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MUCOADHESIVE BUCCAL DELIVERY SYSTEM

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Abstract:

The delivery of drugs through the buccal mucosa has received a great deal of attention over the last two decades, and yet there are not many buccal delivery products available on the market. The buccal route offers an attractive alternative for systemic drug delivery of drugs studies of oral cavity absorption were first reported in 1935. Since then, substantial effort has been focused on drug absorption from a drug delivery system in a particular region of the oral cavity3. because of better patient compliance, ease of dosage form removal in emergencies, robustness, and good accessibility. Use of buccal mucosa for drug absorption was first attempted by Sobrero in 1847, and since then much research was done to deliver drugs through this route. The oral mucosa provides a protective covering for the underlying tissue, being as a barrier for microorganisms and toxins. This article extensively reviews the anatomy and physiology of buccal mucosa, buccal drug delivery system andtheir components, theories, factors affecting drug absorption through buccal mucosa and evaluation.

Keywords:Buccal drug delivery, Mechanism, Theories, Polymers, Evaluation.

INTRODUCTION

The oral route is the one that patients most often choose among the several drug delivery methods. Many drugs cannot be effectively delivered via the traditional oral route based on our current knowledge of the biochemical and physiological aspects of absorption and metabolism. This is because these drugs are extensively subjected to pre-systemic clearance in the liver after administration, which frequently results in a lack of correlation between membrane permeability, absorption, and bioavailability. There are various different types of oral medication administration. Buccal drug delivery is a good alternative among the different routes of drug delivery because this route also has some drawbacks, such as hepatic first pass metabolism and enzymatic degradation within the GI tract, which prevent oral administration of certain classes of drugs, particularly peptides and proteins. The buccal area of the mouth mucosal cavity provides a desirable route of administration for systemic medication delivery. For systemic medication delivery, buccal methods of administration offer many benefits over other routes, such as bypassing the first pass effect and delivering drugs straight to the systemic circulation and avoiding pre-systemic clearance in the GI tract. These elements make the buccal location for systemic medication delivery very appealing and practical. When compared to other drug delivery methods that have limited patient compliance, such as rectal, vaginal, sublingual, and nasal drug delivery for controlled release, the buccal mucosa has a rich blood supply and is relatively permeable. The nasal cavity has been investigated by the research team as a potential site for systemic drug delivery, but the potential for irritation and the irreparable harm that chronic nasal dosage form application could cause to the ciliary action of the nasal cavity have forced this route to the back of the line for drug delivery. Rectal, vaginal, and ocular mucosae all have benefits, but due to the low patient tolerability of these locations, they are more often used for local applications than for systemic drug delivery. The buccal has considerable appeal for both local and systemic drug bioavailability due to its capacity to maintain a delivery system at a specific area for an extended length of time. Additionally, the route also provides quick drug transport to the systemic circulation and avoids degradation by stomach enzymes and first pass hepatic metabolism. The buccal mucosa are rich in blood supply and absorption occurs at this area is

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efficient. Also, the oral cavity is easily accessible for self-medication, and in the event of toxicity, the drug administration must be rapidly stopped by removing the dosage form from the buccal cavity. Because the buccal mucosa is less permeable than the sublingual location, it is a better option for extended medication administration.

Mucoadhesive Drug Delivery System in Oral Cavity

Drug delivery through the oral cavity's membranes can be split into the following categories

1) **Sublingual Delivery**: Drugs are injected into the bloodstream through the mucosal membrane lining the bottom of the mouth.

2) **Buccal Delivery:** By inserting the drug between the gums and cheeks, medications are released through mucosal membrane into the systemic circulation.

3) **Local Delivery**: Medication is placed in the mouth. Buccal Bioadhesive Dosage Form Classification

1. Buccal Bioadhesive Tablets.
2. Buccal Bioadhesive semisolids.
3. Buccal Bioadhesive patch and films.
4. Buccal Bioadhesive Powders.

1. **Buccal Bioadhesive Tablets:** Dry dose forms known as buccal bioadhesive tablets must be moistened before being applied to the buccal mucosa. Bioadhesive polymers and excipients are already used in the formulation of double and multi-layered pills. These tablets are solid dosage forms that were made by directly compressing powder. Depending on the excipients included in the dosage form, they can be put in contact with the oral mucosa and allowed to adhere or dissolve. They have the ability to multi-directionally deliver drugs to the mucosal area or the oral cavity.

2. **Buccal Bioadhesive Semisolids:** The finished powdered natural or synthetic polymers are then dispersed in polyethylene or an aqueous solution to create buccal bioadhesive semisolid dosage forms, such as are base.

3. **Buccal Bioadhesive Patch and Films**: Buccal bioadhesive patches come in a round or oval shape and are constructed of multilayered thin films or two-ply laminates. They primarily have a bioadhesive polymeric layer and an impermeable backing layer that allow drugs to move unidirectionally across the buccal mucosa. The drug is mixed with an alcohol solution of the bioadhesive polymer to create buccal bioadhesive sheets.

4. **Buccal Bioadhesive Powders**: The buccal bioadhesive powder dose forms for Nifedipine are sprayed onto the buccal mucosa and contain a combination of bioadhesive polymers and the medication to reduce diastolic blood pressure.

Need of Mucoadhesive:

- Controlled release.
- Target &localised drug delivery.
- By pass first pass metabolism.
- Avoidance of drug degradation.
- Prolonged effect.
- High drug flux through the absorbing tissue.
- Reduction in fluctuation of steady state plasma level

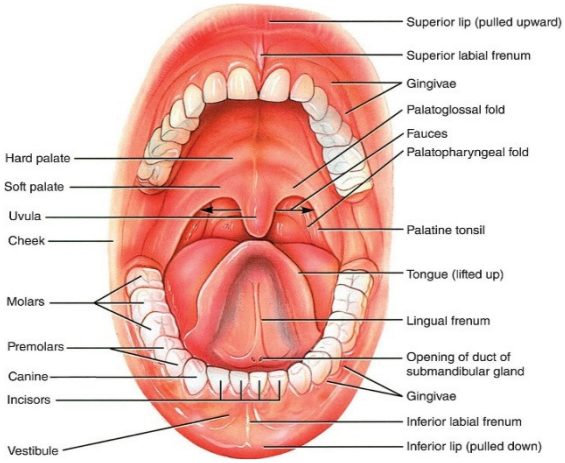

Fig: structure of oral mucosa

Advantages of buccoadhesive Drug Delivery

- Drug administration via the buccoadhesive drug delivery offers several advantages such as:
- Drug is easily administered and extinction of therapy in emergency can be facilitated.
- Drug release for prolonged period of time.
- In unconscious and trauma patient's drug can be administered.
- Drugs bypass first pass metabolism so increases bioavailability.
- Some drugs that are unstable in acidic environment of stomach can be administered by buccal delivery.
- Drug absorption by the passive diffusion.

- Flexibility in physical state, shape, size and surface.
- Maximized absorption rate due to close contact with the absorbing membrane.
- Rapid onset of action.

Limitations of Buccoadhesive Drug Delivery

There are some limitations of buccal drug delivery system such as

- Drugs which are unstable at buccal pH cannot be administered.
- Drugs which have a bitter taste or unpleasant taste or an obnoxious odor or irritate the mucosa cannot be administered by this route.
- Drug required with small dose can only be administered.
- Those drugs which are absorbed by passive diffusion can only be administered by this route.
- Eating and drinking may become restricted.

Mechanism of Mucoadhesion

It can be described by the two stage mentioned below

Contact stage: It involves interaction between mucoadhesive material and mucous layer, the formulation swells and spread over mucus membrane.

Consolidation stage: Mucoadhesive material is activated by the moisture which furthur plasticize the system and allows the mucosal adhesive molecules to separate and connect via weak Vander walls and hydrogen bonds.

Two theories are involved in explaining the consolidation steps:

(a) **Diffusion theory**: It state mutual interaction between mucoadhesive molecules and glycoprotein of mucus caused by interaction of their chains and the formation of secondarybonds.

(b) **Dehydration theory**: In aqueous environment while materials come in contact with mucus, it gets jellified and water filled into the dosage form because of concentration gradient till the osmotic equilibrium is achieved. As a result, mucous membrane's contact time between the formulation mixture and mucus increases. Therefore, it is the movement of water, not the interpenetration of macromolecule chains that causes adhesive connections to strengthen.

Theories of Bioadhesion: Mucosal adhesion is a complicated process and several concepts have been suggested that play an important role in adhesion.

- **Adsorption theory** :According to this theory, when the two surfaces come in contact, the atoms present in two surfaces form chemical bonds due to the surface force acting between them and the adhesion of materials occur. There are 2 types of chemical bonding involved:
  - **Strong Primary bonds:** Covalent bonds are undesirable because they are permanent in nature.
  - **Weak Secondary bonds**: This involves electrostatic forces, hydrogen, Vander Waals forces, and hydrophobic bonds. These bonds have semi-permanent nature and require less amount of energy to break that makes them the most projecting surface interaction form in adhesion.
- **Electronic theory** :The electronic theory indicates that an attractive electrostatic force occurs when glycoprotein mucin network interacts with bio-adhesive material that results in electrons transfer through the adhesive boundary and adhering surface because of variations in their electronic structure. This creates an electric double layer or charge at the interface responsible for adhesion between the two layers.
- **Diffusion theory** 10,20–22 The basis of "Diffusion theory" lies in interaction between strands of mucin and polymer chains. This theory describes that the polymer and mucous chains penetrate to a sufficient depth and are driven by a concentration gradient to form a semi-permanent adhesive bond. Mobility, diffusivity, contact time, flexibility and nature of mucoadhesive strands are the reasons which impact the inter-diffusion of polymer network. According to the literature, for efficient bioadhesive bonds, the depth of interpenetration ranges from 0.2 – 0.5 μm. To calculate the depth following equation is used:

  $l = (tDb)^{1/2}$

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Where, t is contact time and Db is diffusion coefficient of the mucoadhesive material in the mucus. In order for diffusion to occur, both the mucoadhesive and the mucus must have comparable chemical structures. Greater structural similarity results in better mucosal adhesion.

- **Wetting theory**: This theory is predominantly relevant to liquid systems or bio adhesives with low viscosity. This theory defines the affinity of bioadhesive polymer to the surface in order to spread over it and develop intimate contact with the biological surfaces. The liquid bioadhesive material should have an equal to or zero contact angles for proper speeding and diffusivity of polymer must be positive. Lower the contact angle, greater will be affinity. The work of adhesion (Wa) given by the Dupres equation:
- Wa = □A + □B - □AB
- Where, A is biological membrane and
- B is bioadhesive formulation.
- The work of cohesion (Wc) is given by:
- Wc = 2□A or □B

Fracture theory: It states the requisite force for the detachment of polymer from the mucus after adhesion is established. It calculates the maximum tensile strength (fracture strength) during detachment which is equal to adhesive strength is given by:

G = (Eε./L) ½

Where, E refers to Young's modules of elasticity, ε refers to Fracture energy, L refers to Critical crack length of two separated surfaces.

This concept doesn't require any physical interaction between polymer chains and mucus strands that makes it suitable for studying the bioadhesion of rigid polymers that lack flexible chains.

Factors affecting mucoadhesion

Mucoadhesion properties depend upon the bioadhesive polymer and the surface on which polymer is present. Factors that affect the mucoadhesive properties of a polymer are summarized below.

Molecular weight: Molecular weight increases mucoadhesion strength for linear polymers, but not for nonlinear polymers, for example mucoadhesive strength of polyethylene glycols will increase in order of their increasing molecular weight: 2*104 < 2*105< 4*105. High molecular weight polymers promote physical entanglement whereas low molecular weight polymers favoured better mucus layer penetration

Hydrophilicity: Mucoadhesive polymers own hydrophilic functional groups having low hydrogen bonding with the substrate, swell in aqueous media, and thus aid in mucoadhesion by maximum exposure to their mucoadhesive sites. In addition, disentangled state and maximum distance between the chains of swollen polymers leads to high chain flexibility and efficient penetration.

Flexibility: Polymer chain's flexibility plays vital role to facilitate the penetration and attachment of mucoadhesive polymer with mucus. Mucoadhesion is caused by the diffusion of polymer chains in the interfacial regions, and greater the flexibility of polymers larger will be the diffusion into the mucus network. Thus the polymer flexibility may relate to their viscosity and diffusion coefficients.

Concentration of polymer: This factor has its importance in forming a strong adhesive bond between the polymer and mucus. If polymer concentration is too low, the interaction in polymer and mucus will be unstable and the number of invading polymer chains per mucus unit will be low. In high concentration of polymer, the adhesion property decreased as the polymer creates an "unperturbed" state at a critical concentration due to apparently coiled structure. Therefore, solvent accessibility to the polymer decreases, resulting in reduction of chain penetration of the polymer.

Hydrogen bonding capacity: Another factor plays an important role in polymer bioadhesion is hydrogen bonding. For the mucoadhesion to take place the polymers must have the functional groups (OH, COOH etc.) which are capable to form hydrogen bonds and the hydrogen bonding potential will improve by the flexibility of the polymer.

Cross linking density and Swelling: Three significant and inter-related structural considerations of a polymer network are the typical size of pore, crosslink density and the amount and average molecular weight of the cross-linked polymers. In a study Flory suggest that polymer

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swelling is inversely related to the polymer cross-linking. Therefore, it seems equitable as crosslinking density increases, polymerswelling decreases due to slow water diffusion into the polymer and this result in lower interpenetration rate between mucin and polymer.

Charge and pH: Some simplifications regarding the bioadhesive polymers charge have been made earlier, where non-ionic polymers have less amount of adhesion in comparison to anionic polymers. According to Peppas and Buri, the strong anionic charge of the polymer is one of the prerequisite properties for mucoadhesion. Some cationic polymers like chitosan shows higher bioadhesive properties, primarily in a neutral or to some extent in alkaline medium. There is no imperative literature on the effect of membrane charge on the mucoadhesion but the membrane pH can influence the ionized or un-ionized forms of the polymer and hence it may affect the mucoadhesion. The membrane charge has no influence but the membrane pH can affect the mucoadhesion as it has impact on the ionized or un-ionized forms of the polymers.

Characteristics of the Ideal Mucoadhesive Polymer:

- ❖ Polymers and their degradation products should not be poisonous, irritating, or contain leachable pollutants.
- ❖ Optimal characteristics include spreadability, wetness, swelling, solubility, and biodegradability.
- ❖ The pH should be biocompatible, with good viscoelastic properties.
- ❖ Adhere quickly to the buccal mucosa and offer great mechanical strength.
- ❖ The peel, tensile, and shear strengths must fall within the bioadhesive rang
- ❖ Polymer should be widely available and affordably price.
- ❖ Should have bioadhesive properties in both dry and liquid states.
- ❖ Proven capacity to inhibit enzymes locally while increasing penetration.
- ❖ Should have a reasonable shelf life.
- ❖ Strive for the best molecular weight.

POLYMERS USED IN MUCOADHESION

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

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

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

BUCCAL DOSAGE FORMS:

Several buccal adhesive delivery devices were developed at the laboratory scale by many researchers either for local or systemic actions and can be broadly classified in to solid buccal adhesive dosage forms, semi-solid buccal adhesive dosage forms and liquid buccal adhesive dosage forms

Solid buccal adhesive formulations: Solid buccal adhesive formulations achieve bioadhesion via dehydration of the local mucosal surface. They include tablets, micro particles, wafers, lozenges etc.

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1. Tablets:

Buccal adhesive tablets that are placed directly onto the mucosal surface for local or systemic drug delivery have been demonstrated to be excellent bioadhesive formulations. Two types of tablets i.e. monolithic and double-layered matrix tablets have been investigated for buccal delivery of drugs.

a. Monolithic tablets: consist of a mixture that contains drug and swelling bioadhesive/sustained release polymer. These tablets exhibit a bidirectional release. They can be coated on the outer or on all sides but one face with water impermeable hydrophobic substances to allow a unidirectional drug release for systemic delivery.

b. Double layered tablets comprise: an inner layer based on a bioadhesive polymer and an outer non-bioadhesive layer containing the drug for a bi-directional release but mainly a local action. In the case of systemic action, the drug is loaded into the inner bioadhesive layer whereas the outer layer is inert and acts as a protective layer. Alternatively, the drug is loaded into a controlled release layer and diffuses towards the absorbing mucosa through the bioadhesive layer, whereas a water impermeable layer assures the mono-direction.

2. Microparticles

Bioadhesive microparticles offer the same advantages as tablets but their physical properties enable them to make intimate contact with a lager mucosal surface area. In addition, they can also be delivered to less accessible sites including the GI tract and upper nasal cavity.

3. Wafers A conceptually novel periodontal drug delivery system that is intended for the treatment of microbial infections associated with peridontitis was described elsewhere. . The delivery system is a composite wafer with surface layers possessing adhesive properties, while the bulk layer consists of antimicrobial agents, biodegradable polymers and matrix polymers.

4. Lozenges

Bioadhesive lozenges may be used for the delivery of drugs that act topically within the mouth including antimicrobials, corticosteroids, local anaesthetics, antibiotics and antifungals

Semi-solid dosage forms

1. Gels :Gel forming bioadhesive polymers include crosslinked polyacrylic acid that has been used to adhere to mucosal surfaces for extended periods of time and provide controlled release of drugs.

2. Patches/films

Flexible films may be used to deliver drugs directly to a mucosal membrane. They also offer advantages over creams and ointments in that they provide a measured dose of drug to the site. Buccal adhesive films are already in use commercially.

Patch systems are the formulations that have received the greatest attention for buccal delivery of drugs. They present a greater patient compliance compared with tablets owing to their physical flexibility that causes only minor discomfort to the patient. Patches are laminated and generally consist of an impermeable backing layer and a drug-containing layer that has mucoadhesive properties and from which the drug is released in a controlled manner.

Liquid dosage forms

Viscous liquids may be used to coat buccal surface either as protectants or as drug vehicles for delivery to the mucosal surface.A novel liquid aerosol formulation (Oralin, Generex Biotechnology) has been recently developed, and it is now in clinical phase II trials.This system allows precise insulin dose delivery via a metered dose inhaler in the form of fine aerosolized droplets directed into the mouth.

Structure and Design of Buccal dosage form:

Buccal Dosage form can be of-

1. Matrix type: The buccal patch designed in a matrix configuration contains drug, adhesive and additivesmixed together. Transmucosal drug delivery systems can be bidirectional or unidirectional. Bi-directional patches release drug in both the mucosa and the mouth.

2. Reservoir type: The buccal patch designed in a reservoir system contains a cavity for the drug and additives separate from the adhesive. An impermeable backing is applied to control the direction of drug delivery; to reduce patch deformation and disintegration while in the mouth;

and to prevent drug loss. Additionally, the patch can be constructed to undergo minimal degradation in the mouth, or can be designed to dissolve almost immediately. Unidirectional patches release the drug only into the mucosa.

FORMULATION DEVELOPMENTAND PREPARATION OF BUCCAL TABLETS

The mucoadhesive bilayered buccal tablets consist of drug-releasing polymer layer and a backing layer of ethyl cellulose, which allow unidirectional release of the drug. They are prepared by the direct compression method involving two steps. In the first step, the drug polymer mixture is to be prepared by homogeneously mixing the drug with mucoadhesive polymers. The other excipients present in the formulation like the diluents, permeation enhancers, organoleptic agents etc., are to be added to the above mixture in a glass mortar and triturated to achieve a homogeneous blend. The lubricant is now mixed to the blend and compressed within the die cavity of single-stroke multi station tablet machine or single punch tablet compression machine.The upper punch should then be removed and backing layer material, ethyl cellulose to be added over it and finally compressed at a constant compression force. Along with this method Dry Granulation and Wet Granulation method can also be used to develop mucoadhesive buccal tablets.

METHODOLOGY

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.

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.

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.

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.

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.

Evaluation of Buccal Mucoadhesive Tablets

Pre-compression parameters:

Angle of repose

Angle of repose refers to the maximum angle between the powder pile's surface and a horizontal plane. The flow characteristics of several microcapsules were examined by measuring the angle of repose using a fixed funnel method. The angle of repose was computed using the following formula: [62] Tan Θ = height of the pile radius of the base of the pile Where Θ=tan-1 [h/r] Θ=angle of repose

Bulk Density & Tapped Density:

Bulk density and tapped density were determined using a 10 ml graduated cylinder. The pre-weighed sample was placed in a cylinder, its initial volume recorded (bulk volume), and taped 100 times. The

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final volume (tapped volume) was noted down. The bulk density and tapped density were computed using the formula below.

Bulk density = mass of microparticles

bulk volume

Tapped density = mass of microparticles

tapped volume

Carr's Index: The compressibility index (CI) or Carr's index value for microparticles was calculated using the equation below:

Carrs's index (%) = tapped density−bulk density ×100 tapped density

Hausner ratio: The Hausner ratio of microspheres was calculated by comparing the tapped density to the bulk density, using the following equation:

Hausner's Ratio = tapped density bulk density.

POST COMPRESSION STUDIES

Weight Variation:

Test Twenty tablets were chosen at random and weighed individually in a single pan electronic balance, with the average weight calculated using the following formula:

% Wt Variation = Weight of each tablet – Average weight of tablet × 100 Average weight of tablet.

Thickness:The thickness of the tablet is a dimensional parameter that influences the compression process. The tablet thickness was measured using a vernier calliper.

Friability ;

Friability can be determined by tablet strength. Tablet friability can be determined with a friabilator (Aarson). It is expressed as a percentage. The tablets are placed in a plastic chamber that revolves at 25 rpm for 4 minutes, or up to 100 revolutions, dropping atablet from a height of 6 inches with each revolution. Pre-weighed tablets were inserted in the friabilator and rotated 100 times. The percentage loss is determined using the following formula.

% Friability = Initial weight - final weight x 100. Initial weight of tablets

Content uniformity

Ten tablets will be precisely weighed and ground in a glass pestle mortar. An accurately weighed amount equal to 5 mg of pure drug is ingested, and the analysis is carried out in triplicate. Filter and run the assay with UVvisible spectroscopy.

Surface PH

The surface pH of the tablet was assessed to determine any potential in vivo harmful effects. To avoid irritation of the buccal mucosa, the tablet's surface should have a neutral pH. The pills were immersed in 1.0 mL of distilled water in a custom-designed glass tube for 2 hours to allow swelling. Surface pH was then determined by placing the electrode directly on the tablet's surface and allowing it to stabilize for one minute.

In vitro drug release studies

The USP dissolving device is being used in the medication release trial. It could be a rotating paddle type, in which the buccal tablet's backing layer is attached to a glass disc and placed at the bottom of the equipment, or a revolving basket type. The dissolution research will be carried out with a suitable amount of phosphate buffer at pH 6.8, with samples collected at predefined intervals and replaced with fresh buffer medium. The materials are filtered, and a suitable dilution is made and analyzed using a UV spectrophotometer.

Ex vivo Mucoadhesion Strength

The mucoadhesion strength was measured using a modified balance method. The apparatus consists of a modified two-pan balance with a Teflon assembly that holds the tablet and is dropped onto another Teflon assembly with the buccal mucosa connected. Porcine buccal mucosa was used as the model membrane. Before use, themucosa was stored at room temperature in phosphate buffer (pH 7.4). The mucosal membrane was removed by removing the connective and adipose tissue. The sample was equilibrated in 0.2 molar phosphate buffer (pH 6.8) at 37±1°C for 30 minutes. The tablet was secured to the Teflon arm with cyanoacrylate adhesive and lowered onto the mucosa at a constant weight of 5 g for a 5-minute contact period. Mucosal adhesion strength was assessed by the weight (g) required to remove the tablet from the membrane.

Ex-vivo Residence Time

The ex vivo residence duration was measured using a USP disintegration device that was locally customised. The disintegration medium was 800 ml of phosphate buffer with a pH of 6.8, kept at 37°C. Sheep buccal tissue was attached to a glass

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slide with cyanoacrylate adhesive and positioned vertically in the apparatus. To hydrate the buccal tablet, 0.5 ml of phosphate buffer (pH 6.8) was applied to one side of the tablet before contact with the mucosal surface. The glass slide, which was secured vertically, was adjusted so that the tablet alternated between full immersion in the buffer at the lowest point and re-emergence at the highest point. The time required for the tablet to erode or completely detach from the mucosal surface was recorded.

Stability studies

Potential buccal tablets will be tested for stability over three months (90 days) at 40°C and 75±5% relative humidity. The tablets are kept in amber screw-capped bottles in a stability chamber at 40±1°C and 75±5% relative humidity. Samples will be collected monthly to estimate drug content. After three months, dissolution tests and drug content analysis will be performed to assess the drug release profiles and content.

CONCLUSION

Buccal mucoadhesive tablets are a novel drug delivery technology that offers various advantages, including increased bioavailability, prolonged drug release, and enhanced patient compliance. Their formulation necessitates a careful selection of polymers and excipients to provide strong adhesion, effective drug release, and mechanical qualities. These tablets function by creating non-covalent connections with the mucosal surface, allowing the medication to remain in place and give long-term therapeutic benefits. Buccal mucoadhesive tablets have been used successfully in clinical practice for systemic and localised drug distribution, particularly when traditional oral administration is limited by enzymatic breakdown or first-pass metabolism. However, there are still obstacles to overcome, such as formulation stability, patient-to-patient variability, and large-scale manufacturing constraints. Looking ahead, improvements in polymer science, nanotechnology, and bio-responsive drug delivery methods may improve the performance of these tablets. Buccal mucoadhesive tablets have the potential to become an important component of modern medication delivery, improving therapeutic effectiveness and patient quality of life.

REFERENCE

1. Mamatha Y, Prasanth VV and Kumar S A: Buccal drug delivery a technical approach. J. of Drug Deliv. Therapeutic. 2012; 2(2):26- 33.
2. Redddy C, Chatanya KSC and Madhusudan RY: A review on bioadhesive drug delivery system: current status of formulaton and evaluation method. DARU J. Phama. Sci. 2011; 19(6):385- 403
3. Shojaei AH, Chang RK and Guo X: Systemic drug delivery via the buccal mucosal route. http://www.pharmaportal.com. 2001:71-81.
4. Gandhi PA, Dr. M.R.Patel and Dr. K.R. Patel: A review article on mucoadhesive buccal drug delivery system. Int. J. Pharma. Res. Deliv, 2011; 3(5):159-173.
5. Bhanja S, Ellaiah P, Martha SK, Tiwari SP and Das D: Formulation and In vitro evaluation of mucoadhesive buccal tablet of timolol maleate. Int. J. Pharma. Biomed Res. 2010; 1(4):129-134.
6. Gandhi PA, Dr. M.R.Patel and Dr. K.R. Patel: A review article on mucoadhesive buccal drug delivery system. Int. J. Pharma. Res. Deliv, 2011; 3(5):159-173.
7. Wani MS, Dr. SR Parakh and Dr. MH Dehghan: Current status in buccal drug delivery system. 2007; 5(2):160-179.
8. Abnawe,SumitAnand, MucoahesiveDrugg DeliverySystem, Pharmainfo.net. 2009:4(5):147-160.
9. Kumar T.P., Desai K.G., and Kumar S.G., Mechanism of buccal permeation enhancers, Indian J. Pharm. Edu., 36(3); 2002: pp.147-151.
10. Gandhi S.D., Pandya P.R., Umbarkar R., Tambawala T., and Shah M.A., Mucoadhesivedrug delivery system- an unusual maneuver forsite specific drug delivery system, Inter. J. Pharm.Sci., 2011: pp. 851- 872.
11. F. C. Carvalho, M. L. Bruschi, R. C. Evangelista, and M. P. D. Gremião, ‘Mucoadhesive drug delivery systems’,

Brazilian Journal of Pharmaceutical Sciences, vol. 46, no. 1, pp. 117, 2010.
12. B. M. Boddupalli, Z. N. K. Mohammed, R. Nath A., and D. Banji, 'Mucoadhesive drug delivery system: An overview', J Adv Pharm Technol Res,2010: vol. 1, no. 4, pp. 381–387.
13. Kaul M. An Overview of Buccal Drug Delivery System. Int J Pharm Res. 2021;13(01):1303-1321.
14. Gandhi PA. A Review Article on Mucoadhesive Buccal Delivery System. Int J Pharm Res Dev. 2011;3(0974):159-173.
15. Ramesh B, Saravanakumar K, Nagaveni P, Mohan Kumar A, Jaya Preethi P, Vivek Kumar P. A review on buccal drug delivery system. Int J Res Pharm Sci. 2014;5(3):200-204.
16. Shital G, Shinkar D, Ravindra S. Mucoadhesive buccal drug delivery : An Overview. J Adv Pharm Edu Res. 2013;3(4):319-332.
17. Boddupalli BM, Mohammed ZNK, Nath A. R, Banji D. Mucoadhesive drug delivery system: An overview. J Adv Pharm Technol Res. 2010;1(4):381-387.
18. Singh J, Deep P. A review article on mucoadhesive buccal drug delivery system. International journal of pharmaceutical sciences and research. 2013 Mar 1;4(3):916.
19. Amul M, Meenakshi B, Deepak M, Harshna P. Buccal Drug Delivery System: A Review. J Afr. 2016;3:15776.
20. Miyazaki S, Nakayama A, Oda M, Takada M, Attwood D. Chitosan and sodium alginate based bioadhesive tablets for intraoral drug delivery. Biol Pharm Bull.17; 1994: pp.745–747.
21. Ceschel GC, Maffei P, Borgia SL. Design and evaluation of a new Mucoadhesive bilayered tablet containing nimesulide for buccal administration. Drug Deliv. 11; 2004: pp.225–230.
22. Remunan-Lopez C, Portero A, Vila-Jato JL, Alonso MJ. Design and evaluation of chitosan/ethyl cellulose mucoadhesive bilayered devices for Buccal drug delivery. **J.** Control**.** Release 55; 1998: pp.143–152.
23. Abuja A, Khar RK, Ali J. Mucoadhesive drug delivery systems. Drug Dev. Ind. Pharm 23; 1997: pp.489–517.
24. Mitra A. K, Alur H. H.,Johnston, Peptides and Protein- Buccal Absorption, Encyclopedia ofPharmaceutical technology, Marcel Dekker Inc., Edition 2002: pp.2081-2093.
25. V. M. Patel, B. G. Prajapati, H. V. Patel, and K. M. Patel, 'Mucoadhesive bilayer tablets of propranolol hydrochloride', AAPS PharmSciTech, vol. 8, no. 3, pp. E1–E6, 2007.
26. P. Nakhat, A. Kondawar, I. Babla, L. Rathi, and P. Yeole, 'Studies on buccoadhesive tablets of terbutaline sulphate', Indian J Pharm Sci, vol. 69, no. 4, pp. 505–510, 2007.
27. Verma S, Kaul M, Rawat A, Saini S. An overview on buccal drug delivery system. International journal of pharmaceutical sciences and research. 2011 Jun 1;2(6):1303.
28. Sharma N, Jain S, Sardana S. Buccoadhesive drug delivery system: a review. Journal of Advanced Pharmacy Education & Research Jan-Mar. 2013;3(1):9-12.
29. Effect of formulation and process variables on the release, mechanical and mucoadhesive properties of ibuprofen tablet formulations;Oladapo A Adetunji, Michael A Odeniyi, Oludele A ItiolaActa Pol Pharm 72 (2), 357-365, 2015