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Characterization Techniques of Buccal Patches - A Review

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ABSTRACT

The process by which polymers bind to a biological substrate, a man-made or natural macromolecule, mucus, or an epithelial surface is known as mucoadhesion. Mucoadhesion is a process that occurs when a biological substrate adheres to a mucosal layer. Several methods, including the hot extrusion melt method and the solvent casting method, can be used to create the films. The effectiveness and performance of these films may be assessed based on a number of factors, including tensile strength, mucoadhesion residence duration, and kinetic release data analysis. This page discusses buccal patches, their kinds, production processes, and characteristics.

Keywords: Buccal patches, types, factors affecting, manufacturing methods and characterization techniques..

Introduction

In order to apply penicillin to the oral mucosa, gum tragacanth was combined with dental adhesive powder in 1947, leading to the development of bio adhesive drug delivery formulations. Delivery of therapeutic agents via a mucoadhesive drug delivery system has gained a lot of interest in recent years. Some medications are ineffective because of poor bioavailability, GI intolerance, inconsistent and unpredictable absorption, or pre-systemic clearance of alternative delivery routes. The study of mucosal medication delivery has become more intense as a result of recent advancements in drug delivery. These channels include pulmonary, nasal, ocular, buccal, and oral ones among others [1,2]. In order to target a medicine to a specific area of the body for a longer length of time, mucoadhesive drug delivery systems leverage the bio adhesion of certain polymers, which become adhesive upon hydration [3].

Buccal Drug Delivery System:

The mouth's mucosa resembles skin more morphologically and differs greatly from the remainder of the gastrointestinal system. Although the oral mucosa lacks the good permeability, it is often not recognised that the permeability of skin is generally considered to be bad the gut, as shown. The arrangement of the epithelia, which has widely distinct activities, is primarily responsible for these variations throughout the gastrointestinal tract. The stomach, small intestine, and colon are lined with a straightforward, single-layered epithelium, allowing for the shortest possible transport distance for absorbents. In contrast, the mouth cavity and oesophagus are covered by a stratified or multi-layered epithelium that, like skin, is made up of layers with varied levels of differentiation or maturation that become apparent as one moves from the basal cell layer to the surface. For many years, drugs have been administered topically to the oral mucosa [4].

Classification of Buccal Systems:

The ability to easily adhere to the buccal cavity, keep their position for a longer amount of time, and remove them whenever necessary makes recent buccal mucoadhesive formulations an effective substitute for traditional oral drugs. Numerous research teams have investigated mucoadhesive drug delivery methods employing tablets, films, multilayer systems, discs, microparticles, ointments, wafers, lozenges, and hydrogel systems [5].

Buccal Patches:

These flexibles bypass the first pass effect by delivering the medications directly into the systemic circulation over mucous membrane. To treat both local and systemic disorders, buccal patches are inserted in the mouth between the upper gingivae (gums) and cheek. It is discouraged for many pharmaceuticals to interact with digestive system meals, since this may not be acceptable for their stability. This permits easy removal without considerable associated pain and is simple, painless, and discomfort-free. It also has a precise dosing form. Additionally, it demonstrates improved consistency, patient compliance, uniform and sustained drug release, and above important, simple and inexpensive preparation procedures that may be carried out with a variety of widely accessible biocompatible polymers.

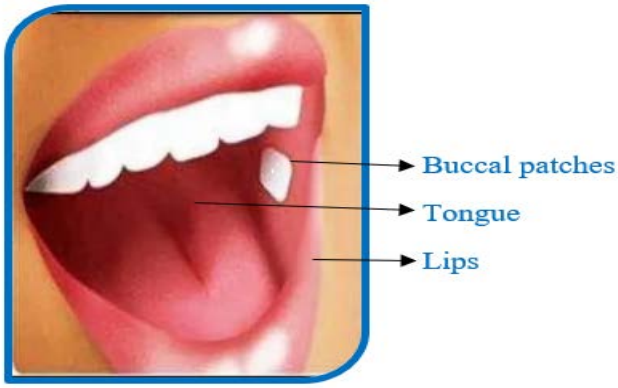

Figure 1: Buccal Patches

Types of Buccal Patches:

The mucoadhesive buccal patches can be of two types

Matric Type: The hydrophilic or lipophilic polymer matrix and the medication are combined to create matrix-style buccal patches. By moulding medicated polymer, a therapeutic disc with a certain surface area is created.

Reservoir Type: A compartment separate from the adhesive in the reservoir system is used for the medicine and additives. Attaching a water-resistant backing prevents medication loss.

Limitations:

There are certain restrictions to drug delivery through the buccal mucosa. This method cannot be used to provide medications that irritate the oral mucosa or have a bitter or unpleasant taste or odour. This method cannot be used to give medications that are unstable at buccal p^H. Only medications with low dosage needs can be taken. Drugs may be ingested with saliva but lose the benefits of the buccal route. Only medications that are absorbed by passive diffusion can be given this way. It's feasible for the patient to ingest the formulation. The swelling and hydration of the bio adhesive polymers may cause the surface to become slippery and compromise the formulation's structural integrity [6-10].

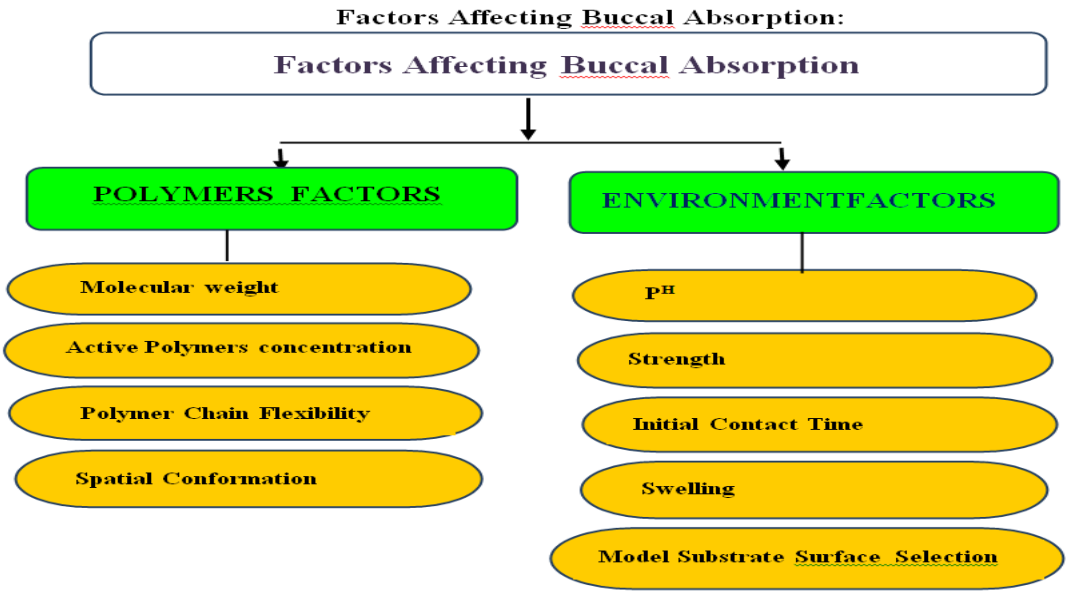

Figure 2: Factors Affecting Buccal Adsorption

Polymer Related Factors:

Molecular Weight: Up to a polymer's molecular weight of 10,000, the bio adhesive force increases; however, after this point is reached, no change occurs. The polymer molecule needs to be long enough to permit chain interpenetration.

Concentration of Active Polymers: The best bio adhesion is the consequence of the right polymer concentration. The adhesive strength significantly decreases in systems that are excessively concentrated. The coiled molecules become solvent deficient and the chains available for interpenetration are sparse in concentrated solutions.

Flexibility of Polymer Chain: Flexibility is a crucial component in interpenetration and expansion. The mobility of each polymer chain decreases when water soluble polymers are cross linked. The effective length of the chain that can penetrate the mucus layer decreases more as the cross-linking density rises, resulting in a reduction in mucoadhesive strength.

Spatial Conformation: A molecule's spatial conformation is just as significant as its molecular weight or chain length. Dextran has a molecular weight of 19,500,000; however it is just as sticky as polyethylene glycol, which has a molecular weight of 200,000. Dextran's helical structure allows it to protect a variety of PEG polymers with a linear conformation from several adhesively active groups, which are principally in charge of adherence.

Environment Related Factors:

P^H: The charge on the surface of the polymers and mucus is affected by p^H. Depending on the pH, mucus will have a varied charge density. due to a shift in how functional groups on the carbohydrate moiety and the amino acids that make up the polypeptide backbone are dissociated.

Strength: Applying a certain strength is important to place a strong bio adhesive system.

Initial Contact Time: The first contact time also increases as the mucoadhesive strength does.

Selection of The Model Substrate Surface: Examining characteristics like permeability, electrophysiology, and histology should be done in order to ensure the viability of the biological substrate.

Swelling: Both the concentration of polymers and the presence of water affect swelling. When oedema is excessive, bio adhesion decreases.

Manufacturing Methods of Buccal Patches:

In order to create mucoadhesive buccal patches/films, the following production

processes are used: solvent casting, hot melt extrusion, direct milling, semi-solid casting, and rolling technique.

Solvent Casting: In the solvent casting process, the necessary quantity of mucoadhesive polymers is treated with solvent, and the polymer swells following vertexing. The determined amount of plasticizer was added to the polymer mixture and vortexed once more. The required amount of medication was liquefied in a tiny amount of solvent system, added to the polymer solution, and well mixed. Following the release of trapped air, the mixture is poured into a thoroughly cleaned petri dish. The developed patches are kept in a desiccator until the evaluation tests are run [11].

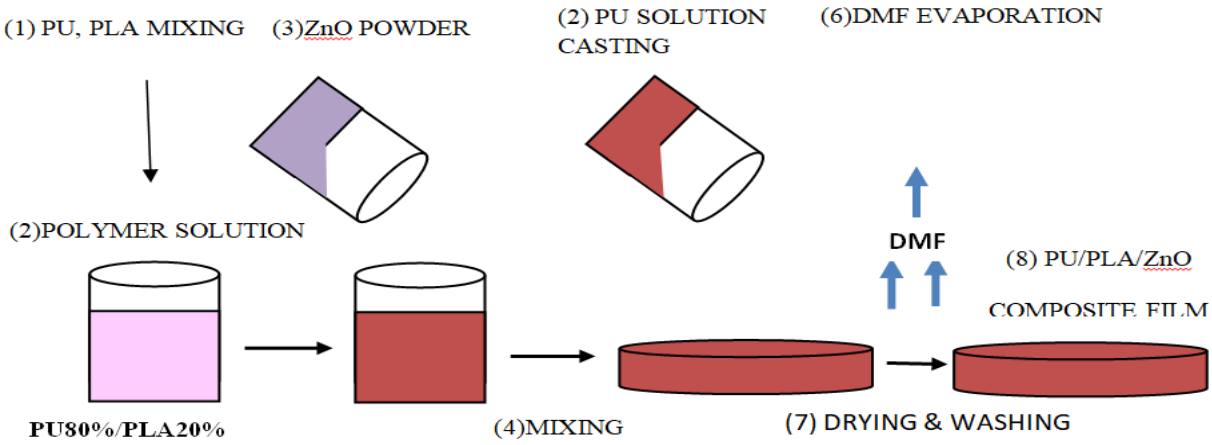

Figure 3: Solvent Casting

Direct Milling: Patches are created using this method without the use of solvents. For motorised mixing of medicine and excipients without the presence of any liquid solution, direct milling or kneading procedures are utilised. The resulting material is rolled to the necessary thickness. After that, the backing material is laminated. Because there is no chance of leftover solvents or health problems brought on by solvents, the solvent-free technique is preferred [12].

Hot Melt Extrusion: In the hot melt extrusion procedure, a molten combination of medicinal components is forced through an aperture to produce various forms. Oral disintegrating films, pellets, granules, and controlled release matrix tablets have all been made via hot melt extrusion. Solid dispersion extrusion involves combining the medicine with immiscible components to make solid dispersions. Finally, dies are used to shape the solid dispersions into films.

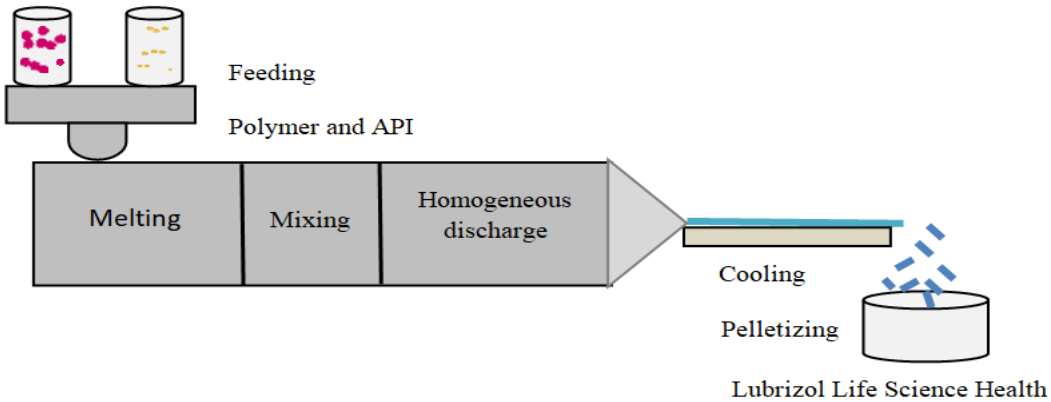

Figure 4: Hot Melt Extrusion

Semisolid Casting: A solution of a film-forming polymer that is water soluble is first arranged in the semisolid casting process. The resultant solution is mixed with an ammonium or sodium hydroxide-prepared solution of an acid-insoluble polymer. The right amount of plasticizer is then added, resulting in the formation of a gel mass. Finally, using heat-controlled drums, the gel mass is moulded into films or ribbons.

Rolling Method: This technique involves rolling a drug-containing solution or suspension on a carrier. Water and an alcohol-water combination make up the majority of the solvent. The film is cut into the required shapes and sizes after being cured on rollers [13].

Characterization of Mucoadhesive Films:

Organoleptic Evaluation: Organoleptic qualities including colour, flavour, and taste may be determined visually by inspecting the generated film formulation. E-tongue software is helpful for analysing the flavour of a composition. Good taste and uniformity in colour and smell help patients accept a treatment [14].

Surface Ph: For the film to pass through the oral mucosa without causing irritation or harmful consequences, the pH level should be close to 7 or neutral. Surface pH-by-pH metres are used to determine film that has been dissolved in an appropriate solvent [15].

Contact Angle: Measurement of the contact angle may be used to forecast a film's wetting ability, disintegration, and dissolution time. Within 10 seconds, a specially created device with a digital camera snaps a photo of a drop of double-distilled water put on the surface of a dry film, which is then further analysed using software to pinpoint the precise contact angle [16].

Transparency: Availability of oral film using an ultraviolet (UV) spectrophotometer, determine the film's transmittance as follows:

Transparency = (Log T600)/B = −€C

Where T600 = transmittance at 600 nm, b = film thickness (mm) and c = concentration [17].

Swelling Studies: In phosphate buffer with a pH of 6.6, swelling studies for Buccal films can be quantified gravimetrically. Utilizing a cyanoacrylate adhesive sealant, attach films to pre-weighed glass supports. Place film-covered supports in the phosphate buffer at 37 °C. At certain intervals, remove the devices from the medium, dab them dry using tissue paper, and weigh them [18]. The films should be dried at 40 °C until they reach a consistent mass after the wet weight has been determined. The following formulae can be used to calculate erosion gravimetrically and the swelling index (S.I).

Swelling Index (%) =Ws−Wdwd

Erosion (% Mass Loss) =Original Weight−Remaining Dry Weight/Original Weight×100

Where Wd and Ws are the weights of dry and swollen devices, respectively.

Thickness: A film with a consistent and ideal thickness between 5 and 200 micrometres can deliver accurate dosage and good absorption. The thickness of a film is measured using a micrometre screw gauge, calibrated digital vernier callipers, or any other measuring tool that has been specifically created for the task. To calculate thickness, five separate locations—four corners and the centre—should be employed [19].

Interaction Study: To create an efficient Buccal film, a drug-excipient interaction analysis utilising FTIR or DSC thermogram is required [20].

Tensile Strength: Tensile strength is the amount of stress that may be applied before a film specimen breaks. It is the applied weight at rupture multiplied by the film's cross-sectional area.

Tensile Strength = Weight at Failure × 100/Film Thickness × Film Width [17]

Percent Elongation: Percent elongation capacity can be used to represent a film's ability to stretch following the application of force all the way up to distortion before it breaks. The formula used to compute it is:

% Elongation = Increase In Length of Film × 100/Initial Length Of Film [18]

Tear Resistance: Tear resistance is a measurement of the greatest resistance a film can withstand at low speeds of up to 50 mm/min before the specimen tears under load or force. A brittle, rigid film demonstrates a high tensile strength [21].

Folding Endurance: By repeatedly folding a 2 x 2 cm^2 film specimen at the same location until it breaks or a noticeable fracture is noticed, one may determine a film's folding endurance [22].

Percentage Moisture Loss: The percentage of moisture loss of the film must be determined in order to assess its physical stability and integrity. Using the following formula, determine the weight loss of a 2 x 2 cm^2 film after 72 hours of storage in simple desiccators with fused anhydrous calcium chloride:

Percent Moisture Loss = (Initial Weight − Final Weight)/Initial Weight × 100 [23]

Percentage Moisture Absorption: The Buccal films were precisely weighed before being put into desiccators with 100 ml of saturated aluminium chloride solution and 86% relative humidity. The films were removed after three days and weighed [24].

Percent Moisture Absorption = (Final Weight -Initial Weight)/Initial Weight × 100

Drug Content Uniformity: The standard test defined for the individual active drug in any of the standard pharmacopoeia is used to assess content uniformity. It fluctuates between 85 and 115% [24].

Scanning Electron Microscopy: Scanning electron microscopy is extremely advance technology to analyse surface morphology of film and drug - excipients interaction too [22-24].

In Vitro Disintegration Test: Film should disintegrate, which means break when in contact with water or saliva, within 5 to 30 seconds, for effective absorption through the oral mucosa [23,24].

In Vitro Dissolution Studies: To calculate the amount of active medicine released into the dissolving medium per unit of time under controlled circumstances (liquid/solid interface, concentration, 37 0.5°C of temperature, and 50 rpm), dissolution experiments are crucial [20].

Permeation Studies: Even though the oral mucosa has 4–1000 times the permeability of skin, permeation tests need to be done. Porcine Buccal mucosa and a modified Franz diffusion cell can be used to examine the permeability. There are donor and receptor compartments in a Franz diffusion cell. Mucosa is positioned between the two compartments, and it should have the same size as the head of the receptor compartment. The receptor compartment is filled with buffer and kept at 37 ± 0.2°C while being stirred by magnetic beads at a speed of 50 rpm to maintain thermodynamics. Keep a film specimen in close contact with the mucosal surface after moistening it with a few drops of simulated saliva. One millilitre of simulated saliva with a pH of 6.8 should be placed in the donor compartment. At certain intervals,

samples are removed and are replaced with an equal volume of new media. The amount of medication that has penetrated can be calculated using an appropriate analytical approach [19].

Stability Study in Human Saliva: Film stability tests were carried out using actual human saliva. 10 people (ranging in age from 18 to 40) provided saliva samples, which were then filtered. The films were inserted in a petri dish with 5 ml of human saliva and baked for 6 hours at a regulated temperature of 37°C ± 0.2°C. At specific time intervals, the films were checked for changes in morphology and physical stability. The resulting mixture was placed on Petri dish—natural human saliva—and these were monitored for appearance, colour, shape, and physical stability on a regular basis. The findings show that the physical characteristics of the film do not change, making the produced formulation more stable during administration or storage in the buccal cavity over time [17, 21-24].

Stability Study as Per Ich Guidelines: International Conference on Harmonization (ICH) rules is applied to establish formulation stability. Films that have been properly packaged should be kept for three months in a variety of humidity and temperature settings before having all relevant metrics, such as drug content, disintegration time, and physical qualities, assessed [22-24].

Conclusion: Compared to regulated medication administration over prolonged periods of time, the buccal mucosa has a number of benefits. Recently, mucoadhesive buccal patches have become more significant in medication delivery. There is still a lot of research being done on mucoadhesive buccal patches made of different natural polymers all around the world. Patients can safely employ buccal medication administration since it can be stopped if side effects manifest. This review paper described the characteristics of buccal patches that are mucoadhesive. The buccal drug administration method, however, is a promising topic for further study with the aim of systemic distribution of orally ineffective medicines.

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