World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(REVIEW ARTICLE)

Buccal films as a platform for systematic and local drug delivery: An updated review

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World Journal of Advanced Research and Reviews, 2025, 27(01), 2208-2218

Publication history: Received on 17 June 2025; revised on 22 July 2025; accepted on 25 July 2025

Article DOI: https://doi.org/10.30574/wjarr.2025.27.1.2771

Abstract

Buccal drug delivery has emerged as one of the most promising and patient-friendly approaches for systemic and local therapy due to its ability to bypass first-pass metabolism, offer rapid absorption, and improve bioavailability. The oral mucosa, consisting of keratinized and non-keratinized epithelium, provides a unique environment for mucoadhesive formulations, making it ideal for buccal films. These films utilize polymers, plasticizers, penetration enhancers, and other excipients to achieve an optimal balance between mechanical strength, adhesive properties, and drug release characteristics. Compared with traditional dosage forms, buccal films offer numerous benefits, such as enhanced patient compliance, quick disintegration, and suitability for pediatric and geriatric patients. However, the formulation and manufacture of buccal films present significant challenges, including moisture sensitivity, limited surface area for drug absorption, and constraints on the quantity of active pharmaceutical ingredients. To overcome these, advances in polymer technology, plasticizers, and mucoadhesion strategies have enabled the design of sophisticated delivery platforms, making buccal films highly attractive for the administration of peptides, proteins, and other therapeutic agents. This review provides an in-depth examination of the characteristics of the oral cavity, the design and evaluation of buccal films, their manufacturing methods, and critical evaluation parameters. Additionally, it explores future prospects for extending the application of buccal films to a wider range of therapeutic areas, highlighting their role as a viable and innovative delivery platform for the next generation of pharmaceuticals.

Keywords: Buccal film; Oral mucosa; Bioavailability; First-pass metabolism; Drug permeability; Patient compliance

1. Introduction

The oral mucosa is considered one of the most convenient and widely accepted routes for drug administration. This route offers many advantages when compared to other routes such as preventing enzymatic degradation of the drug molecules in the gastrointestinal tract by passing hepatic first pass metabolism and good patient acceptance when compared to ocular, nasal, rectal, and vaginal routes. Due to its larger surface area, the oral mucosa allows low molecular weight drugs to permeate the mucosal epithelium more rapidly than the ocular and nasal routes. [1] The pediatric and geriatric patients experience difficulty in swallowing oral solid dosage form that's why oral disintegrating films were formed to avoid vomiting in patients. Buccal drug delivery represents a significant and valuable route for administering medications. [2] Buccal drug delivery is the administration of medications through the buccal mucosa the inner cheek lining enabling absorption for both local and systemic effects. [3] To facilitate this route, a variety of dosage forms have been developed, including tablets, lozenges, chewing gums, sprays, films, patches, hydrogels, pastes, ointments, solutions, and microspheres. Among these, buccal films stand out as the most promising and efficient method for drug delivery across the epithelium, with the added benefit of enhanced patient compliance. [4] However, creating high-quality buccal films poses significant challenges, necessitating continuous evaluation and in-depth analysis of their performance.

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2. Oral mucosa characteristics

The oral cavity membrane comprises both keratinized and non-keratinized epithelial tissues (Figure 1). The keratinized epithelium of mucosa is mainly non-polar lipids (ceramides and acyl ceramides), and it is relatively impermeable to water. So, it is suitable for local treatment in the oral cavity. [5] The non-keratinized mucosal epithelium is mainly composed of polar lipids like cholesterol sulphate and glucosylceramides, which makes it more permeable compared to the keratinized mucosa. Thus, it is appropriate for both systemic and local treatment in the oral cavity. Due to the presence of salivary mucin molecules and their negative charge, the mouth cavity is an excellent route for drug delivery. In the mucous secretions, mucins play an important role in coating the oral cavity, because they can be conjugated to positively charged molecules of the drug and affect particular tissues and thus help drug delivery system. Hence, they are commonly utilized for the modeling of mucoadhesive drug delivery systems. Examining the interactions between different polymers and the mucin-polymer interface offers valuable insight into the fundamental mechanisms of mucoadhesion. The adhesive strength is primarily attributed to molecular bridges formed between mucin and polymer chains. Additionally, the electronic properties of mucin play a significant role in this process. Therefore, mucoadhesion results from a synergistic effect of mucin's electrical characteristics and the formation of molecular interactions or bonds with the polymer. [6]

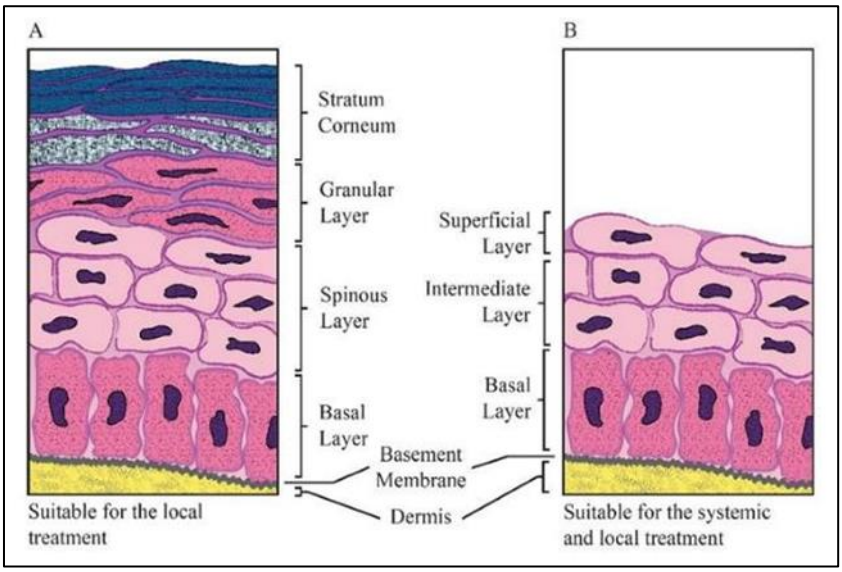

Figure 1 (A) The oral keratinized epithelium (B) Non-keratinized epithelium

Variations in permeability, blood flow, and residence time across different regions of the oral mucosa are influenced by distinct tissue properties. [7]

For drug delivery purposes, the oral mucosal cavity is typically categorized into three main routes:

- **Sublingual delivery** – Systemic drug delivery via the mucosal membranes lining the floor of the mouth
- **Buccal delivery** – Drug administration through the mucosal membranes lining the inner cheeks (buccal mucosa)
- **Local delivery** – Targeted drug delivery within the oral cavity intended for localized action on the oral tissues. [8]

2.1. Permeability

Research indicates that the buccal mucosa exhibits a permeability that is 4 to 4000 times greater than that of the skin. This wide range highlights the significant variability in permeability across different regions of the oral cavity, which is largely attributed to the diverse structures and functions of the various types of oral mucosa. Generally, the buccal mucosa exhibits greater permeability compared to the sublingual mucosa. This difference is influenced by the relative thickness and degree of keratinization of these tissues: the sublingual mucosa is thin and non-keratinized, the buccal mucosa is thicker but also non-keratinized, and the palatal mucosa is of intermediate thickness and keratinized.

Currently, it is believed that the primary permeability barrier in the oral mucosa is formed by intercellular material originating from membrane coating granules (MCGs), located within the outermost 200 μm of the superficial epithelial layer. Permeation studies using large molecular weight tracers such as horseradish peroxidase and lanthanum nitrate have demonstrated that these substances can penetrate only the outermost one or two layers of epithelial cells when applied to the surface. However, when applied from the submucosal side, they reach up to, but do not infiltrate, the outermost epithelial layers. These findings indicate that the flattened cells in the surface layers serve as the primary barrier to drug permeation, while the deeper, more isodiametric cell layers exhibit comparatively higher permeability. [9]

2.2. Role of Saliva

Salivary fluid is an exocrine secretion composed of about 99% water and contains a mixture of electrolytes such as sodium, potassium, calcium, chloride, magnesium, bicarbonate, and phosphate along with various proteins. These proteins include enzymes, immunoglobulins, antimicrobial agents, mucosal glycoproteins, trace amounts of albumin, and several polypeptides and oligopeptides that play key roles in maintaining oral health. [8, 10]

2.2.1. Functions of Saliva [11]

- Buffer Capacity
- Digestion
- Dilution and Cleaning
- Integrity of Tooth Enamel
- Protection and Lubrication

2.3. Role of mucus

Mucus carries a negative charge and is primarily composed of large glycoproteins known as mucins. Mucins have a protein core that is heavily O-glycosylated on serine and threonine residues and contains numerous proline residues, which disrupt helical structures. Saliva generally has a pH range between 5.8 and 7.4. [7]

2.3.1. Functions of Mucus [12,13]

- Bioadhesion of mucoadhesive drug delivery system
- Cell- cell adhesion
- Lubrication
- Protective in nature due to hydrophobicity

3. Buccal drug delivery system

Buccal controlled drug delivery systems have been developed due to the oral cavity's suitability as a potential site for drug administration. This route avoids acid hydrolysis and first-pass metabolism. However, the continuous secretion of saliva can influence drug release from buccal films. The presence of a mucin layer on the oral mucosa provides an opportunity to design mucoadhesive systems that remain at the absorption site for extended periods through mucoadhesion. Prolonged contact with the absorption membrane enhances drug uptake. With appropriate dosage form design and formulation, the pH of the buccal cavity does not pose a challenge to drug stability or effectiveness. Additionally, the permeability and local environment of the buccal mucosa can be modified to support and enhance drug permeation. [14]

3.1. Novel buccal dosage forms [11]

Innovative buccal dosage forms include buccal adhesive tablets, patches, films, semisolid preparations such as ointments and gels, as well as powders.

3.1.1. Buccal mucoadhesive tablets

Buccal mucoadhesive tablets are solid dosage forms that become moistened upon contact with the buccal mucosa, enabling adhesion and drug release. A representative example is a double-layer tablet featuring an adhesive matrix layer composed of hydroxypropyl cellulose (HPC) and polyacrylic acid, along with an inner core formulated with cocoa butter, insulin, and a penetration enhancer like sodium glycocholate.

3.1.2. Patches and Films

Buccal patches are made up of two distinct layers: an impermeable backing layer and an adhesive polymer layer. The adhesive layer is produced by casting an aqueous polymer solution onto the backing layer, and the finished patch is usually cut into an oval shape to facilitate convenient application.

3.1.3. Semisolid Preparations (Ointments and Gels)

Bioadhesive gels or ointments typically exhibit lower patient acceptability when compared to solid bioadhesive dosage forms. Additionally, these formulations are primarily used for localized drug therapy within the oral cavity rather than for systemic delivery.

3.1.4. Powders

When a powder formulation containing hydroxypropyl cellulose (HPC) and beclomethasone is sprayed onto the oral mucosa of rats, a notable increase in residence time is observed compared to an oral solution. Approximately 2.5% of the beclomethasone remains on the buccal mucosa for over 4 hours.

4. Buccal film

A buccal film is a non-dissolving, thin modified-release dosage form consisting of one or more polymer layers embedded with the drug and other excipients. It may include a mucoadhesive polymer layer designed to adhere to the oral mucosa, gingiva, or teeth, enabling controlled drug release either into the oral mucosa (unidirectional release) or both into the mucosa and the oral cavity (bidirectional release). After a predetermined duration, the film is removed from the mouth and properly discarded. [15]

4.1. Ideal Characteristics of Orally Soluble Buccal Film Drug Delivery System [16]

- Water is not required for administration.
- Its production method is very cost effective.
- Having a taste masking property.
- Polymer used should be non-toxic and non-irritant.
- Drug should have pleasant taste.
- It hydrates and dissolves in the buccal cavity within a matter of seconds.
- There should be no residue present in the buccal cavity after administration.
- Should have sufficient hardness.

4.2. Advantages of Buccal Film [17, 18]

Buccal films have some advantages includes:

- Dissolution rate is quicker than other conventional dosage forms.
- Increases patient compliance.
- Stable.
- Cost effective.
- Enhances the efficacy and lower the dose.
- Onset time of the drug is increased and hence there is enhanced absorption of the drug.
- Avoid first-pass metabolism and increases bioavailability.
- Acidic environment can be avoided.
- Favourable for geriatric and pediatric patients where complete dosing can be difficult.

4.3. Disadvantages of Buccal Film [19, 20]

Some of the disadvantages of buccal film are as follows:

- Buccal films are prone to moisture sensitivity, which can impact their integrity, stability, and drug release profile.
- The amount of drug incorporated into buccal films should be kept low, as high doses may affect film integrity, adhesion, and drug release efficiency.
- Buccal films offer a relatively limited surface area for drug absorption, which may restrict the rate and extent of drug uptake.

- The dissolved drug may be cleared from the buccal cavity through the natural process of saliva swallowing, potentially reducing the amount available for absorption.

5. Aspects of buccal films' formulation

Buccal films are typically composed of several key ingredients, including a polymer for film formation, a plasticizer to enhance flexibility, the active drug, a sweetener to improve palatability, and other necessary additives to optimize performance and stability. Recently, mucoadhesive films using polymers have been vastly used.

5.1. Active pharmaceutical ingredient

Buccal films are generally designed to incorporate active pharmaceutical ingredients (APIs) in concentrations ranging from 5% w/w to 30% w/w of the total polymer weight, depending on the drug's potency, solubility, and desired release profile. To ensure effectiveness and maintain film integrity, the drug dose is usually limited to less than 20 mg per day. The water-soluble drugs can be found in the buccal film in a dissolved condition or as a solid solution, hydrophobic medications are evenly distributed throughout the film or complexation with different cyclodextrins can increase the drug's solubility. Depending on the desired drug release profile, the active pharmaceutical ingredient (API) can be incorporated into the buccal film in various forms such as milled, nanocrystalline, micronized, or particulate forms. The film texture will be enhanced by the usage of micronized API, as well as for improved dissolving and homogeneity. Any medicinally active substance that is suitable for oral ingestion and can be absorbed through the buccal mucosa such as drugs for ulcers and antiallergic medications can potentially be formulated into buccal drug delivery systems. [16]

5.2. Water soluble polymers

Polymers that are water-soluble considered as a film former and its use in medical and nutraceutical applications has drawn significant attention since it gives the films quick disintegration, a pleasant mouthfeel, and strong mechanical qualities. Higher molecular weight polymers have led to a slower rate of polymeric disintegration. Methyl cellulose A-3, A-6, and methyl cellulose A-15 are a few of the water-soluble polymers utilized as film formers, along with K-3 Pullulan. [21, 22]

5.3. Plasticizers

The use of plasticizers in the creation of a buccal medication delivery system is absolutely essential since they aid by enhancing the buccal film's mechanical qualities, including its tensile strength and elongation, while also offering other benefits including a decrease in the film's brittleness and increased flexibility as well as a higher degree of the polymer's flow characteristic and a lower glass transition temperature. Glycerin, sorbitol, propylene, and polyethylene glycol are a few examples of plasticizers, as are tri-acetin, dibutyl phthalate, tri-ethyl citrate, acetyl tri-ethyl-citrate, and various citrate esters. The amount of plasticizer to be used can be 20% or less of the total dried polymer's weight. The selection of plasticizers is determined by factors such as the type of polymer, solvent compatibility, and overall formulation stability. Using an excessive amount of plasticizer or pairing it with incompatible materials can lead to defects in the buccal film, such as peeling, splitting, or cracking. [16]

5.4. Mucoadhesive polymers

Mucoadhesion is primarily believed to occur through the hydration and swelling of the polymer, driven by the diffusion of water. This process leads to the dehydration of mucin and the expansion of the polymer, which enhances the flexibility of the polymer chains and promotes interchain penetration, thereby increasing mucoadhesive strength. The features of polymer to be utilized for buccal formulation depend on extent of spreading capacity and capacity to create various kinds of molecule and molecule bonds at distinct stages of water absorption. Various mucoadhesive polymers have been researched recently for extending dose form or active retention in specified locations of the oral mucosa. Acrylic acid–polyethylene glycol (PEG) copolymers and monomethyl ether copolymers are commonly used in the formulation of buccal dosage forms. Additionally, various types of cellulose derivatives, such as sodium carboxymethyl cellulose (NaCMC), are frequently employed. Chitosan, a naturally derived polymer, is also widely used due to its positive charge, biocompatibility, and biodegradability. Because of its electrostatic interaction with mucin's negatively charged O-linked oligosaccharide chain, chitosan has been widely used as a mucoadhesive polymer. Chitosan's limited solubility at the physiological pH of the buccal mucosa and compatibility concerns with anionic medicines and excipients are what restrict its widespread use. Many chitosan derivatives are now being researched to improve chitosan's solubility and permeability at various pH levels without any precipitation caused by drug-polymer complexation. [16]

5.5. Penetration enhancers

Improving drug penetration through buccal mucosa was achieved by using penetration enhancers. The use of water is one of the straightforward penetration enhancers examples, their effects should be reversible and not irritating. Surfactants (like Tween), fatty acids (like oleic acid), terpenes (like eucalyptus), and solvents (like ethanol) are just a few of the chemicals that might increase penetration. Additionally, polymers with the mucoadhesion property, bile salts, azone, and presently chitosan, its derivatives, and have the potential to increase penetration. Chitosan is considered a potential penetration enhancer for hydrophilic macromolecular drugs that are absorbed via the transmucosal route, due to its ability to transiently open tight junctions and improve drug permeability across mucosal membranes. [23]

5.6. Saliva stimulating agent

Fast-dissolving film preparations dissolve quickly because more saliva is produced when using them. As a result, these dosage forms may incorporate saliva-stimulating agents like citric acid and tartaric acid to enhance drug dissolution and absorption in the buccal cavity. [24]

5.7. Cooling agent

Using monomethyl succinate as cooling agents contributes to the enhancement of the mouthfeel and flavour intensity of the film. In addition to saliva enhancers, agents like WS-3 a menthol derivative that is virtually non-volatile, odorless, and tasteless compared to menthol are commonly utilized as cooling agents in buccal formulations. Other widely used cooling agents, such as WS-23 and Ultracoll II, may also be included to improve the sensory experience and enhance patient acceptability. [11]

5.8. Sweetening agents

Sweeteners are essential in pharmaceutical products wanted to dissolve or disintegrate in the mouth. Traditional sweetener sources include sucrose, dextrose, glucose, liquid glucose, and fructose. For the purpose of developing oral medications, poly hydric alcohol like mannitol is important because, they are free of a bitter aftertaste and have a lesser risk of causing cancer. For individuals with diabetes, the use of naturally occurring sugars in buccal formulations is restricted, necessitating the inclusion of sugar-free or non-glycemic sweeteners to ensure safety and suitability. Artificial sweeteners, such as aspartame and saccharin, are consequently most frequently employed in food products and pharmaceutical items. [16]

5.9. Surface active agents

Surfactants serve as wetting, dispersing, and solubilizing agents in buccal film formulations, aiding in the rapid melting of the film and the efficient release of the active ingredient. Additionally, they are incorporated into fast-dissolving buccal films to improve the solubility and bioavailability of poorly water-soluble drugs. Common examples include Poloxamer 407, sodium lauryl sulphate, benzalkonium chloride, as well as non-ionic surfactants like Tweens and Spans. [16]

5.10. Agents for stabilizing and thickening

The solution or dispersion used for preparing the film for casting has better consistency and viscosity by the addition of stabilizing and thickening agents before casting. Cellulose derivatives and carrageenan are some examples of naturally occurring stabilizers and thickeners in a 5% w/w concentration. [25]

6. Manufacturing methods of buccal film

Buccal film formulation is mainly prepared by following three methods [26]

- Solvent Casting Method
- Hot Melt Extrusion Method
- Direct Milling Method

6.1. Solvent Casting Method [27, 28]

In solvent casting method, required quantity of polymer is added and dissolved in distilled water. Active pharmaceutical ingredient in small quantity added in this solution. Plasticizer is added in solution and stirred well. Solution is then casted on petridish and kept in hot air oven for drying at 40^0C. After drying, it was cut from the petri plate using a blade and placed in a desiccator for 24 hours. Henceforth cut in required size and shape.

Steps involved in Solvent Casting Method.

- **Preparation of the casting solution -** The polymer, active ingredient, and excipients are either dissolved or evenly distributed in an appropriate solvent to form a consistent solution.
- **Elimination of air bubbles** - The solution is deaerated to remove any trapped air, ensuring a smooth film surface.
- **Casting into the mould** - A measured quantity of the solution is transferred into the mould to produce a uniform layer.
- **Drying the cast solution** - The solution is dried under controlled conditions until the solvent fully evaporates and a thin film is formed.
- **Cutting the final dosage form** - The dried film is cut into pieces containing the required dose of the drug.

6.2. Hot Melt Extrusion Method [11]

In the hot melt extrusion method, the drug is combined with other excipients and heated until it melts. The molten mixture is then pushed through an orifice, producing a uniform material that can be shaped into granules, tablets, or films. This method is widely applied in the development of transdermal drug delivery systems.

Steps involved in Hot Melt Extrusion Method.

- The drug is blended with solid carriers.
- Extruder having heaters melts the mixture.
- Finally, the melted mixture is shaped in films by the dies.

6.3. Direct Milling Method [11]

This method is solvent free method. In this technique, the drug and excipients are blended in the absence of any liquid, either through direct milling or kneading. The resulting material is rolled onto a release liner until the desired thickness is achieved. This technique is often chosen because it removes the risk of residual solvents and prevents solvent-related health issues.

7. Parameters for evaluating buccal film

7.1. The Film's weight

The weight of each buccal film is measured individually using a calibrated balance and noted accordingly. [29]

7.2. Film thickness

This test is carried out with a calibrated micro meter screw gauge to measure the uniformity of how thick the film is since it has a substantial impact on the film's dosing precision and maintains the production process's predictability. A mean value is calculated after five analyses of the film's thickness. [30]

7.3. pH of the Film's surface

After the films have interacted with 1 ml of distilled water for 2 h at 25^0C, the pH can be measured by placing the electrode on the film's surface and letting it equilibrate for 1 min. [31]

7.4. Folding endurance

The film is continuously folded in the same spot till it breaks to assess how long it can withstand folding. The number of folds a film can endure in a specific area before rupturing is known as its folding tolerance. [3]

7.5. Tensile strength [3]

A film's tensile strength is the amount of force needed to cause deformation failure. In between two clamps that are spaced apart by a certain amount, film strips of a particular size are held.

"Tensile strength (N/mm^2) = breaking force (N) / cross sectional area of sample".

7.6. *In-vitro* disintegration time

The in vitro disintegration time is determined by placing the film in a petri plate containing 2 mL of distilled water and rotating it every 10 seconds, while visually monitoring the time taken for complete disintegration. This time is then recorded as the period during which the film disintegrates. [32]

7.7. Homogeneity of the drug content

Homogeneity determination was assessed by taking 5 films that had been previously weighed, and dissolved in 100 ml of isotonic phosphate buffer, pH 6.8, then allowing the mixture to stand for 2 h using a magnetic stirrer, then, the resulting liquid was filtered employing Whatman filter paper, and after the correct dilution, the medication was assessed using a spectrophotometer. [31]

7.8. Test for percent moisture loss [33]

The percentage of moisture loss was determined by putting two films measuring 2 x 2 cm^2 with anhydrous calcium chloride in a desiccator for three days. After removing and weighing the film sheets, an equation was employed to calculate the per centage of moisture lost.

"Percentage Moisture Loss = [(Initial weight - Final weight) / Initial weight] X 100%"

7.9. Percentage moisture uptake [33]

The films were placed in a desiccator containing saturated potassium chloride solution and maintained at 25°C for 24 hours to achieve drying at 84% relative humidity. After 24 hours, the films were removed and weighed. The percentage of moisture uptake can be determined by employing the formula below.

"Percentage moisture uptake = [(Final weight - Initial weight) / Initial weight] X 100%"

7.10. Swelling index [34]

Each buccal film was weighed separately (W1) and placed in a petri plate with phosphate buffer (pH 6.8). After allowing the films to swell, they were gently blotted with filter paper to eliminate excess surface water and then reweighed (W2). The swelling index (S1) was determined using the following formula:

"SI = (W2 - W1) / W1"

where; SI = Swelling index, W2 = Final weight. W1 = Initial weight.

7.11. *In-vitro* drug release [31]

Two chambers Franz diffusion cell was utilized, one of which contains a buffer solution with a pH of 6.8 and the other of which has 10 mg of the medicine as a donor. Between these sections, a dialysis membrane (Mol. Wt. 12,000-14000Da) that had previously been soaked for 2 h in receptor media was used to create a barrier. The flowing water bath kept the temperature at 37^0C throughout the entire procedure. For up to 8 h, 0.5 ml of the sample was taken out of the receptor compartment and replaced with a new buffer at predetermined intervals. The appropriate dilution was done, and spectroscopic analysis was carried out to find how much medication was released.

The following formula was used to determine the flux value:

Flux = Amount of drug released (mg)/Time (hr) Area (cm^2)

7.12. Ex-vivo muco-adhesion time

The buccal film is applied to freshly excised sheep or rabbit buccal mucosa, which is secured to a glass slide. To determine the mucoadhesion time, the film is gently pressed using fingertips and moistened with a drop of phosphate buffer (pH 6.8). The mucosa is then covered for 30 seconds. The glass slide is placed in a beaker containing phosphate buffer (pH 6.8) and maintained at a temperature of 37 ± 1°C. After 2 min, a 50-rpm stirring speed is introduced, and film adherence for 24 h to mimic the buccal cavity environment. Along with the film's time collapsing, a timer records how long it takes for shape and colour changes to become apparent. [26]

7.13. *Ex-vivo* permeation studies

The adapted Franz diffusion cell comprised of two sections: a donor chamber and a receptor chamber, each having a 25 ml capacity, was implemented to carry out permeation investigations. In order to control the environment of the test at 37^0C, a water jacket comprised of 23 ml of pH 6.6 phosphate buffer was inserted within the compartment that holds the receptors. The dissected buccal epithelium was installed between the two chambers, and a Teflon-coated magnetic bead was used to suspend the complete assembly on a magnetic stirrer. After the buccal film was set aside to stabilize, 1 ml of the sample was taken out at regular intervals and properly diluted for spectrophotometric analysis. [35]

7.14. Stability studies

Stability tests are carried out for the purpose of examining any changes that may occur while storing any formulation. All of the formulations were stored in stability chambers for three months in triplicate at 40-42^{0}C and 75^{0}C + 5 % RH. Stability experiments were analysed for folding durability, drug content, and in vitro drug release. [36]

8. Future aspects of buccal film

Buccoadhesive buccal films can serve as carriers for potent drugs that are suitable for administration through the buccal route. [27] The drug release profile can be assessed through dissolution studies of the buccal film. Additionally, in vivo studies can be conducted to evaluate the performance of the formulated buccal film. Stability studies can also be performed to determine the film's shelf life and durability.

9. Conclusion

This review highlights that buccal films stand out as one of the most promising and attractive dosage forms, thanks to their distinct properties compared to other advanced buccal drug delivery systems. They bypass first-pass metabolism and enhance the bioavailability of the active ingredient. Buccal administration offers a valuable non-invasive option for delivering potent peptide-based and potentially protein-based therapeutics, as well as a promising approach for the systemic delivery of drugs that are ineffective when taken orally. Nonetheless, achieving safe and effective enhancement of buccal permeation and absorption remains crucial for advancing buccal drug delivery. Ongoing research on buccal films aims to support the systematic delivery of medications unsuitable for oral administration.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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