10.37021/ijper.v7i1.02

REVIEW ARTICLE

Orally Disintegratng Tablets: A Recent Advancment

Ashwini Jadhav[1*], Kiran Bhosale[2], Neha Gupta[3], Tushar Shelke[4]

ABSTRACT

The oral route is the most common and easily administered the various types of dosage forms like tablets, capsules, syrups, suspensions, elixirs etc. but some patients facing the difficulties to swallow of these formulations.In terms of formulation, a orally disintegrating tablet (ODT) differ from an conventional tablet by modification of normal disintegrants with a superdisintegrant which is highly sensitive to aqueous environment (saliva) and disintegrates in fraction of time enhancing disintegration followed by immediate dissolution .This unique property helps rapid onset of action, avoid chocking, no water requirement, pleasing mouth feel, avoid first pass metabolism .The present review depicts various aspects of ODT"s formulation, selection of superdisintegrants, conventional technologies.

Keywords: Oraly Disintegrating tablets,Superdisintegrants,S olubility,Dosage forms.

How to cite this article: Jadhav A, Bhosale K, Gupta N, Shelke T. Orally Disintegratng Tablets: A Recent Advancment. Int. J. Pharm. Edu. Res. 2025;7(1):8-14.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

Oral drug delivery remains the preferred route for administration of various drugs. Solid dosage forms are popular because of ease of administration, accurate dosage, self-medication, pain evasion and most importantly the patient compliance. Tablets and capsules are the most popular dosage forms. But one important drawback of such dosage forms is dysphagia or difficulty in swallowing. To solve the abovementioned problem, pharmaceutical technologists have put in their best efforts to develop a fast-dissolving drug delivery, i.e. mouth dissolving tablet that disintegrates and dissolves rapidly in the saliva, within a few seconds without the need of drinking water or chewing[1]. Such formulations provide an opportunity for product line extension in the many elderly persons will have difficulties in taking conventional oral dosage forms (viz., solutions, suspensions, tablets, and capsules) because of hand tremors and dysphagia. Other groups that may experience problems using conventional oral dosage forms include the mentally ill, the developmentally disabled and patients who are uncooperative, on reduced liquid-intake plans, or are nauseated. The technologies utilized for fabrication of fast dissolving tablet include lyophilization, molding, direct compression, cotton candy process, spray drying, sublimation,massextraction ,nanonization,and quick dissolve formation[2].

US Food and Drug Administration Center for Drug Evaluation and Research (CDER) defines, an Orally disintegrating tablets(ODT) as "a solid dosage form containing medicinal substances, which disintegrates rapidly, usually within a matter of seconds, when placed upon tongue". Fast dissolving tablets are those when put on tongue disintegrate instaneously releasing the drug which dissolve or disperses in the saliva. Some drugs are absorbed from the mouth, pharynx and oesophagus as the saliva passes down into the stomach. In such cases, bioavailability of drug is signicantly greater than those observed from conventional tablets dosage form[3]. Their growing importance was underlined recently when European pharmacopoeia adopted the term "orodispersibles tablet "as a tablet that to be placed in the mouth where it disperse rapidly before swallowing. The bioavailability of some drugs maybe increased due to absorption of drug in oral cavity and also due to pregastric absorption of saliva containing dispersed drugs that pass down into the stomach[4-7].

Desired Criteria for ODT's

Desired characteristics of ODT's are as follows:

- Not require water to swallow, but it should dissolve or disintegrate in the mouth in matter of seconds.
- It should be compatible with taste masking.
- It should be portable without fragility concern.
- It should have a pleasing mouth feel.
- Leave minimal or no residue in the mouth after oral administration.
- Exhibit low sensitivity to environmental conditions as humidity and temperature.
- Allow the manufacture of tablet using conventional processing and packaging equipment at low cost.[8,9]

Faculty of Pharmacy, department of Pharmaceutics, Genba Sopanrao Moze College of Pharmacy, Wagholi Pune, Mahaashtra.412207

Corresponding Author: Ashwini Jadhav, Faculty of Pharmacy, department of Pharmaceutics, Genba Sopanrao Moze College of Pharmacy, Wagholi Pune, Mahaashtra.412207, E-mail: avj.gsmcop@gmail.com

Salient Features of ODT's

Silent features of ODTS are as follows

- Ease of administration to geriatric and psychiatric patients who refuse to swallow a tablet.
- Convenient for administration and accurate dosing as compared to liquids.
- No need of water to swallow the dosage form, which is highly convenient feature for patients who are traveling and do not have immediate access to water. Good mouth feel property of orally disintegrating tablet helps to change the basic impression of medication as 'Bitter pill' particularly for antihypertensive patients.
- Rapid dissolution and absorption of drug, which may produce rapid onset of action.
- Some drugs are absorbed from the mouth, pharynx and esophagus as the saliva passes down into the stomach, which enhances the bioavailability of drugs.
- Ability to provide advantage of liquid medication in the form of solid preparation.
- Pregastric absorption can result in improved bioavailability and as a result of reduced dosage improved clinical performance through a reduction of unwanted effects.[10,11]

Advantages of ODTs

Advantages of ODTs are as follows:

- Good for patient with swallowing difficulties
- Improved patient compliance
- Good for antihypertensive compliance
- Smooth mouth feels and pleasant taste
- Cost effective
- Convenient to administer during travelling or working without need of water
- The pre-gastric drug absorption avoids the first pass metabolism
- Good chemical stability as conventional oral solid dosage form

Disadvantage of ODTs

- The tablet may leave unpleasant taste hard in mouth if not formulated properly
- Drug with larger dose are difficult to formulate
- Tablet usually have insufficient mechanical strength
- Drug absorbed at specific site cannot be given in this dosage form
- These tablet shows high friability

Conventional techniques used for preparation of ODT's:

Direct compression

Direct compression is the easiest way to manufacture tablets. It can be done with conventional equipment, commonly available excipients and a limited number of processing steps. It also allows to accommodate high doses, and final weight of tablet can easily exceed that of the other production methods.

Directly compressed tablet's disintegration and solubilization depends on various factors such as single or combined action of disintegrants, water-soluble excipients and effervescent agent.Disintegrant efficacy is based on force equivalent concept, which is the combined measurement of swelling force development and amount of water absorption and defines the capability of disintegrant to transform absorbed water into swelling force. Disintegrant efficacy is strongly affected by tablet size and hardness. Large and hard tablet require more disintegration time. As consequences, products with optimal disintegration properties often have medium to small size and high friability and low hardness. The tablet with high friability and low hardness has less physical resistance, which cause breakage of tablet edges during the opening of blister alveolus.

ODT prepared by direct compression method involves use of superdisintegrant. Superdisintegrant are the agent, which are completely effective in very low concentration (2-5%). So to ensure a high disintegration rate of orally disintegrating drug delivery system (ODDS), choice of suitable type and an optimal amount of disintegrant is important. Other formulation components such as water-soluble excipients or effervescent agents can further enhance dissolution or disintegration properties but main drawback of using effervescent excipients is their highly hygroscopic nature.

The simultaneous presence of disintegrant with a high swelling force called disintegrating agent and substances with low swelling force (starch, cellulose and direct compression sugar) defined as "swelling agent" was claimed to be a key factor for rapid disintegration of tablet, which also offers physical resistance[12]

Freeze Drying

A process, which involves sublimation of water from the product after freezing, is called freeze-drying. Freeze-dried forms offer more rapid dissolution than other available solid products as process imparts glossy amorphous structure to the bulking agent and sometimes to the drugs.

A tablet that rapidly disintegrates in aqueous solution includes a partially collapsed matrix network that has been vacuum dried above the collapse temperature of the matrix. The matrix is partially dried below the equilibrium freezing point of the matrix. Vacuum drying of the tablet above its collapse temperature instead of freeze drying below its collapse temperature provides a process for producing tablets with enhanced structural

integrity, while rapidly disintegrating in normal amounts of saliva.

However, the use of freeze-drying is limited due to high cost of the equipment and processing. Other major disadvantages of the final dosage forms include lack of physical resistance in standard blister packs.[13]

Moulding

Mouldability is defined as the capacity of the compound to get moulded or compressed. Low mouldability means that the compound show reduced compressibility by tablet and rapid dissolution while high moulding compounds show excellent compressibility and slow dissolution.

Tablets produced by moulding are solid dispersions. Physical forms of the drug in the tablets depend whether and to what extent it dissolves in the molten carrier. The drug can exist as discrete particles or micro particles dispersed in the matrix. It can dissolve totally in the molten carrier to form solid solution or dissolve partially in the molten carrier and the remaining particles stay undissolved and dispersed in the matrix. Disintegration time, drug dissolution rate and mouth feel will depend on the type of dispersion or dissolution. Moulded tablets disintegrate more rapidly and offer improved taste because the dispersion matrix is, in general, made from water-soluble sugars.[14]

Sublimation

Compressed tablets composed of highly water-insoluble excipients do not dissolve rapidly in the water because of its low porosity, so porous tablets that exhibit good mechanical strength and dissolve quickly is the best remedy for above problem.

Heinemann and Rose et. al. have produced porous tablet by addition of inert solid ingredients such as urea, urethane, ammonium bicarbonate, camphor, naphthalene with other tablet excipients and the blend was compressed into tablet. Then, volatile material from compressed tablet is removed by sublimation so as to impart porosity to the tablet as shown in fig no 1.1.

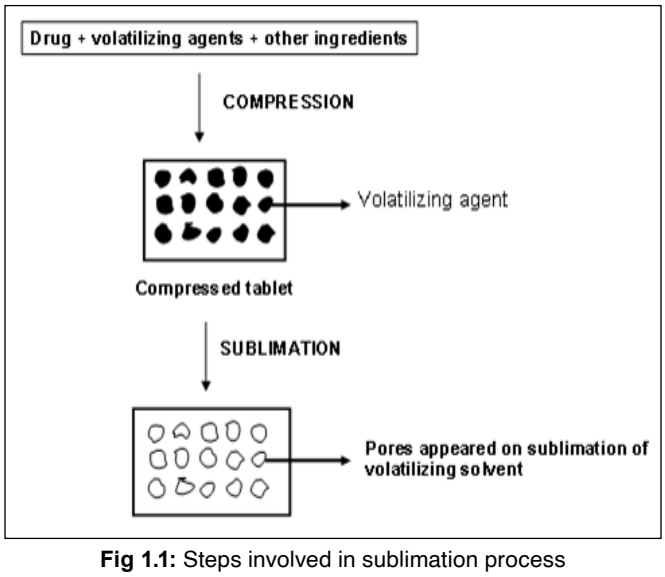

Fig 1.1: Steps involved in sublimation process

A method of producing ODT using water as the pore forming material has been described by Makino, et al. Koizumi, et al have developed a new method of preparing high porosity tablet that dissolve rapidly within 10-20 seconds and exhibit sufficient mechanical strength using mannitol with camphor, a subliming material.[15]

Spray Drying

As the processing solvent is evaporated rapidly during spray drying, it gives highly porous and fine powders. Allen and Wang have employed spray-drying technique to prepare fast dissolving tablets. They developed formulation by using mannitol as bulking agent, hydrolyzed and non-hydrolyzed gelatin as support matrix, sodium starch glycolate as disintegrant and acidic material (citric acid) and /or alkali material (ex. $NaHCO_3$) to enhance disintegration and dissolution. When immersed in an aqueous medium the tablets compressed from spray -dried powder, disintegrated within 20 seconds.[16]

Mass-Extrusion

In this technology the active blend is softened by using the solvent mixture of water soluble polyethylene glycol, methanol and then softened mass is expulsed through the extruder or syringe to get a cylinder of the product into even segments using heated blade to form tablets. The dried cylinder can also be used to coat granules of bitter tasting drugs in order to mask their bitter taste.[17]

Cotton candy process

This process is so named as it utilizes an inimitable spinning mechanism to produce floss like crystalline structure, which mimics cotton candy. This technique involves formation of matrix of polysaccharides or saccharides by simultaneous action of flash melting and spinning. The matrix formed is partially recrystallized to have better flow properties and compressibility. This matrix is milled and blended with active ingredients as well as excipients and subsequently compressed to ODTs. This process can accommodate high doses of drug and offers improved mechanical strength. However, high process temperature limits the use of this process [18]

Phase transition

Kuno*et al* proposed a novel method to prepare ODTs with sufficient hardness by involving the phase transition of sugar alcohol. In this technique, ODTs are produced by compressing and subsequently heating tablets that

Table 1.1: Patented technologies used for ODT's and examples[25-26]

Patented Technology	*Technique Employed*	*Company Name*	*Active Ingredient (Brand Names)*	*Advantages*
Zydis	Lyophilization	R.P. Scherer, Corp.	Loratidine (Claritin Reditab and Dimetapp	Highly porous in nature, quick dissolution increased bioavailability
Quicksolv	Lyophilization	Janseenpharma	Cisapride monohydrate (propulsidQuicksolve)	Short disintegration time, good mouth feel
Lyoc	Lyophilization	Farmalyoc	Phloroglucinol hydrate(spasfonLyoc	Accommodate high dose, disintegrate rapidly
Orasolve	Effervesentdisintegrant compression	CIMA Labs	Paracetamol TempraQuicklet),Zolmitriptan (ZolmigRepimelt)	Unique taste masking, fast dissolution.
Durasolve	Molding	CIMA Labs	Hyoscyamine sulphate(NuLev) Zolmitriptan (Zolmig ZMT)	Good rigidity
Wowtab	Compression molded tablets	Yamanouchi pharma tech	Famotidine (Gaster D)	Adequate dissolution rate and hardness
Flash dose	Cotton candy process	Fuisz Technology Ltd	Tramadol HCL (Relivia flash dose)	Highly porous in nature, pleasant mouth feel
Flash dose	Effervesentdisintegrant microencapsulated drug compression	Prographarm Group	verapamil(Nurofen Flash tab	Conventional tablet manufacturing required.
Ziplets	Molding	Eurand international	verapamil (cibalgina due fast	Sufficient mechanical strength
Oraquick	Micromask taste masking	K.V.Pharm.Co.,Inc.	Hyoscymine sulphate ODT	Significant friability, appropriate for thermo liable drug
Advatab	Microcaps and diffuscap CR Technology	Eurand international	Adva Tab Cetrixine AdvaTabParacetamol	High drug loading,Improved mechanical strength.

contain two sugar alcohols, one with high and other with a low melting point. Heating process enhances the bonding among particles leading to sufficient hardness of tablets which was otherwise lacking owing to low/ little compatibility.[19]

Melt granulation

Melt granulation is a process in which pharmaceutical powders are efficiently agglomerated by the use of binder which can be a molten liquid, a solid or a solid that melts during the process. For accomplishing this process, high shear mixers are utilized, where the product temperature is raised above the melting point of binder by a heating jacket or by the heat of friction generated by impeller blades. Perissutti*et al* prepared carbamazepine fast-release tablets by melt granulation technique using polyethylene glycol 4000 as a melting binder and lactose monohydrate as hydrophilic filler.[20]

Patented Technologies used for ODT's

Rapid-dissolving characteristic of ODTs is generally attributed to quick penetration of water into tablet matrix resulting in its fast disintegration. Several technologies have been developed on the basis of formulation aspects and different processes. Resulting dosage forms vary on several parameters like mechanical strength, porosity, dose, stability, taste, mouth feel, dissolution rate and overall bioavailability. Following table no 1.1 represents the list of unique patented technologies, their scientific basis, and patent owner along with significant advantages.[21-24]

Direct compression

Conventional equipment, commonly available excipients and a limited number of processing steps are involved in direct compression. Disintegrant efficiency is strongly affected by tablet size and hardness. Large and hard tablet have disintegration time more than that usually required. As a consequence, product with optimal disintegration properties often have medium to small size and high friability and low hardness. disintegrant have major role in disintegration and dissolution of orally disintegrating tablets made by direct compression.

Preparation involves the addition of superdisintegrants in optimum concentration to the formulation to achieve rapid disintegration/dissolution. For e.g. MCC and Crosspovidone, crosscarmellose sodium.[27]

Superdisintegrants

Newer substances are more effective at lower concentrations with greater disintegrating efficiency

and mechanical strength. Water penetration rate and rate of disintegration force development are generally positively related to disintegrant efficiency in non soluble matrices. However, such a positive correlation is not always observed between tablet disintegration time and drug dissolution rate. Superdisintegrants provide quick disintegration due to combined effect of swelling and water absorption by the formulation. Due to swelling of superdisintegrants, the wetted surface of the carrier increases, which promotes the wet ability and dispersibility of the system, thus enhancing the disintegration and dissolution. Effective superdisintegrants provide improved compressibility, compatibility and have no negative impact on the mechanical strength of formulations containing high-dose drugs. Number of factors affects the disintegration behavior of tablets. The optimum concentration of the superdisintegrant can be selected according to critical concentration of disintegrant. The ability to interact strongly with water is essential to disintegrant function. Combinations of swelling and/or wicking and/or deformation are the mechanisms of disintegrant action. The disintegrants have the major function to oppose the efficiency of the tablet binder and the physical forces that act under compression to form the tablet.[28]

Selection of superdisintegrants

Although superdisintegrants primarily affect the rate of disintegration, but when used at high levels they can also affect mouth feel, tablet hardness and friability. Hence, various ideal factors to be considered while selecting an appropriate superdisintegrants for a particular formulation should:

- Produce rapid disintegration, when tablet comes in contact with saliva in the mouth/oral cavity.
- Be compactable enough to produce less friable tablets.
- Produce good mouth feel to the patients. Thus, small particle size is preferred to achieve
- Patient compliance.
- Have good flow, since it improves the flow characteristics of total blend.

Mechanism of disintegrations by superdisintegrants

There are five major mechanisms for tablet disintegration as follows:-

- Swelling
- Porosity and Capillary Action (Wicking)
- Deformation
- Due to disintegrating particle/particle repulsive forces
- Enzymatic reaction

- *a. Swelling*

Swelling is believed to be a mechanism in which certain disintegrating agents (such as starch) impart the disintegrating effect. By swelling in contact with water, the adhesiveness of other ingredients in a tablet is overcome causing the tablet to fall apart as shown in fig.no.1.2 E.g. (Sodium starch glycolate, PlatagoOvata)[29]

- *b.Porosity and Capillary Action (Wicking):*

Effective disintegrants that do not swell are believed to impart their disintegrating action through porosity and capillary action. Tablet porosity provides pathways for the penetration of fluid into tablets. The disintegrant particles (with low cohesiveness & compressibility) themselves act to enhance porosity and provide these pathways into the tablet. Liquid is drawn up or "wicked" into these pathways through capillary action and rupture the interparticulate bonds causing the tablet to break apart as shown in fig no 1.3E.g.Crospovidone,Crosscar millose.[30-31]

- *c. Deformation:*

Starch grains are generally thought to be "elastic" in nature meaning that grains that are deformed under pressure will return to their original shape when that pressure is removed. But, with the compression forces involved in tableting, these grains are believed to be deformed more permanently and are said to be "energy rich" with this energy being released upon exposure to water. In other words, the ability for starch to swell is higher in "energy rich" starch grains than it is for starch

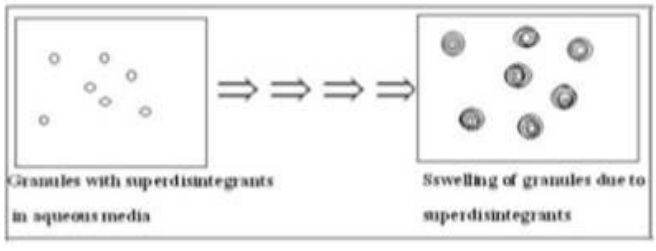

Fig. 1.2: Mechanism of superdisintegrants by swelling

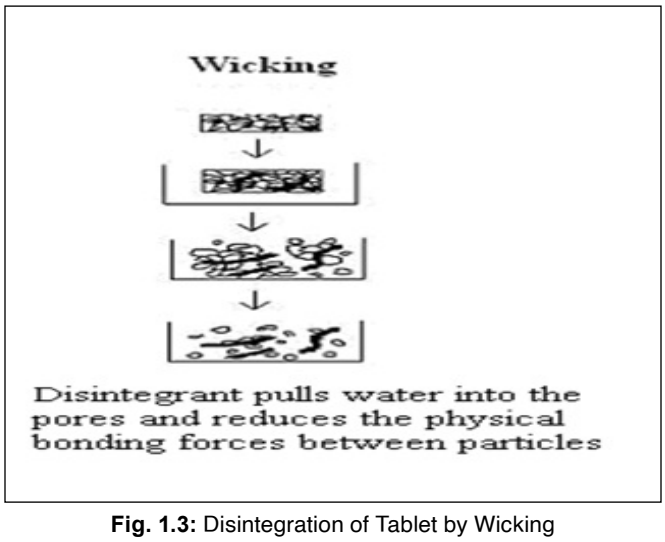

Fig. 1.3: Disintegration of Tablet by Wicking

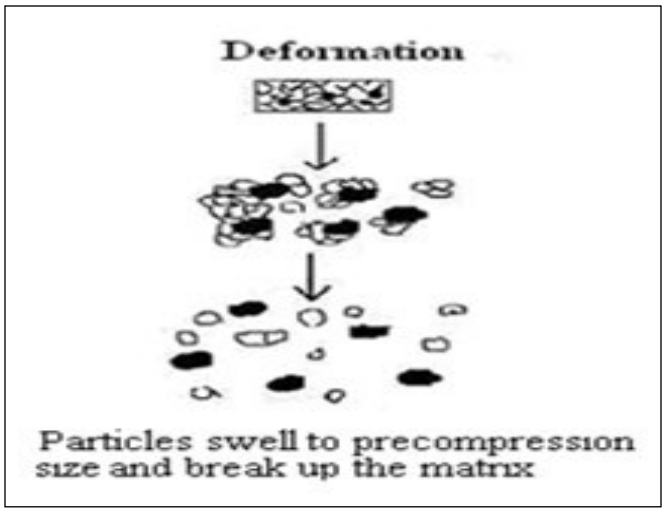

Fig. 1.4: Disintegration by Deformation

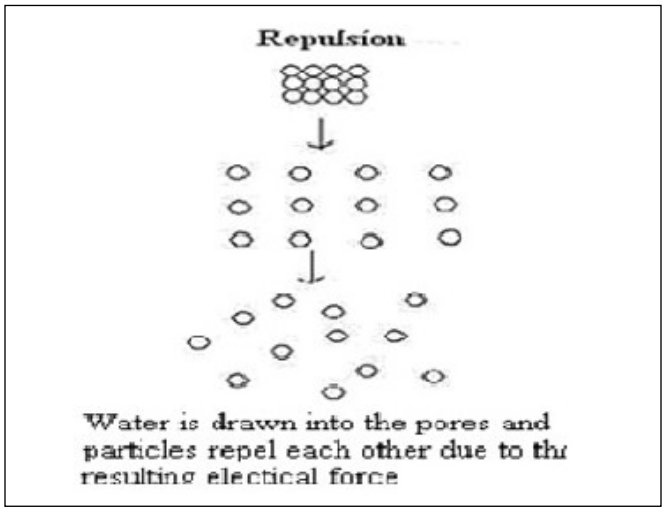

Fig. 1.5: Disintegration by Repulsion

grains that have not been deformed under pressure as shown in fig no1.4.[32]

- *d. Due to disintegrating particle/particle repulsive forces:*

Another mechanism of disintegration attempts to explain the swelling of tablet made with nonswellable disintegrants. Guyot-Hermann has proposed a particle repulsion theory based on the observation that nonswelling particle also cause disintegration of tablets as shown in fig no 1.5 The electric repulsive forces between particles are the mechanism of disintegration and water is required for it. Researchers found that repulsion is secondary to wicking. It is believed that no single mechanism is responsible for the action of most disintegrants. But rather, it is more likely the result of inter-relationships between these major mechanisms.[33]

By Enzymatic Reaction:

Enzymes present in the body also act as disintegrants. These enzymes dearth the binding action of binder and helps in disintegration. Due to swelling, pressure is exerted in the outer direction that causes the tablet to burst or the accelerated absorption of water leads to an enormous increase in the volume of granules to promote disintegration.[34]

CONCLUSION

Tablets are widely used dosage forms for their ease of modification based on pharmacological action. In general ,therapeutic effect of a drug depends on drug absorption profile which is solely dependent on disintegration followed by dissolution .This property of disintegration can be improved by using super disintegrants indirectly improving dissolution. Use of superdisintegants to facilitate fast disintegration in absence of water allowing drug release in oral cavity simultaneously helps to overcome problems such as chocking, first pass metabolism, pediatric, geriatric administration ,and several drawback of conventional tablet dosage form. Orally disintegrating tablet were successfully prepared with different Superdisinte grants by direct compression. The present studies were helped in understanding the effect of formulation process variables especially the concentration of different super disintegrants on the dispersion time and drug release profile.From the present studies it can be concluded that natural Superdisintegrant are suitable for the orally disintegrating tablet preparation.

REFERENCE

1. Gandhi A. Mouth dissolving tablet: a new venure in modern formulation tech. Pharma Innovation 2012;1:16-21.
2. Sastry SV, Nyshadham JR, Fıx JA. Recent technological advances in oral drug delivery. A review. Pharm Sci Technol Today 2000;3:138–45.
3. Habib W, Khankari RK, Hontz J. Fast-dissolve drug delivery systems. Crit Rev Ther Drug Carrier Sys 2000;2:61–72.
4. Lindgren S, Janzon L. Dysphagia: prevalence of swallowing complaints and clinical finding. Med Clin North Am 1993;3–5
5. Sehgal P, Gupta RG, Singh UK, Chaturvedi A, Gulati A, Sharma M. Fast dissolving tablets: a new venure in drug delivery. Am J Pharm Tech Res 2012;2:253-79.
6. Pahwa R, Gupta N. Orodispersible tablets: superdisintegrants used in an orally disintegrating tablet: a review. Int J Pharma Sci Res 2011;2:2767-80.
7. Bandari S, Mittapalli R, Gannu R, Rao Y. Orodispersible tablets: an overview. Asian J Pharm 2008;2:2-11
8. Hanawa T. New oral dosage form for elderly patients: preparation and characterization of silk fibroin gel. Chem Pharm Bull 1995;43:284–28.
9. Siddiqui M, Garg G, Sharma P. Fast dissolving tablets: preparation, characterization, and evaluation: an overview. Int J Pharm Sci Rev Res 2010;2:87-96.
10. Hirani JJ, Rathod DA, Vadalia RK. Orally disintegrating tablets: a review. Tr J Pharm Res 2009;8:161-72.
11. Sharma N, Sharma J, Jat R, Rathore A. Fast dissolving tablet

as a novel dosage form: a review article. In J of Res and Dev In Pharm and Life Sci 2012;12:190-4.
12. Sharma YR. Elementary Organic Spectroscopy, Principles, and Chemical Applications, S. Chand Publication; Reprint; 2016. p. 11-73.
13. Chatwal GR, Anand SK. Instrumental methods of instrumental methods of chemical analysis. 5th
14. Banker GS, Rhodes CT. Optimization techniques in pharmaceutical formulation and processing. In: 4 Edition. Himalaya Publishing House; 2009. p. 2.49-2.51. th
15. Bele MH. Pharmaceutics formulation and processing of conventional dosage form. First Edition. Carrer Publication; 2012. p. 48-55, 128-131. Ed. Vol. 121. Modern Pharmaceutics. New York; Basal: Marcel Dekkar: 2008. p. 609-10.
16. Kalia A, Khurana S, Bedi N. Formulation and evaluation of mouth dissolving tablet of oxcarbazepine. Int J Pharm Pharm Sci 2009;1:12-3.
17. Jain C, Naruka P. Formulation and evaluation of fast dissolving tablet of valsartan. Int J Pharm Pharm Sci 2009;1:219-26.
18. Roy A. Orodispersible tablet: a review. Asian J Pharm Chem Res 2016;2:19-26.
19. Indian Pharmacopoeia. Government of India Ministry of Health and Family Welfare, Published by The Indian Pharmacopoeal Commission, Ghaziabad; 2014. p. 2964, 1469, 2143, 2151.
20. Arunachalam A, Lavakumar V, Shankar M. Formulation and in vitro evaluation of levofloxacin oral dispersible tablets. Asian J Res Chem Pharm Sci 2013;1:31-9.
21. Dobetti L. Fast melting tablet: development and technologies. Pharm Tech 2001;2:44-8.
22. Lorenzp Lamosa ML, Cuna M, Vila Jato JL, Torres D. Fast dissolving drug delivery system. J Microencapsul 1997;14:607.
23. Virley P, Zydis YR. A novel fast dissolving dosage form. Manuf Chem 1990;2:36-7.
24. Caretensen JT. Guidelines for drug stability: principles and practices. Third Edition. Marcel Dekkar; 2005. p. 252-55.
25. Singh Harkirat, Kaur Lakhvir, Singh Gurjeet, Dhawan RK, Orodispersible Tablets: A New Trend in Drug Delivery, Int. J. Pharm. Sci. Rev. Res., 202169(1); 127-131
26. Sharma Mukesh Chandra and Leel Monika, A Review: Oral Dispersible Tablets, International Journal of Drug Development and Research, 2022, 1-5
27. Bhattacharya Suhasis, Mohanta Tanmay, Das Sujit, Basak Rumpa, Orodispersible Tablet in Treatment of Migraine: Opportunities, Challenges and Recent Advancements, Journal of Drug Delivery and Therapeutics, 2021; 11(4):149-156
28. Kenneth Roshan, Keerthy H.S, Orodispersible Tablets: A Compendious Review, Asian Journal of Pharmaceutical Research and Development, 2021; 9(3): 66-7
29. Lalla JK, Mamania HM. Fast dissolving of rofecoxib tablets. Ind J Pharm Sci 2004; 59(4):23-26
30. Pandey, K. U., Joshi, A., & Dalvi, S. V.. Evaluating the efficacy of different curcumin polymorphs in transdermal drug delivery. Journal of Pharmaceutical Investigation, 2020;51(1), 75–84.
31. Waghmare, P., Vrunal, M., & Mithun, M. Formulation and evaluation of fast dissolving oral film containing extracts of ocimum sanctum and glycyrrhiza glabra to treat mouth ulcer. Eur. Chem. Bull, 2023;12, 2121-2129.
32. Rathore, L., Gehalot, N., & Jain, V. A Short Review on Advancement in Fast Dissolving Oral Thin Films. Current Research in Pharmaceutical Sciences, 2022;11(4), 112–117.
33. Solaiman A, Suliman AS, Shinde S, Naz S, Elkordy AA. Application of general multilevel factorial design with formulation of fast disintegrating tablets containing croscaremellose sodium and Disintequick MCC-25. Int J Pharm. 2016;501(1-2):87-95
34. Hannan PA, Khan JA, Khan A, Safiullah S. Oral dispersible system: A new approach in drug delivery system. Ind J Pharm Sci. 2016;7(8):2-7