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Buccal Drug Delivery Systems: Unveiling the Potential and Progress in Pharmaceutical Administration

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ABSTRACT
By permitting formulations to be deposited into the mouth cavity, generally between the upper gums and inner cheek, the buccal mucosa serves as an important location for medication administration. This approach may be used to treat both local and systemic medical issues. An undulating basement membrane separates stratified squamous epithelial cells from connective tissue, having discrete zones bordered by non-keratinized or keratinized epithelium. Mucus secretion improves adhesion and support, whereas salivary components contribute to mucosal barrier characteristics. Drug permeability via the buccal mucosa is controlled by a variety of variables, including the absence of tight junctions, which makes it more permeable than skin. Saliva includes a high molecular weight mucin (MG1) that coats the mucosal surface and keeps it clean.Saliva contains a high molecular weight mucin (MG1) that coats the mucosal surface and maintains hydration and protection. Saliva is produced by both the major and minor salivary glands. For buccal medication distribution, solid, semi-solid, and liquid dosage forms are utilised, each with its own set of benefits. Notably, the market's different delivery technologies are extending the potential for buccal medicine administration. However, problems remain, such as the development of effective mucoadhesive formulations and standardised mucoadhesion assessment methodologies. The future of buccal drug administration seems promising, notably in vaccine formulations and peptide and protein delivery, with advances in materials and formulation methodologies improving bioavailability and opening up new therapeutic options.

KEYWORDS: Buccal drug delivery, Oral mucosa, Local and systemic drug administration, Drug degradation, First-pass metabolism, Drug permeability, Mucoadhesive formulations, Transmucosal drug delivery

I. INTRODUCTION

The buccal mucosa covers the inner cheek lining, and formulations meant for buccal administration are injected into the oral cavity, especially between the upper gingivae (gums) and the inner cheek (also known as the buccal pouch). This method is used to treat both local and systemic medical disorders.[1] This review will concentrate solely on this explanation of buccal medication distribution, while other literature may include the entire mouth cavity under the umbrella term "buccal cavity." Because of the convenience of administration and the avoidance of potential drug degradation in the gastrointestinal system and first-pass metabolism, the oral cavity is an appealing location for drug delivery. The mouth cavity has four potential medication delivery sites: buccal, sublingual, palatal, and gingival. Buccal drug delivery is the distribution of medications within/through the buccal mucosa to effect local/systemic pharmacological effects. Buccal-delivered medications can be utilised to treat disorders in the oral cavity as well as systemically. However, intrinsic restrictions such as short residence duration, narrow absorption area, and barrier nature of the buccal mucosa make buccal medication distribution difficult. [2,3]

The oral cavity is a favourable channel for medication administration since it allows for mucosal (local) as well as transmucosal (systemic) effects. medications are targeted to the specific oral mucosa area in mucosal delivery, whereas medications are absorbed into the circulation over the oral mucosal barrier in transmucosal delivery.[4] The oral mucosa is less sensitive and has less enzymatic activity than other mucosal locations. For absorption, two ways use the sublingual and buccal mucosa. Sublingual administration is appropriate for highly permeable medications in acute diseases, whereas buccal administration is appropriate for chronic ailments

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needing continuous release. With biotech advancements, interest in buccal delivery has grown, benefitting peptides that are unsuitable for oral administration owing to breakdown. Such high-weight hydrophilic medicines are often administered parenterally, which is less convenient for patients due to frequent injections and high doses.[5]

The masticatory mucosa is located in chewing stress sites and has keratinized cells. A lamina propria connects it to the periosteum. The mucous membrane, on the other hand, has non-keratinized epithelium and a thin, elastic lamina linked to the submucosa. The dorsal mucosa of the tongue is specialised, including papillae and taste receptors. The thickness of the mucosa varies, with buccal being 500-800 m, sublingual and gingival being 100-200 m. Lipophilic medicines are blocked by it. Saliva, released by glands, produces a 70-100 m thick layer on mouth surfaces. Mucus, proteins, minerals, and enzymes are all found in saliva. The pH fluctuates from 5.5-7, depending on stimulation and meals. The normal flow rate is 0.5 mL min-1, the daily secretion rate is 0.5-2 L, and the continuous oral saliva flow rate is 1 ml.[6]

Sublingual for under-tongue administration, buccal for systemic action via cheek lining, and non-specific oral delivery for localised therapy are the three techniques used for oral mucosa medication delivery. The decision is determined by the location and mucosal permeability. Because of its poor permeability and mobility, the buccal mucosa is ideal for sustained-release, sticky transmucosal devices. Understanding hurdles and transportation is critical for successful buccal delivery. [6,7] This research thoroughly examines the histology, physiological, and transport mechanisms, as well as the justification for trans-buccal drug delivery devices. Because of its soft environment for medication absorption, buccal drug delivery is a preferable option to oral administration. Despite limitations such as low permeability and surface area, benefits such as vascularization, accessibility, and patient tolerance make it intriguing. Concerns include saliva dilution, medication ingestion, and choking dangers. Enzyme activity in the buccal mucosa is lower than in other routes, which offsets certain drawbacks.[8]

ANATOMY OF BUCCAL MUCOSA

The buccal mucosa, like skin, plays an important function in safeguarding underlying tissues. It is made up of stratified squamous epithelial cells that are isolated from connective tissue by an undulating basement membrane. Before shedding, this epithelium, generated by developing keratinocytes, changes in size, shape, and content from the basal to the superficial layers. The soft palate, tongue's ventral side, mouth floor, alveolar mucosa, vestibule, lips, and cheeks are lined with non-keratinized mucosa, while the hard palate and non-flexible oral parts are lined with keratinized epithelium. Mucus, a viscous secretion, produces a sticky gel blanket and guarantees adhesion and mechanical support. [9,10]

Saliva aids drug absorption by increasing accessibility, serum concentration, and bypassing stomach acidity. The buccal mucosa's high permeability and surface area facilitate systemic medication administration.[11] The oral mucosa borders the mouth cavity and is made up of several layers, each of which has a distinct role. The stratified squamous epithelium, which consists of many cell layers, is the outermost layer.[12] Divided cells travel upwards, develop, and finally become keratinized, providing a protective barrier in the basal layer. The basal lamina is a thin extracellular matrix that sits underneath the epithelium and supports the epithelial cells. The lamina propria, or connective tissue, comprises blood arteries, neurons, immune cells, and fibroblasts.[13] A deeper submucosa layer containing blood arteries, neurons, adipose tissue, and salivary glands exists in some locations, contributing to processes such as saliva production. Masticatory mucosa (keratinized, for strained parts), lining mucosa (non-keratinized, for less stressed areas), and specialised mucosa (on the tongue's dorsum with papillae and taste buds) are the three types of oral mucosa.[14] The buccal epithelium, in particular, lacks keratinization, has numerous cell layers with unique maturation patterns, and is endowed with gap junctions, desmosomes, and hemidesmosomes allowing for intercellular communication. This distinct shape impacts medication absorption across the buccal mucosa, which is an important element of buccal drug administration systems.[15]

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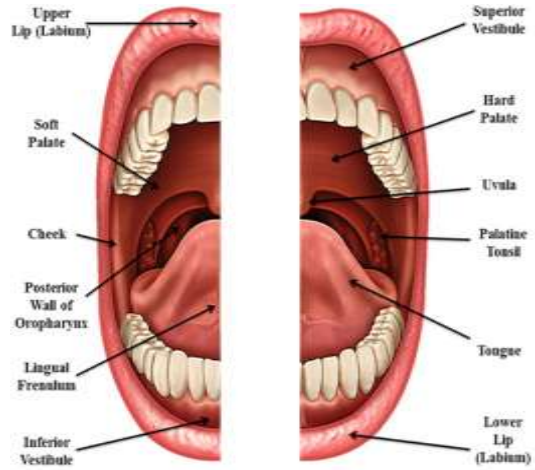

Fig. 1: Anatomy of the Buccal Mucosa: Layers and Structural Components

DRUG PERMEABILITY

The permeability of drugs via the buccal mucosa is an important component of buccal drug delivery devices. The permeability of the buccal mucosa varies according to parameters such as the drug's physicochemical qualities, molecular size, lipophilicity, and charge. The mucosa's distinct structure, notably its stratified squamous epithelium and lack of tight connections, makes medication penetration relatively straightforward.[16] The presence of mucus, the pace of saliva production, and possible enzymatic breakdown in the mucosa, on the other hand, can all have an effect on drug permeability. penetration enhancers, mucoadhesive formulations, and nanotechnology-based techniques are all used to improve medication penetration.[17] A thorough understanding of these permeability processes is required for the development of efficient buccal drug delivery systems with increased bioavailability and therapeutic effects.[18]

PERMEABILITY BARRIER

The permeability characteristics of the buccal epithelium bear similarities to both intestinal mucosa and skin. Unlike skin, buccal mucosa lacks tight junctions common to intestinal and nasal mucosa, instead featuring gap junctions, desmosomes, and hemidesmosomes, which foster loose intercellular links, rendering it more permeable. [19,20] This epithelium's permeability coefficient values for water and horseradish peroxidase exceed those of skin, indicating the presence of a permeability barrier. The connective tissue within the oral mucosa is not a formidable penetration obstacle due to its insufficiently dense extracellular matrix, allowing hydrophilic penetrants to traverse.[21] Notably, the primary barrier to penetration is situated within the upper one-third to one-quarter of the buccal epithelium, with the flattened surface of cell layers acting as the primary barrier region. This "barrier region" contains "Membrane-coating granules" (MCGs) derived from intermediate cell layers, influencing permeability. MCGs discharge their contents into the intercellular space of the upper epithelial layers, contributing significantly to the permeability barrier.[22] Variations in regional permeability are associated with differences in epithelial thickness and keratinization, linked to MCG-derived intercellular material's chemical composition. Polar lipids, particularly ceramides, play a crucial role in determining permeability, with non-keratinized epithelia exhibiting higher permeability and lower ceramide concentration compared to keratinized epithelia.[23]

SALIVA AND ITS ROLE IN BUCCAL MUCOSA

1. **Salivary Coating and Mucin:[24]**
- Saliva coats the mucosal surface, generating an unstirred layer around 70 m thick.
- A particular high molecular weight mucin known as MG1 plays an important function.
- MG1 binds to the oral mucosa, guaranteeing hydration, lubrication, and the concentration of protective molecules such as secretory immunoglobulins, as well as the prevention of microbe adhesion.

2. **Barrier Properties of Saliva:[25, 26]**
- Saliva and its mucin content help the oral mucosa's barrier function.
- Evidence shows that saliva aids in the maintenance of the mucosal barrier.

3. **Major Salivary Glands:[27]**
- The major salivary glands are made up of lobules that release saliva.
- Saliva is released by the parotid glands through ducts around the upper teeth.
- Saliva is secreted under the tongue by submandibular glands.
- Sublingual glands secrete saliva via a network of ducts in the mouth floor.

4. **Minor Salivary Glands:[26]**
- The major salivary glands are made up of lobules that release saliva.

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- Saliva is released by the parotid glands through ducts around the upper teeth.
- Saliva is secreted under the tongue by submandibular glands.
- Sublingual glands secrete saliva via a network of ducts in the mouth floor.

5. **Whole Saliva and Flow Rate: [28, 29]**
- Whole saliva is the combined secretion of the main and minor salivary glands.
- Under normal circumstances, entire saliva flows at a rate of 1-2 ml/min.

6. **Enamel Protection and Neutralizing Fluid:[28]**
- Excessive salivary flow protects the mouth by bathing it in neutralising fluid.
- This reduces the risk of dental enamel damage.

7. **Composition of Saliva:[27,29]**
- Water accounts for about 99.5% of the makeup of saliva.
- Proteins, glycoproteins, and electrolytes are also present.

8. **Electrolyte Content:[30]**
- Saliva has a high concentration of electrolytes, including potassium (7 times the plasma level), bicarbonate (3 times the plasma level), calcium, phosphorus, chloride, thiocyanate, and urea.[30]

9. **pH and Enzymes:[30]**
- The pH of saliva is normally between 5.6 and 7.
- Enzymes found in saliva include -amylase (which hydrolyzes 1-4 glycosidic bonds), lysozyme (which digests bacterial cell walls), and lingual lipase (which breaks down lipids).

CLASSIFICATION OF BUCCAL DRUG DELIVERY SYSTEMS

Solid Dosage Form [31]

Buccal medication administration via solid dose forms comprises mucoadhesive tablets for extended interaction, sustained-release tablets for controlled dissolution, and fast-dissolving tablets for immediate action. Film-based methods such as sticky patches and dissolvable films improve medication absorption. Medicated lozenges, troches, microspheres, and nanoparticles all have different drug release techniques.

Table No. 1: Types of Buccal Solid Dosage Forms

Classification Criteria	Types of Buccal Solid Dosage Forms [32]
Tablet-Based Systems	
Mucoadhesive Buccal Tablets:	Tablets containing mucoadhesive agents for prolonged buccal contact
Sustained-Release Buccal Tablets:	Tablets designed for controlled and extended drug release
Fast-Dissolving Buccal Tablets:	Tablets that dissolve rapidly in the buccal cavity for quick action
Film-Based Systems	
Buccal Film Disks:	Thin films adhering to the buccal mucosa for drug delivery
Dissolvable Buccal Films:	Films that dissolve on contact with saliva, releasing the drug
Patch-Based Systems	
Buccal Adhesive Patches:	Patches delivering drugs through adhesive contact with buccal mucosa
Lozenge and Troche Systems	

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Medicated Buccal Lozenges:	Medicated lozenges designed for controlled buccal drug release
Troches:	Disc-shaped dosage forms placed in the buccal cavity for drug release
Multiple-Unit Particulate Systems	
Buccal Microspheres:	Microscopic spheres containing drug particles for controlled release
Buccal Nanoparticles:	Nano-sized drug particles for enhanced buccal delivery

Semi-solid Dosage Form[33]

Buccal drug delivery systems in semi-solid dose forms come in a variety of configurations. Sustained or temperature-triggered medication release is provided by mucoadhesive and thermosensitive gels. Medicated ointments provide drugs locally, whereas pastes provide controlled release. Drug-loaded sachets are put in the buccal cavity in sachet-based systems, and lipid-based formulations improve drug solubility and permeability. These semi-solid forms broaden the options for improving buccal medication administration.

Table No. 2: Types of Buccal Semi-Solid Dosage Forms

Classification Criteria	Types of Buccal Semi-Solid Dosage Forms
Gel-Based Systems	
Mucoadhesive Buccal Gels:	Gels containing mucoadhesive agents for sustained drug release
Thermosensitive Buccal Gels:	Gels that undergo gelation upon contact with body temperature
Ointment-Based Systems	
Medicated Buccal Ointments:	Ointments designed for localized drug release on the buccal mucosa
Paste-Based Systems	
Medicated Buccal Pastes:	Pastes offering controlled and prolonged drug release in the oral cavity
Sachet-Based Systems	
Buccal Drug-Loaded Sachets:	Drug-loaded sachets placed in the buccal cavity for controlled release
Other Semi-Solid Systems	
Buccal Lipid-Based Formulations:	Lipid-based formulations for enhanced drug solubility and permeability

Liquid Dosage Form [34]

Buccal medication delivery systems for liquid dose forms provide a wide range of choices. Mucoadhesive solutions enable long-term drug release, whilst fast-action solutions ensure rapid absorption. Medicated suspensions provide for controlled localised administration, whilst emulsions provide sustained release inside the buccal cavity. Buccal drug sprays disperse tiny drug particles, while lipid-based solutions improve solubility and absorption. These liquid formulations broaden the options for optimising buccal medication delivery while appealing to a variety of therapeutic demands and preferences.

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Table No.3: Types of Buccal Liquid Dosage Forms

Classification Criteria	Types of Buccal Liquid Dosage Forms
Solution-Based Systems	
Mucoadhesive Buccal Solutions:	Solutions containing mucoadhesive agents for prolonged drug release
Rapid-Action Buccal Solutions:	Solutions designed for quick drug absorption and onset
Suspension-Based Systems	
Medicated Buccal Suspensions:	Suspensions for controlled and localized drug release
Emulsion-Based Systems	
Medicated Buccal Emulsions:	Emulsions providing sustained drug release in the buccal cavity
Spray-Based Systems	
Buccal Drug Sprays:	Sprays for fine drug particle delivery to the buccal mucosa
Other Liquid Systems	
Buccal Lipid-Based Solutions:	Lipid-based solutions for enhanced drug solubility and absorption

EVALUATION TEST FOR TABLET (SOLID DOSAGE FORM OF BUCCAL DELIVERY SYSTEM): [63]

1. **Drug Release and Dissolution Studies:**
   - Perform dissolution studies to determine how quickly and to what extent the drug is released from the tablet.
   - Analyze the drug release kinetics (e.g., zero-order, first-order) to understand the release profile.

2. **In vitro Permeation Studies:**
   - Conduct permeation studies using artificial buccal membranes or tissue to measure the drug's permeability through the buccal mucosa.
   - Evaluate the rate of drug permeation and potential factors affecting it.

3. **Mucoadhesive Properties:**
   - Assess the tablet's mucoadhesive properties to determine its ability to adhere to the buccal mucosa.
   - Perform studies to understand the effect of variables like formulation and contact time on mucoadhesion.

4. **Biocompatibility and Irritation Studies:**
   - Evaluate the potential irritation or adverse effects of the tablet on buccal tissues.
   - Perform histological examinations and assess inflammation, edema, and other indicators of tissue irritation.

5. **Physical and Chemical Stability:**
   - Subject the tablets to stability studies under various storage conditions (temperature, humidity) to assess their shelf-life.
   - Monitor changes in drug content, dissolution profile, and physical appearance over time.

6. **Bioavailability and Pharmacokinetics:**
   - Conduct bioavailability studies to determine the drug's systemic exposure after buccal administration.
   - Analyze pharmacokinetic parameters such as peak plasma concentration (Cmax), time to reach Cmax (Tmax), and area under the curve (AUC).

7. **Patient Acceptability and Compliance:**
   - Perform user acceptability studies to gauge patient preference and comfort with the buccal tablet.
   - Collect feedback on taste, texture, ease of use, and overall experience.

8. **Effect of Food and Beverages:**
   - Investigate whether the presence of food or beverages affects the drug's absorption and overall performance.

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- Conduct studies under both fasting and fed conditions to understand any potential interactions.

9. **Drug-Drug Interactions:**
- Evaluate the potential for drug interactions if the buccal tablet is intended to be used concurrently with other medications.
- Assess whether the tablet affects the absorption or metabolism of other drugs.

10. **Comparative Studies:**
- Compare the buccal delivery system with other routes of administration (e.g., oral, intravenous) in terms of pharmacokinetics, bioavailability, and patient outcomes.

11. **Long-term Safety and Efficacy:**
- If applicable, conduct long-term studies to assess the safety and efficacy of prolonged use of the buccal tablet.

12. **Regulatory Compliance:**
- Ensure that the buccal tablet meets regulatory standards and guidelines for drug delivery systems.

EVALUATION TEST FOR SEMISOLID DOSAGE FORM[64,65]

. In vitro Drug Release Studies:
- Conduct dissolution studies to evaluate the rate and extent of drug release from the semisolid formulation.
- Utilize a suitable dissolution apparatus that mimics the physiological conditions of the buccal cavity.

2. Mucoadhesive Strength Test:
- Measure the mucoadhesive strength of the formulation to assess its ability to adhere to the buccal mucosa.
- Utilize a texture analyzer or similar instrument to determine the force required to detach the formulation from a buccal mucosa model.

3. Rheological Characterization:
- Assess the rheological properties of the semisolid formulation (e.g., viscosity, shear thinning behavior) to ensure appropriate consistency and ease of administration.

4. Bioadhesion Studies:
- Perform studies to evaluate the interaction between the formulation and the mucosal tissue.
- Use methods like tensile or shear tests to measure the force required to separate the formulation from the mucosa.

5. Drug Permeation Studies:
- Conduct in vitro permeation studies using buccal mucosa or a suitable membrane to determine the drug's ability to permeate across the mucosal barrier.

6. Stability Studies:
- Perform stability studies under various conditions (e.g., temperature, humidity) to ensure that the formulation maintains its integrity, drug content, and effectiveness over time.

7. In vivo Studies (if applicable):
- If feasible, conduct in vivo studies in animal models or human subjects to evaluate the formulation's performance in a more physiological setting.

8. Irritation and Sensitivity Testing:
- Assess the potential for local irritation, inflammation, or sensitivity reactions on the buccal mucosa caused by the formulation.

9. Drug Content and Uniformity:
- Analyze multiple samples of the formulation to ensure uniform distribution of the drug and consistent drug content.

10. Microbiological Testing (if applicable):
- Perform microbiological testing to assess the potential for microbial growth or contamination in the formulation.

11. pH Testing:
- Measure the pH of the formulation to ensure it is within an acceptable range for buccal administration and does not cause irritation.

12. Compatibility Studies:
- Assess the compatibility of the drug with the excipients in the formulation to ensure that there are no chemical or physical interactions that could affect stability or drug release.

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13. In vitro Permeation Studies:

- Evaluate the permeation profile of the drug through a buccal membrane or a suitable model to assess the drug's ability to penetrate the buccal mucosa.

14. Particle Size Analysis (if applicable):

- Measure the particle size of the formulation to ensure consistency and appropriate particle distribution.

EVALUATION TEST FOR LIQUID DOSAGE FORM[66]

- **Drug Content Uniformity:**Analyze multiple samples from different parts of the liquid dosage form to ensure uniform distribution of the drug throughout the formulation.
- **pH Measurement:** Measure the pH of the liquid dosage form to ensure it falls within an acceptable range that is suitable for buccal administration and won't cause irritation to the oral mucosa.
- **Viscosity:** Determine the viscosity of the liquid to ensure it has the appropriate consistency for buccal application and doesn't easily drip or run off the mucosal surface.
- **Compatibility Testing:** Assess the compatibility of the drug with the other ingredients in the formulation to ensure there are no chemical interactions that could compromise drug stability or safety.
- **Drug Release Profile:** Conduct in vitro release studies using simulated buccal conditions to evaluate the rate and extent of drug release from the liquid dosage form.
- **Permeation Studies:** Use artificial membrane models or in vitro buccal tissue models to assess the ability of the drug to permeate through the buccal mucosa.
- **Bioadhesive Strength:** Measure the bioadhesive strength of the liquid dosage form to ensure it adheres well to the buccal mucosa and maintains contact for an appropriate duration.
- **Irritation/Toxicity Testing:** Conduct in vitro and/or in vivo irritation and toxicity studies to evaluate the potential for irritation or adverse effects on the buccal mucosa.
- **Microbiological Testing:** Perform microbial quality testing to ensure the product is free from microbial contaminants that could pose a risk to the patient.
- **Stability Testing:** Evaluate the stability of the liquid dosage form under various storage conditions to ensure the drug's potency, physical attributes, and overall quality are maintained over time.
- **Dose Accuracy:** Test the accuracy of the delivery system to ensure that each administration provides the intended dose of the drug.
- **Patient Acceptance:** Conduct consumer preference studies or surveys to gauge patient acceptance, taste, and overall experience with the buccal liquid dosage form.
- **Particle Size Analysis:**Analyze the particle size distribution of the liquid formulation to ensure it is suitable for buccal administration and won't cause discomfort.
- **Residual Drug Analysis:** Evaluate the amount of residual drug remaining in the delivery system after administration to ensure proper drug delivery and minimize wastage.
- **Packaging Compatibility:** Evaluate the compatibility of the liquid formulation with the packaging materials to ensure there are no interactions that could affect the drug or compromise the packaging integrity.

MARKETED BUCCAL DRUG DELIVERY PRODUCTS

Table No. 4: Marketed Buccal Drug Delivery Products: Diverse Approaches and Active Pharmaceutical Ingredients.

Dosage Form	Product Active	Pharmaceutical Ingredient
Tablet	Loramyc	Miconazole[35]
	Buccastem	Prochlorperazine Meleate[36]
	Aphtach	Triamcinolone Acetonide[37]
	Suboxone	Buprenorphine Hydrochloride –Naloxone HCl[38]
	Straint SR	Testosterone[39]
	Effentora	Fentanyl Citrate[40]

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	Sabutex	Buprenorphine Hydrochloride[41]
	Suscard	Glyceryl Trinitrate[42]
Spray	Zolpimist	Zolpidem[43]
	Sativex	Cannabis based[44]
	Nitrostat	Nitroglycerine[45]
Gel	Bonjela	Cetalkonium Chloride, Choline Salicylate[46]
	Corsodyl	Chlorhexidine Digluconate[47]
	Fastum	Ketoprofen[48]
Lozenge	Actiq	Fentanyl Citrate[49]
Pellets	Coralan	Hydrocortisone Sodium Succinate[50]
Patch	Dentipatch	Lidocaine[51]
	Coreg	Carvedilol[52]

II. FUTURE CHALLENGES

The permeability of drugs via the buccal mucosa is an important component of buccal drug delivery devices. The permeability of the buccal mucosa varies according to parameters such as the drug's physicochemical qualities, molecular size, lipophilicity, and charge. The mucosa's distinct structure, notably its stratified squamous epithelium and lack of tight connections, makes medication penetration relatively straightforward. The presence of mucus, the pace of saliva production, and possible enzymatic breakdown in the mucosa, on the other hand, can all have an effect on drug permeability. penetration enhancers, mucoadhesive formulations, and nanotechnology-based techniques are all used to improve medication penetration. A thorough understanding of these permeability processes is required for the development of efficient buccal drug delivery systems with increased bioavailability and therapeutic effects.Although the majority of non-parenteral formulations are peroral, other delivery routes, such as buccal, are gaining popularity.[53] The relative rarity of oral mucosal dosage forms, on the other hand, poses a development challenge that necessitates collaboration across drug research disciplines. The continual development of transmucosal dosage forms for a variety of substances demonstrates the growing capabilities of buccal administration. Mucoadhesive systems stand out in the growing field of buccal drug delivery research, providing novel carriers that are adaptable to diverse mucosal tissues. However, development is hampered by a lack of agreement on mucoadhesive processes and standardised evaluation methodologies. Future developments include the investigation of buccal adhesive administration for vaccinations and tiny proteins/peptides.To improve buccal permeability, researchers are pursuing novel materials and creative systems, responsive polymers, and formulation techniques. While obstacles remain, the future of buccal drug administration seems bright, thanks to developing materials, formulation tactics, and a better knowledge of mucosal complexity aimed at improving bioavailability and therapeutic results. [54,55,56,57]

III. CONCLUSION

The buccal drug delivery system appears to be a potential method of providing drugs to treat both local and systemic medical disorders. This paper delves into the complexities of this approach, with the buccal mucosa serving as the major target for drug delivery within the oral cavity. This specific method distinguishes buccal delivery from larger words that cover the entire mouth cavity.The buccal mucosa's structural features, such as its stratified squamous epithelium and absence of tight connections, enhance drug penetration, giving it an advantage over other mucosal routes. This permeability, along with the advantages of lower enzymatic activity and sensitivity compared to other mucosal surfaces, makes the buccal mucosa an appealing drug delivery route. Its capacity to have both local and systemic effects emphasises its potential.[58]

Despite the benefits, buccal medication administration is not without difficulties. The short residence period, restricted absorption region, and barrier nature of the buccal mucosa limit the design and performance of drug delivery devices. To

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guarantee prolonged release, effective medication penetration, and low degradation within the oral cavity, formulations must be carefully designed. This necessitates a thorough understanding of mucosal anatomy, drug permeability parameters, and techniques for improving drug delivery.[59]

Buccal medication administration options include a variety of dose forms, including solid, semi-solid, and liquid formulations. Mucoadhesive tablets, film-based systems, gel-based formulations, and other novel techniques strive to overcome the buccal mucosa's intrinsic constraints, optimising medication release and absorption. Notably, the analysis identified numerous marketed medicines that used buccal administration, emphasising the practical utility of this method.In the future, researchers will investigate innovative materials, formulation tactics, and permeability improvement approaches to improve buccal medication delivery.[60] Biotechnology advancements, particularly for difficult compounds like peptides, provide promising potential for prolonged release and improved therapeutic effects. Collaboration across disciplines is essential for further refining mucoadhesive procedures, standardising assessment techniques, and realising the full potential of buccal medication delivery.[61] The review emphasises the value of the buccal drug delivery method as a tool in pharmaceutical administration. Despite inherent difficulties, advances in materials science, formulation processes, and a better knowledge of mucosal subtleties are propelling the creation of buccal drug delivery devices. This method strikes a compromise between local and systemic effects, improving patient compliance, minimising drug degradation, and potentially revolutionising medicine delivery.[62]

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