REVIEW ON MUCOADHESIVE BUCCAL TABLETS

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**ABSTRACT**

Mucoadhesive buccal tablets represent a promising drug delivery system that allows drugs to be absorbed directly through the buccal mucosa, bypassing the gastrointestinal tract and hepatic first-pass metabolism. This route offers several advantages, including improved bioavailability, rapid onset of action, ease of administration, and enhanced patient compliance. These systems use mucoadhesive polymers such as HPMC, carbopol, chitosan, and sodium alginate to ensure prolonged adhesion to the mucosal surface, allowing sustained drug release.This review focuses on the principles of mucoadhesive, the anatomy of the buccal cavity, and various types of polymers used in buccal tablet formulation. It also discusses formulation approaches, evaluation parameters like mucoadhesive strength and drug release profiles, and current advancements including bilayer tablets and nanoparticle-based systems. Mucoadhesive buccal tablets have shown great potential for delivering both systemic and local therapies, making them an effective and innovative alternative to conventional dosage forms.
**Key words:** sublingual delivery, buccal delivery,Polymers, Mechanism, Methods, Evaluation.

1. **INTRODUCTION**

Oral drug administration is the preferred and most **common** route for drug delivery. Several advantages associated with it include: it **is patient-friendly, painless**, has the ease of **self-medication**, and allows for a flexible and controlled dosing schedule in comparison to most other drug delivery systems. Although the oral route is preferred for administration of drugs, it also presents major disadvantages such as **first pass effect**, **gastrointestinal enzymatic degradation** and delay between the time of administration and absorption, which is detrimental in the case of drugs with rapid onset requirements[1]. These difficulties have provided the impetus for exploring alternative routes for the delivery of drugs, which include routes such as **pulmonary, ocular, nasal**, **rectal, buccal, sublingual, vaginal, and transdermal**. Transmucosal routes of drug delivery which is comprised of the mucosal linings of the nasal, rectal, vaginal, ocular, and oral cavity offer excellent opportunities and potential advantages over peroral administration for systemic drug delivery. These advantages include possible bypass of first pass effect, avoidance of presystemic elimination within the GI tract and, depending on the particular drug, a better enzymatic flora for drug absorption. Within the oral mucosal cavity, delivery of drugs is broadly classified into two categories:

(a) Sub Lingual delivery, which is systemic delivery of drugs through the mucosal membranes lining the floor of the mouth

 (b) Buccal delivery, which is drug administration through mucosal membranes lining the cheeks

**Advantages**

1. Avoids first-pass metabolism, enhancing bioavailability.

2. Provides controlled and sustained drug release.

3. Non-invasive and easy to administer

.4. Suitable for drugs with poor gastrointestinal stability.

5. Improves patient compliance, especially in elderly and children.

**Disadvantages**

1. Limited to drugs with small dose requirements.

2. Mucosal irritation or allergic reactions may occur.

3. Eating, drinking, or talking can dislodge the tablet.

4. Saliva can dilute the drug or interfere with adhesion.

5. Only applicable to drugs with adequate buccal permeability.{1}



1. **MECHANISM**

Buccal permeation enhancers play a significant role in improving the absorption of drugs administered through the buccal mucosa by employing multiple mechanisms. One of the primary methods is by altering the rheological properties of mucus. The mucus layer, along with the overlying saliva, forms a viscoelastic barrier that can hinder drug absorption. Certain enhancers reduce the viscosity of these layers, allowing the drug to diffuse more effectively. Another key mechanism involves increasing the fluidity of the lipid bilayer membrane. By disturbing the packing of intracellular lipids and proteins, these enhancers facilitate the transport of drugs through the intracellular route, which is considered the primary pathway for buccal absorption. Additionally, some permeation enhancers act on the tight junctions between epithelial cells, particularly by targeting desmosomes, which leads to the loosening of cell connections and enhances paracellular transport.Furthermore, enzymatic degradation within the buccal mucosa poses a barrier to drug absorption. Enhancers that inhibit enzymes such as peptidases and proteases help in overcoming this enzymatic barrier, thus protecting the drug from breakdown.{2} Interestingly, changes in membrane fluidity can also indirectly affect enzyme activity. Lastly, some enhancers increase the thermodynamic activity of drugs by altering their partition coefficient. This improves drug solubility and promotes better absorption through the mucosa. These combined actions make buccal permeation enhancers an essential component in the development of effective buccal drug delivery systems.

 **3. THEORIES OF MUCOADHESION**

**3.1. Wetting Theory**

This theory applies to liquid or low-viscosity mucoadhesives and emphasizes the importance of the adhesive's ability to spread over the mucosal surface. A low contact angle indicates strong affinity and better mucoadhesion. The surface and interfacial energies play a key role in adhesion.

**3.2. Diffusion Theory**

According to this theory, adhesion occurs through the interpenetration and entanglement of polymer chains from the adhesive and the mucus. Factors like contact time, polymer flexibility, and chemical compatibility influence the depth of penetration, which typically ranges from 0.2–0.5 µm.

**3.3. Electronic Theory**

This theory suggests that when the adhesive and mucus come into contact, differences in their electronic structures lead to the formation of an electrical double layer. Adhesion results from electrostatic attraction due to electron transfer at the interface.

**3.4. Fracture Theory**

Fracture theory relates the strength of mucoadhesion to the force required to separate the two joined surfaces. It considers mechanical properties like Young’s modulus and fracture energy, focusing on how cracks form and propagate.

**3.5. Adsorption Theory**

This theory proposes that after initial contact, adhesion results from intermolecular interactions. While strong primary covalent bonds are generally avoided in mucoadhesion, weaker secondary bonds like hydrogen bonding, Van der Waals, and electrostatic forces contribute to effective adhesion.

**3.6. Mechanical Theory**

Mechanical theory explains mucoadhesion through the physical interlocking of the adhesive into the rough surfaces of the mucosa. The greater the surface roughness, the better the adhesive can anchor itself, enhancing bond strength.Absolutely! Here's a more detailed version with headings and expanded explanations for each type of polymer used in mucoadhesive drug delivery system.{3,5}

 **4. POLYMERS USED IN MUCOADHESION**

**4.1. Natural Mucoadhesive Polymers**

Natural polymers are biocompatible, biodegradable, and often less toxic, making them suitable for mucoadhesive applications. Chitosan, derived from chitin, is one of the most studied due to its cationic nature and ability to interact with negatively charged mucin. Alginate, extracted from brown seaweed, forms gels in the presence of calcium ions and is known for its gentle mucoadhesive properties. Other natural polymers like pectin, gelatin, and guar gum also exhibit mucoadhesive characteristics by forming hydrogen bonds and expanding upon hydration.{6}

**4.2. Synthetic Mucoadhesive Polymers**

Synthetic polymers are popular for their reproducibility and tunable properties. Carbopol (polyacrylic acid) is a highly effective mucoadhesive polymer due to its ability to form hydrogen bonds and swell in aqueous environments. Polyvinyl alcohol (PVA) and polyethylene glycol are also used for their film-forming abilities and compatibility with other drug delivery components. Synthetic polymers allow for customization of drug release profiles, mechanical strength, and stability.

**4.3. Semi-Synthetic and Cellulose-Derived Polymers**

Cellulose derivatives are widely used in mucoadhesive formulations because of their swelling ability and strong hydrogen bonding potential. Hydroxypropyl methylcellulose (HPMC), carboxymethylcellulose (CMC), and methylcellulose (MC**)** are among the most common. These polymers hydrate quickly and form viscous gels that adhere well to mucosal surfaces. They are often used in buccal, ocular, and vaginal drug delivery systems due to their safety and effectiveness.{7}

 **5. METHODOLOGY**

**5.1. Direct Compression Method**

This is the most commonly used and simplest method for preparing mucoadhesive buccal tablets. In this method, the active drug, mucoadhesive polymer (such as HPMC, Carbopol, or sodium alginate), and other excipients are mixed thoroughly to obtain a uniform blend. This blend is then directly compressed into tablets using a tablet press{8}. This method does not require heat or moisture, making it suitable for heat- and moisture-sensitive drugs.

**5.2. Wet Granulation Method**

In this method, the drug and excipients are first mixed, and then a granulating fluid (often a binder solution like PVP) is added to form a wet mass. This mass is passed through a sieve to form granules, which are then dried and compressed into tablets. Wet granulation improves the flowability and compressibility of the formulation, but it is not suitable for moisture-sensitive drugs.

**5.3. Melt Granulation Method**

Melt granulation involves the use of a meltable binder such as polyethylene glycol (PEG). The drug and excipients are mixed with the melted binder to form granules. Once cooled, these granules are compressed into tablets{9}. This method eliminates the need for solvents and is considered environment-friendly and safe for moisture-sensitive drugs.

**5.4. Solvent Casting Method (for Films or Matrix Tablets)**

This technique is more commonly used for buccal films or layered matrix systems. The drug and polymers are dissolved in a suitable solvent (e.g., ethanol or water), and the solution is cast onto a flat surface. After solvent evaporation, a film is formed, which can be cut into desired sizes. It allows for controlled release and is ideal for flexible buccal dosage forms.

**5.5. Bilayer Tablet Technique**

This method involves the preparation of two separate layers: one mucoadhesive layer containing the drug and a second backing layer that prevents drug release from the opposite side. The backing layer (usually made of hydrophobic polymers like ethyl cellulose) ensures unidirectional drug release towards the mucosa, improving drug bioavailability and patient compliance.{10}

 **6.EVALUATION TESTS**

**6.1. Angle of Repose (Ɵ)**

Angle of repose is the maximum angle formed between the surface of a powder pile and the horizontal plane, indicating the flow property of the powder. It is determined using the fixed funnel method. A lower angle suggests better flow, which is crucial for tablet formulation. The angle is calculated using:

Tan Ɵ = Height (h) / Radius (r)
Ɵ = tan⁻¹ (h / r)

* 1. **Bulk Density & Tapped Density**

Bulk density is the ratio of the mass of microparticles to the bulk volume, while tapped density is calculated after tapping the sample 100 times to obtain a reduced volume. These values help determine the powder’s packing ability.

**Bulk Density = Mass / Bulk Volume**

**Tapped Density = Mass / Tapped Volume**

**6.3. Carr’s Index**

Also known as the compressibility index, it indicates flowability and is calculated as

 **Carr’s Index (%) = (Tapped Density − Bulk Density) / Tapped Density × 100**

**6.4. Hausner’s Ratio**

This ratio gives insight into powder flow and is calculated by

 **Hausner’s Ratio = Tapped Density / Bulk Density**

### ****6.5. Hardness Test:****

### This test measures the mechanical strength of tablets using a Pfizer hardness tester. The average is taken from three tablets per batch.

**6.6. Weight Variation Test:**

Ten tablets from each batch are individually weighed using an electronic balance, and the average weight is calculated to ensure uniformity.

**6.7. Tablet Thickness:**

Measured using vernier calipers for ten tablets per batch, this ensures consistent thickness across formulations.

**6.8. Friability:**

 The friability of 10 tablets will determine using Roche friabilator. This device subjects the tablets to the combined effect of abrasions and shock in a plastic chamber revolving at 25 rpm and dropping the tablets at a height of 6 inches in each revolution. Preweighed sample of tablets will place in the friabilator and will subject to 100 revolutions. Tablets will dedust using a soft muslin cloth and reweigh

**6.9 Content uniformity**:

 ensures each tablet contains a drug amount within a specified range. It confirms consistent drug distribution across all units in a batch.

### ****6.10 In-Vitro Bioadhesive Strength:****

### Bioadhesive strength refers to the ability of a tablet to adhere to a biological membrane. It was measured using a modified physical balance with porcine buccal mucosa and phosphate buffer (pH 6.8) as the medium. Tests were done in triplicate, and the average strength was recorded.{4,5}

**Force of Adhesion (N) = (Bioadhesive Strength / 100) × 9.81**

 **7. CONCLUSION**

Mucoadhesive tablets offer a promising approach for sustained and targeted drug delivery through mucosal surfaces. Various preparation methods like direct compression and wet granulation ensure proper formulation. Pre-compression and post-compression parameters help evaluate flow properties, tablet strength, and uniformity. In-vitro bioadhesive strength testing confirms the tablet's ability to adhere to mucosal tissues effectively. Overall, the use of suitable polymers and optimized techniques can enhance therapeutic outcomes. These formulations improve patient compliance and drug bioavailability.

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