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BUCCAL DRUG DELIVERY: AN EMERGING PLATFORM FOR SYSTEMIC AND LOCALIZED THERAPY

GUJJARLAMUDI ABHINAYA, KONDAVEETI KEERTHANA, V. VAMSI, CHANDU BABU RAO

Priyadarshini Institute of Pharmaceutical Education and Research, 5TH Mile, Pulladigunta, Guntur-522017, Andhra Pradesh, India.

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***Corresponding Author**
Gujjarlamudi Abhinaya

Abstract
Buccal drug delivery systems (BDDS) have emerged as a promising alternative to conventional oral drug administration by overcoming limitations such as extensive first-pass metabolism, gastrointestinal degradation, and reduced bioavailability. The buccal mucosa offers a highly vascularized and relatively permeable surface, enabling direct drug entry into systemic circulation and thereby enhancing therapeutic efficacy while minimizing hepatic metabolism. This route provides advantages including painless administration, rapid onset of action, improved patient compliance, and suitability for pediatric, geriatric, unconscious, and non-cooperative patients. Bioadhesion and mucoadhesion play crucial roles in prolonging the residence time of dosage forms by facilitating interaction between the formulation and mucin layer of the oral mucosa. Drug permeability across the buccal membrane is influenced by physiological and anatomical factors, as well as formulation strategies incorporating penetration enhancers, enzyme inhibitors, and novel bioadhesive polymers. Despite extensive research and development of various dosage forms such as tablets, patches, gels, sprays, and films, only a limited number have achieved clinical and commercial success. Challenges such as limited surface area, salivary washout, and lack of standardized in vitro evaluation methods remain significant. Overall, BDDS represents a technologically advanced and patient-friendly drug delivery approach with substantial therapeutic potential.

Keywords: *Buccal Delivery, Oral Mucosa, Mucoadhesion.*

INTRODUCTION

Bio adhesion is a process characterised by interfacial molecular attracting interactions between the biological substrate surfaces and naturally or synthetically occurring polymers, allowing polymer to stick to the surface biological layers over a delayed periode the GI tract, orally administered groups of medications, particularly proteins and peptides, is not recommended. Therefore, absorption mucosal layer is thought to be potentially for administrating sites for drugs. For local and systemic site of action for delivery of drug the oral cavities are seen to be useful. Localized therapies are used for treating disorders like oral candidiasis, dental caries, gingivitis, oral lesions, and xerostomia whereas systemically the delivery is seen for treating angina and asthma [1]. Buccal administration is one of the most effective medication administration techniques for both systemic and local pharmacological activities. The tissues that adhere to polymers, whether natural or manufactured, are referred to as bio-adhesion, for prolonged, regulated drug distribution, the buccal mucosa provides a number of benefits. First-pass metabolism in the liver and pre-systemic elimination in the gastrointestinal tract are avoided, and the mucosa is adequately supplied with both vascular and lymphatic drainage, the buccal drug delivery system about treatment of diseases and thereby enhancing the quality of life, it has gained considerable interest as a major participant in Pharma industry. The delivery system which utilized the property of bio-adhesion of certain polymers, become adhesive on hydration is known as the mucoadhesive drug delivery system. This delivery system includes the following:

- Buccal Drug Delivery System
- Rectal Drug Delivery System
- Sublingual Drug Delivery System
- Nasal Drug Delivery System
- Ocular Drug Delivery System
- Vaginal Drug Delivery System

AN OVERVIEW STRUCTURE OF THE ORAL MUCOSA IN THE ORAL CAVITY

Mastication, speech, and the start of the digestive process are just a few of the physiological processes

carried out by the oral cavity, an intricate and dynamic anatomical area. A specialized mucous membrane that borders the mouth cavity.

1.1 Buccal Mucosa

Location: The lateral walls of the oral cavity are formed by the buccal mucosa, which borders the inner cheek.

STRUCTURAL CHARACTERISTICS

1.1 Squamous Epithelium Stratified: The primary component of the buccal mucosa is a stratified. Squamous epithelium that protects against chemical and mechanical harm [2].

1.2 Connective Tissue: The connective tissue layer, which lies underneath the epithelium, is home to small salivary glands, blood vessels, and nerves.

1.2 Sublingual Mucosa

2.1 Location: The sublingual mucosa covers the floor of the mouth and is located beneath the tongue.

Structural Characteristics

2.2 Thin Epithelium: In comparison to other areas of the oral mucosa, the sublingual region's epithelium is comparatively thin.

1.3 Gingival Mucosa

1.3.1 Location: The gums are formed by the gingival mucosa, which surrounds and shields the teeth [3].

The Structural Elements include:

1.3.2 Gingival Epithelium: The stratified squamous epithelium covering the gingiva is keratinized and provides resistance against the mechanical stress caused by brushing and biting.

The Oral Mucosa Serves Several Functional Purposes: [4, 5].

First, it provides protection against physical trauma, pathogens, and chemical irritants.

Secondly, it contains nerves that contribute to touch, temperature, and pain perception, all of which are necessary for normal oral function.

Lastly, saliva is secreted by small salivary glands in the connective tissue layer, which lubricates the oral cavity and aids in digestion. For the purpose of creating efficient drug delivery systems that target the buccal, sublingual, and gingival mucosa.

SUPPLY OF BLOOD TO THE BUCCAL MUCOSA

1. Arterial Supply: The buccal artery, in particular, is the major branch of the external carotid artery that supplies blood to the buccal mucosa [6].

2. Microcirculation: The buccal mucosa has a highly developed microvasculature, which promotes effective medication absorption. Drugs that penetrate the buccal epithelium are rapidly delivered throughout the body thanks to capillaries in the submucosa

3. Lymphatic Drainage: Regional lymph nodes, especially the submandibular and deep cervical lymph nodes, receive lymphatic veins from the buccal mucosa.

MECHANISM FOR BIOADHESION:

Bio adhesion is an interfacial occurrence that occurs when two materials, in which any one should be biological, is kept intact together because of interfacial force. Adherence may occur between artificial materials & biologicals, like the adhesion of a polymer-copolymer to a biological membrane. Bio adhesion is greatly influenced by the polymer's hydration. Some critically known degree of hydration is required for optimal bio adhesion. The active adhesion site may not fully be freed and ready for interacting if there is partial hydration. Polymer is bound to mucosal tissue consisting of mucin layers in the process of mucoadhesion. The mechanism of polymer–mucus interactions leading to mucoadhesion has been the subject of several theories. Hydrogen bonds between polymer chains dissociate during hydration [7,8].

IDEAL CHARACTERISTICS OF BUCCAL DRUG DELIVERY SYSTEM

- The medications utilized in buccal drug delivery that are solely absorbed by the passive diffusion Citation process.
- The medications' molecular weight should be between 200 and 500 Daltons, and they should not smell.
- These that are hydrophilic and lipophilic can be appropriately added to buccal dosage forms.
- Buccal drug delivery devices are ideal for the tasteless and persistent pH medications.
- For a few hours, it should stay attached to the attachment site.
- The medicine should be released under strict surveillance.

FACTORS AFFECTING BIOADHESIVE

1. Polymer-related factors: Numerous qualities or properties of the active polymers are important in mucoadhesion. Concentration, polymer, swelling, specific confirmation, molecular weight, and polymer chain flexibility are all factors that may influence mucoadhesion.
2. 2. Environmental factors: mucoadhesion may influenced by the pH of the polymer-substrate interface, first contact time and functional strength [9].

FORMULATION COMPONENTS OF THE MUCOADHESIVE DRUG DELIVERY SYSTEM

1. Drug or Active pharmaceutical ingredient (API): The selection of the API is very critical in this drug delivery system. The API is decided based on physicochemical properties, dose, and type of the formulation to be developed.

2. Physiological Factors

2.1 Mucosal Surface Characteristics:

Individual differences exist in the composition and topography of the buccal mucosa. The degree of

hydration, surface charge, and roughness can all affect how well mucoadhesive systems interact.
2.2 Saliva Composition: The adhesive qualities of saliva are influenced by its composition, which includes its mucin concentration and viscosity. Saliva has properties that can either help or inhibit bioadhesion.

EVALUATION OF MUCOADHESIVE FORMULATIONS

1. pH of surface: The pH surface of the mucoadhesive formulation is measured to see whether there are any potential negative effects in vivo. The buccal patches are to be expanded for 2 hours at room temperature on an agar plate surface which is in contact with 1 ml of distilled water. To measure the pH, the swollen patch's surface is placed with the pH paper [10].
2. Measurements of thickness: This test is applied for the mucoadhesive patch formulations. Each film's thickness is measured at five separate spots using an electronic digital micrometre (centre and four corners).
3. Folding Endurance: It's determined manually. The patch is folded at the same location over and over until it ruptures or breaks.

ADVANTAGES OF ADHESIVE DRUG DELIVERY SYSTEM [11,12]

1. Bioavailability enhancement: For bio adhesive formulation the residence time is more in comparison to conventional dosage forms so the drug is more available at the site of absorption leading to the enhancement of the bioavailability.
2. Rapid onset of action: Bio adhesive formulations show the rapid onset of the pharmacological action in comparison to the conventional dosage forms
3. Protection from the acidic environment: The drug is matrixed into the polymeric system that protects from the acidic environment of the stomach.

DISADVANTAGES OF BUCCAL ADHESIVE DRUG DELIVERY SYSTEM [13, 14].

1. Ulcer development: Due to the prolonged adhesiveness of the formulation, there may be chances of ulcer development at the site of application.
2. Lack of in vitro model: So far there is no accurate in vitro model available to simulate the drug action in vivo.
3. Drug dilution: Due to the continuous secretion of the saliva, there are great chances of drug dilution leading to the submissive therapeutic response.

FUTURE DEVELOPMENT AND TRENDS NANOTECHNOLOGY PROGRESS

1.Nanotechnology Advancement: Nanocarrier research and development should continue to improve medication transport, targeting, and therapeutic results
2.Advanced Drug Delivery System: Study of cutting-edge drug delivery technologies, including as hydrogels, implanted controlled-release devices, and smart polymers. Using 3D printing technology to create customized, demand-driven medication distribution systems.
Patient focus Approaches: Concentrate on creating formulations that are more palatable to patients and have better taste masking and acceptance. When creating buccal drug delivery systems, patient preferences and lifestyles are taken into account.
Environment Technology: Emphasis on sustainable production methods and eco-friendly materials. Investigating environmentally friendly and biodegradable polymers for oral medication administration [15].

CONCLUSION

Buccal drug delivery has various benefits that includes comfort of administration, accessibility and withdrawal, retentivity, high patient compliance, cost, and low enzymatic activity. This method can be utilised to avoid 1st-pass metabolism in liver as well as pre-systemically occurring clearance in the GIT. This site is also seen to be appropriate for a retentive device and is agreeable to any patient. Another advantage is that the permeability in the locally appearing environment of the mucosal layer and may be managed and altered to provide accommodation to drug absorption with correct dosage form designs and formulations. Buccal drug administration has the potential to be a practical and interesting method for non-invasive delivery of strong peptides and protein therapeutical agents, as well as a means of systemic dispersion of orally ineffective drugs. Mucoadhesive buccal patches have applications from various angles, including avoiding first-pass metabolism in the liver and pre-systemic elimination in the gastrointestinal tract. The mucosa is well supplied with both vascular and lymphatic drainage, and first-pass metabolism in the liver and pre-systemic elimination in the gastrointestinal tract are avoided.

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