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A Comprehensive Review on Sublingual Tablets

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Abstract

Sublingual tablets offer a practical and efficient method of medication administration, especially for youngsters, the elderly, and patients with dysphagia. By avoiding first-pass metabolism, these pills dissolve quickly beneath the tongue and enable quick bloodstream absorption. This approach is perfect for illnesses that need immediate medication effects, such pain management, migraines, hypertension, and mental disorders, since it increases bioavailability and guarantees quick pharmacological activity. To create a variety of sublingual formulation process such as direct compression, freeze-drying, spray-drying, and sublimation are examples of innovative manufacturing, such as tablets, films, sprays, and lipid matrix-based systems. The selection of excipients, including disintegrants, lubricants, and sweeteners, substantially affects the formulation's efficacy and patient adherence. Despite its advantages, sublingual drug delivery has certain limitations, such as short retention time, limited drug load capacity, and restrictions on eating, drinking, or speaking during administration. Nevertheless, the efficacy and applicability of sublingual drug delivery system are improving due to continuous advancements in formulation technologies and excipient selection.

Keywords: Sublingual, Matrix, Promethazine

Introduction

Sublingual tablets are convenient for patients with dysphagia and hand tremors, especially young children, elderly patients, mentally retarded, and bedridden patients. The medication can be absorbed either directly or swiftly through the mucosal lining of the mouth beneath the tongue thanks to these tablets' fast dissolution in the mouth. By avoiding first-pass metabolism, this medication is absorbed from the stomach and linked to mesenteric circulation via the portal vein. To maintain their softness, sublingual pills are flat, tiny, and softly compacted. To keep the tablet in place, patients should refrain from eating, drinking, smoking, and talking. They also disintegrate quickly in little amounts of saliva. The goal of sublingual systemic medication delivery is to produce pharmacological activity right away.[1-3] Sublingual products are designed for various indications, including migraines and mental illnesses. For short-acting medications, the sublingual method offers 3–10 times the absorption compared to oral approaches. Not all medications are permeable, although the majority are absorbed by simple diffusion. Sublingual administration circumvents the hepatic first pass metabolic processes and offers instant pharmacological effects.[4]

Children with underdeveloped muscles and nervous systems often experience swallowing problems, which can be easily addressed with fast disintegrating sublingual tablets. Because oral drug administration is safe, convenient, natural, and economical, it is widely used.

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Sublingual tablets can be produced efficiently by employing the best production practices and choosing the right pharmaceutical excipients.[5] Oral mucosa, including buccal and sublingual mucosa, has gained attention for its improved bioavailability, particularly in treating schizophrenia and manic/mixed episodes of bipolar disorder. Asenapine sublingual tablets, available in 5mg and 10mg strengths, dissolve in saliva within 10 seconds. [6] Similarly, people with hypertension who are adults or old may be prescribed manidipine sublingual pills. [7] Cystic fibrosis patients are considering lung transplantation, and sublingual tacrolimus is a promising alternative due to its good permeability, rapid absorption, bioavailability, and easy accessibility. This new calcium inhibitor offers pharmacokinetic advantages, making it an economic choice over intravenous routes, enhancing their quality of life. [8, 9]

Sublingual fentanyl formulations are more effective at managing pain because they escape First pass metabolic processes and offer rapid entry into the bloodstream. They are useful for pain control because of their physicochemical characteristics, which allow for the creation of different formulations. [10] Zolpidem, a popular and well-tolerated drug, is becoming a global market leader in the hypnotic area with new formulations like EDULARTM, a sublingual version developed for sleep-onset insomnia. These innovative formulations are making Zolpidem a popular choice in the market. [11, 12] Additionally, the sublingual formulations are utilized for paediatric acute pain management and immediate analgesia in prehospital and hospital emergency departments. [13]

For the medication of PPH (POSTPARTUM HEMARRHAGE), a common cause of heavy bleeding following delivery, misoprostol is another appropriate medication option that may be administered sublingually. PPH continues to kill a significant number of women globally. However, a 600 microgram sublingual dosage of misoprostol causes severe fever and shivering in women because of its faster and greater plasma concentration. For the management of PPH, an 800 microgram dose of misoprostol seems to be an effective first therapy. [14-16] Sublingual administration of medications like ergotamine Tartrate and zolmitriptan may also be used to treat migraines. Nowadays, a growing number of people are using nicotine alternative treatment to assist them in quitting smoking. 3-(1-Methyl-2-pyrrolidinyl) pyridine sublingual formulations work well as a substitute for smoking cessation medication. [17]

Sublingual Gland [18-20]

Saliva and mucin, which are produced by the sublingual glands beneath the tongue, aid in chewing, swallowing, and oral hygiene. Food is made slick by saliva, which facilitates digestion and swallowing. This gland helps with patient compliance, improved bioavailability, and quick medication absorption.Saliva aids in controlling the microbial balance, enzyme activity, and mouth pH. The three main glands that produce saliva are:1. Parotid2. The submaxillary3. The sublingual Compared to general intramuscular fluid (GI), sublingual glands create between 0.5 to 2.0 liters of saliva per day, but their constant volume is just 1.1 milliliters, which results in a reduced medication release. Saliva flow fluctuates according to:-The time of day- The kind of stimuli- Level of stimulation

Sublingual drug absorption mechanism: [21-24]

Drug absorption in the mouth depends on lipid solubility, osmosis, ionization, and molecular weight. Medications are absorbed through oral epithelial cells via endocytosis, though the process may vary across the stratified epithelium. Acidic salivary stimulation and vasodilation enhance absorption into the bloodstream. The mouth's mucous membrane, made of mucous glands and squamous epithelium, is similar in both the buccal and sublingual mucosa.Cell lobules that make up salivary glands release saliva into the mouth via ducts.

The three main pairs are:

1. Sublingual
2. Submandibular
3. Parotid

Acidic tastes increase saliva production to protect tooth enamel. The sublingual artery supplies the gland, tongue, gums, and mouth. It branches from the lingual artery, which are main supplier of blood originated from external carotid artery to the floor of the mouth and the tongue. Due to its

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S.NO	Advantages	Disadvantages
1	Fast Action: By avoiding the digestive tract, it acts more quickly than oral medications	Teeth discolouration might result from long-term usage of harsh or acidic medications.
2	Avoids Metabolism: This increases efficacy by avoiding digestive enzymes and liver breakdown.	The utilisation of sustained-delivery techniques is not sublingually optimised.
3	Improved Patient Comfort: simpler than tablets, safe for unconscious patients, and needle-free.	Patients who refuse to take sublingual medicine cannot receive it.
4	Reduced Dosage, Fewer negative Effects: High efficacy and little negative effects are the results of direct absorption.	When smoking narrows arteries, it decreases the absorption of drugs during sublingual therapy.
5	Fast Absorption: The mouth's wide surface area and abundant blood supply guarantee rapid medication absorption.	Tablets, films, and sprays are common sublingual dose forms. Various manufacturing techniques are employed according to their benefits and efficacy
6.	Perfect for Emergencies: Used to provide immediate relief from ailments including angina and asthma.	While sublingual administration obstructs speech, eating, and drinking, it is not appropriate for long-term usage.

proximity to the internal carotid artery, it provides quick access to the brain's blood supply.

Factors affecting the sublingual absorption: [25]

It looks like you are discussing the factors influencing drug absorption through the oral mucosa, particularly the sublingual route. Here's a structured breakdown of the key points:

Biphasic Solubility

The drug must be soluble in both lipids and aqueous buccal fluid to facilitate absorption through the mucosa.

Oral Mucosal Binding

Drugs that strongly bind to the oral mucosa exhibit low systemic availability, reducing their effectiveness when absorbed through the sublingual route.

Saliva's pH and pKa

The average pH of saliva is 6.0, favoring the absorption of unionized drugs.

A drug is optimally absorbed if its **pKa is <10 for a base** and **>2 for an acid**.

Drug Lipophilicity

To be effectively absorbed sublingually, a drug must have **higher lipid solubility** than required for GI absorption, facilitating passive diffusion across the epithelium.

Oral Epithelium Thickness

The sublingual epithelium is **thinner (100–200 µm)** than the buccal epithelium.

This leads to **faster absorption** due to less barrier resistance and lower saliva volume.

Advantages and Disadvantages (26-29)

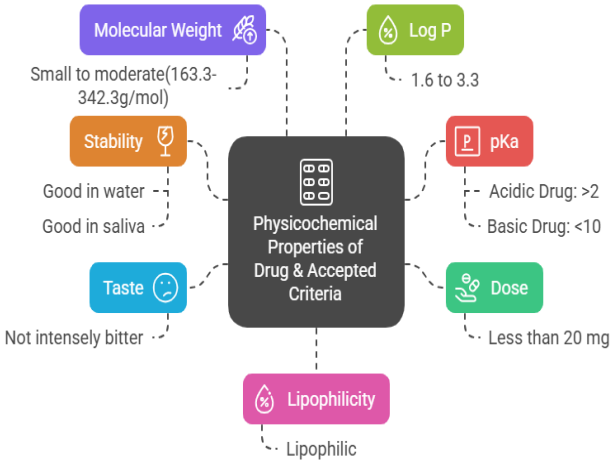

Fig.1: Physicochemical Properties for Sublingual Drug Delivery

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Marketed Sublingual Tablets: A list of some of the marketed sublingual tablets along with the manufacturers were listed in table

Active ingredient	Brand name	Manufacturer
Buprenorphine Hcl	Subutex	Sun Pharma
Fentanyl Citrate	Abstral	Galena Biopharmaceuticals
Asenapine	Saphris	Merck
Isosorbide dinitrate	Imdur	Astrazeneca
Ergoloid mesylates	Ergomes	Cipla
Zolpidem Tartrate	Intermezzo	Purdue Pharma
Ergotamine Tartrate	Ergomar	Rosedale pharmaceuticals
Nitroglycerin	Nitrostat	pfizer

Sublingual Formulation [30-33]

There are several sublingual formulations that fall under the following categories: sublingual tablets, sublingual films, sublingual sprays, and sublingual capsules.

Sublingual tablet

Tablets that are sublingual are soft, flat, and compact. In order to facilitate rapid API absorption, they dissolve rapidly in saliva.

Fast Disintegrating Sublingual Tablets

For old persons, tiny kids, and conditions without access to water, fast-dissolving tablets are ideal. They quickly dissolve once positioned under the tongue, delivering the drug for sublingual uptake. They are more practical than traditional oral forms. According to CHMP, sublingual tablets are of great advantages to children. Their effectiveness is based on flavour, size, and disintegration time.

Sublingual Bioadhesive Films

The most recent idea for a sublingual film is based on a water-soluble carrier coated in microscopic material particles and a bioadhesive polymer. This facilitates the drug's rapid breakdown and reduces the oral cavity's bioadhesive qualities.

Spray for the Sublingual

In this formulation, the medication is stored in a container with a metered valve after being dissolved or distributed in a solvent. When in operation, the valve administers the proper amount into the sublingual area.

Sublingual Lipid Matrix Tablets

Compared to conventional oral procedures, these tablets combine liposomal and sublingual technology for quicker and more efficient drug absorption. They provide a dependable, practical, and speedy dosage choice.

Vitamin Sublingual Tablets:-Doctors often recommend taking cyanocobalamin, or vitamin B12, under the tongue because it is essential for metabolism.

Sublingual immunotherapy

This treatment treats seasonal and perennial allergic conjunctivitis, particularly in industrial workers, by administering allergen extracts by sublingual drops. Although treatment may result in anaphylactic reactions, allergen-specific immunotherapy (SIT), which entails monthly injections for three years, benefits individuals with severe allergies and asthma.

Manufacturing techniques used in preprartion of sublingual tablets [34-44]

The formulation's suitable blank-taste excipients will promote the active ingredients' dissolution and disintegration, resulting in a sublingual tablet that dissolves quickly. The manufacturing of sublingual tablets uses the following types of techniques:

Direct Compression method: The pharmaceutical industry widely uses instant compressed sublingual tablet technology because it is cheap and simple to use. It involves a mix of basic materials with little granulation prior to compression and lubrication so that it rapidly disintegrates and has a high strength. Sugar-based excipients enhance the taste and solubility while the right disintegrant will ensure rapid dissolution. Advances in excipients improve dissolution and mechanical strength. [34-35]

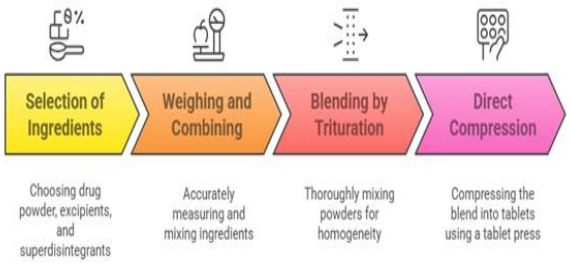

Fig.2: Direct Compression Process

S.NO	**Advantages**
1	Production costs and duration can be decreased.
2	It is possible to increase the product's stability.
3	Requires fewer pieces of equipment and less process validation.
4	Fit for the processing of APIs that are susceptible to moisture and water.
5	There is very little chance of batch-to-batch variance.
6	Dry method.
7	Minimum labour inputs.
8	Low electricity usage.

S.no	**Disadvantages**
1	Stratification could occur due to differences in particle size and bulk density, affecting the homogeneity of the contents.
2	A high dose of a drug can cause problems with direct compression. It requires diluents. The tablet becomes large, which is difficult to swallow and costly.
3	Static charges may be generated when dry materials are handled, which may lead to an even distribution of medication.
4	The drug may interact with direct compression diluents. For example, an amine drug that contains lactose discolors the tablet.

Compression moulding method: The tablets prepared by this process disintegrate and dissolve within 5-10 seconds. However, the tablets are difficult to handle and transport because of their poor mechanical strength. Special packaging may be necessary. The strength of the tablets can be enhanced by applying a suitable binder. However, the binder substance should be optimized so that it does not cause harmful effects. This method provides soluble excipients for rapid dissolution and taste modifiers for patient acceptance. Evaporating the solvent from a medication solution or suspension at ambient temperature or straight from a molten matrix are two methods used to create moulded tablets. [36-39]

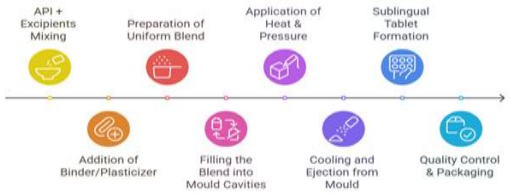

Fig. 3: Compression Moulding Process

S.no	**Advantages**
1.	The process is less complex.
2.	It uses lower-cost tools.
3.	It is apt for the more substantial parts along with the sizeable products.
4.	It is also a fitting choice for both multicolored and insert-moulding products.
5.	Economical for small runs of manufacturing.

Freeze drying method: The freeze drying process is expensive and time-consuming in the production of sublingual tablets. It has great porosity and fast disintegration, however that give it an edge over other techniques. A high-pressure hoover is applied, the product's temperature is lowered below the freezing point, and the temperature is then raised to eliminate water vapours. For the preparation of a high-quality freeze-dried cake dosage form, temperature at the sublimation interface and collapse at lower temperatures are very important. Usually light in weight, the resulting tablets have highly porous architectures that dissolve or disintegrate rapidly. The freeze drying technique is less frequently used to prepare sublingual tablets due to its poor stability at high temperatures and humidity levels.[40-43]

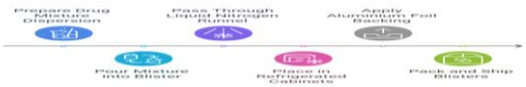

Fig.4. Freeze Drying Process

S.no	**Advantages**
1.	Less damage to materials that are heat sensitive.
2.	Formation of fragile porous structures.

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3.	Rate and completeness of rehydration.
4.	Once the material is set, freeze-drying does not diminish its toughness.
5.	The method is favoured for food preservation as the flavours and nutritional content may not change.

S.no	**Disadvantages**
1.	Equipment is expensive to purchase initially.
2.	Costly energy.
3.	Long processing time (typically 4–10 hours per drying cycle)
4.	Potential damage to goods by alterations in pH and tonicity.

Spray drying method:

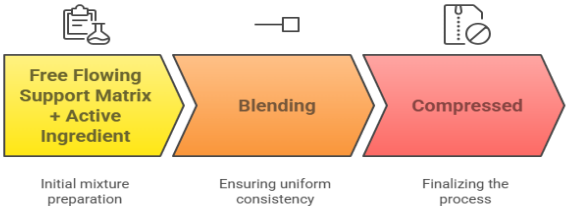

Fig.5. Spray Drying Process

This method allows for the production of a fine extremely porous powder as well as the evaporation of processing solvent. Using support matrix in the form of hydrolysed and non-hydrolyzed gelatine along with additional ingredients like mannitol as bulking agent, sodium starch glycolate and crosscarmellose sodium as disintegrants besides acidic materials like citric acid and alkali like sodium bicarbonate to enhance disintegration and dissolution rate, spray dryers are most commonly used in the pharmaceutical and biochemical process for the preparation of readily dissolving tablets or chewable tablets. This tablet prepared by this method, when dispersed in a solution, dissolves in less than 20 seconds.

Sublimation method: The porous structure in the tablet matrix is necessary for the rapid disintegration of the oral disintegrating tablet. As the porosity of the matrix-structured tablets was less, conventional compression of tablets containing highly water-soluble excipients often failed to dissolve rapidly. Hence, volatile chemicals are used for the sublimation process to develop porous matrices. Following the removal of the volatile substance by the sublimation process, a porous matrix was developed about 30%.

Fig. 6. Sublimation Process

Mass Extrusion Technique: This involves the softening of the active blend with a solvent mixture of methanol and water-soluble polyethylene glycol followed by injection or extrusion of the softened mass to form a cylindrical extrude that is subsequently cut into equal pieces with a heated blade for the formation of tablets. Another application of this technique is for the coating of bitter medication granules to mask their flavour.

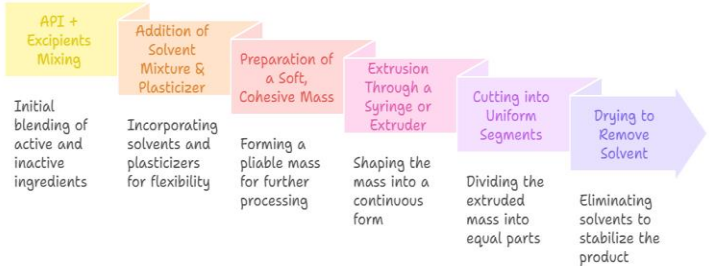

Fig.7. Mass Extrusion Process

S/No	**Advantages**
1.	Low price per component.
2.	Operating flexibility.
3.	As the product is also heated after performing hot extrusion, changes are easy.
4.	Continuously working.
5.	Huge amounts of output are produced.
6.	Raw material for use in large numbers.
7.	Mixing is excellent.
8.	Good mechanical properties of the cold-extruded component.

S.no	**Disadvantages**
1.	Size differences in the products.
2.	Restriction on the product since a single type of cross section is obtained at any given time.

Excipients for Sublingual Dosage Forms [18, 19, 33]

The USFDA states that oral disintegrating tablets are solid dose forms that disintegrate quickly beneath the tongue in a matter of seconds. The active component and other excipients must not react with the excipients used for these formulations.

The main ingredients in sublingual tablets are a lubricant, a diluent, and at least one disintegrant. Excipients have changed throughout time from being basic, small ingredients to being crucial parts of contemporary medication compositions. Changing physical characteristics like disintegration time, regulating the release site (intestine or stomach), regulating the release rate (instant, delayed, or sustained), and improving flavor and taste are some of their primary roles.

Binder: - Binders for Sublingual Forms of Dosage There are many classes into which binders in sublingual formulations can be divided, including: Wetting agents, such as polysorbates and sorbitan solution esters, lower the surface tension of liquids. Dry binders, such as cross-linked polyvinylpyrrolidone and Pregelatinized starch, offer structural stability. Polyvinylpyrrolidone and cellulose derivatives are examples of solution binders. Binders that dissolve in water or ethanol, such polyvinylpyrrolidone. Disintegration time and tablet strength are influenced by the choice and concentration of binders in combination with disintegrants. In order to increase mechanical resistance, binder usually consists of polymers having a disordered structure. Ethanol, acetone, isopropyl alcohol, gelatin, gum Arabic, sucrose, glucose, potato starch, zein, and ethyl cellulose are examples of common binders.

For example, the odorless, hygroscopic white powder known as polyvinylpyrrolidone (PVP) dissolves readily in the majority of polar solvents but is insoluble in nonpolar ones. Garekaniet al.'s study looked at how the characteristics of paracetamol tablets were affected by various PVP grades, which ranged from 2,000 to 50,000. Even under severe compression, the PVP 10,000 and PVP 50,000 tablets showed excellent resistance to crushing. PVP 10,000 produced the best dispersion of the active component, whereas PVP 2,000 produced the worst results in tablet formulation.

Fillers: Tablet formulations include fillers to get the required bulk and size. Good flowability, the right density, little moisture absorption, chemical stability, and a pleasing flavor are all characteristics of ideal fillers. Lactose, mannitol, glucose, saccharose, sodium chloride, starch, cellulose, and starch derivatives are examples of common fillers. Lactose lengthens the disintegration period but increases tablet toughness and abrasion resistance. Additionally, it increases heat resistance and storage stability. On the other hand, pills containing xylitol dissolve immediately in the tongue. Because of its sweet flavor, mannitol, a sugar alcohol that was once made from manna (Fraxinus) but is now manufactured synthetically, is used as a filler and binder (5–25%) in sublingual tablets. Patients with congestive heart failure or anuria, however, should not use it.

Disintegrants or Superdisintegrants:

Disintegrants speed up the breakdown of pills, enabling rapid medication release.

Superdisintegrants are significantly more effective since they quickly increase the bulk of the tablet, which speeds up disintegration. They contain ingredients such Crospovidone, croscarmellose sodium, and sodium starch glycolate, andare often used in trace concentrations (1-10%). According to studies, tablets containing sodium starch glycolate dissolve in around 4.2 minutes, but those containing polyplasdone XL and polyplasdone XL-10 dissolve in 3.4 and 3.6 minutes, respectively.

This indicates that tablets containing polyplasdone dissolve more quickly than others. Low solubility, excellent water absorption, easy flow, and non-reaction with the medicine are all characteristics of a good disintegrant. Microcrystalline cellulose, crospovidone, and croscarmellose sodium are typical examples. Even in modest quantities, superdisintegrants are more effective than ordinary disintegrants, improving the performance of tablets.

Characteristics of Superdisintegrants:
Poor gel formation.
The ability to stay hydrated should be high.
Good flow and molding properties are expected.
Drugs shouldn't build complexes.
Be able to work with other excipients.
It must not be poisonous.
It ought to be inert.
The process by which superdisintegrants function is swelling. They either increase granule volume, which facilitates disintegration, or they produce outward swelling pressure, which causes the tablet to break apart when they absorb water. Overuse of these agents can affect the tablet's hardness, friability, and mouthfeel even if they speed up the disintegration process. Primarily, natural disintegrants enhance the dosage form's hydrophilic character and give swelling qualities. Lepidium sativum seed mucilage, Fenugreek seed mucilage, Gellan gum, Locust bean gum, Gum Karaya, Mango peel pectin, Agar and treated agar, Guar gum, Soy polysaccharide, Chitin, and Chitosan are a few examples of natural superdisintegrants.

Antiadherents:
These compounds increase tablet compression, decrease friction, and enhance powder flow. They stop the tablets from adhering to the device. They reduce friction and prevent powder particles from clumping since the majority are water-repellent. Because too much antiadherent might alter how tablets breakdown and function in the body, they are typically used in tiny doses (up to 1%). Talc, starch, magnesium stearate, and colloidal silica are examples of common antiadherents. Aluminum, calcium, and magnesium stearate are the most often utilized stearates. There is also sodium stearyl fumarate, which is used at 0.5–2%. Compared to magnesium stearate, it has less problems, such as uneven tablet hardness and sluggish disintegration, and is less water-repellent. Compared to magnesium stearate tablets, sodium stearyl fumarate tablets dissolve more quickly, have superior bioavailability, and have betterphysical qualities overall.

Lubricants: These substances are employed to lubricate the formulation. These are magnesium stearate and stearic acid. Used between 1 and 5%, it lessens friction between the tablets and die wall surface, avoiding the formulation's sticking and picking characteristics.

Sweeteners and sugar-based excipients: The purpose of these excipients is to make the dosage form sweeter. Dextrose, sugar, fructose, aspartame, sodium saccharin, sucrose, and sugar alcohols are a few examples. They increase patient compliance by improving flavor and mouthfeel.

Flavouring agent: These kinds of substances are employed to provide the tablet flavor. For instance, fruit essences, citrus oils, vanilla, peppermint flavor, cooling flavor, and aromatic flavor oil.

Evaluation of Sublingual [45]

General Appearances
The elegance and look of the tablet are crucial for customer acceptability. Size, shape, colour, and taste are all important considerations.

Hardness
A Monsanto hardness tester (Cadmach) is used to measure the hardness of tablets. After sandwiching the tablet between two plungers and applying pressure until it breaks, the reading is noted.

Friability
Use the Roche Fibrillator to examine a tablet's friability. Friability gauges a tablet's strength or resilience. This is how you go about it:
1.) Weigh out ten or twenty tablets.
2.) In the Roche Fibrillator, put them.
3.) For four minutes, rotate the fibrillator at 25 RPM.
4.) Weigh the tablets once more after that.
5.) Determine the percentage of weight loss.
6.) No more than 1% of the body weight should be lost.
% FRIABILITY = Weight Loss/Initial Weight 100

Uniformity of weight
A digital weighing balance is used to determine the tablet's weight. Every tablet's weight is recorded and contrasted with the mean.

Thickness
A micrometre or vernier callipers are used to measure thickness, and the result should not differ by more than 50% from the standard value.

Wetting Time
The tablet is put on a circular piece of tissue paper that has been put in a petri dish for this test. By

adding a specific amount of distilled water and monitoring how long it takes to completely wet the tablet's surface, the wetting time is calculated.

Water Absorption Ratio

The formula (Wlast - Wfirst) / W_first can be used to get the water absorption ratio. whereW_first and W_last stand for the weight of the dry sublingual tablet and the fully soaked tablet, respectively.

Disintegration Time

The disintegration time is measured using a disintegration testing instrument. A tablet is put in a mesh-bottomed basket and immersed in a 37°C water bath. The amount of time needed for complete disintegration is recorded using a stopwatch. Dispersible pills must dissolve in three minutes in accordance with pharmacopeial norms.

Dissolution Studies

Dissolution is measured using a USP Paddle-Type Dissolution Apparatus. In 900 cc of pH 6.8 phosphate buffer, the test is run at 50–100 rpm and maintained at 37±0.5°C. A 5 ml sample is extracted every two minutes, combined with fresh medium, and filtered through Whatman filter paper. Measurements of absorbance between 290 and 321 nm are made using a UV spectrophotometer.

In-vitro disintegration Time

The time it takes for sublingual tablets to dissolve is measured using a USP disintegration instrument and 900 cc of pH 6.8 phosphate buffer at 100 rpm and 37±2°C. The time it takes for complete disintegration is expressed in seconds.

Conclusion

Sublingual medication delivery provides a rapid, effective, and patient-centric alternative to traditional oral and parenteral methods. By avoiding hepatic metabolism, it provides higher bioavailability and quicker therapeutic effects, making it particularly valuable in emergency treatments and for patients with swallowing difficulties. While challenges exist, including formulation stability and patient compliance issues, innovative techniques and novel excipients continue to enhance the effectiveness of sublingual dosage forms. The development of sublingual formulations for various therapeutic areas, including pain management, cardiovascular diseases, and psychiatric conditions, underscores its growing significance in pharmaceutical sciences. Future research should focus on optimizing drug permeability, improving taste masking, and developing sustained-release sublingual systems to expand its clinical applications.

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