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A Review Article on Buccal Patch

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Abstract: *Buccal drug delivery has emerged as an effective alternative route for systemic and local administration of therapeutic agents. The buccal mucosa offers a highly vascularized, easily accessible, and relatively permeable surface that enables rapid drug absorption while bypassing hepatic first-pass metabolism. Buccal patches—thin, flexible, mucoadhesive dosage forms—provide controlled and sustained drug release with improved patient compliance and minimal gastrointestinal irritation. This review provides a comprehensive overview of buccal patches, including oral mucosa anatomy, mechanisms of buccal absorption, classification, formulation components, advantages, evaluation parameters, and types of natural and synthetic mucoadhesive polymers used. Various manufacturing methods such as solvent casting, direct milling, and hot-melt extrusion are discussed along with examples of drugs delivered via the buccal route. The review highlights the potential of buccal patches as a promising drug delivery system for enhancing bioavailability and therapeutic efficacy of numerous drugs*

Keywords: Buccal patch, buccal drug delivery, mucoadhesion, transmucosal delivery, mucoadhesive polymers, oral mucosa, solvent casting, hot-melt extrusion, sustained release, bioavailability, drug permeation, buccal absorption

I. INTRODUCTION

Transmucosal delivery of therapeutic agents is a popular method because mucous membranes are relatively permeable, allowing for rapid uptake of a drug into the systemic circulation and avoiding the first pass metabolism. This efficient uptake offers several benefits over other methods of delivery and allows drugs to circumvent some of the body's natural defense mechanism. Transmucosal products can be designed to be administered via the nasal route by using sprays, pumps and gels, via the oral/buccal route by using mucoadhesive quick dissolve tablets like sublingual tablet, bilayer mucoadhesive tablet and buccal patches formulations and via vaginal or urethral routes using suppositories.

In the development of these drug delivery systems, mucoadhesion of the device is a key element. The term 'mucoadhesive' is commonly used for materials that bind to the mucus layer of a biological membrane. Mucoadhesive polymers have been utilized in many different dosage forms in efforts to achieve systemic delivery of drugs through the different mucosae.

Buccal patches are small, flexible, mucoadhesive dosage forms designed to deliver drugs through the buccal mucosa (inner lining of the cheek). They adhere to the mucosal surface and provide controlled and sustain drug release directly into systemic circulation, bypassing hepatic first-pass metabolism. Compared to conventional oral solid dosage forms, buccal patches enhance bioavailability, reduce dosing frequency, minimize gastrointestinal irritation, and improve patient compliance. Their non- invasive nature and ease of administration make them a promising alternative for both local and systemic drug delivery.

Routes Of transmucosal Drug delivery:(1)

There are different routes utilized for delivering drugs through mucosa Mentioned below

- ➢ Nasal Route
- ➢ Rectal Route
- ➢ Ocular Route
- ➢ Vaginal Route

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➢ Oral mucosal

In oral mucosal examples like Sublingual tablets, Bilayer mucoadhesive tablets, Films and Patches, Patches is promising dosage form Because of its bypassing hepatic first-pass metabolism direct systemic circulation and patient compliance.

Anatomy and Physiology of the Oral Mucosa:(2)

The oral mucosa is anatomically divided into three layers the outermost layer of stratified squamous epithelium, followed by basement membrane and, lastly, the connective tissue composed of the lamina propria and submucosa . The permeability of buccal mucosa is 4–4000 times greater than the skin epidermis and less than that of the intestinal mucosa. In the oral cavity, the order of permeability is sublingual > buccal > palatal. This is due to the physical characteristics of each tissue, with sublingual tissue being relatively thin and nonkeratinized, while palatal tissue is keratinized.

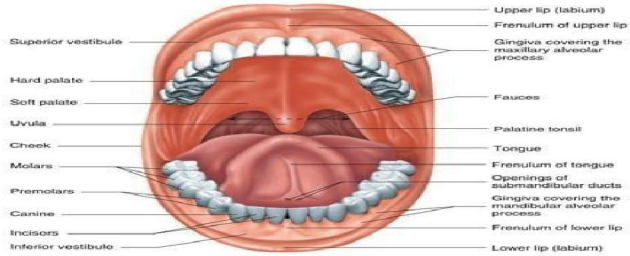

Fig No 1:-Anatomy of oral mucosa(2)

Epithelium:- The buccal epithelium, as an example, consists of approximately 40–50 layers of stratified squamous epithelial cells. The basal layer is mitotically active and produces epithelial cells, which then migrate through a number of intermediate layers. As the cells migrate to the surface, they increase in size and become flattened. Cytoplasmic organelles disappear and protein content is elevated. Cells are then shed at the surface of the epithelium. The turnover time for the epithelium is typically considered to be 5–6 days .Composition of the epithelium varies with location in the oral cavity. The gingiva and hard palate (areas subject to mechanical stress) are keratinized, whereas the soft palate and sublingual regions are nonkeratinized. Thus, the thickness varies from 500 to 800 µm. One important biochemical feature of the buccal epithelium is the presence of large molecular weight (40–70 kDa) proteins called tonofilaments. The epithelial cells are surrounded by a matrix rich in carbohydrate– protein complexes, which act as a lubricant to promote cell-to-cell adhesion. The buccal epithelium is also characterized by the presence of large intercellular junctions, primarily gap junctions .The superficial layer of epithelium is the predominant barrier to drug diffusion. Permeation studies with horseradish peroxidase and lanthanum nitrate have shown that the flattened superficial layers constitute the major barrier, while the lower layers are relatively permeable. This is true in both keratinized and nonkeratinized epithelium, suggesting that keratinization does not offer as much resistance to buccal drug permeation as once thought. The permeability barrier of the epithelium is mainly due to the presence of membrane-coating granules (MCGs), which are described below.

Membrane-Coating Granules:- MCGs are spherical or oval-shaped organelles, 100– 300 nm in diameter. The MCGs contain primary lipids and accumulate when the cells leave the basal layer, begin to differentiate, and migrate toward the surface. They are present in both keratinized and nonkeratinized epithelium, but differ in composition. The granules fuse with the cell membrane at the superficial layers and discharge their contents into the intercellular spaces. MCGs themselves, or their discharged contents, typically influence the permeability of the epithelium to permeants.

Basement Membrane:- The basement membrane is the boundary between the basal layer of the epithelium and the connective tissues. It is a trilaminar structure consisting of lamina lucida (upper amorphous layer), lamina densa, and a sublayer of fibrous material. The lamina densa is composed of highly ordered collagen, which imparts strength to the structure. The basement membrane appears as ridges and folds that project into the epithelium. Thus, it has a larger surface area compared to the epithelium and, as such, this larger surface area may present a moderate degree of resistance to drug permeation/transport by affecting the diffusional pathlength of the permeant (drug molecule). The

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basement membrane serves three important functions: adherence between the epithelium and the underlying connective tissue, mechanical support to the epithelium, and a barrier to the passage of cells and macromolecules.

Connective Tissues : Connective tissue consists of lamina propria and submucosa, if present. The lamina propria is a continuous sheet of connective tissue comprised of collagen, elastic fibers, and cellular components. It is insufficiently dense to offer resistance to relatively large molecules. However, the hydrated matrix in this tissue promotes the passage of hydrophilic permeants. The lamina propria is rich in blood vessels that open into the internal jugular vein, thus avoiding first-pass metabolism.

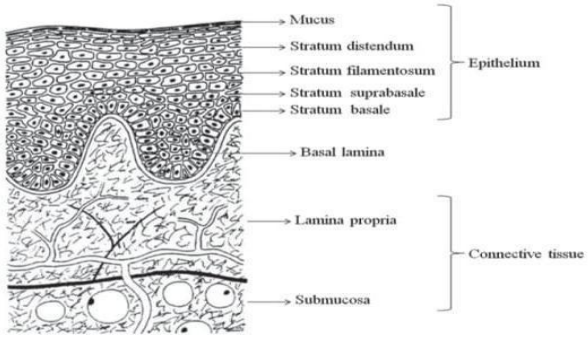

Fig no 2:- TS of Oral Mucosae)

Buccal drug delivery:(3)

A delivery system designed to deliver drugs systemically or locally via buccal mucosa. Buccal delivery refers to the drug release which can occur when a dosage form is placed in the outer vestibule between the buccal mucosa and gingival.

Mechanism of Buccal Absorption:(4)

Buccal drug absorption occurs by passive diffusion of the nonionized species, a process governed primarily by a concentration gradient, through the intercellular spaces of the epithelium. The passive transport of non-ionic species across the lipid membrane of the buccal cavity is the primary transport mechanism. The buccal mucosa has been said to be a lipoidal barrier to the passage of drugs, as is the case with many other mucosal membrane and the more lipophilic the drug molecule, the more readily it is absorbed . The dynamics of buccal absorption of drugs could be adequately described by first order rate process. Several potential barriers to buccal drug absorption have been identified. Dearden and Tomlison (1971) pointed out that salivary secretion alters the buccal absorption kinetics from drug solution by changing the concentration of drug in the mouth(5) .The linear relationship between salivary secretion and time is given as follows Where

$$-dm/dt=KC/ViVt$$

Classification Of Buccal Drug Delivery System:(6)

A. Solid dosage forms:

i. Buccal tablet
ii. Lozenges
iii. Wafers
iv. Buccal film and Patches
v. Buccal chewing gum

B. Semisolid dosage forms:

i. Ointments
ii. Gels

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C. Liquid dosage forms:

i. Spraying agents

ii. Emulsions in the form of liposomes, nanoparticles.

Ideal Characteristics of Buccal Drug Delivery System:(7)

- Safety and non-toxicity.
- Non-irritancy
- Biocompatible pH.
- Elevated flexibility
- Instant adherence to buccal mucosa.
- Longer retention time (8)
- Optimum drug absorption rate and extent.
- Sustain release of a drug (9)

Buccal Patches : (10)

Buccal Patches are thin, flexible, mucoadhesive dosage .Buccal Patches are a type of drug delivery system that is placed inside the mouth, specifically on the inner lining of the cheek (buccal mucosa). They are designed to slowly release the drug into the bloodstream through the mucous membrane. This method helps the drug avoid breakdown in the stomach and liver (first-pass metabolism), which can improve its effectiveness. Patches are laminates that consist of a reservoir layer containing drugs and an impermeable backing layer. Drug is released in a controlled manner from the reservoir layer. Bioadhesive surface is for mucosal attachment. Mucoadhesive patches can be made up to 10-15 cm2 in size, but with an oval shape, they are typically 1-3 cm 2 to fit comfortably into the middle of the buccal mucosa. The film attached to the oral mucosal should be kept in place for at least few hours.(11)

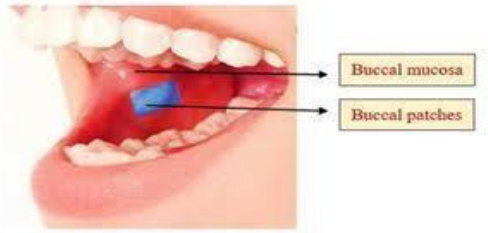

Fig No 3 :- Buccal Patcha:

Composition Of Buccal Patch :(13)

- Active ingredient.
- Polymers (adhesive layer):- Hydroxy ethylcellulose, hydroxypropyl cellulose, polyvinyl pyrrolidone, polyvinyl alcohol, carbopol and other mucoadhesive polymers.
- Diluents:- Lactose DC is selected as diluent for its high aqueous solubility, its flavouring
- characteristics, and its physico mechanical properties, which make it suitable for direct compression. other example : microcrystalline starch and starch.
- Sweetening agents:- Sucralose, aspartame, mannitol, etc.
- Flavouring agents:- Menthol, vanillin, clove oil, etc.
- Backing layer:- Ethyl cellulose, etc.
- Penetration enhancer:- Cyano acrylate, etc.
- Plasticizers:- PEG-100, 400, propylene glycol.

Advantages :(14)

- Bypass of the gastrointestinal tract and hepatic portal system, increasing the bioavailability of orally

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• administered drugs that otherwise undergo hepatic first metabolism.
• Improved patient compliance due to the elimination of associated pain with injections; administration of drugs in unconscious or incapacitated patients.
• Sustained drug delivery.
• A relatively rapid onset of action can be achieved relative to the oral route, and the formulation can be removed if therapy is required to be discontinued.
• Increased ease of drug administration.

Applications:(15)
• Cardiovascular diseases: for delivery of drugs like nitroglycerin in angina and hypertension.
• Post surgical pain management: used as analgesic(16)
• Hormonal therapy: used for sustained delivery of hormones like estradiol and testosterone.
• Oral disorders: for local treatment of mouth ulcers, infections, and inflammation.
• Smoking cessation: for delivery of nicotine to reduce withdrawal symptoms.
• Diabetes: Investigated for insulin and peptide drug delivery to avoid injections.
Evaluation parameter of Buccal formulation:(17)
• Folding endurance
• Thickness of the film
• Weight uniformity
• Physical appearance
• Drug content
• Moisture absorption studies
• Percentage moisture uptake
• Moisture loss studies
• Percentage moisture loss
• Swelling study

Types Of Mucoadhesive Polymers Used In Buccal Drug Delivery System:(18)
A. Natural /Semi natural Polymer: following natural/ semisynthetic polymers are reported to have been used in preparation of mucoadhesive buccal patches:-
➢ **Chitosan:** (19) Chitosan is a biopolymer of a derived type of chitin that occurs naturally. Chitosan is a linear polysaccharide comprised of randomly distributed β-(1-4)-linked D-glucosamine deacetylated unit) and N-acetyl-D-glucosamine (acetylated unit).Commercial chitosan, like Pandalus borealis, is derived from shrimp shells and other sea crustaceans.
Properties of chitosan: Good bioavailability and low toxicity. Mucoadhesive nature. Chitosan has ability to produce many different forms when combined with other chemical entities. In drug delivery, it shows positive charge under acidic conditions. Chitosan is insoluble in neutral and basic environments. Chitosan may form many translational metal ions. Ability to bind to other molecules by itself. Power for target drugs to take particular cellular action. It has fungistatic and bacteriostatic effects.

Pharmaceutical application:
1. It is a good thinner for the direct compression of the formulation of tablets.
2. It is used as a wet granulation binder
3. Regulated release of drugs from tablets, granules and film is shown by chitosan.
4. It increases the viscosity during the processing of hydrogels in solutions.
5. Chitosan facilitates the dissolution of poorly soluble drugs and increases drug absorption in the delivery system of nasal and oral drugs. Guar Gum:(20) Guar gum is a type of galactomannan that occurs naturally and is also called

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guaran. Around 80 % galactomannan, 12 % water, 5 % protein, 2 % acid soluble ash, and 0.7 % fat are found in guar gum. Guar gum's molecular weight is approximately 1 million. Due to its long chain structure and high molecular weight, guar gum has high viscosity. Guar gum is a polysaccharide that consists of galactose and mannose sugar.

Properties of Guar gum: In cold and hot water, guar gum is easily soluble, but in many organic solvents it is insoluble. Other excellent features, such as the emulsifying agent, thickening agent, stabilizing agent, and film forming agent. It has the ability to monitor rheology by management of the water phase. The temperature, pH, salts and other solids influence the viscosity of guar gum. Due to its drug release retarding property, guar gum is used in colon delivery. Guar gum in the big intestine is also prone to microbial degradation.

Pharmaceutical application:

1. Guar gum is used as a binder or as disintegrant in tablets in the pharmaceutical industry.
2. It is used in some bulk-forming laxatives as well.
3. Guar gum is used in the cosmetics and toiletries industry as a thickener in toothpastes and as a conditioner in shampoos.

Tragacanth:(21) Tragacanth is a natural gum obtained as dried juice from many species of genus Astragalus, including Adscendin, A. Gummifer's, and A. brachycalyx.

Properties of Tragacanth: Tragacanth gum is a viscous, odorless, tasteless and water-soluble mixture of polysaccharides.

Pharmaceutical application:

1. It is used in tablets and pills as an adhesive agent.
2. Tragacanth is used in creams, pastes and lotions for emulsify oil droplets Used as an agent for in biphasic dosage.

Sodium alginate:(21) Alginic acid, or alginate, is an anionic polysaccharide, also referred to as algin, derived from brown algae cell walls. It has the ability to bind and form a viscous gum with water. In water, alginic acid can absorb 200- 300 times its own weight when water is extracted from alginate. Mainly, alginate is derived from seaweed. Alginic acid is produced predominantly by two genera of bacteria, such as Pseudomonas and Azotobacter. They play an important role in the preparation of the pathway of biosynthesis. The sodium salt of alginic acid is .sodium alginate. NaC6H7O6 is the formula. The gum derived from the cell walls of brown algae is sodium alginate. Sodium alginate is slowly soluble in water and insoluble in ethanol and ether.

Pharmaceutical application:

1. It is flavorless gum and used to increase viscosity in the food industry.
2. It is used as emulsifier.
3. Used in indigestion tablets and the preparation of dental impressions.
4. It is used for pulling radioactive toxins from the body because of their good chelating property.

Lectins:(22) Due to its natural ability to bind directly to free sugar or to sugar residues of polysaccharides, glycoproteins, or glycolipids that can be free or attached (as in cell membranes), Lectins have gained broad attention from biomedical scientists in the last few years. Because of their relatively strong resistance to acidic pH and enzymatic degradation, and the omnipresence of binding sites along the GIT, Lectins are good candidates for oral delivery. However, binding is only possible if the corresponding sugar moieties are available on the mucosal epithelium. As there is no homogeneous occurrence of corresponding specific sugar moieties along the GIT, interactions of lectins can be specific to some particular cellular type (e.g. M cells) or a specialized area (e.g. colon). Lectin was considered as a sugar binding protein having the ability to agglutinate cells and/or precipitate glycoconjugates.

Pharmaceutical application:

1. Used for targeted drug delivery due to their ability to bind specific cell receptors.
2. Help in mucoadhesive drug delivery systems to enhance absorption.

Pectins: (23) Specifically, it is an anionic polysaccharide, a heteropolysaccharide contained in most primary cell walls and often abundant in the nonwoody sections of terrestrial plants. Pectin is a normal component of the human diet but does not contribute substantially to nutrition. It is produced as a white to light brown powder commercially, primarily

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extracted from citrus fruits. Its mucoadhesiveness is due to large number of carboxyl groups in its structure is responsible for interaction with the mucus. Pectin gets to hydrate and form viscous hydrogel in contact with aqueous solution and hence facilitates the mucoadhesion.A texture analysis approach was used to test the mucoadhesive properties of various forms of pectin with varying degrees of esterification (DE) and molecular weights (MWs) against porcine GI mucosa. The mucoadhesion of pectin may be due to the mechanism of adsorption or electrostatic repulsion between pectin and mucin on the mucin molecules.

Pharmaceutical application:

Serves as a natural polymer for controlled and colon-targeted drug delivery acts as a gelling and thickening agent in formulations like gels and suspensions.

Starch:(24) As a result of its biocompatibility and hydrophilic nature, polysaccharide has been widely used as mucoadhesive drug delivery systems. In particular, starch (amylum) consists of a large number of glucose units linked together by glycosidic bonds.Two native starches (maize starch and waxy maize starch) and one pre-gelatinized waxy maize starch have already been investigated for their muco-adhesive properties. Using the method of milling and spray-drying, the mucoadhesive properties of starches were induced or improved. The moisture absorbing property of starch makes it ideal to become a system-like mucoadhesive gel. The absorption causes the mucosal membrane to dehydrate, resulting in the drug moiety being channelled into paracellular close junctions. When combined with permeation enhancers the increased release rate and higher surface area can simultaneously be greatly amplified. Amylose-rich cross-linked starch acetate, aminoethyl and carboxymethyl derivatives were evaluated for controlled drug release, and among these derivatives, amylose rich cross-linked starch carboxymethyl derivatives exhibited better mucoadhesion at neutral pH, making it more suitable for buccal delivery.

Pharmaceutical application: Acts as a binder, disintegrant, and filler in tablet formulations used as a biodegradable polymer in controlled drug release systems.

Synthetic polymer:(25)

➢ Cellulose derivatives: Cellulose derivatives are obtained by esterification, etherification or crosslink reaction between hydroxyl groups in cellulose with a chemical reagent. Hydroxypropyl methylcellulose (HPMC), sodium carboxymethyl cellulose (CMC-Na), hydroxypropyl cellulose (HPC) and hydroxyethyl cellulose (HEC) are polymers widely used for mucoadhesive adherence. Flavia Laffleur et al. studied the preparation of buccal patch with various cellulose derivatives such as carboxymethyl cellulose sodium salt (CMC) (medium viscosity), 2-hydroxyethyl cellulose (HEC) (average Mw 90,000 Da), (hydroxypropyl)methyl cellulose (HPMC) with solvent casting technique and evaluated their mucoadhesion and stability and this analysis showed that cellulose-based patches exhibit great and promising potential for various Buccal applications and intraoral cavity disorders (25)CMC-Na is an anionic adhesive substance with hydrogen bonding ability and strong mucous membrane adhesion. Singh et al. used CMC-Na as the key adhesive material to prepare the oral adhesive film of salbutamol sulphate, which had a strong coefficient of expansion, adhesion potential and in vitro release behavior. At the same time, for 4 hr, it had a calming effect on the bronchus that was longer than that of the solution of salbutamol sulphate (1.5 h) (27)Non ionic neutral cellulose derivatives such as HPMC have moderate adhesion as they are free of proton- donating carboxylic acid groups, which reduces the ability to form hydrogen bonds. While using HPMC K4M and carbomer 934P as mucoadhesive materials and ethyl cellulose as a backing material, Hiral Koradia et al., by direct compression, developed unidirectional buccal Mirtazapine tablets. Low drug release at the initial time point (1h) and full drug release at 6 h, optimum swelling and good bioadhesive strength were given by the prepared unidirectional oral tablets, suggesting a possible alternative drug delivery mechanism for Mirtazapine. (28)Acyclovir and polylactic acid-glycolic acid copolymer (PLGA) have been prepared into nanoparticles by Al-Dhubiab et al. Taking the HPMC as an adhesive material and Eudragit RL100 as a film forming material, they made these materials into a film with oral biological adhesion. The drug penetrated the mucosa at a stable rate. Its bioavailability was increased by 8 times compared to oral dosage forms.(29)

➢ Acrylates:(30) One of the best mucoadhesive polymers is known to be currant PAA in mucoadhesive materials. Its high solubility in water greatly limits its usage as a carrier for a drug's sustained release. To minimize the water

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solubility of PAA, interpolymer complexation of PAA with PEG, PEG macromer, poloxamer, and PVP has been observed. In this regard, Chun et al. stated that the water solubility of PAA decreased due to the complexation of PAA with these polymers to retain adhesive force. Interpolymer complexation between PVP/ PAA results in aggregation and precipitation in ethanol and water .Strong complexation due to strong hydrogen bonding between PAA and PVP could be utilized to prepare mucoadhesive microspheres. Both the polymers PAA and PVP precipitate. Emulsification of PAA solution and PVP in solutions causes collision of droplets leading to complexation hardening to make microspheres.

List of drug delivered via buccal route:(31)

In an effort to determine the feasibility of buccal route as a novel route of drug delivery, several drugs have been studied. The variation in class of compounds illustrates that the pharmaceutical industries have an alternative and novel routes of administration for existing drugs.

Active Ingredients:

- Acitretin
- Acyclovir
- Arecoline
- Buprenorpine
- Carbamazepine
- Chitosan
- Chlorpheniramine maleate
- Metronidazole
- Morphine sulphate
- Nicotine
- Nifedipine
- Omeprazole
- Oxytocin
- Piroxicam
- Ergotamine tartrate (etc).

Methods of Manufacturing Buccal Patch:(32)

1. Solvent casting: In the process of solvent casting, a mucoadhesive polymer, drug and other excipients are dissolved under the magnet stirrer in a sufficient solvent to extract trapped air and form a homogeneous solution. The blend is then cast into a clean petri dish and dried in a hot air oven at 4000C (5) Cast patches are placed in a desiccator before future evaluation continues. There are a lot of research studies on mucoadhesive patches created by the method of solvent casting. Dubey et. al used solvent casting technique to prepare mucoadhesive oral patches of hydrochlorothiazide (HCZ) and atenolol (ATN) using different concentrations of sodium alginate, hydroxyl propyl methyl cellulose, carbopol 934P and sodium carboxy methyl cellulose polymer and polyvinyl alcohol as a backing layer to achieve sustained release and enhanced bioavailability besides having short and simple method it has some limitation such as Polymer must be dissolved in a volatile solvent. Moreover, a few amounts of solvent may remain in theinal film. Drug loading capacity in solvent casted films is low. The synthesized film does not have a suitable uniformity.

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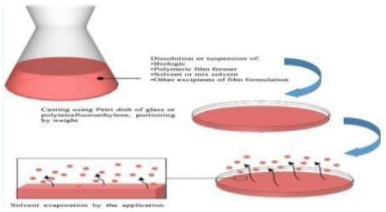

Fig No 4:- Solvent Casting Method(32)

2. Direct milling:(33) Patches are formed in this process, without the use of solvents. Without the presence of any liquefied solutions, indirect milling or kneading methods are used for motorized mixing of drugs and excipients. The desired thickness is achieved by rolling the resulting material. Then the backing material is laminated. The solvent-free process is selected because residual solvents and health concerns caused by solvents are not likely.

3. Hot melt extrusion:(34) In hot melt extrusion method, blend of pharmaceutical ingredients is molten by the extruder having heater and different shapes yielded via die by forcing molten mixture through an orifice. hot melt extrusion has been used for the fabrication of controlled release matrix tablets, pellets, granules, oral disintegrating films dosage forms .Here are certain benefits such as molten polymers during the extrusion process can function as thermal binders and act as drug depots and/or drug release retardants upon cooling and solidification. Since it is anhydrous process, the numbers of processing and time-consuming drying steps are reduced. Independent of compression properties, a matrix may be massed into ia larger unit. De-aggregation of suspended particles in the molten polymer is caused by the extreme mixing and agitation forced by the spinning screw, resulting in a more uniform dispersion and the process is continuous and efficient. When solubilized or distributed at the molecular level in HME dosage types, the bioavailability of the drug substance may be increased. Pharmaceutical Hot-Melt Extrusion processes can be categorized as either ram extrusion or screw extrusion.

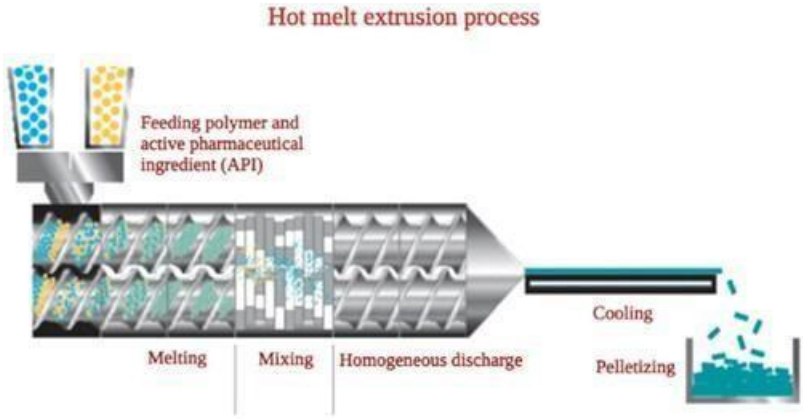

Fig No 5 : Hot Melt Extrusion(34)

Conclusion: Buccal patches represent a highly promising approach for both systemic and local drug delivery due to their ability to bypass first-pass metabolism, enhance bioavailability, and provide controlled and sustained drug release. Their non-invasive nature, ease of administration, and improved patient compliance make them advantageous over conventional oral dosage forms. The selection of suitable mucoadhesive polymers, formulation excipients, and manufacturing methods plays a critical role in determining patch performance. Advances in natural and synthetic polymers, permeation enhancers, and nanotechnology-based systems further expand the potential of buccal patches for delivering a broad range of therapeutic agents, including peptides and drugs with poor oral bioavailability. Overall, buccal patches continue to evolve as an effective and patient-friendly drug delivery platform with significant clinical and pharmaceutical relevance.

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