WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.453
Volume 14, Issue 7, 387-406. Review Article ISSN 2277–7105

RECENT INSIGHT ON MUCOADHESIVE BUCCAL FILMS: A PROMISING PLATFORM FOR ENHANCED DRUG DELIVERY

Parthiban S.[1] and Yashaswini N. R.[2]*

[1]Department of Pharmaceutics, Bharathi College of Pharmacy, Bharathinagara, Mandya, Karnataka, India-571422.

[2]II M Pharm (Pharmaceutics) Bharathi College of Pharmacy, Bharathinagara, Mandya, Karnataka, India-571422.

Article Received on
07 February 2025,

Revised on 27 Feb. 2025,
Accepted on 19 March 2025

DOI: 10.20959/wjpr20257-36040

***Corresponding Author**
Yashaswini N. R.
II M Pharm (Pharmaceutics)
Bharathi College of Pharmacy, Bharathinagara, Mandya, Karnataka, India-571422.

ABSTRACT

A buccal film is a thin, flexible film that is designed to be placed between the gum and cheek in the mouth. It is often used as a form of drug delivery system, allowing medications to be absorbed through the mucous membranes in the mouth. The film typically dissolves or melts quickly, releasing the medication for absorption into the bloodstream. Where Bioadhesion is the phenomenon of interfacial molecular attractive forces between natural or synthetic polymers and biological substrate surfaces that enables the polymer to stick to the biological surface or mucosal surface for a long time. The buccal portion of the mouth's mucosal cavity provides a charming route of administration for systemic medication delivery. In the present review, introduced buccal film delivery with Mucoadhesion, advantages, various technologies involved in the preparation of buccal film.

KEYWORDS: Buccal Films, Oral Drug Delivery, Bioadhesion

INTRODUCTION

Oral drug delivery system

The oral route is the most frequently used method for drug administration, favoured for its benefits like being non-invasive, enhancing patient compliance, and providing convenience in drug delivery. Several factors influence oral drug absorption, such as the drug's solubility, permeability through the mucosal lining, and its stability within the gastrointestinal tract.[1] The main challenges in oral drug delivery include overcoming issues like difficulty

swallowing pills, delivering unpleasant-tasting medications, and minimizing the frequency of doses.[2]

There are five areas in which the oral cavity's mucosal membranes are located

1. The sublingual
2. The buccal mucosa (Cheeks)
3. Gingival (Gums)
4. Palatal mucosa
5. The lip lining

Each of these sites has a distinct morphology, drug permeability, and ability to retain a system for the desired amount of time. The mouth cavity has been used to provide both local and systemic drug therapy. The sublingual mucosa has a richer blood supply, is thinner, and is more porous than the buccal mucosa.

A retentive system and controlled, extended drug distribution can be implemented using the buccal mucosa's vast, smooth, and largely static surface.[3] Water (90–98%), glycoproteins (1-4%), electrolytes, cell constituents, lipids, proteins, enzymes, and immunological agents (1-4%) make up the majority of mucus. Because mucus is a viscoelastic gel with shear-thinning effect, it can occasionally be seen as a single layer.[4] Despite the constant secretion of mucus, The GI tract secretes the most of it, but each organ does so in varying quantitiesand thicknesses. Glycoproteins called Mucins are what give mucus its Mucoadhesive properties. Mucins are secreted by goblets, which are epithelial cells.[5] Because Mucins are essential for covering the oral cavity with mucous secretions because they can influence particular tissues and be conjugated to positively charged medication molecules. This facilitates the method of medication distribution. Consequently, it is used in Mucoadhesive system modelling.[6]

- **Buccal drug delivery system**

Buccal drug delivery is an innovative method of administering medication through the mucous membrane lining the inside of the cheek. This route offers several advantages over traditional oral and intravenous administration. One of the primary benefits is improved bioavailability, as buccal delivery bypasses the gastrointestinal tract and hepatic first-pass metabolism, allowing more of the drug to enter systemic circulation directly. This can result in a quicker onset of action, which is particularly beneficial for conditions requiring rapid relief.[7]

Types of novel buccal dosage forms

It includes,

1. Buccal Mucoadhesive tablets
2. Patches
3. Films
4. Semisolids (Ointments and gels) and Powders.

A. Buccal mucoadhesive tablets

Buccal Mucoadhesive tablets are solid dosage forms that must be moistened before placing them on the buccal mucosa. An example includes a dual-layer tablet, featuring an adhesive matrix layer of Hydroxy Propyl Cellulose (HPC) and Polyacrylic Acid, with an inner core containing cocoa butter, insulin, and a penetration enhancer like Sodium Glycocholate.

B. Buccal Patches and Films

The two layers of buccal patches are created by casting an aqueous sticky polymer solution onto a non-permeable backing sheet, which is subsequently cut into the appropriate oval form. The "Zilactin" Mucosal Adhesive film serves as an illustration; it is made using three organic acids and an alcoholic Hydroxy Propyl Cellulose (HPC) solution. Even when this film is exposed to liquids, it can remain on the oral mucosa for at least 12 hours.

C. Buccal Semisolid Preparations (Ointments and Gels)

When compared to solid formulations, Bioadhesive gels or ointments are typically less well-liked by patients and are mostly utilized for localized medication administration in the oral cavity. Orabase is a type of oral Mucoadhesive system that is made up of Gelatine, Sodium Carboxy Methyl Cellulose (NaCMC), and finely ground pectin that are all mixed together in a gel base made of mineral oil and Polyethylene. 15 to 150 minutes is how long this formulation will remain in situ.

D. Buccal powders

In animal trials, a considerable increase in residence time is noted when HPC and Beclomethasone are administered as powder to the oral mucosa; 2.5% of Beclomethasone is observed to persist on the buccal mucosa for more than 4 hours.[8]

❖ **Advantages**

- The membrane locations are easily accessible, facilitating the application, localization, and removal of the delivery system.

- Because they have a longer duration of contact with the mucosa, many medications operate better.
- High patient acceptance in contrast to alternative non-oral medication delivery methods.[9] By entering the systemic circulation directly through the internal jugular vein, acid hydrolysis in the gastrointestinal (GI) tract is prevented.

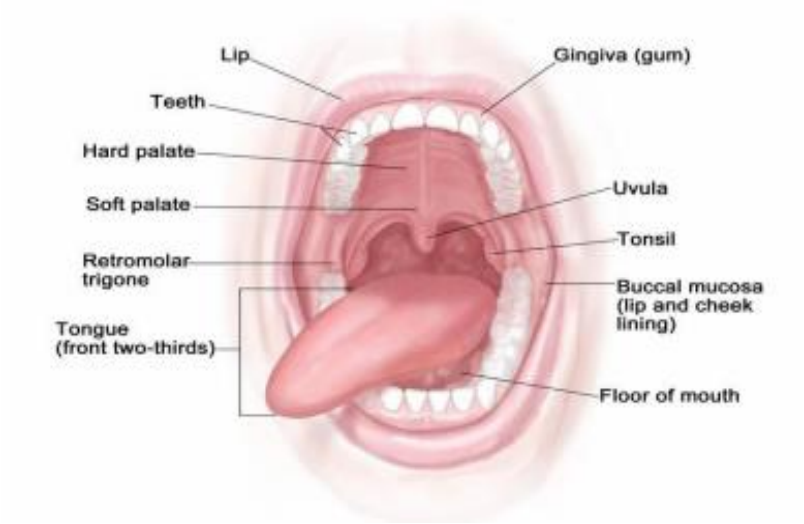

Figure 01: Mucosal region of mouth.

- Another benefit of this approach is the buccal mucosa's quick cellular recovery.[10]
- Easy management and great accessibility.
- Smooth muscle and a somewhat immobile mucosa make it appropriate for administering retentive dose forms.
- Low enzymatic activity and easy drug withdrawal.
- Suitable for medications or excipients that irritate or harm the mucosa in a mild, reversible manner.
- Adaptability in design, including the ability to create unidirectional or multidirectional release systems for systemic or local activities.[11]

❖ **Disadvantages**

- Prolonged use of a medication that has the potential to cause ulcers.
- There isn't a suitable model for oral mucosal transport in vitro drug screening. This is the main disadvantage of this medication delivery method.
- It is necessary to assess patient acceptability with regard to flavour, irritability, and mouth feel.
- The buccal membrane has a lower permeability than the sublingual membrane.

- A smaller amount of surface. The buccal membrane is one of the approximately 50 cm of non-keratinized tissues that make up the 170 cm^2 of oral cavity membrane surface area that is available for medication absorption.
- The drug's solubility as a result of constant salivary flow (0.5-2 l/day).
- Saliva swallowing may also result in the loss of dissolved or suspended medication and, eventually, the dose form being removed against one's will.[12]

❖ **Mechanism of buccal absorption**

Buccal drug absorption takes place through the intercellular gaps of the Epithelium by passive diffusion of the nonionized species, which is mainly controlled by a concentration gradient. The main transport method for non-ionic species is passive transport across the buccal cavity's lipid membrane. Along with many other Mucosal membranes, the buccal mucosa has been described as a lipoidal barrier to drug passage, meaning that the more lipophilic the drug molecule, the easier it is to be absorbed. Drug absorption dynamics in the buccal region could be sufficiently explained by a first-order rate process. By altering the concentration of the medication in the mouth, salivary secretion modifies the buccal absorption kinetics from drug solution, as noted by Dearden and Tomlinson (1971). The following is the linear relationship between time and salivary secretion:

$$-\frac{dm}{dt} = \frac{KC}{ViVt}$$

Where,

M - Mass of drug in mouth at time tı, C - Concentration of drug in mouth at time

K - Proportionality constant, Vi- The volume of solution put into mouth cavity and Vt - Salivary secretion rate.[13]

❖ **Buccal film**

✓ Buccal films, in particular, are thin, flexible, and Mucoadhesive strips that adhere to the buccal mucosa, releasing the drug in a controlled manner. This delivery system enhances patient convenience and compliance due to its ease of use and non-invasive nature. Patients can administer the medication themselves without the need for water or complicated instructions, and the films can be removed if necessary, providing an additional safety measure.[14]

- ✓ Additionally, the buccal mucosa's rich vascularisation facilitates rapid absorption and a swift onset of therapeutic effects. The convenience and compliance associated with buccal films cannot be overstated; they are easy to administer, non-invasive, and can be removed if necessary, which can significantly improve patient adherence to treatment regimens.[15]

❖ **Manufacturing methods of buccal film[16]**

✓ Buccal film formulation is mainly prepared by following three methods.

1. Solvent casting method
2. Hot melt extrusion method
3. Direct milling or kneading method

1. Solvent casting method

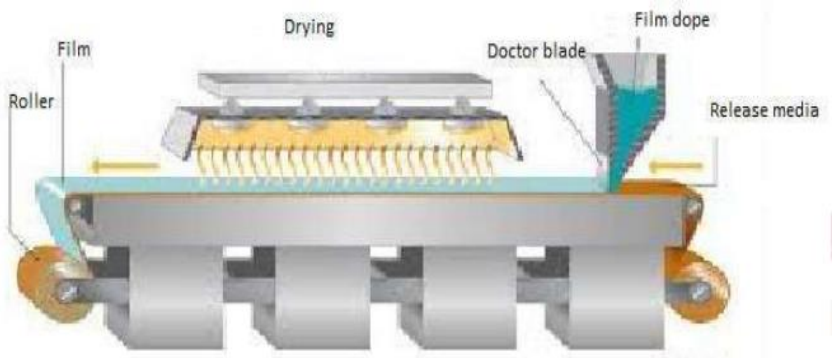

Figure 02: Solvent casting method.

Steps involved in preparation of buccal film

Prepare the casting solution (API, polymer, distilled water). Deaerate this solution. Transfer the appropriate volume of solution into the mould. Then dry the transferred casting solution. Cut the final dosage form into shapes.[16]

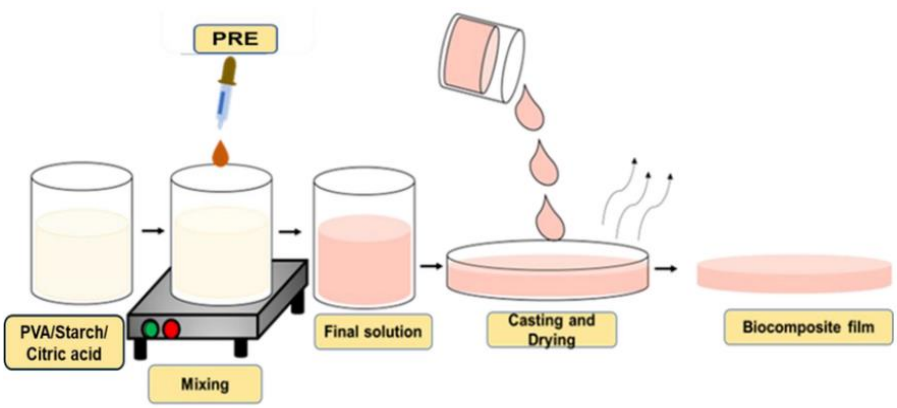

Figure 03: Steps involved in preparation of Buccal Film.

2. Hot melt extrusion method

➢ Procedure for Preparing Buccal Film by Using Hot-Melt Extruded Method.

Step 1: Pre-Treatment of polymers

- Pure polymers were oven-dried at 50°C for 24 hours to remove any adsorbed moisture before extrusion.

Step 2: Ingredient preparation

- All formulation ingredients (excluding the active drug) were weighed accurately.
- The weighed ingredients were sifted through a 35-mesh sieve to ensure uniform particle size.
- The sieved ingredients were then mixed uniformly.

Step 3: Drug and Formulation blending

- The active drug was added to the formulation mixture.
- The mixture was transferred into a Patterson Kelly twin-shell dry blender.
- Blending conditions:
- Speed: 25 rpm
- Time: 10 minutes
- This step ensured uniform distribution of the drug in the final blend.

Step 4: Extrusion process

- The final blended formulation was hand-fed at a near-constant flow rate into a mini-hopper of the extruder.
- Extrusion parameters:
- Screw speed: 50 rpm
- Barrel temperature range: 120°C to 160°C
- Extruder type: Bench-top co-rotating twin-screw hot-melt extruder
- Die type: Transverse-slit die
- Torque: Maintained at 20–40% (10–13 N·m)
- Die pressure: Monitored and recorded during the process

Step 5: Post-Processing of Hot-Melt Extruded Films

- The produced HME films were cut to the desired size.
- Films were flushed with nitrogen to prevent oxidation.

- Packaged in Aluminium foil and stored in foil-lined polyethylene bags until further analysis.[17]

3. Direct milling method

- Steps for Solvent-Free Direct Milling or Kneading Method:

Step 1: Weigh ingredients

- Accurately measure the required amounts of the active pharmaceutical ingredient (API) and excipients.

Step 2: Pre-mixing

- Lightly mix the API and excipients in a dry state to ensure initial uniformity.

Step 3: Direct milling or kneading

- Use a milling or kneading machine to blend the mixture thoroughly without any solvent.
- Apply mechanical force to disperse the API evenly in the excipients, creating a homogeneous mixture.

Step 4: Thickness adjustment

- Process the blended material to achieve the desired consistency or viscosity.

Step 5: Rolling on Release-Liner Rollers

- Pass the uniform mixture through rollers lined with a release liner.
- Control the rolling pressure to get the required thickness.

Step 6: Final processing

- If required, cut or shape the material into the final form.
- Perform necessary quality checks, including uniformity and mechanical properties.

Step 7: Packaging & Storage

- Transfer the processed material into appropriate packaging.
- Store under recommended conditions to maintain stability and efficacy.

  This method ensures a solvent-free process, eliminating solvent residues and related health risks.[18]

❖ **Ingredients used in the formulation**

1. Drugs

Although buccal film can be used to administer a variety of medicinal substances, there are still certain limitations because it might be challenging to create medications with large dosages and molecular weights as buccal film. Typically, the buccal film can be made with 5–30% (w/w) of the medication. Hydrophobic medications are uniformly distributed throughout the buccal film, whereas hydrophilic pharmaceuticals are in the form of dissolvent substance or solid solution condition.[19] The medicinal moiety can be ground, micronized, or formed into nanoparticles to alter the drug's release and obtain the desired release profile. By employing drug particles that have been micronized, the consistency, dissolving profile, and homogeneity of the drug contents of buccal film can be improved. It is advisable to use a medication in the form of buccal film to treat cough, allergies, motion skinless, pain disorders, and some local oral disease conditions.[20]

2. Excipients

The formulation of buccal drug delivery systems, particularly buccal film, primarily focuses on Mucoadhesive polymers because of the critical role that contact between the buccal mucosa and the film plays in effectively delivering the drug.[21]

3. Penetration enhancers

Substances that are used to enhance the penetration of the active moiety are called penetration enhancers. They should not produce irritation and have reversible effect. One of the simple examples of penetration enhancer is the use of water. When the skin gets hydrated it gradually increases the permeability as water cause the opening of the compact structure of needle base.[22]

4. Taste Masking and Sweetening agents

It's critical to cover up the unpleasant taste of medications in order to improve patient compliance. Some techniques, such as complex formation or salting out technology, can be utilized to cover up the bitter taste (buccal film). The sweetening agent is a crucial component of Orodispersible formulations, particularly those intended for peads. The formulas contain both artificial and natural sweeteners. Examples of natural sweeteners include sucrose, dextrose, fructose, glucose, liquid glucose, and maltose; examples of artificial sweeteners include saccharin, aspartame, sucrose and others.[19]

5. Saliva stimulating agent

Increasing the rate of saliva production is the goal of using saliva stimulating chemicals, which will help the rapid dissolving strip formulations dissolve more quickly. Generally speaking, salivary stimulants can be made from acids used in meal preparation. The few examples of salivary stimulants are citric acid, which is the most preferred, followed by malic acid, lactic acid, ascorbic acid, and tartaric acid.[23]

6. Flavouring agents

An oral disintegrating or dissolving formulation's acceptability by a person is determined by the flavour quality that is detected in the initial seconds following consumption and the formulation's aftertaste, which last for at least ten minutes. Age was found to have a major impact on taste fondness. While the younger generation prefers flavours like fruit punch, raspberry, etc., the elderly prefer mint or orange flavours. The selection of flavouring agents includes synthetic flavour oils, oleo resins, and extracts made from different plant components such as leaves, fruits, and flowers. Flavour oils include Peppermint, Cinnamon, Spearmint, and Nutmeg oils, whereas fruity flavours include Vanilla, Cocoa, Coffee, Chocolate, and Citrus. Fruit essence type is found in fruits like Apples, Pineapples, Cherries, and Raspberries.[24]

7. Colouring agents

Colouring agents are used to improve the appearance of buccal film. There are different FD&C approved colouring agents.[25]

8. Plasticizers

It is a component that the oral films require. The choice of plasticizer is based on how well it works with the polymer and what kind of solvent is utilized for film casting. It increases the film's elasticity while decreasing its brittleness. Their usage ranges from 1 to 20% w/w of dry polymer weight. Among the examples are castor oil, glycerol, propylene glycol, low molecular weight polyethylene glycols, citrate derivatives such as Triacetin and Acetyl citrate, and phthalate derivatives such as dimethyl, diethyl, and Dibutyl derivatives.[26]

9. Polymers

To prepare a film formulation that is water-soluble, excipients or polymer must be water soluble with low molecular weight and excellent film-forming capacity. The chosen polymer should be free of leachable contaminants, non-toxic, and non-irritating. It should have strong

spreadability and wetting properties. It should have adequate tensile, peel, and shear strengths. It should be reasonably priced and easily accessible. Examples of appropriate polymers that can be added to FDFs include Pullan, Gelatine, Hydroxy Propyl Methyl Cellulose (HPMC) and Corboxy Methyl Cellulose (CMC).Polyvinyl Alcohol, Sodium alginate, Xanthine gum, Tragacanth gum, Chitosan, Guar gum, Acacia gum, Methyl methacrylate copolymer and Hypromellose are most commonly used for preparation of buccal films.[27]

Table 01: Classification of polymer used in buccal films.[28]

Based on source	
1. Synthetic polymer	Cellulose derivatives, Poly (acrylic acid) polymers, Poly (hydroxyethyl methyl acrylate), Poly (ethylene oxide), Poly (vinyl alcohol), Poly (vinylpyrrolidone), Thiolated polymer, Polyurethanes.
2.Natural polymer	Tragacanth, Sodium alginate, Agarose, Guar gum, Xanthan gum, Karaya gum, carrageenan, Chitosan, Soluble starch, Pectin, Gelatin.
Based on solubility	
1.Water-soluble polymer	Hydroxy Ethyl Cellulose, Hydroxy Propyl Cellulose, PAA, Sodium CMC, HPMC, Sodium alginate, Carbopol
2.Water-insoluble polymer	Chitosan, Ethyl cellulose, Polycarbofil.
Based on charge	
1.Cationic	Chitosan, Dimethylamine ethyl-dextran, Amino dextran .
2.Anionic	Chitosan-EDTA, CMC, CP, pectin, PC, PAA, xanthan gum, sodium CMC, alginate.
3.Non-ionic	Hydroxyethyl starch, PVA, PVP HPC, scleroglucan, poly (ethylene oxide).
Based on generation	
1.First generation	Chitosan, dimethyl amino ethyl-dextran, Amino dextran Chitosan-EDTA,CMC, CP, pectin, PC, PAA, sodium, xanthan gum, sodium CMC alginate, Hydroxy ethyl starch, PVA, PVP HPC, Scleroglucan, Poly (ethylene oxide)
2. Second generation	Lectins, Thiolated polymers
Based on potentialbioadhesive forces	
1.Covalent bond	Cyanoacrylate
2.Hydrogen bond	CP, PVA, PC, Acrylates
3.Electrostatic bond	Chitosan

Table 02: Recently reported research work on buccal films.[29-48]

S. No	Author	Method	Polymers	Observation
01	Nair et al., AB (2021)	Solvent Casting Method	HPMC F4M, HPMC K4M, HPMC K100M,Eudragit	The Rizatriptan buccal delivery system demonstrated promising potential for improving clinical efficacy in migraine treatment. The

			RS 100, Tween 80, Polyethylene glycol 200 (PEG 200)	developed buccal films exhibited optimal drug release and enhanced absorption, suggesting a feasible alternative to traditional dosage forms. These findings support the potential of buccal therapy for more effective migraine management.
02	Salehi S et al., (2019)	Solvent Casting Method	Hydroxypropyl Methylcellulose (HPMCK4M) Polyethylene glycol graft-copolymer	The optimized mucoadhesive buccal film successfully co-delivered RB and PRH, demonstrating favourable physical, mechanical, and drug release properties. The formulation showed good drug permeation through rat buccal mucosa and minimal histological damage. Future in vivo studies are recommended to confirm the efficacy and safety of the formulation.
03	Jose J et al., (2021)	Solvent Casting Method	Hydroxypropyl Methyl Cellulose, Polysorbate 80	The mucoadhesive buccal films of Benzocaine, using Chitosan and HPMC, demonstrated effective drug release and permeation properties. The formulation with an optimal ratio of Chitosan to HPMC and appropriate plasticizers showed the best performance. These films offer a promising controlled drug delivery system for mouth ulcer treatment, improving patient convenience and compliance.
04	Begum MY et al., (2021)	Solvent Evaporation Method	Carbopol P934, HPMC K4M, Chitosan, PVP K30, and Sodium alginate	The ketorolac Tromethamine Mucoadhesive buccal films, using a combination of Carbopol P934, Sodium alginate, and PVP K30, demonstrated excellent physicochemical properties suitable for buccal application. The films showed effective drug release, Mucoadhesion, and significant anti-inflammatory and analgesic activities. These results suggest the buccal film as a promising alternative for the delivery of KTM, improving therapeutic outcomes.
05	Abdella S et al., (2022)	Solvent Casting Method	HPMC, Kollicoat IR (PVA-PEG copolymer)	The Mucoadhesive buccal films of Estradiol, developed using co-solvency and nano-emulsion methods, demonstrated excellent drug release, permeability, and

				mechanical properties. The nano-emulsion approach showed promising results with enhanced drug permeation and potential for sustained Estradiol release. These films could be a viable option for improving hormonal therapy, particularly for menopausal symptoms.
06	Mady OY et al., (2021)	Solvent Casting Method	Carboxymethyl Cellulose, Tween 80, Polyvinylpyrrolidone K40	The study demonstrated that Bioadhesive buccal films can effectively address challenges in oral drug administration, improving drug bioavailability. The buccal films showed enhanced pharmacokinetic parameters, such as increased Cmax and AUC, compared to oral forms. These findings suggest that Bioadhesive buccal films are a promising dosage form for drugs with absorption issues.
07	Mady OY et al., (2023)	Solvent Casting Method	HPMC E3, HPMC K4 and C 940	The study demonstrates that Doxy Hyc-loaded mucoadhesive buccal films are effective for prolonged antibiotic release and exhibit favourable in vitro and in vivo performance. The formulation showed promising results in treating periodontitis in rats, improving clinical parameters and reducing MMP-8 levels. Further human studies are necessary to confirm the potential of these films for local oral treatments.
08	Korelc K et al., (2023)	Solvent Casting Method	Chitosan types Chitopharm™, CM, M and L, Viscosan	The study successfully developed child-friendly mucoadhesive films and wafers for controlled drug delivery, using Chitosan-based formulations. The selected formulations exhibited favourable mucoadhesive properties, suitable drug release, and biocompatibility. Mucoadhesive wafers, in particular, demonstrated a more sustained drug release, making them a promising alternative to films for Pediatric applications.
09	Jovanović M et al.,	Solvent Casting	Gelatin (Type A Gelatinfrom	The study demonstrated that both Gelatin-based mucoadhesive films

	(2021)	Method	porcine skin (~300 g Bloom)and type B Gelatinfrom bovine skin (~225 g Bloom)	(GA and GB) are promising carriers for delivery to the buccal mucosa, offering targeted drug delivery and reduced dosing. GA films exhibited better mechanical properties and faster drug release, while GB films showed stronger Mucoadhesion forces but slower drug release. Both formulations offer good potential for improved bioavailability and therapeutic efficacy.
10	Vajrala LL et al., (2023)	Solvent Casting Method	HPMC, PVP	The study successfully identified Basil Seed Mucilage as a cost-effective and suitable natural polymer for buccal film formulations. The selected formulation demonstrated excellent drug content and mucoadhesive strength, paving the way for further optimization. Carvedilol buccal films showed promising physicochemical properties, indicating their potential as an effective controlled drug delivery system.
11	Kristó K et al., (2022)	Solvent Casting Method	Chitosan 80/1000	Successfully developed Ascorbic acid-containing Chitosan films as buccal drug delivery systems, highlighting the role of ascorbic acid as a plasticizer and its impact on film properties. The optimal concentration of ascorbic acid was determined to be 2%, offering favourable drug release characteristics for cationic drugs. These findings contribute valuable insights into the structure and formulation of Chitosan-based films for future drug delivery applications.
12	Pamlényi K et al., (2022)	Solvent Casting Method	HPMC, Sodium alginate	The study successfully formulated buccal films using SA, demonstrating strong mechanical and mucoadhesive properties. Interactions between excipients, particularly hydrogen bonding, enhanced the films' thermal and mechanical stability. Promising formulations were identified, showing potential for use in buccal

				drug delivery systems.
13	MOHAMED MI et al., (2024)	Solvent Casting Method	HPMC,Hydroxy Propylcellulose (HPC), Sodium Carboxy Methyl Cellulose (Na CMC), Gelatin, Polyvinyl pyrrolidone	Lornoxicam mucoadhesive buccal films were successfully developed using various polymers, showing promising properties for effective drug delivery. The optimal formulation demonstrated good bioadhesion, drug release, and stability, suggesting its potential for pain relief and inflammation treatment. Further clinical studies are needed to confirm the therapeutic efficacy and applicability of these films.
14	Jillani U et al., (2022)	Solvent Casting Method	HPMC, Agarose	The study demonstrated that Ondansetron hydrochloride mucoadhesive buccal films, enhanced by iontophoresis, significantly improved bioavailability and rapidly controlled emesis in experimental animals. The films showed good compatibility, effective drug incorporation, and minimal tissue damage. These results suggest the potential of this formulation for faster, more efficient emesis management with fewer side effects.
15	Arpa MD et al., (2021)	Solvent Casting Method	HPMC (low molecular weight; viscosity of ~15 cP,PVP K30	Terbinafine Hydrochloride loaded Buccal Films with HPMC polymer showed excellent Bioadhesion and controlled drug release, offering effective treatment for Oropharyngeal Candidiasis.
16	Khan MS et al., (2024)	Solvent Casting Method	Hydroxypropyl Methylcellulose (HPMC), sodium alginate, and Polyvinyl alcohol, Chitosan	The Mucoadhesive buccal films for Diclofenac Sodium demonstrated excellent drug release control, mechanical stability, and strong adhesion, ensuring sustained and effective pain relief. The films were biocompatible, stable, and met all necessary standards for drug delivery. These promising results indicate the films' potential as an innovative solution for pain management.
17	Winarti LI et al., (2021)	Solvent Casting Method	Chitosan, HPMC, Ethylcellulose	The combination of HPMC and Chitosan enhances the mucoadhesive strength and

				residence time of buccal mucoadhesive films. The optimized formulation demonstrated favourable swelling, Mucoadhesion, and sustained drug release properties. The release kinetics followed a non-Fickian diffusion mechanism, indicating controlled drug delivery.
18	MADHURI P et al., (2024)	Solvent Casting Method	HPMCK4M, HPMC K15M, HPMC K100M, Ethyl cellulose, Sodium CMC and HPC.	The optimized abacavir sulphate Mucoadhesive buccal films demonstrated significantly improved oral bioavailability compared to marketed formulations. In vivo pharmacokinetic studies in rabbits revealed a prolonged Mucoadhesion duration in the buccal area. This extended residence time likely contributed to the enhanced bioavailability of the drug.
19	Mahapatra AP et al., (2021)	Solvent Casting Method	HPMC, K100M, Sodium alginate, Chitosan, Eudragit RS100	Buccal mucoadhesive films of Alfuzosin hydrochloride show great potential as a drug delivery system with satisfactory residence time and controlled zero-order drug release. The combination of HPMC and Chitosan in the optimized formulation makes it an effective option for buccal administration. This system could help bypass extensive hepatic first-pass metabolism, offering an efficient alternative for drug delivery.
20	Mahajan HD et al., (2025)	Solvent Casting Method	Hydroxyl propyl methylcellulose E-15, E-5, Polyethylene glycol 400, Polyethylene glycol 200,	Mucoadhesive buccal films of Azilsartan Medoxomil showed excellent drug release, Mucoadhesion, and stability, confirming their potential for effective buccal drug delivery.

CONCLUSION

Buccal adhesive systems provide several benefits, including low enzymatic activity, retentivity, ease of administration and withdrawal, accessibility, cost effectiveness, and patient compliance. Avoiding first-pass metabolism in the liver and pre-systemic excretion in the gastrointestinal route is two of the many uses for buccal films. The future prospects of

buccal films are characterized by ongoing advancements in formulation techniques, expanding applications, and the incorporation of novel technologies.

REFERENCES

1. Alqahtani MS, Kazi M, Alsenaidy MA, Ahmad MZ. Advances in Oral Drug Delivery. Front. Pharmacol, 2021; 19, 12: 618411.
2. Gupta H, Bhandari D, Sharma A. Recent trends in oral drug delivery: a Review. Recent Patents on Drug Delivery & Formulation, 2009; 1, 3(2): 162-73.
3. Shahiwala A. Applications of Polymers in Buccal Drug Delivery. In Appl Poly Drug Deliv, 2021; 1(1): 43-76. Elsevier.
4. Duggan S, Cummins W, O'Donovan O, Hughes H, Owens E. Thiolated Polymers as Mucoadhesive Drug Delivery Systems. Eur J Pharma Sci, 2017; 100(1): 64-78.
5. Golshani S, Vatanara A, Amin M. Recent Advances in Oral Mucoadhesive Drug Delivery. J Pharm Pharm Sci, 2022; 25(1): 201- 17.
6. Laffleur F. Mucoadhesive Polymers for Buccal Drug Delivery. Drug Dev Ind Pharm, 2014; 40(5): 591-8.
7. Smart JD. Buccal Drug Delivery. Expert Opin Drug Deliv, 2005; 1, 2(3): 507-17.
8. Aishwarya MN, Raj VP, Debnath S, Babu MN. A review on Buccal Drug Delivery System. Research Journal of Pharmaceutical Dosage Forms and Technology, 2017; 9(3): 109-13.
9. Verma S, Kaul M, Rawat A, Saini S. An Overview on Buccal Drug Delivery system. Int. j. pharm. sci. res., 2011; 1, 2(6): 1303.
10. Reddy PC, Chaitanya KS, Rao YM. A Review on Bioadhesive Buccal Drug Delivery Systems: current status of formulation and evaluation methods. DARU J. Pharm. Sci, 2011; 19(6): 385.
11. Puratchikody A, Prasanth VV, Mathew ST, Kumar A. Buccal Drug Delivery: past, present and future-a review. Int. J. Drug Deliv, 2011; 1, 3(2): 171.
12. Singh J, Deep P. A review article on Mucoadhesive buccal drug delivery System. Int. j. pharm. sci. res, 2013; 1, 4(3): 916.
13. Karnati MR. Design, Formulation and Evaluation of Buccal Dosage Form for Anti Hypertensive Drug (Master's thesis, Rajiv Gandhi University of Health Sciences (India), 2013.

14. Khattab WM, Gad S, El-Sayed MM, Ghorab MM. Simple Controlled Release Delivery System for an Anti-hypertensive Drug via Buccal Route. Br. J. Pharm. Res, 2014; 15, 4(10): 1174.
15. Elkady OA, Tadros MI, El-laithy HM. QbD Approach for Novel Crosslinker Verma S, Kaul M, Rawat A, Saini S. An Overview on Buccal Drug Delivery System. Int J Pharm Sci Res, 2011; 2(6): 1303-21.
16. Jagtap VD. Buccal Film—A Review on Novel Drug Delivery System. Int. J. Res. Rev, 2020; 7: 17-28.
17. Palem CR, Dudhipala NR, Battu SK, Repka MA, Rao Yamsani M. Development, Optimization and In vivo Characterization of Domperidone-controlled release Hot-Melt-Extruded Films for Buccal Delivery. Drug Development and industrial pharmacy, 2016; 3, 42(3): 473-84.
18. Nautiyal U, Saini M. Fast dissolving Buccal film: A comprehensive Review. Asian Pacific Journal of Nursing and Health Sciences, 2023; 20, 6(1): 11-22.
19. Madhavi B, Murthy V, Rani A, Kumar G. Buccal Film Drug Delivery System – an innovative and emerging technology. J. Mol. Pharm. Org. Process. Res, 2013; 1: 2–6.
20. Venkatalakshmi R, Sudhakar Y, Madhuchudana Chetty C, Sasikala C, Varma M. Buccal Drug Delivery using Adhesive Polymeric Patches. Int. J. Pharm. Sci. Res, 2012; 3: 35–41.
21. Monomers and Polymers. Feb Hanif M, Zaman M, Chaurasiya V. Polymers used in Buccal Film: a review. Designed, 2015; 17, 18(2): 105-11.
22. Williams AC, Barry BW. Penetration Enhancers. Adv. Drug Deliv. Rev, 2012; 64: 128–137.
23. Mahajan A, Chhabra N, Aggarwal G. Formulation and Characterization of Fast Dissolving Buccal Films: A review. Der Pharm Lett, 2011; 3(1): 152-65.
24. Puthil SP and Dixit RP: Oral Strip Technology: overview and future potential. J Control Release, 2009; 139: 94-107.
25. Morales JO, McConville JT. Manufacture and Character-ization of Mucoadhesive BuccalFfilms. Eur. J. Pharm. Biopharm, 2011; 77: 187–199.
26. Arunachalam A, Karthikeyan M, Konam K. Fast Dissolving Drug Delivery: a review. J of global trend in pharmaceutical science, 2010; 1(1): 92-110.
27. Bala R, Pawar P, Khanna S and Arora S: Orally Dissolving Strips: A new Approach to Oral Drug Delivery System. Int. J. Pharm. Investig, 2013; 3: 67-76.
28. Ugoeze KC. Bioadhesive Polymers for Drug Delivery Applications. Bioadhesives in Drug Delivery, 2020; 1: 29-56.

29. Nair AB, Shah J, Jacob S, Al-Dhubiab BE, Patel V, Sreeharsha N, Shinu P. Development of Mucoadhesive Buccal Film for Rizatriptan: In Vitro and in Vivo evaluation. Pharmaceutics, 2021; 15, 13(5): 728.
30. Salehi S, Boddohi S. Design and Optimization of Kollicoat® IR based Mucoadhesive Buccal Film for Co-delivery of Rizatriptan Benzoate and Propranolol hydrochloride. Materials Science and Engineering: C, 2019; 1, 97: 230-44.
31. Jose J, Sisira MV, Prasanth ML, Prasanth CS, Pradeep PS. Design and Characterization of Buccal Films of Benzocaine for Mouth Ulcer. Polymer, 2021; 10(250): 250.
32. Begum MY, Alqahtani A, Ghazwani M, Ramakrishna MM, Hani U, Atiya A, Rahamathulla M. Preparation of Carbopol 934 based Ketorolac Tromethamine Buccal Mucoadhesive Film: in Vitro, Ex vivo, and in Vivo assessments. Int. J. Polym. Sci, 2021; 2021(1): 4786488.
33. Abdella S, Afinjuomo F, Song Y, Upton R, Garg S. Mucoadhesive Buccal Film of Estradiol for Hormonal Replacement Therapy: Development and in-vivo performance prediction. Pharmaceutics, 2022; 28, 14(3): 542.
34. Mady OY, Abulmeaty MM, Donia AA, Al-Khureif AA, Al-Shoubki AA, Abudawood M, Abdel Moety DA. Formulation and Bioavailability of Novel Mucoadhesive Buccal Films for Candesartan Cilexetil in rats. Membranes, 2021; 26, 11(9): 659.
35. Dinte E, Muntean DM, Andrei V, Boșca BA, Dudescu CM, Barbu-Tudoran L, Borodi G, Andrei S, Gal AF, Rus V, Gherman LM. In vitro and in vivo Characterisation of a Mucoadhesive Buccal Film loaded with Doxycycline hyclate for topical application in Periodontitis. Pharmaceutics, 2023; 8, 15(2): 580.
36. Korelc K, Larsen BS, Gašperlin M, Tho I. Water-soluble Chitosan eases Development of Mucoadhesive Buccal Films and wafers for children. Int. J. Pharm, 2023; 25, 631: 122544.
37. Jovanović M, Tomić N, Cvijić S, Stojanović D, Ibrić S, Uskoković P. Mucoadhesive Gelatin Buccal Films with Propranolol Hydrochloride: Evaluation of Mechanical, Mucoadhesive, and Biopharmaceutical Properties. Pharmaceutics, 2021; 18, 13(2): 273.
38. Vajrala LL, Umashankar MS, Alagusundaram M. Application of Statistical tools for the Formulation and Optimization of Carvedilol Mucoadhesive Buccal Films by using Natural Polymers. ScienceRise, Pharm. Sci, 2023; 31(4 (44)): 63-75.
39. Kristó K, Módra S, Hornok V, Süvegh K, Ludasi K, Aigner Z, Kelemen A, Sovány T, Pintye-Hódi K, Regdon Jr G. Investigation of Surface properties and free volumes of

Chitosan-based Buccal Mucoadhesive Drug Delivery films containing Ascorbic acid. Pharmaceutics, 2022; 1, 14(2): 345.

40. Pamlényi K, Kristó K, Sovány T, Regdon Jr G. Development and Evaluation of Bioadhesive BuccalFfilms based on Sodium Alginate for allergy therapy. Heliyon, 2022; 1: 8(8).
41. Mohamad MI, EL-Shaboury KF, Abdallah MA. Formulation and Evaluation of Lornoxicam MucoadhesiveBbuccal Films. J. Pharm. Res, 2024; 1: 28(4).
42. Jillani U, Mudassir J, Ijaz QA, Latif S, Qamar N, Aleem A, Ali E, Abbas K, Wazir MA, Hussain A, Abbas N. [Retracted] Design and Characterization of Agarose/HPMC Buccal Films Bearing Ondansetron HCl In Vitro and In Vivo: Enhancement Using Iontophoretic and Chemical Approaches. Biomed Res. Int, 2022; 2022(1): 1662194.
43. Arpa MD, Ünükür MZ, Erim ÜC. Formulation, Characterization and In vitro release studies of Terbinafine Hydrochloride loaded Buccal Films. J. Pharm. Res, 2021.
44. Khan MS, Ahmad RN, Badruddoja A, Mashkoora M, Akhtar JS, Rafeeque SB, Ahmed AA, Shafiullah FS, Khawar MM, Ahmed WA, Iftekhar AA. Development and Evaluation of Mucoadhesive Buccal Films for the Sustained Release of Diclofenac Sodium: An innovative approach for pain management.
45. Winarti LI, Laily AZ, Sari LO, Irawan ED, Nurrahmanto D, Rosyidi VA, Barikah KZ, Ameliana LI. Formula Optimization and In vitro release kinetic studies of Diltiazem hydrochloride Mucoadhesive Bilayer Buccal Film. Int J App Pharm, 2021; 10, 13: 7-12.
46. MADHURI P, RADHA G. Development And In Vitro Evaluation of Abacavir Sulphate Mucoadhesive Buccal Films. Int J App Pharm, 2024; 16(1): 161-5.
47. Mahapatra AP, Nagvenkar SP, Gude R. Studying Formulation and Physicochemical Characterization of Buccal Mucoadhesive Films Containing Alfuzosin Hydrochloride. Technol. Innov. Pharm. Res, 2021; 1: 75-88.
48. Mahajan HD, Ahmad I, Salunke P, Shirsat P, Manyar A, Sayyed G, Khan S. Formulation and Evaluation of Mucoadhesive Buccal Film of Azilsartan Medoxomil By Solvent Casting Method. Cuest. Physiote, 2025; 20, 54(4): 414-27.