

Advances in Sublingual Drug Delivery: From Concept to Clinical Application

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ABSTRACT:

Sublingual tablets have emerged as an effective and patient friendly drug delivery system that enables rapid drug absorption through the sublingual mucosa, thereby bypassing hepatic first-pass metabolism and enhancing bioavailability. This review highlights the fundamental aspects of sublingual drug delivery, including its anatomy, physiology, and mechanism of absorption. The formulation of sublingual tablets involves careful selection of drug candidates and excipients such as superdisintegrants, diluents, binders, and lubricants to ensure rapid disintegration and optimal therapeutic performance. Various manufacturing techniques, including direct compression, wet granulation, and advanced methods like freeze drying and compression molding, are discussed for their role in improving tablet characteristics. Evaluation parameters such as hardness, friability, disintegration time, wetting time, drug content uniformity, and in vitro dissolution studies are essential to ensure quality and efficacy. The review also covers marketed formulations and diverse therapeutic applications in cardiovascular diseases, pain management, hormonal therapy, and central nervous system disorders. Furthermore, recent advances such as fast-dissolving technologies, nanotechnology-based systems, and mucoadhesive formulations have significantly enhanced the potential of sublingual delivery systems. Overall, sublingual tablets represent a promising and innovative approach in modern pharmaceutics, offering rapid onset of action, improved patient compliance, and effective therapeutic outcomes.

KEYWORDS: Oral drug delivery, Sublingual drug delivery, Bioavailability enhancement, Oral transmucosal absorption

Oral administration is a route of administration where a substance is taken through the mouth. Many medications are taken orally because they are intended to have a systemic effect, reaching different parts of the body via the blood stream. Tablet is defined as a compressed solid dosage form containing medicaments with or without excipients. According to the Indian Pharmacopoeia Pharmaceutical tablets are solid, flat or biconvex dishes, unit dosage form, prepared by compressing a drugs or a mixture of drugs, with or without diluents (1).

The concept of sublingual drug delivery dates back to the early 19th century, with nitroglycerin being one of the first drugs administered via this route for the treatment of angina. Over time, advancements in pharmaceutical technology have expanded the application of sublingual systems beyond cardiovascular drugs to include analgesics, sedatives, and hormones. The evolution of fast-dissolving and rapidly disintegrating formulations has further enhanced the effectiveness and patient acceptability of sublingual tablets. Sublingual drug delivery plays a crucial role in modern pharmaceutics due to its ability to provide rapid drug absorption and onset of action. It is especially beneficial for drugs that undergo extensive first-pass metabolism or are unstable in the gastrointestinal environment. Additionally, this route improves patient compliance, particularly in pediatric and geriatric populations, as it eliminates the need for swallowing. Sublingual tablets are also advantageous in emergency conditions where immediate therapeutic action is required, such as in angina attacks, allergic reactions, and pain management (2).

Sublingual tablets are solid dosage forms designed to be placed beneath the tongue, where they rapidly dissolve and release the drug for

I. INTRODUCTION

absorption through the sublingual mucosa directly into the systemic circulation. This route bypasses the gastrointestinal tract and first-pass hepatic metabolism, resulting in rapid onset of action and improved bioavailability for certain drugs. Sublingual delivery is particularly suitable for potent drugs requiring quick therapeutic effects, such as nitroglycerin used in angina pectoris (3).

1.1. Advantages (4)

- ✓ Ease of administration to patients who refuse to swallow a tablet, such as pediatric, geriatric patients and psychiatric patients.
- ✓ Convenience in administration of drug and accurate dosing formulations. as compared to liquid
- ✓ Water is not required for swallowing the dosage form, which is convenient feature for patients who are traveling and do not have immediate access to water.
- ✓ Good mouth feels property helps to change the basic view of medication as "bitter pill", particularly for pediatric patients.
- ✓ Fast dissolution of medicament and absorption which will leads to rapid, onset of action.
- ✓ Some drugs are absorbed from the mouth pharynx and oesophagus as the saliva passes down into the stomach, in such cases bioavailability of drugs is increased.
- ✓ It provides advantages of liquid formulations in the form of solid dosage form.
- ✓ Pregastric absorption can result in improved bioavailability and as a result of reduced dosage, improved clinical performance through a reduction of unwanted effects.

1.2. Disadvantages (5)

- ✓ Since sublingual administration of drugs interferes with eating, drinking, and talking, this route is generally considered unsuitable for prolonged administration.
- ✓ Although this site is not well suited to sustained-delivery systems.
- ✓ Sublingual medication cannot be used when a patient is uncooperative.
- ✓ The patient should not smoke while taking sublingual medication, because smoking causes vasoconstriction of the

vessels. This will decrease the absorption of the medication.

- ✓ Various types of sublingual dosage forms are available, but tablets, films and sprays are in trends these days. For the preparation of these dosage forms different methods are described depends upon the feasibility and advantages over the others.
- ✓ One disadvantage, in any case, is tooth staining and brought about by long term utilization of this technique with acidic or generally burning medications and fillers.

1.3. Factors affecting the sublingual absorption (5)

- 1.3.1. *Drug Lipophilicity*: For a drug to be fully absorbed under the tongue, the drug must have a lipid solubility slightly higher than that required for gastrointestinal absorption required for passive permeation.
- 1.3.2. *Salivary Solubility*: In addition to high lipid solubility, the drug should be soluble in aqueous oral fluids. i.e., Absorption requires biphasic solubility of the drug.
- 1.3.3. *Salivary pH and pKa*: The average pH of saliva is 6.0, so this pH favours the absorption of non-ionized drugs. Furthermore, drug absorption through the oral mucosa occurs at pKa values greater than 2 for acids and less than 10 for bases.
- 1.3.4. *Binding to Oral Mucosa*: Drugs that bind to the oral mucosa have low systemic availability.
- 1.3.5. *Thickness Of Oral Epithelium*: The thickness of the sublingual epithelium is 100-200 μm , so it is thinner than the cheek thickness. As a result, the epithelium becomes thinner and the drug is soaked in a small amount of saliva, resulting in faster absorption of the drug.
- 1.3.6. *Oil-to-water partition coefficient*: Compounds with good oil-water partition coefficient are easily absorbed through the oral mucosa. An oil-water partition coefficient range of 40-200 is considered optimal for drug absorption under the tongue.

II. ANATOMY AND PHYSIOLOGY OF THE SUBLINGUAL REGION

2.1 Structure of the Sublingual Mucosa

The sublingual mucosa is a thin, non-keratinized epithelial membrane located beneath the tongue, with a thickness of approximately 100–200 μm . It consists of a stratified squamous epithelium, a basement membrane, and an underlying lamina propria rich in connective tissue. Unlike keratinized regions of the oral cavity, the sublingual mucosa is relatively permeable due to its thin epithelial layer and high hydration level, which facilitates rapid drug diffusion. The absence of a thick keratin barrier and the presence of loosely arranged epithelial cells contribute significantly to its suitability for systemic drug delivery via the sublingual route (6).

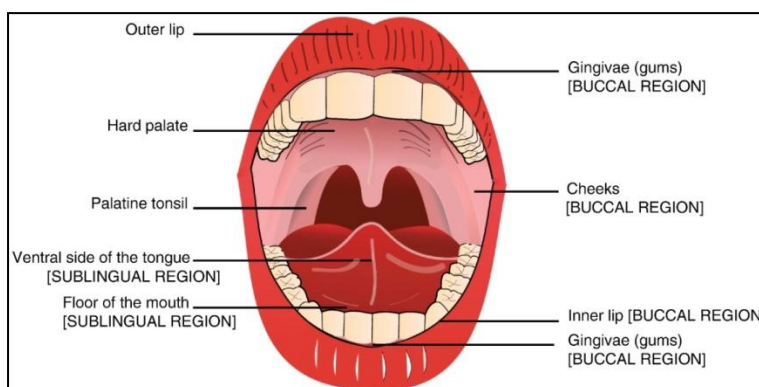
2.2. Blood Supply and Permeability

The sublingual region is highly vascularized, primarily supplied by the deep lingual artery, a branch of the lingual artery. This extensive capillary network lies close to the mucosal surface, allowing drugs to be rapidly absorbed into the

systemic circulation. The high permeability of the sublingual mucosa is attributed to its thin epithelial barrier and rich blood flow, which together enhance drug transport and minimize lag time. Additionally, the direct drainage of blood into the systemic circulation bypasses hepatic first-pass metabolism, significantly improving the bioavailability of susceptible drugs (7).

2.3 Mechanism of Drug Absorption

Drug absorption through the sublingual mucosa primarily occurs via passive diffusion across the epithelial membrane. Two main pathways are involved: the transcellular (intracellular) route, favored by lipophilic drugs, and the paracellular (intercellular) route, which allows the passage of small hydrophilic molecules through aqueous channels. The rate and extent of absorption depend on factors such as drug solubility, lipophilicity, degree of ionization, and concentration gradient. Once absorbed, the drug enters the venous circulation and is transported directly into systemic circulation, leading to a rapid onset of action (8).



(Courtesy- Kraan et al., 2014)

Figure 1: Represents the anatomy & physiology of sublingual region

III. IDEAL CHARACTERISTICS OF DRUGS FOR SUBLINGUAL DELIVERY

Drugs suitable for sublingual delivery should possess high permeability across the thin and vascularized sublingual mucosa, along with a low molecular weight (generally $< 500 \text{ Da}$) to facilitate rapid diffusion. They should exhibit balanced lipophilicity ($\log P$ between 1 and 5) and adequate aqueous solubility to ensure quick dissolution in the limited volume of saliva. A suitable pK_a is essential

so that a significant fraction of the drug remains unionized at salivary pH (6.0–7.0), enhancing membrane permeation. The drug must be chemically stable in saliva, non-irritating to the oral mucosa, and effective at low doses due to the limited absorption area. Additionally, drugs that undergo extensive first-pass metabolism are considered ideal candidates, as sublingual administration bypasses hepatic metabolism and improves bioavailability (9).

Table 1: Represents Physiological Criteria of drug for Sublingual Drug Delivery System

Parameter	Accepted Range / Criteria	Significance
Permeability	High (Permeability coefficient > 10^{-6} cm/s)	Ensures rapid absorption through sublingual mucosa
Lipophilicity (Log P)	1 – 5	Balances solubility in saliva and membrane permeability
Molecular Weight	< 500 Da	Enhances diffusion across mucosal membrane
Mucosal Irritation	Non-irritant (no tissue damage)	Prevents irritation and ensures patient compliance
Stability in Saliva	Stable at pH 6.0 – 7.0	Avoids degradation in oral cavity
Dissolution Rate	Rapid (within 1–2 minutes)	Provides quick onset of action
pKa / Ionization	Unionized fraction > 50% at salivary pH	Improves membrane permeability
Dose Requirement	Low dose (generally ≤ 25 mg)	Suitable due to limited absorption surface area
Saliva Solubility	Moderate to high (> 1 mg/mL preferred)	Ensures adequate dissolution in small saliva volume
Blood Supply Utilization	Rapid absorption via rich vascular network	Enables direct systemic delivery and bypass of first-pass metabolism

IV. FORMULATION OF SUBLINGUAL TABLETS (10-12)

4.1 Selection of Drug Candidates

Selection of suitable drug candidates is a critical step in the formulation of sublingual tablets. Ideal drugs are those requiring rapid onset of action, possessing low molecular weight, high permeability, and adequate lipophilicity. Drugs that undergo extensive first-pass metabolism or are unstable in the gastrointestinal tract are particularly suitable for this route. Additionally, the drug should be effective at low doses and remain stable in the salivary environment to ensure efficient absorption through the sublingual mucosa.

4.2 Excipients Used

Excipients play a vital role in ensuring rapid disintegration, palatability, stability, and overall performance of sublingual tablets.

4.2.1 Superdisintegrants

Superdisintegrants are essential for promoting rapid tablet disintegration in the small volume of saliva available in the sublingual cavity. Commonly used superdisintegrants include croscarmellose sodium, sodium starch glycolate, and crospovidone. These agents facilitate quick water uptake and swelling, leading to fast tablet breakup and enhanced drug dissolution.

4.2.2 Diluents

Diluents are used to increase the bulk of the tablet and improve compressibility. Water-soluble diluents

such as mannitol, lactose, and microcrystalline cellulose are commonly employed in sublingual formulations. Mannitol is particularly preferred due to its pleasant mouthfeel and cooling sensation, which enhances patient acceptability.

4.2.3 Binders

Binders provide mechanical strength to the tablet and ensure integrity during handling and packaging. In sublingual tablets, binders such as polyvinylpyrrolidone (PVP), hydroxypropyl methylcellulose (HPMC), and natural gums are used in minimal quantities to avoid delaying disintegration while maintaining adequate hardness.

4.2.4 Lubricants

Lubricants are added to reduce friction during tablet compression and ejection. Common lubricants include magnesium stearate and talc. However, their concentration must be carefully controlled, as excessive use can create a hydrophobic barrier, slowing down tablet disintegration and drug dissolution.

4.2.5 Flavoring and Sweetening Agents

Flavoring and sweetening agents are incorporated to improve the taste and overall palatability of sublingual tablets, as the drug remains in the oral cavity during administration. Sweeteners such as aspartame, saccharin sodium, and sucralose, along with flavoring agents like mint, orange, or fruit flavors, are commonly used to enhance patient compliance.

V. MANUFACTURING TECHNIQUES (13,14)

Following methods can be used to prepare sublingual tablets

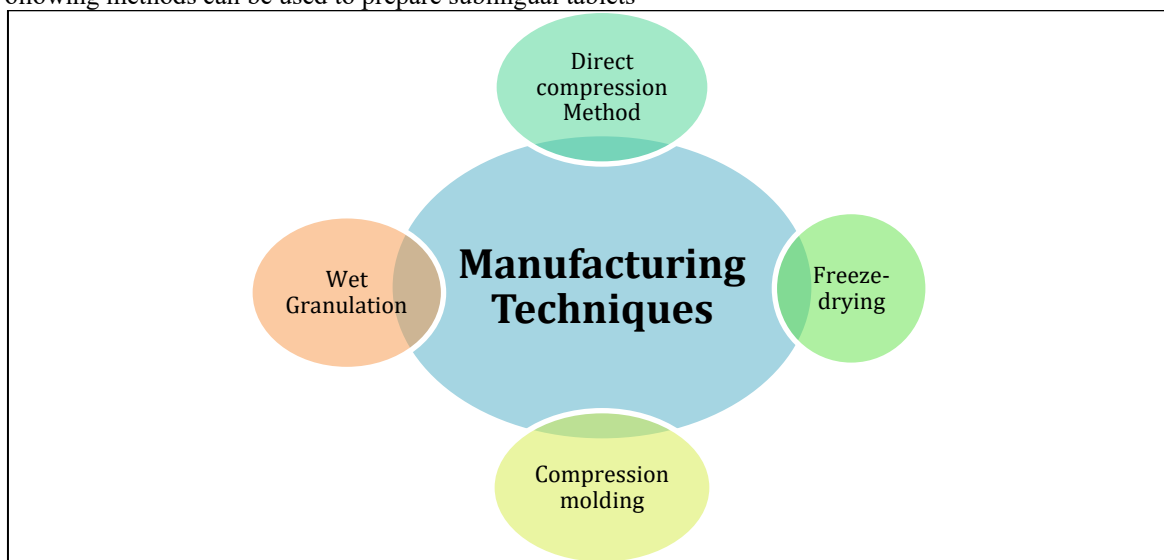


Figure 2: Represents manufacturing techniques of sublingual tablets

5.1. Direct compression method: Direct compression is the most commonly used method for preparing sublingual tablets due to its simplicity, cost-effectiveness, and suitability for moisture- and heat-sensitive drugs. In this technique, the drug is blended with directly compressible excipients such as superdisintegrants, diluents, and lubricants, followed by compression into tablets without any prior granulation. This method ensures rapid disintegration and is widely preferred for sublingual formulations requiring fast onset of action. Daiichi (Tokyo, Japan) developed a fast disintegrating formulation of moderate strength, using a combination of starch or cellulose, and one or more water-soluble saccharides. Erythritol was found to be the best sugar for this type of formulation, showing rapid disintegration that was not affected by the hardness of the tablet, good palatability coupled with sweetening, and a refreshing sensation in the mouth because of the occurrence of endothermic heat of dissolution.

5.2. Wet Granulation: Wet granulation involves the formation of granules by adding a liquid binder solution to the powder blend, followed by drying and compression. This technique improves the flow properties, compressibility, and content uniformity of the formulation, especially for drugs with poor flow characteristics. However, it is less preferred for sublingual tablets containing moisture-sensitive drugs and may slightly increase disintegration time due to stronger interparticle bonding.

5.3. Compression molding: Tablets produced by this method will disintegrate and dissolve rapidly (within 4 to 11 sec). Disadvantage of this method is tablets having poor mechanical strength, to overcome this problem binders are added to formulation blend. Takeda (Osaka, Japan) developed a mixture containing a combination of starches and sugars, which after blending with the active pharmaceutical ingredient and wetting with a suitable amount of granulating fluid, can be compression molded. The formulations manufactured from this proprietary mixture were reported to have sufficient mechanical strength and exhibit fast disintegration. Novartis Consumer Health (Basel, Switzerland) filed a patent application for tablets prepared by dispensing the drug solution or suspension into molds, evaporating the solvent from the molds by heating under reduced pressure, or microwave radiation, and then sealing the dried units directly in the mold. Nippon Shinyaku (Kyoto, Japan) compression molded and dried a kneaded mixture containing drug and a water-soluble sugar. This process claimed to impart a sufficient physicochemical stability to the tablet, good appearance, and dissolution time of less than 30 s in the sublingual region.

5.4. Freeze drying: This is costly and consumes more time compared to direct compression; this method produces tablets of poor mechanical strength. Tablets produced by this method will have high porosity and dissolve instantly. This method is suitable for heat sensitive drugs.

VI. EVALUATION PARAMETERS

6.1. Pre-compression Parameters

Pre-compression parameters are evaluated to ensure the suitability of powder blends for tablet compression. These include angle of repose, bulk density, tapped density, Carr's index, and Hausner's ratio, which indicate the flow properties and compressibility of the powder. Good flowability is essential for uniform die filling and consistent tablet weight, while proper compressibility ensures mechanical strength of the final tablets.

6.1.1. Angle of Repose: Angle of repose is determined using funnel method. The blend is poured through funnel fixed at height that can be raised vertically until a maximum cone height (h) is obtained. Radius of the heap (r) was measured and angle of repose was calculated using the formula:

$\theta = \tan^{-1}(h/r)$ Where, θ is the angle of repose, h is height of pile; r is radius of the base of pile.

6.1.2. Bulk Density: Apparent bulk density (ρ_b) is determined by pouring the blend into a graduated cylinder. The bulk volume (V_b) and weight of powder (M) is determined. Calculate the bulk density using formula:

$$\rho_b = M / V_b$$

6.1.3. Tapped Density: The measuring cylinder containing known mass of blend is tapped for a fixed time. The minimum volume (V_t) occupied in the cylinder and weight (M) of the blend is measured. Calculate the tapped density (ρ_t) using the following formula:

$$\rho_t = M / V_t$$

6.1.4. Carr's or Compressibility Index: The simplest way of measurement of free flow of powder is compressibility, an indication of the ease with which a material can be induced to flow is given by compressibility. The compressibility index of the granules is determined by Carr's compressibility index (I), which is calculated by using the following formula:

$$I = (V_0 - V_t) \times 100 / V_0$$

6.1.5. Hausner's Ratio: Hausner ratio is an indirect index of ease of powder flow. It is calculated by the following formula Hausner's ratio = ρ_t / ρ_b Where, ρ_t is tapped density and ρ_b is bulk density. Lower Hausner ratio (<1.25) indicates better flow properties than higher one (>1.25).

6.2 Post-compression Parameters

6.2.1 Hardness: Hardness (crushing strength) measures the mechanical integrity of tablets and their ability to withstand handling, packaging, and transportation. For sublingual tablets, moderate

hardness is required to maintain strength without delaying disintegration. The crushing strength or hardness of the tablets is measured with help of a Monsanto hardness tester and expressed in kg/cm².

6.2.2 Friability: The friability of tablets using 10 tablets as a sample was measured using a Roche Friabilator. Tablets are rotated at 25 rpm for 4 minutes or up to 100 revolutions. The tablets are then reweighed after removal of fines and brushing, and the percentage of weight loss is calculated and a weight loss of less than 1% is generally considered acceptable, indicating adequate durability.

$$\% \text{Friability} = \frac{(\text{initial weight} - \text{final weight}) \times 100}{\text{initial weight}}$$

6.2.3 Disintegration Time: Disintegration time for sublingual tablets is determined using disintegration apparatus (USP) with suitable media. The volume of medium is 900 ml and temp were 37 ± 0.2 °C. The time in seconds taken for complete disintegration of the tablet with no palatable mass remaining in the apparatus was measured. To comply the test all tablets should disintegrate within 3 minutes. Disintegration time is a critical parameter for sublingual tablets, as they must dissolve rapidly in the oral cavity. Ideally, sublingual tablets should disintegrate within 1–2 minutes to ensure quick drug release and onset of action.

6.2.4 Wetting Time: The wetting time of the tablets is measured using a very simple process. Five circular tissue papers of 10 cm diameter are placed in a Petri dish of 10-cm diameter. Ten millilitres of solutions of water-soluble dye (eosin) are added to the Petri dish. A tablet is carefully placed on the surface of tissue paper. The time required for water to reach the upper surface of the tablet is noted as the wetting time. Wetting time indicates how quickly the tablet absorbs saliva and begins to disintegrate. It is an important parameter for fast-dissolving formulations, with shorter wetting times correlating with faster disintegration and improved patient experience.

6.2.5 Drug Content Uniformity: This test ensures that each tablet contains a uniform amount of drug within specified limits (typically 85–115% of label claim). Uniformity is crucial for consistent therapeutic efficacy and safety.

6.2.6 In vitro Dissolution Studies: In-vitro release rate study of sublingual's tablets is carried out using the Paddle Apparatus (USP) method. The dissolution test was carried out using 900 ml of suitable buffer at 37 ± 0.50 °C and 50 rpm. A sample (5 ml) of the solution was withdrawn from the dissolution apparatus at fixed time interval and withdrawn volume was replaced with fresh

dissolution media. The % release of drug is calculated. In vitro dissolution studies assess the rate and extent of drug release from the tablet in a suitable dissolution medium, often simulating

salivary conditions. Rapid and complete drug release is desired for sublingual tablets to achieve immediate therapeutic action.

Table 2: Represents various marketed sublingual tablet formulation

S. No.	Brand Name	Drug	Indication	Strength	Manufacturer
1	Nitrostat	Nitroglycerin	Angina pectoris	0.3 mg, 0.4 mg, 0.6 mg	Pfizer Inc.
2	Nitroquick	Nitroglycerin	Angina pectoris	0.4 mg	Various (generic)
3	Isordil SL	Isosorbide dinitrate	Angina pectoris	2.5 mg, 5 mg	Valeant Pharmaceuticals
4	Suboxone SL	Buprenorphine + Naloxone	Opioid dependence	2 mg/0.5 mg, 8 mg/2 mg	Indivior Inc.
5	Temgesic SL	Buprenorphine	Moderate to severe pain	0.2 mg	Reckitt Benckiser
6	Ergometrine SL	Ergometrine maleate	Postpartum hemorrhage	0.2 mg	Various
7	Zolpidem SL (Intermezzo)	Zolpidem tartrate	Insomnia (middle-of-night waking)	1.75 mg, 3.5 mg	Purdue Pharma
8	Ondansetron ODT*	Ondansetron	Nausea and vomiting	4 mg, 8 mg	Multiple manufacturers
9	Fentanyl SL (Abstral)	Fentanyl citrate	Breakthrough cancer pain	100–800 mcg	ProStrakan Inc.
10	Asenapine (Saphris)	Asenapine	Schizophrenia, bipolar disorder	2.5 mg, 5 mg, 10 mg	Allergan

VII. APPLICATIONS OF SUBLINGUAL TABLETS

Sublingual tablets are widely used in various therapeutic areas due to their rapid onset of action and ability to bypass first-pass metabolism. In cardiovascular diseases, drugs like nitroglycerin and isosorbide dinitrate are administered sublingually for the immediate relief of angina pectoris. In pain management, potent analgesics such as buprenorphine and fentanyl are delivered via the sublingual route for rapid relief, particularly in breakthrough and chronic pain conditions. Hormonal therapies, including drugs like desmopressin and certain steroid hormones, utilize sublingual delivery to improve bioavailability and avoid gastrointestinal degradation (14). Additionally, in central nervous system (CNS) disorders, medications such as asenapine (for schizophrenia and bipolar disorder) and zolpidem (for insomnia) are effectively administered sublingually to achieve faster therapeutic effects. Overall, this route enhances patient compliance and provides a valuable alternative for drugs requiring rapid systemic action (16).

VIII. RECENT ADVANCES (15,16)

8.1 Fast Dissolving Technologies

Fast dissolving technologies have significantly improved the performance of sublingual tablets by enabling rapid disintegration and drug release within seconds. Techniques such as freeze drying (lyophilization), spray drying, and the use of superdisintegrants have been widely adopted to enhance tablet porosity and wettability. These approaches ensure quick dissolution in the limited volume of saliva, leading to faster onset of action and improved patient compliance, particularly in geriatric and pediatric populations.

8.2 Nanotechnology-Based Systems

Nanotechnology-based approaches, including nanoparticles, nanoemulsions, and nanocrystals, have emerged as promising strategies to enhance sublingual drug delivery. These systems improve drug solubility, permeability, and stability, thereby increasing bioavailability. Nanocarriers also facilitate controlled and targeted drug delivery across the mucosal membrane, overcoming limitations associated with poorly soluble and low-permeability drugs.

8.3 Mucoadhesive Systems

Mucoadhesive systems are designed to prolong the residence time of drugs at the sublingual site, thereby enhancing drug absorption. Polymers such as chitosan, carbopol, and hydroxypropyl methylcellulose (HPMC) are commonly used to provide adhesion to the mucosal surface. This approach reduces drug loss due to saliva washout and allows for sustained drug release, improving therapeutic efficacy and reducing dosing frequency.

IX. FUTURE PERSPECTIVES

The future of sublingual tablet drug delivery is expected to advance significantly with the integration of innovative technologies and novel formulation approaches. Emerging trends such as nanotechnology-based carriers, including nanoparticles and nanoemulsions, are anticipated to enhance drug solubility, permeability, and targeted delivery across the sublingual mucosa. The

development of mucoadhesive and bioadhesive systems will further improve residence time and drug absorption, overcoming challenges associated with rapid saliva washout. Additionally, fast-dissolving and 3D-printed tablets are gaining attention for their ability to provide precise dosing, rapid disintegration, and personalized therapy. Advances in permeation enhancers and enzyme inhibitors are also expected to expand the range of drugs suitable for sublingual delivery, including peptides and proteins. Furthermore, increasing focus on patient-centric design, such as improved taste masking and ease of administration, will enhance compliance, particularly in pediatric and geriatric populations. Overall, continued research and technological innovation are likely to position sublingual tablets as a versatile and efficient platform in modern drug delivery systems.

Table 3: Recent patents on sublingual tablets in chronological order

S. No.	Year	Patent No.	Title / Invention	Applicant / Assignee	Key Innovation
1	2018	US20180071345A1	Fast-dissolving sublingual tablet formulations	Aquestive Therapeutics, Inc.	Rapid disintegration with improved taste masking and enhanced bioavailability
2	2019	WO2019145678A1	Sublingual pharmaceutical composition containing buprenorphine	Indivior UK Ltd.	Improved opioid dependence treatment with better absorption and reduced abuse potential
3	2020	US20200360421A1	Sublingual tablet comprising cannabinoid compounds	GW Research Ltd.	Enhanced sublingual delivery of cannabinoids for pain and neurological disorders
4	2021	WO2021223456A1	Mucoadhesive sublingual tablet composition	BioDelivery Sciences International	Increased residence time using mucoadhesive polymers for prolonged absorption
5	2022	US20220133789A1	Fast-disintegrating sublingual tablet for migraine treatment	IntelGenx Corp.	Rapid-release zolmitriptan formulation for acute migraine management
6	2023	WO2023102456A1	Sublingual nanoparticle-based tablet formulation	Sun Pharmaceutical Industries Ltd.	Nanotechnology-based delivery for poorly soluble drugs with enhanced permeability
7	2024	US20240112567A1	Personalized 3D-printed sublingual tablets	Triastek, Inc.	Customized dosing using 3D printing technology for precision medicine

X. CONCLUSION

Sublingual tablets represents as a highly effective and promising method for drug delivery, providing a quick onset of action, greater bioavailability, and improved adherence by avoiding

degradation in the gastrointestinal tract and the hepatic first-pass effect. The effectiveness of this delivery system is primarily influenced by the careful selection of drug candidates, the optimization of formulation ingredients, and the

implementation of appropriate manufacturing methods to ensure rapid disintegration and efficient drug absorption. Evaluation criteria are essential in maintaining the quality, safety, and efficacy of the final product. The diverse therapeutic uses further underscore the clinical importance of sublingual tablets in treating both acute and chronic health conditions. Furthermore, new developments like fast-dissolving technologies, carriers utilizing nanotechnology, and mucoadhesive systems have broadened the application and efficiency of this delivery method. Although there are some limitations, ongoing research and technological advancements are anticipated to address current issues and further solidify sublingual tablets as an adaptable and dependable option in advanced drug delivery systems.

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