BREAKING THE MOLD: UNDERSTANDING THE MECHANISM OF FAST DISSOLVING TABLETS

Anjali Gupta[1], Nikita Patil[2], Akash Yadav[3]*, Dinesh Kumar Jain[4]

Abstract

Oral dosage forms that dissolve quickly in the mouth are called fast-dissolving tablets (FDT). Results will appear faster, patient compliance will increase, and it will be easier than using medication. FDT is also easier to create and store than tablets. There are many technologies that can create FDT. A popular method is to spray-dry chemical ingredients into thin films and then coat them on a carrier medium. Explosion of the drug contained in the carrier can also be achieved using another method, a process called melt extrusion. Medications, including mild medications and biologics, can cause FDT. FDT can be used to treat a variety of medical conditions, including pain relief, migraine relief, and respiratory disorders. Patients who have difficulty swallowing regular tablets, such as children, the elderly, and people with dysphagia, may find this medication easier to administer. Overall, FDT has many advantages not found in tablets. They run quickly through the system, increase patient compliance, and are easy to create and maintain. Many drugs can be effectively delivered using FDT.

Key words: Fast dissolving tablet, Bioavailability, Direct compression, Rapid disintegration, Innovative medication

[1,2,3*,4]IPS Academy College of Pharmacy, Knowledge Village, Rajendra Nagar, A.B. Road, Indore-452012

***Corresponding Author:** Dr. Akash Yadav
*IPS Academy College of Pharmacy, Knowledge Village, Rajendra Nagar, A.B. Road, Indore-452012, India
Email: akashyadav@ipsacademy.org

DOI: - 10.53555/ecb/2022.11.12.300

Introduction

The most popular and widely used delivery method is oral administration. The most obvious problem with oral prescriptions such as tablets and capsules are that they are difficult to swallow, which can lead to noncompliance, especially in young and older patients. [1] Ease of use and collaboration between patients have become important when developing prescriptions. Sensory sensitivity and patient birth in children and adults have recently begun to receive more attention. [2]

As a result, oral dissolving tablets, also known as oralrapidly dissolving/disintegrating tablets (FDD S), have become more popular as a new drug delivery method. You do not need to swallow these medications with a glass of water because they dissolve quickly in your mouth. [3] Currently, it is important to produce medicines in a useful way. A Prescription is a drug delivery method used to deliver medication to an individual. Different types of medications have different methods of administration, including tablets, syrups, suspensions, suppositories, injections, transdermals, and patches. [4]

All these prescriptions and new prescriptions have advantages and disadvantages. Improving the quality of medication dispensing is a major challenge currently facing pharmacists. [2] For effective treatment, the drug must be taken in the right amount and height, in the right place, to minimize negative effects. To create a useful form, scientists must first understand as much as possible the physical and chemical laws that govern the drug's ingredients. [5]

The development of new dosage forms for oral administration is leading to drug research. Many of these measures aim to develop new drug delivery methods or improve patient compliance. Among the many dosage forms designed to facilitate taking the drug, oral bacteria have become the first choice of scientists in production. The oral cavity is easily accepted by the patient, has good mucosal permeability, good blood supply, and is resistant to bacteria due to the absence of Langerhans cells. [6]

Dosage Form

Any type of pharmaceutical organization that aims to achieve medical goals is called medicine. Since drugs cannot be taken in their pure form, they must be mixed in the appropriate form for the drug to pass into the body. [4] A prescription is a pharmaceutical product in commercial use and usually contains a mixture of active pharmaceu tical ingredients and other non-reusable materials that are not counted as ingredients or packaging.

The oral route is attracting increasing attention due to its advantages such as easy application, design possibilities and good patient compliance. [7] Management language is far from the most accepted and accepted form of management. It has become the first choice in drug administration due to its features such as ease of application, strong patient compliance and good performance. [3]

Drugs taken orally usually pass through the intestinal tract and liver, where they undergo various enzyme processes (first pass metabolism) and mix with the intestinal fluid. Therefore, only a small fraction of the drug enters the systemic circulation (this portion is called oral bioavailability of the drug). [8]

This recipe is popular due to its advantages such as easy production, easy administration, accurate dosage, stability and safety. [9] Swallowing is a common problem in young people due to the development of muscles and bones. Other groups that may have problems with oral prescriptions include psychiatric patients, patients with developmental disabilities, and fragile patients who are uncooperative or experience nausea. [10]

Classification of dosage forms

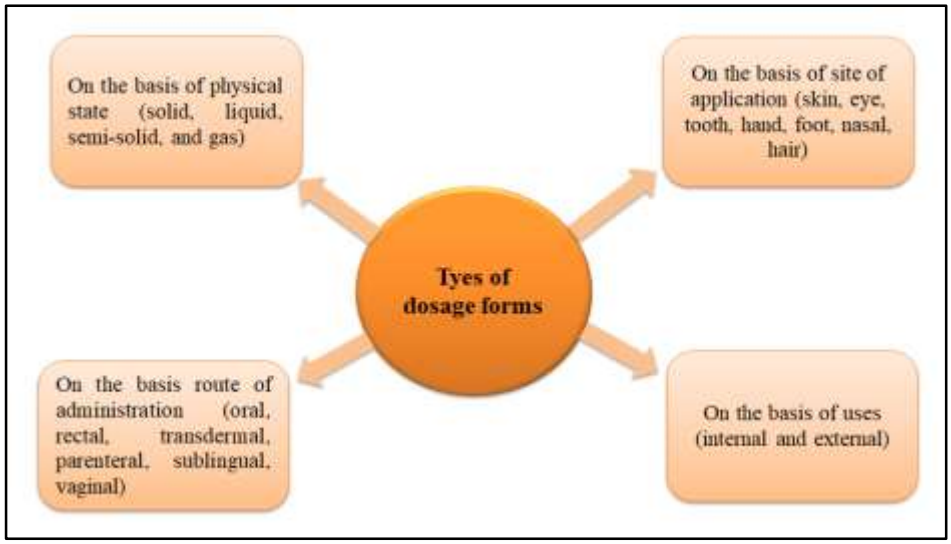

Fig. 1: Classification of dosage forms

Dosage forms are divided into the following, as shown in Figure 1: [11]

- ✓ According to physical body – solid, liquid, semi-solid and gas.
- ✓ By method of administration - oral, rectal, transdermal, parenteral, intra-respiratory, intranasal, urethral, genital, intraocular, sublingual.
- ✓ According to the place of use - skin, eyes, teeth, hands, feet, nose, hair.
- ✓ Depending on use - internal and external.

Tablets

Tablets have a long history and represent a widely accepted form of drugs, possibly by combining them with excipients. Properties such as size, weight and shape vary depending on factors such as dosage and application time. Tablets have been a popular medication choice due to their affordability, user-friendliness and better safety for patient efficiency. [9] The popularity of tablets in medicine is reflected in their ability to meet many conditions and changes in health. Over the years, these small doses have proven invaluable, providing easy access, convenience and reliability in drug delivery. Their enduring appeal lies in their cost-effectiveness, simplicity, adaptability, and the important role they play in improving patient compliance and safety. [12]

Classification of tablets

Tablets are classified as follows, as shown in Figu re 2:

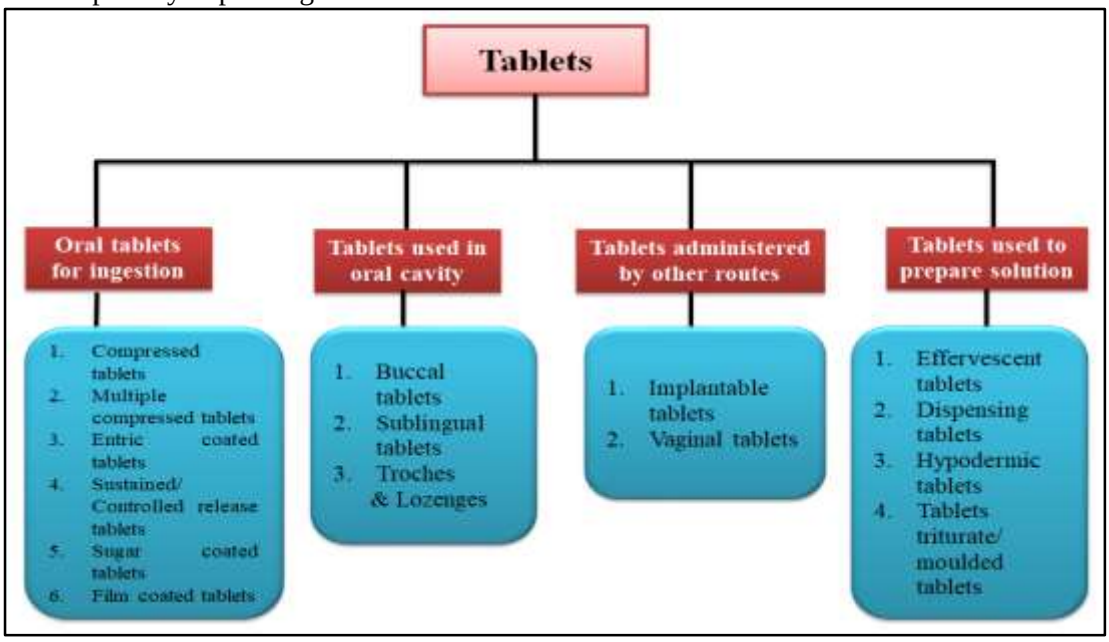

Fig. 2: Classification of tablets

- ✓ Oral tablets: standard compressed tablets, polycompressed tablets, concentrated tablets, chewable tablets, and rapid-acting tablets.
- ✓ Insoluble oral tablets: tablets and tablets, sublingual tablets, buccal tablets, dental cones and orally dissolving/rapid-dissolving tablets.
- ✓ Tablets used with other methods: genital area tablets, rectal tablets and implants.
- ✓ Tablets for the preparation of in vivo/in vitro solutions: effervescent tablets, molded tablets and abrasive tablets.
- ✓ According to its structure: split piece, perforated piece, concave and convex piece and core.
- ✓ Depending on the method of action: sustained-release tablets (sustained-release tablets, controlled-release tablets, etc.). [13]

Advantages of Tablets

- ✓ Tablets are pharmaceutical products that provide the most accurate dosage and least variable content of any oral dosage form.
- ✓ Tablets are cheaper than other oral prescriptions.
- ✓ It is easy to carry.
- ✓ May include odors and smells.
- ✓ Suitable for mass production.
- ✓ Best chemical and microbiological stability compared to all other dosage forms.
- ✓ Rapid elimination and absorption of the drug may lead to rapid onset of action.

Disadvantages of Tablets

- ✓ Tablets should not be given to a person who is drowsy or drowsy.
- ✓ It is also not suitable for people with swallowing problems such as children and the elderly.
- ✓ Drugs with poor wetting properties and slow disintegration may be difficult or impossible to produce and produce into tablets with full bioavailability.
- ✓ Patients with vomiting and diarrhea cannot take or inhale this medicine.
- ✓ Many medications can cause stomach upset when taken in tablet form. Stomach and digestive system. [14]

Fast Dissolving Tablets

Rapid-dissolving tablets are a new type of medication approved by the U.S. Food and Drug Administration in 1998 and are designed to disintegrate in the mouth, dissolve or be eliminated through saliva without the need for water. [15] These oral tablets (ODT) are characterized by rapid disintegration, usually within a few seconds of contact with saliva. This property has proven to be important for enhancing drug absorption and subsequently improving the oral absorption and bioavailability of water-insoluble drugs. [16]

As the formulation of ODT faces challenges with soluble compounds, there is a need to focus on increasing solubility to see bioavailability. In this pursuit, the resolution of the data needs to be improved. The use of ODT accelerates and improves the effectiveness of water-insoluble drugs. The dispersion process has emerged as an effective method to improve the bioavailability and solubility of such drugs. [17]

Furthermore, the prepared tablets disintegrate rapidly in water or dissolve rapidly in the mouth, as shown in Figure 3. This approach not only solves the problem with resolution but also helps make it easier to manage. [18]

Fig. 3: Action of fast dissolving tablets

The fast-dissolving tablets provide effective medication for patients who have difficulty taking medications, including children, those receiving medical treatment, and those with mental illness. These tablets are made from a soft molded matrix that is not very porous or has low compressive strength. [17] This formulation allows for rapid distribution in saliva, eliminating the need for water and providing a convenient delivery method for those who have difficulty taking medications orally. Tablets like these are especially useful for people with swallowing or tracking issues, improving the overall patient experience and helping improve treatment outcomes while being easy to administer. [19]

Mechanism of fast dissolving tablets:

The tablet extraction process involves breaking the tablet into small pieces and then dissolving them in a liquid medium, usually water. This separation accelerates the absorption of the main ingredients due to their increased surface area. However, since the material collected from the broken tablet will take longer to dissolve, the effectiveness of the tablet will be affected. [20]

Fig. 4: Mechanism of fast dissolving tablets

For fast and effective disintegration, Fast Disintegrating Tablets (FDT) play an important role. The FDT is designed to explode or detonate within a short period of time. These tablets often contain super disintegrants such as crospovidone, croscarmellose, and sodium starch glycolate, as shown in Figure 4. These super disintegrators form the backbone of Tablet Rapid Disintegration Technology. [18] The addition of these ingredients allows the tablet to quickly mix its contents, making the products available quickly. This technological advancement is important for drugs or formulations that need to be brought to market quickly, providing effective and efficient strategies for timely drug delivery. [21]

Important characteristics of fast-dissolving tablet:

- ✓ Assist in medication management for mentally ill, debilitated and depressed patients.
- ✓ The dose can be swallowed without water.
- ✓ Large amounts of paper break down and dissolve quickly.
- ✓ The drug is absorbed through the mouth, throat and esophagus through saliva in the stomach.
- ✓ These conditions increase the bioavailability of the drug.
- ✓ Overcoming drug addiction. [22]

Advantages of fast-dissolving tablets

- ✓ Conventional dosage is mandatory for drinking, there is no FDT.
- ✓ This makes it easier for patients who are walking or dehydrated to adapt.
- ✓ Rapid disintegration and disintegration of tablets increases bioavailability, especially for poorly soluble and hydrophobic drugs.
- ✓ Tablets dissolve and are absorbed quickly in the mouth.
- ✓ Depending on the drug formula, it dissolves or breaks down immediately in saliva, so it starts to act faster.
- ✓ FDT dissolves quickly, which can increase the bioavailability of some drugs and improve the therapeutic effect.

- ✓ In people with digestive problems, PDTs do not cause irritation or discomfort as they pass through the intestines.

Disadvantages of fast dissolving tablets:

- ✓ Medicines that need to be absorbed from a specific area cannot be delivered quickly in tablet form.
- ✓ These tablets should be used with caution as they are less crumbly than tablets.
- ✓ Once removed from the blister packaging, it should be used immediately as safety outside the blister cannot be guaranteed.
- ✓ Their physical strength is lower than tablets.
- ✓ Dosage uniformity is very difficult.
- ✓ Dry mouth due to decreased saliva production may not be a good candidate for this medication. [23]

Formulation Constituents (Besides API) of Fast Dissolving Tablets

Table 1. List of excipients used in fast dissolving tablets formulation. [24]

S. No.	Excipients	Role	Synthetic	Natural
1	Disintegrant/ Super disintegrants	They facilitate tablet breaking when it comes in contact with water as well as in GIT	Croscarmellose sodium, crospovidone, SSG, starch etc.	Fenugreek seed mucilage, Chitin and chitosan, Guar gum etc.
2	Binders	Impart cohesiveness to powdered materials	Gelatin, glucose, lactose, MC, EC, HPMC, CMC, Acacia, PEG etc.	Rice starch, maize starch, potato starch etc.
3	Diluents	Make required bulk of tablet, improve cohesion, flow properties, compatibility, and stability	Lactose, spray dried lactose, MCC, mannitol, sorbitol, dibasic calcium phosphate etc.	Starches, hydrolyzed starches and partially pre-gelatinized starches etc.
4	Lubricants	Prevent adhesion of tablet material to surface of dies and punches and reduce inter particulate friction	Insoluble stearic acid, magnesium stearate, talc, paraffin, sodium benzoate, PEG etc.	Aloe vera, yogurt, olive oil and virgin coconut oil.
5	Glidants	Improve flow characteristics of powder mixture	Colloidal silicon dioxide, talc etc.	Corn starch
6	Sweeteners	Produce a palatable dosage form	Sucrose, sucralose, saccharin, aspartame etc.	Honey, dates, coconut sugar etc.
7	Flavouring agents	Enhance palatability	Peppermint, vanilla, orange, banana, mango, cinnamon, etc.	Caraway, clove, lemon, spearmint, rose etc.

Tablet Disintegration

The compact powder breaks into small pieces when the tablet comes into contact with the liquid medicine. Disintegration is the first step in the bioavailability cascade, facilitating the tablet to break down into smaller particles after digestion by the gastrointestinal tract. This allows the drug to dissolve more quickly, thus increasing its bioavailability. For immediate-release tablets, the separation and sorting process is combined. International Conference on Harmonization (ICH) Tripartite Guideline Q6A examines the use of isolation as an alternative test for testing. [25] API and excipients together form the tablet formulation and are used to convert the tablet into a dosage form. [26] In general, excipients formed in tablets are responsible for performing some important activities such as facilitating the penetration of liquid into the tablet matrix and initiating the post-disintegration process. [27] Disintegrants are added to the tablets to facilitate this process. That is why disintegrants are considered one of the most important excipients. [28]

Manufacturing of Fast Dissolving Tablet

According to the latest developments in the industry, the production of fast-dissolving tablets, especially rapidly dissolving oral tablets, can be divided into two types. [29] The first is to produce tablets using traditional methods, and the second is to produce tablets using advanced technology. Fast-dissolving tablets can be produced using a variety of methods; however, the following are the most commonly used, as shown in Figure 5: [30]

Direct compression: Direct compression is a widely used and cost-effective tablet production method characterized by its efficiency and simplicity. This method stands out from many production technologies with its low production level and saves time and money. [31] In the field of tablet production, direct compression is preferred, as is the direct conversion of the

powder mixture containing active ingredients and additives into tablets. The key to this method is that the powder mixture flows evenly through the mold, which is then compressed into the desired tablet form. This compression process is called "direct compression" because the process is simple and complex intermediate steps are avoided. [32]

One of the main advantages of direct compression is its simplicity. Unlike other tablet production methods that involve complex processes, direct processing requires fewer steps, making it a popular choice for pharmaceutical and other industries. This flexibility not only increases production time but also reduces costs associated with complex processes. The powder mixture used in direct compression contains active ingredients (medicinal products) and additional materials (may contain binders). Fillers and disintegrants. These ingredients are carefully combined to form a single mixture to ensure the tablets are uniform. The mixture is compressed and the tablets have the desired properties such as size, shape and quantity. Effectiveness is another sign of direct opposition. By eliminating intermediate processes such as granulation or wet, the method simplifies production, making it a fast and efficient option. The simplicity of direct compression also contributes to its adaptability to various drug formulations. [33]

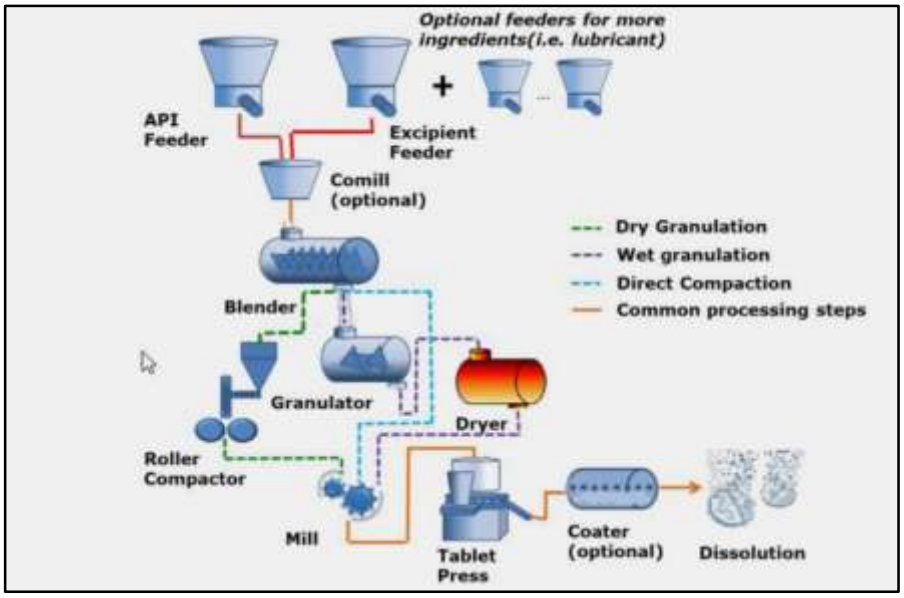

Fig. 5: Steps involved in direct compression method of tablet manufacturing

Wet granulation: Wet granulation is an important method in tablet production and provides a multi-step process to produce tablets with good properties. The process involves granulating active ingredients in carefully planned steps to create a product that meets stringent standards. [34] The process begins with mixing and placing the active ingredients. These ingredients mix with the liquid to form a moist, granular mass. Liquids are added for many purposes, such as promoting particle adhesion, improving flow properties, and promoting particle formation. This moisture is then processed into granules of the correct size and consistency. [35]

After the granulation stage, the wet granules will move on to the main drying stage. Drying is important to remove excess moisture from the pellets and increase their stability. This stage is important to prevent problems such as clumping or deterioration of the active ingredients due to moisture. The dry product is sieved to remove impurities and complete the product size to ensure the product is fine and consistent. [36]

The dry and sieved granules are then mixed with various additional excipients. These excipients may include binders to improve tablet adhesion, disintegrants to promote tablet disintegration during swallowing, lubricants to improve tablet release, and other ingredients to fine-tune tablet properties. Careful selection and proportioning of these excipients contribute to the overall efficiency and effectiveness of the final tablet. The last step is compression, where the granule-excipient mixture is compressed into tablet form. This compression step gives the tablet its final shape, size and quantity. The tablets are then subjected to stringent checks to ensure they meet certain requirements. [37]

Long granulation, although many steps, has the advantage of improved flow, consistent content and improved equipment. This method is

particularly suitable for formulations that require a mixture of various ingredients or do not have sufficient strength. Despite its complexity, wet granulation is still a widely used method in the production of drugs and tablets. [38]

Dry granulation: Dry granulation is a special method of tablet production that has a special process that turns ingredients and additives into granules without the use of glue. The technology provides many steps that help create tablets with special properties, making it useful for the pharmaceutical industry and other industries. [39]

The process begins with careful mixing of the active ingredients and additives. Unlike wet granulation, no liquid is used in the first stage of dry granulation. The dry powder mixture is then compressed into granules. This compaction is done using force, usually using a roller or tamper. The resulting granules exhibit improved flow and adhesion, forming the basis for the next step of tableting. After the initial compression, the granules are processed by mixing with various additives. These additives serve many purposes, from improving tablet disintegration to ensuring even distribution of ingredients. Customized options and inclusion of these additives improve the overall quality and performance of the final tablet product. [40]

After mixing the granules with other excipients, the next important step is tablet formulation. The granules are compressed into tablets using a tablet press. This compression gives the tablet its final shape, size and density. There is no liquid present during the granulation process, so it is called "dry granulation" to distinguish it from the wet granulation process. [41] Dry granulation has many advantages, including increasing the stability of moisture-sensitive compounds and preventing aging. Take necessary steps to dry it. Additionally, this method is particularly suitable for formulations where use with a liquid binder is undesirable or impractical. The effectiveness of dry granulation makes it an attractive choice for drug formulations that require controlled release, sustained release, or special separations. [42]

Lyophilization: Lyophilization, a sophisticated drying process, plays a pivotal role in the pharmaceutical industry, particularly in the preparation of tablets. The method involves a series of intricate steps aimed at preserving the integrity of sensitive compounds through the removal of moisture. The lyophilization process begins with the preparation of a suspension or solution containing the active ingredient and various additives. This initial step ensures a homogenous mixture, crucial for achieving uniformity in the final tablet product. The carefully formulated mixture is then subjected to a vacuum, a critical element in the lyophilization process. The vacuum reduces the pressure, facilitating the removal of moisture under low-temperature conditions. [43]

The next crucial stage involves freezing the suspended or solution-based mixture. This freezing step is designed to convert liquid material into solid ice and effectively immobilize the material within the matrix. The freezing process prevents the formation of large ice that could damage the quality of ingredients or ingredients. The mixture is now frozen and the freeze-drying process continues by heating. This heat passes through the liquid phase and sublimes water ice directly from ice to vapor. Sublimation of water molecules is done under vacuum conditions to ensure good and gentle removal of chemical components without causing heating that would affect their stability. [44]

After the drying process is completed, the product is a dry and porous material, often called freeze-dried cake. This cake is then crushed into a fine powder, which forms the basis for making tablets. Lyophilized powder has increased stability because the removal of water reduces the risk of degradation and chemical reactions, especially in heat-sensitive compounds. The final step is to compress the freeze-dried powder into tablets using a tablet press. [45] This compression allows the tablet to know precise specifications such as shape, size and quantity to ensure consistency in every room. Good lyophilization methods, which include freezing, sublimation, and tablet formation, are particularly useful for drug formulations that require preservation of sensitive ingredients (eight or active ingredients that are prone to degradation in the presence of moisture or pressure). hot. Therefore, freeze drying has become an important tool in pharmaceutical production that helps produce stable and effective tablets. [46]

Forming: The shaping process in tablet formulation consists of mixing the active ingredients and additives in a molten material or plastic and then shaping this amalgam into tablets. This method stands out for its versatility and has a unique approach to the production of quality tablets. The basic steps of the molding process revolve around the production of molten or plastic

material. [47] This is done by heating a mixture containing active ingredients and various excipients to a temperature at which the ingredients become soft or solid. The choice of excipients is important because they affect all properties of the tablet, including stability, disintegration properties and ease of moulding. [48]

When the melted or large plastic is finished the next step is to make tablets. This can be done through a variety of techniques such as molding or compression. During the molding process, molten material is poured into a pre-formed mold, allowed to cool, and solidifies into tablet form. Compression, on the other hand, involves applying pressure to the plastic material to compress it directly into the tablet. Choosing the right molding machine depends on the specific requirements of the tablet, including its size, shape, and desired properties of the final product. [49]

Processing is particularly important in cases where the active ingredients or ingredients find their properties in a molten or plastic state. This method is versatile and can be applied to a wide variety of drug formulations and provides a way to solve problems associated with other tablet manufacturing processes. Additionally, the molding process is ideal for mixing heat-sensitive ingredients because the temperature is usually brief and controlled. The tablets produced during the molding process are uniform in size, quality and quantity. The efficiency and simplicity of this method make it attractive, especially where time and cost are important factors in production. Molding as a pharmaceutical manufacturing tool provides pharmaceutical manufacturers with important tools to produce tablets with different properties to meet the needs of different models. [50]

Conclusion

In summary, fast-dissolving tablets (FDT) are fast-acting and effective dosage forms that are more effective than tablets and capsules. It dissolves or breaks down quickly in the mouth without the need for water, making it a beneficial and good choice for people who have difficulty swallowing or need immediate assistance. These apps are not just the beginning; FDT is also proving to have promising clinical applications. FDT can be used to deliver active pharmaceutical ingredients (APIs) designed for oral absorption rather than liver pre-metabolism, thereby increasing their bioavailability. This is useful for many active pharmaceutical ingredients (APIs), including some antibiotics, antibiotics, and hormones. FDT is also considered a managed release API deployment technology. Controlling the isolation and degradation of the FDT allows for slow and steady release of the API over time. Taking medication regularly can help people who need to take medication but are affected by high doses. Taken together, FDT is an exciting new form of medicine that offers many opportunities to advance treatment and help patients. They have positive effects that make them useful for many types of patients, and their therapeutic effects are currently being investigated.

Acknowledgement

We would like to express our sincere gratitude to IPS Academy College of Pharmacy, Indore for providing access to resources and facilities that facilitated our above article.

Competing Interest

The authors have declared that no competing interest exists.

References

1. Liu Z, Shi C, Fang Y, Zhao H, Mu Y, Zhao L, Shen L. A comprehensive understanding of disintegrants and disintegration quantification techniques: From the perspective of tablet microstructure. Journal of Drug Delivery Science and Technology. 2023:104891:15-28.
2. Masih A, Kumar A, Singh S, Tiwari AK. Fast dissolving tablets: A review. International Journal of Current Pharmaceutical Research. 2017;9(2):8-18.
3. Sharma I, Sharma V. A comprehensive review on fast dissolving tablet technology. Journal of Applied Pharmaceutical Science. 2011:50-8.
4. Hannan PA, Khan JA, Khan A, Safiullah S. Oral dispersible system: A new approach in drug delivery system. Indian journal of pharmaceutical sciences. 2016 Jan;78(1):2.
5. Panigrahi R, Behera SP, Panda CS. A review on fast dissolving tablets. International Journal of Pharmaceutical Research. 2010; 7(1):34-42.
6. Nagar P, Singh K, Chauhan I, Verma M, Yasir M, Khan A, Sharma R, Gupta N. Orally disintegrating tablets: formulation, preparation techniques and evaluation. Journal of Applied Pharmaceutical Science. 2011:35-45.
7. Sharma NP, Leel M. A review on dispersible tablets: A novel drug delivery system for pedietrics and geriatrics. International Journal Drug Development Research 2019;14(1):34-45.

8. Ubhe, T.S. and Gedam, P. A brief overview on tablet and it's types. Journal of Advancement in Pharmacology. 2020;1(1):22-31.
9. Talevi, A. and Quiroga, A.M.P. ADME processes in pharmaceutical sciences. Springer: Cham, Switzerland. 2018;362-369.
10. Raj, G.M. and Raveendran, R. Introduction to basics of pharmacology and toxicology, general and molecular pharmacology principles of drug action. Springer Singapore. 2019; 417-429.
11. Nandhini, J. and Rajalakshmi, A.N. Dispersible tablets: A review. Journal of Pharmaceutical Advanced Research. 2018; 1(3):148-155.
12. Cilurzo F, Musazzi UM, Franzé S, Selmin F, Minghetti P. Orodispersible dosage forms: Biopharmaceutical improvements and regulatory requirements. Drug Discovery Today. 2018;23(2):251-9.
13. Srinivasan S, Elumalai K, Cherian BV, Ramanujam SK. Formulation and characterization of metformin hydrochloride orodispersible tablets with super disintegrants. Intelligent Pharmacy. 2023;31-36.
14. AlHusban F, Perrie Y, Mohammed AR. Formulation and characterisation of lyophilised rapid disintegrating tablets using amino acids as matrix forming agents. European Journal of Pharmaceutics and Biopharmaceutics. 2010;75(2):254-62.
15. Aggarwal P, Nautiyal U, Mali RR. A review on fast dissolving tablet. International Journal of Recent Advances in Science Technology. 2015; 2:20-8.
16. Masih A, Kumar A, Singh S, Tiwari AK. Fast dissolving tablets: A review. International Journal of Current Pharmaceutical Research. 2017;9(2):8-18.
17. Gupta A, Mishra AK, Gupta V, Bansal P, Singh R, Singh AK. Recent trends of fast dissolving tablet-an overview of formulation technology. International Journal of Pharmaceutical & Biological Archives. 2010;1(1):1-0.
18. Ahmed IS, Nafadi MM, Fatahalla FA. Formulation of a fast-dissolving ketoprofen tablet using freeze-drying in blisters technique. Drug Development and Industrial Pharmacy. 2006;32(4):437-42.
19. Markl D, Zeitler JA. A review of disintegration mechanisms and measurement techniques. Pharmaceutical Research. 2017;34(5):890-917.
20. Yasmin R, Shoaib MH, Ahmed FR, Qazi F, Ali H, Zafar F. Aceclofenac fast dispersible tablet formulations: Effect of different concentration levels of Avicel PH102 on the compactional, mechanical and drug release characteristics. PloS one. 2020;15(2):123-132.
21. Rahane RD, Rachh PR. A review on fast dissolving tablet. Journal of Drug Delivery and Therapeutics. 2018;8(5):50-55.
22. Nandhini J, Rajalakshmi AN. Dispersible tablets: A review. Journal of Pharmaceutical Advanced Research. 2018;1(3):148-55.
23. Mutalik S, Shetty RS. Formulation and evaluation of directly compressible tablets of panchgani lavana. International Journal of Pharmaceutics. 2004; 278:423-33.
24. Jain A, Radiya P, Wadekar R, Limaye S, Pawar C. Natural excipients-an alternative to synthetic excipients: a comprehensive review. International Journal of Pharmaceutical and Medicinal Research. 2014;2(4):123-7.
25. Murugesan V, Balaraman S, Krishnamoorthy M, Ramamurthy VA, Krishnamoorthy M. Formulation and evaluation of ranolazine fast dissolving tablets using various superdisinte grants. Journal of Young Pharmaceutics. 2023;57(1):124-31.
26. Siddiqui MN, Garg G, Sharma PK. Fast dissolving tablets: preparation, characterization and evaluation: an overview. International Journal of Pharmaceutical Sciences Review and Research. 2010;4(2):87-96.
27. Khanna K, Xavier G, Joshi SK, Patel A, Khanna S, Goel B. Fast dissolving tablets: A novel approach. International Journal of Pharmaceutical Research & Allied Sciences. 2016;5(2):311-22.
28. Alam MT, Parvez N, Sharma PK. FDA-approved natural polymers for fast dissolving tablets. Journal of Pharmaceutics. 2014;34-45.
29. Joshi R, Garud N, Akram W. Fast dissolving tablets: a review. International Journal of Pharmaceutical Science Research. 2020;11(4):1562-70.
30. Vemula SK, Daravath B, Repka M. Quality by design (QbD) approach to develop fast-dissolving tablets using melt-dispersion paired with surface-adsorption method: formulation and pharmacokinetics of flurbiprofen melt-dispersion granules. Drug Delivery and Translational Research. 2023:1-9.
31. Chauhan V, Kumar K, Teotia D. Fast dissolving tablets: a promising approach for drug delivery. Universal Journal of Pharmaceutical Research. 2017;2(4):51-57.
32. Kumar S, Garg SK. Fast dissolving tablets (FDTs): Current status, new market opportunities, recent advances in manufacturing technologies and future

prospects. International Journal of Pharmaceutical Science. 2014;6(7):22-35.
33. Mineshkumar NV, Maisuria D, Patel T. A review on fast dissolving tablet. Pharma Science Monitor. 2023;14(2):45-65
34. Shivajirao DS, Puranik S. Development and evaluation of fast dissolving tablets. Journal of Current Pharma Research. 2023;17(4):54-73.
35. Gaikwad SS, Kshirsagar SJ. Review on tablet in tablet techniques. Beni-Suef University Journal of Basic and Applied Sciences. 2020; 9:1-7.
36. Agrawal R, Naveen Y. Pharmaceutical processing–A review on wet granulation technology. International Journal of Pharmaceutical Frontier Research. 2011;1(1):65-83.
37. Kristensen HG, Schaefer T. Granulation: A review on pharmaceutical wet-granulation. Drug Development and Industrial Pharmacy. 1987;13(4):803-72.
38. Hansuld EM, Briens L. A review of monitoring methods for pharmaceutical wet granulation. International Journal of Pharmaceutics. 2014;472(1-2):192-201.
39. Sun CC, Kleinebudde P. Mini review: Mechanisms to the loss of tabletability by dry granulation. European Journal of Pharmaceutics and Biopharmaceutics. 2016; 106:9-14.
40. Kleinebudde P. Roll compaction/dry granulation: pharmaceutical applications. European Journal of Pharmaceutics and Biopharmaceutics. 2004;58(2):317-26.
41. Bacher C, Olsen PM, Bertelsen P, Sonnergaard JM. Compressibility and compactibility of granules produced by wet and dry granulation. International Journal of Pharmaceutics. 2008;358(1-2):69-74.
42. Ahmed J, Thomas L, Mulla MZ, Al-Attar H, Maniruzzaman M. Dry granulation of vitamin D3 and iron in corn starch matrix: Powder flow and structural properties. Food Research International. 2023; 165:112497.
43. Kullmann D, Martinez CL, Lümkemann J, Huwyler J. Part I: Significant reduction of lyophilization process times by using novel matrix-based scaffolds. European Journal of Pharmaceutics and Biopharmaceutics. 2023; 184:248-61.
44. Kawasaki H, Shimanouchi T, Kimura Y. Recent development of optimization of lyophilization process. Journal of Chemistry. 2019; 2019:1-4.
45. Kasper JC, Winter G, Friess W. Recent advances and further challenges in lyophilization. European Journal of Pharmaceutics and Biopharmaceutics. 2013;85(2):162-9.
46. Kurhade Y, Phadtare D. Review on fast dissolving tablets-A new era in novel drug delivery system. International Journal in Pharmaceutical Science. 2023;1(6):106-22.
47. Guowei J, Zhihui C, Yuhan Z, Yongjun M, Qingqing Y. Formulation study of duloxetine hydrochloride enteric-coated tablets. SN Applied Sciences. 2023;5(2):63.
48. Brouillard RE, Griffith CL, Inventors; Penick & Ford Ltd, assignee. Tablets and method of forming. United States Patent US. 1971;20-40.
49. Witte A, Ulrich J. An alternative technology to form tablets. Chemical Engineering & Technology: Industrial Chemistry-Plant Equip ment-Process Engineering-Biotechnology. 2010; 33(5):757-61.
50. Qi X, Qin J, Ma N, Chou X, Wu Z. Solid self-microemulsifying dispersible tablets of celastrol: formulation development, charaterization and bioavailability evaluation. International Journal of Pharmaceutics. 2014;472(1-2):40-7.