive, expectorants), anxiety drugs, CVS agent, sore throat, erective dysfunction drugs, antihistamines, antiasthamatics, GI disorders, nausea, pain and CNS (antiparkinson's disease). The overview of different drugs and its properties associated with film formulations are being enlisted in table 1.

The ideal properties of drug for the development of oral strips formulation:

a. The drug should have low dose.
b. The dug have extensive high first pass metabolism.
c. It should be non-bitter.
d. It should have quick onset of action.
e. The dug should have high solubility and high permeabilility (BCS class I).

Polymers [63-66]**:** Polymers play an important role in the film formation. Hydrophilic polymers are used in the preparation so that film can dissolve rapidly in the oral cavity and drug is delivered to the systemic circulation via dissolution when it comes in contact with the saliva in the buccal cavity [12]. The polymers can be used alone or in combination in a film to get the desired film properties. Robustness of film depends on the type and amount of polymer in the formulation. Now a day's both natural and synthetic polymers are used in the oral cavity. Natural polymers are safe, effective and devoid of side effect so more preferred than synthetic polymers.

Ideal properties of the polymers used in the oral film:[15]

1. Polymers should be non toxic and non- irritant
2. It should be non- bitter
3. Polymers should be tasteless
4. It should be devoid of leachable impurities
5. It should be inexpensive and readily available
6. It should not be an obstacle in the disintegration time
7. It should have good wetting and spreadibility property
8. It should exhibit sufficient peel, shear and tensile strength
9. It should have sufficient shelf life
10. It should not cause secondary infection in the oral cavity.

Plasticizer:[86-97] Plasticizers are the important excipient of the oral film. It improves the flexibility and a mechanical property of the film like tensile strength and elongation and reduces the brittleness of the strip. Plasticizer significantly improves the strip properties by reducing the glass transition temperature of the polymer. A plasticizer should be selected so that it must be compatible with the drug, polymers as well as with the other excipients used in the oral film. Plasticizer can improve the flow and enhances the strength of polymer. Film cracking, splitting and peeling take place by the use of inappropriate plasticizer. Plasticizers are used in the concentration of 0–20%w/w of dry polymer weight. Different plasticizers used in the preparation of the oral films are Glycerol, propylene glycol, polyethylene glycol, dimethyl, dibutyl, diethyl phthalate, tributyl, triethyl, actyl citrate, triacetin and castor oil.

Sweetening Agent:[98-106] Sweeteners are the important component used in the oral films. Generally sweeteners are used for the taste masking of bitter drugs so that drugs are palatable. Sweeteners are used alone or in combination between the concentrations of 3-6%w/w. Natural as well as artificial sweeteners are used in the preparation of oral film. Natural sweeteners used are xylose, ribose, glucose, sucrose, maltose, steviosides, dextrose, fructose, liq. Glucose and isomaltose. Fructose is sweeter than sorbitol and mannitiol and thus widely used as a sweetner. Artificial sweetners used in oral films are sodium or calcium saccharine salts, cyclamates salts, Acesulfame k etc. Acesulfame k and sucralose have more than 200 & 600 times sweet. Neotame & Altitame have more than 2000-8000 times sweetening power as compared to sucrose. Dipeptide based sweeteners: Aspartame. Protein based sweetener: Thaumatin I & II.

Saliva stimulating agent:[107-108] These are used to increase the secretion of saliva so that the oral film disintegrate and dissolve faster in the oral cavity. The acids which are used in the preparation of food are generally used as saliva stimulators. These agents are used alone or in combination between 2-6%w/w of the oral strip. Citric acid, malic acid, lactic acid, ascorbic acid, tartaric acid are the saliva stimulating agent. Citric acid is the most preferred among them. The stimulation of salivation can be measured be comparing the amount of resting flow & stimulated flow at equal time under same condition.

Flavouring agent: Flavouring agent are those ingredients which impart flavour to any of the formulation. The perception of flavour varies from individual to individual ethnicity and personal liking. Any US-FDA approved flavour can be added to the formulation according to the choice of the individuals of different age groups. The flavours liking changes with the age as geriatric population like mint or orange flavour while young generation like fruit, raspberry, strawberry flavour. Flavouring agent should be compatible with the drug and other excipients. Flavouring agents are selected depend on their flavour impart in first few seconds and its after taste. Upto 10% of the flavouring agent can be added to the oral strip formulation. Flavouring agent can be extracted from different part of the plant like leaves, flower, fruit, bark, and seeds.

Colouring agents: Colouring agent imparts colour to the formulation. Colouring agents are selected according to the flavour. FD&C approved Colouring agents are incorporated in the oral film.

METHOD OF PREPARATION:

Oral fast dissolving film can be prepared by five methods: [40-62]

- Solvent casting
- Semisolid casting
- Hot melt extrusion
- Solid dispersion extrusion
- Rolling

Generally Solvent casting method is most preferred for the manufacture of fast dissolving film:

1. Solvent Casting Method: This is the most preferred method to manufacture fast dissolving film. In this method firstly water soluble ingredients are mixed in water to form viscous solution. API and remaining ingredients are dissolved in smaller amount of solution and combined with bulk by using high shear processor. Vacuum is used to remove the air entrapped. The solution formed is then cast as a film and pour the solution in a glass mould and allow the solution to dry in an oven at 45-50°C which is then cut into pieces of the desired size.

2. Semisolid Casting: This method is preferred when acid insoluble polymers are used in the preparation of oral fast dissolving film. Firstly solution of water soluble polymers is prepared. The solution is added to a solution of acid insoluble polymer. Plasticizer is added in the appropriate amount so that a gel mass is formed. The gel mass formed is then casted into the films or ribbons by using heat controlled drums. Acid insoluble polymers used to prepare films include: cellulose acetate phthalate, cellulose acetate butyrate. The thickness of the film is about 0.015-0.05 inches. Acid insoluble polymer and film forming polymer are used in the ratio of 1:4.

3. Hot melt extrusion: In this method the polymers which have low molecular weight and low viscosity are preferred. Drug is mixed with the carrier in the solid form so that granular material is formed. These granules are then dried and then introduced into the extruder. The speed of the screw should be around 15rpm so that the granules reside inside the extruder for about 3-4min. The processing temperatures should be 80°C (zone1), 115°C (zone 2), 100°C (zone 3), and 65°C (zone 4). The extrudate (T= 65°C) then pressed into a cylindrical calendar to obtain a film.

4. Solid dispersion extrusion: In this method immiscible components are taken they are then extruding with drugs. Solid dispersion is then prepared and by means of dies the solid dispersion is shaped into films.

5. Rolling method: In this method firstly solution or suspension of drug is prepared which have certain rheological consideration. Either water or mixture of water and alcohol is mainly used as solvent. Suspension or solution containing drug is rolled on the carrier. Films are dried on the rollers and cut into desirable shapes and sizes.

EVALUATION OF THE ORAL FILM

- **Mechanical properties**
  - Thickness
  - Dryness/tacktest
  - Tensile strength
  - Percent elongation
  - Young's modulus
  - Tear resistance
  - Folding endurance
- **Organoleptic test**
- **Swelling test**
- **Surface pH test**
- **Contact angle**
- **Transparency**
- **Assay/ content uniformity**
- **Disintegration test**
- **In-vitro dissolution test**

Thickness: A thickness of film should be measured with the help of micrometer screw gauge or calibrated digital vernier callipers. Film should be measured at five points i.e. from the centre and from all the four corners and then mean thickness is calculated. It is necessary to determine the uniformity of thickness as it is directly related to accuracy of dose in the film.

Dryness/ Tack test:[109] Dryness is the property to measure the solvent or water content present in the film whereas tack is the tenacity with which the film adheres to any piece of paper which is pressed into contact with the strip. Eight stages of film drying

process have been recognized i.e. set-to-touch, dust-free, tack-free, dry-to-touch, dry-hard, dry-through; dry-to-recoat & dry print free. Now instruments are also available to study.

Tensile strength:[110] It is the maximum stress applied to a point of a film at which the strip specimen breaks. It is calculated by applied load at rupture divided by the cross section area of the strip as given in the equation:

Tensile strength= Load at failure*100/ strip thickness* strip width

Percent Elongation: [111] when stress is applied, a film sample stretches and this is referred to as strain. Strain is basically the deformation of film divided by original dimension of the sample. Generally elongation of film increases as the plasticizer content increases.

Percent elongation= $L*100/L_0$

L = Increase in length of film

L_0 = Initial length of film

Young's Modulus: Young's modulus or elastic modulus is the measure of stiffness of film. It is represented as the ratio of applied stress over strain in the region of elastic deformation as follows:

Young's Modulus= Slope*100/ Film thickness* cross head speed

Hard and brittle film demonstrates a high tensile strength and Young's modulus with small elongation.

Tear Resistance: [112] The maximum stress or force (that is generally found near the onset of tearing) required to tear the film is recorded as the tear resistance value in Newton (or pounds -force)

Folding Endurance: [113] Folding endurance is determined by repeated folding of the film at the same place till the fill breaks. The number of times the film is folded without breaking is computed as the folding endurance value.

Organoleptic Evalution: [114-115] This is essential step in case of most oral formulation due to more residence time in the oral cavity. The product should possess the desired features of sweetness and flavour which is acceptable to large mass of population. For evaluation of psychophysical evaluation of the product, special controlled human taste panels are used. In-vitro methods of utilizing taste sensors, specially designed apparatus and drug release by modified pharmacopoeial methods are being used for this purpose. Experiments using electronic tongue measurements have also been reported to distinguish between the sweetness levels in taste masking formulation.

Swelling Test: [116-117] Simulated saliva solution is used to conduct the swelling property study. Firstly weigh all the samples of film and placed on the preweighed stainless steel wire mesh. 15ml of the saliva solution is added in the plastic container and the mesh containing film sample is submerged into it. Increase in weight of film was observed until a constant weight was observed.

The degree of swelling was calculated using parameters:

$$\alpha = wt\text{-}wo/w_o$$

wt = weight of film at time t

wo= weight of film at time zero

Surface pH Test: [116-117] Surface pH of the film was determined by placing the film on the surface of 1.5% w/v agar gel followed by placing pH paper (pH range 1-11) on films. The change in the color of pH paper was observed and reported.

Contact Angle: Contact angle are measured by Goniometer (AB Lorentz and wettre, Germny) at room temperature. Take a dry film and place a drop of distilled water on the surface of the dry film. Images of water droplet were recorded with in 10 sec of deposition by means of digital camera. The contact angle was measured on both side of drop and average is taken.

Transparency: [118-119] The transparency of the films can be determined using a simple UV spectrophotometer. Cut the film in the rectangular shape and placed inside the spectrophotometer cell. Determine the transparency of the film at 600nm.

The transparency of the film was calculated as follows:

Transparency= $(\log T_{600})/b = -\epsilon C$

Where, T_{600}= transmittance at 600nm

b= film thickness (mm)

C= concentration

Assay/ Content Uniformity: This is determined by any standard assay method described for the particular API in any of the standard pharmacopoeia. Content uniformity is determined by estimating the API content in individual strip. Limit of content uniformity is 85-115%.

Disintegration Test:[120-121] The disintegration time limit is 90sec or less. Although no official guidelines is available for oral strips. Pharmacopoeial disintegrating test apparatus may be used for the study. Typical disintegration time for oral strip is 5-30sec.

In-vitro Dissolution test: [122-123] Dissolution testing can be performed using the standard basket or paddle apparatus described in any of the pharmacopoeia. The dissolution medium will essentially be selected as per the sink conditions and highest dose of the API. Many times the dissolution test can be difficult due to tendency of the strip to float onto the dissolution medium when the paddle apparatus is employed.

Table 1: Generalized Details of Different Ingredients of Oral Film

S. No	INGRADIENTS	AMOUNT(w/w)
1	Drug(API)	5-30%
2	Water soluble polymer	45%
3	Plasticizer	0-20%
4	Saliva stimulating agent	2-6%
5	Surfactant	Q.S.
6	Sweetening Agent	3-6%
7	Flavours, Colours, Fillers	Q.S

Table 2: Rationale of fast dissolvable films formulation of selected drug

DRUG	CATEGORY	DOSE (mg)	SOLUBILITY	PROBLEM ASSOCIATED
Salbutamol sulphate	Antiasthematic	6- 16	Soluble 1 in 4 of water; slightly soluble in ethanol, chloroform, and ether	High first pass metabolism, bioavailability 50%
Montelukast sodium	Antiallergic	5-10	freely soluble in ethanol, methanol and water and practically insoluble in acetonitrile	Protein binding 99%, bioavailability 65%
Levocirtrazine dihydrochloride	5-HT Antagonist	5	Soluble in water	Low bioavailability, first pass metabolism
Ropinirole Hydrochloride	Antiparkinsonism drug	3-9	Soluble in water	Bioavailability 50-55%, bitter drug
Triclosan	Antimicrobial agent	3.5	Practically insoluble in water; very soluble in most organic solvents	Bitter taste, insoluble in water
Sertraline	Antidepressant drug	4	Slightly soluble in water and freely soluble in ethanol	Bioavailability 45%, low solubility, extensive first pass metabolism
Ondansetrone hydrochloride	Antiemetic drug	8-16	Soluble in aq. Solutions, solubility decreases with pH	Extensive first pass metabolism, 60% bioavailability,short half life i.e 5hr
Rizatriptan Benzoate	5-HT Agonist	5-10		Bioavailability 40-45%, extensive first pass effect
Valsartan	Antihypertensive	80-160	Slightly soluble in water, soluble in ethanol and methnol	Bioavailability 23%, protein binding 94-97%
Verapamil	Antihypertensive, antianginal. antiarrythmic	40-120	Practically insoluble in water, freely soluble in lower alcohol, acetone, ethyl acetate, chloroform, soluble in benzene and ether	20% bioavailability, 90% protein binding of drug, extensive first pass metabolism
Domperidone	Antiemetic	10-20	Low water solubility, soluble in acidic pH	Protein binding is 91-93%
Ivabradine Hydrochloride	Antianginal drug	5-10	Soluble in water	Extensive first pass metabolism, short half life of 2hr, 40% bioavailability
Citalopram hydrobromide	Antidepressant	20-60	Sparingly soluble in water, soluble in ethanol	Bitter drug, low solubility
Dexamethsone	Antiemetic	0.5-9	Insoluble in water, soluble in ethanol, chloroform, acetone, sparingly soluble in methanol, slightly soluble in ether	Solubility problem, 65% drug excreted in urine in 24hr
Ambroxol hydrochloride	Mucolytic agent	30	Soluble in water	Extensive first pass effect
Meclizine HCl	Antiemetic agent	25-100	Poorly water soluble	Bitter drug, solubility problem

Table 3: Overview of different ingredients employed in formulating of fast dissolving films

Drug	Polymer	Plasticizer	Super Disintegrant	Sweetener	Method of preparation	Property improved
Salbutamol sulphate	HPMC, HPC, Sodium Alginate	-	-	Aspartame	Solvent evaporation method	Taste masking of bitter drug
Montelukast sodium	HPC, HPMC	Glycerine	Cross povidone, croscarmellose sodium	Sucrose	Solvent casting method	Maximum drug release and it follow first order kinetics
Levocirtrazine dihydrochloride	Eudragit· EPO, HPMC E 5 LV, and PVA	Glycerin, dibutyl phthalate, propylene glycol, and PEG 400	-	Mannitol, Aspartame	Solvent casting method	Increase in % drug release
Ropinirole Hydrochloride	Pullulan gum	PEG 400	-	Sucralose, Aspartame	Solvent casting method	Increase in % drug release using pullulan gum
Triclosan	HPMC (Methocel E3, E5, E15 premium LV)	pylene glycol	-	Aspartame, mannitol, sorbitol and xylitol	Solvent casting method	Improve solubility of poorly water soluble drug
Sertraline	polyvinyl pyrrolidone, Carbopol 934P	Propylene glycol or PEG 400	-	Mannitol, sodium saccharin	Solvent casting method	Improvement of solubility, bioavailability and increase in % drug release
Ondansetron Hydrochloride	polyvinylalcohol, polyvinyl pyrrolidone, Carbopol 934P	Propylene glycol or PEG 400	-	Mannitol, sodium saccharin	Solvent casting method	Improve patient compliance, better bioavalability, taste masking of bitter drug
Rizatriptan Benzoate	HPMC E 15, maltodexrin	-	Sodium starch glycolate	Aspartame, mannitol	Solvent casting method	Improve drug release, patient compliance, better bioavalability
Valsartan	HPMC (E5, K4M, 50cps), Propylene glycol, hupu gum, guar gum	PEG	-	Sorbitol	Solvent casting method	Taste masking of drug, improve drug solubility and bioavailability
Verapamil	HPMC E6, maltodextrin	Glycerol	-	Aspartame	Solvent casting method	Improve bioavailability, bypass first pass metabolism
Domperidone	PVA	Glycerine	-	mannitol	Solvent casting method	Quick onset of action
Ivabradine Hydrochloride	Hydroxy propylmethyl cellulose E5	PEG 400	Crospovidone, SSG	Aspartame	Solvent casting method	Bypass first metabolism
Amlodipine Besylate	Sodium Alginate	Glycerol	SSG	Aspartame	Solvent casting method	Enhanced dissolution rate, taste masking, and better patient compliance and effective therapy
Citalopram hydrobromide	HPMC E5	Proylene glycol	-	Sorbitol	Solvent casting method	Quick onset of action, improve patient compliance
Cetrizine Hydrochloride	Pullulan gum	PEG 400	-	Aspartame, Sucralose	Solvent casting method	Taste masking, improve mechanical properties of film
Dicyclomine Hydrochloride	PVA,, HPMC-15, HPMC-50: Eudragid, HPMC-15:PVA	PEG 400	-	Aspartame	Solvent casting method	Better theraputic efficiacy, increase bioavailability, taste masking of drug
Metaclopramide Hydrochloride	HPMC E6, SCMC,	Glycerol	Sodium bicarbinate	Saccharine sodium	Solvent casting method	Patient complaince, physical property improve
Telmisartan	HPMC E5, HPMC50cps, HPMC K4M	Propylene glycol	-	sorbitol	Solvent casting method	Enhance solubility, bypass first pass metabolism
Tianeptine Sodium	NG73, HPMC, Hydroxy ethyl cellulose, PVP K 90, RS780, maltodextrin	PEG	-	-	Solvent casting method	Emhance compliance and convenience by elderly and pediatric patients
Valdecoxib	HPMC, Eudragit EPO	Glycerol	-	Aspartame	Solvent casting method	Improve drug release, mask bitter taste

Table 4: Characteristics of Some Natural Polymers Employed In Oral Films and Their Applications

Polymer	Film Forming Ability	Viscosity	Melting Point	Solubility	Application
Pullulan gum	It form flexible film in 5-25% solution	It is 100-180mm²/s viscous at 10%w/w, and at 30°C	107°C	Soluble in hot and cold water	Used in food industry to provide bulk and texture, as plasma expender in replacement of Dextran, for coating of immediate release tablets, for preparation of capsule shell
Sodium Algenate	It have film forming capacity	Typically, a 1% w/v aq. Sol^{n}, at 208C, will have a viscosity of 20–400 mPa s (20–400 cP)	>300°C (572°F)	Slowly soluble in water and form colloidal solution	Stabilizing agent; suspending agent; tablet and capsule disintegrant; tablet binder; viscosity increasing agent
Pectin	It have film forming capacity	-	152°C	Soluble in water; insoluble in ethanol (95%) and other Organic solvents	Used as gel forming agent for sustained release drugs, used as adsorbant, emulsifying agent, stabilizing agent, bulk forming agent for the preparation used for management of diahorrea and constipation
Gelatin	Very good film forming capacity	4.3-4.7mPa s for a 6.67%w/v aq. Solution at 60°	-	Soluble in glycerin, acid, alkali. Swell in water and softens. Soluble in hot water	Used in the preparation of hard and soft gelatin capsule, in implantable delivery system, in microcapsulation of drugs, used topically in wound dressing.
Malto Dextrin	Very good film forming capacity	Less than 20 mPa s for a 20% w/v aqueous solution	-	Swells in water and softens. Soluble in hot water	Used as binder and diluent in tablet, carrier in spray dried redispersible emulsion, used as carbohydrate source in oral nutritional suppliment, used in confectionary and food product.

Table 5: Synthetic Polymers Used In Oral Films

Polymer	Film Forming Ability	Viscosity	Melting Point	Solubility	Application
Hydroxy propyl cellulose	It has a good film forming property and 5%w/w solution is generally used for film coating	The viscosity of solutions ranges from 75 mPa s–6500 mPa s	It softens at 130 °C; chars at 260–275 °C	It is freely soluble in water, soluble in many cold and hot polar organic solvents	Used as a tablet binder, in preparation of modified release dosage form, microcapsules, As thickening agent in the oral and topical Formulations. Due to its nonionic nature, as emulsifier in the cosmetic formulations.
Hydroxy propyl methyl cellulose	It has a film forming ability in 2–20%w/w concentrations	Viscosity of various grades ranges from 3 mPa s–100,000 mPa s	Browns at 190–200 °C glass transition temperature is 170–180 °C	Soluble in cold water, forming a viscous colloidal solution, insoluble in chloroform, ethanol	Used as a tablet binder, film coating agent, film forming agent and as a matrix for use in extended release formulations, suspending and thickening agent, emulsifier, suspending agent and stabilizing agent in gels and ointments,adhesive in plastic bandage and as a wetting agent in contact lenses
Sodium carboxy methyl cellulose	Good film forming property	Aqueous 1% w/v solutions with viscosities of 5–2000 mPa s	Browns at approximat-ely 2278C, and chars at approximately 2528C.	Practically insoluble in acetone, ethanol (95%), ether and toluene	Coating agent; stabilizing agent; suspending agent; tablet and capsule disintegrant; tablet binder; viscosity-increasing agent; water-absorbing agent
Polyvinyl alcohol	Good film forming property	High viscosity 40.0–65.0, Medium viscosity 21.0–33.0, Low viscosity 4.0–7.0	228°C for fully hydrolyzed grades; 180-1908°C for partially hydrolyzed grades	Soluble in water; slightly soluble in ethanol (95%); insoluble in organic solvents	Coating agent; lubricant; stabilizing agent; viscosity-increasing agent
Poly ethylene oxide	Good film forming property	WSR N-10 30–50	65-70°C	Polyethylene oxide is soluble in water and a number of common organic solvents such as acetonitrile, chloroform, and methylene chloride.	Mucoadhesive; coating agent; tablet binder; thickening agent.
Carboxy methyl cellulose	Good film forming property	The 1%w/w aqueous solution has viscosity in the range of 5–13,000 mPa s	Browns at 227 °C and chars at 252 °C.	It is easily dispersed in water to form a clear or colloidal solution	Used as a viscosity increasing agent, stabilizer for preparation of suspensions and emulsions, utilized as a binder or disintegrant, cryoprotective agent.It is reported for use in combination with other film forming polymers for preparation of oral films
Starch and modified starch	Modified starches have a property to form quick dissolving films.	2%w/v aqueous dispersion of starch provides 13 mPa s viscosity.	It decomposes at 250 °C	Soluble in water and ethanol. It swells in water by about 5 to 10% at 37 °C	Starch is used as binder, diluents and disintegrate, for coating of immediate release dosage forms, used in the treatment of dehydration.
Kollicoat	Kollicoat have good film forming property, it form transparent film	<15 mPa s for Kollicoat MAE 100 P and Kollicoat MAE 30 DP	209°C	>50% in water	Film-forming agent; tablet binder; tablet diluents

Table 6: Different flavours used in the oral strip are:

Oils	peppermint oil, cinnamon oil, spearmint oil, nutmeg oil
Fruit flavours	Apple, raspberry, cherry, strawberry, pineapple
Salt	Butterscotch, maple, apricot, peach, vanilla, mint, anise
Bitter	Wild cherry, walnut, chocolate, mint, anise
Sweet	Vanilla, fruit, berry
Sour	Citreous flavour, root bear, raspberry

Table 7: Marketed Product of Oral Film

Oral film	Active ingredients	Manufacturer/ marketed	Category
Klonopin Wafers	Clonazepam	Solvay pharmaceuticals	Antianxiety
Listerine cool mint pocket paks	Cool Mint	Pfizer	Mouth freshener
Benadryl	Diphenhydramine HCl	Pfizer	Antiallergic
Listerine	cool mint	Pfizer	Mouth freshener
Chloraseptic	Benzocaine/ Menthol	Prestige	Sore throat
Gas-X	Simethicone	Novartis	Anti Flatuating
Sudafed PE	Phenylephrine	Wolters Kluwer Health Inc.	Releliving Congestion
Supress^{R}	Menthol	InnoZen^{R}, Inc	Cough suppressants
Triaminic	Diphenhydramine HCl	Novartis	Anti allergic
Theraflu	Dextromethorphan HBR	Novartis	Cough suppressants

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