

Preparation and Assessment of Rapidly-Dissolving Tablets of Diltiazem HCl By Using Native and Man-Made Super Disintegrants

Mohan Varma M¹, Mohan Sai², Prasanna E³, Kusumanjali Devi Ch⁴,
Kshema Lathangi M⁵

Pharmaceutics Department, Shri Vishnu College of Pharmacy, Vishnupur, Bhimavaram, West Godavari (Dist.)534202, Andhra Pradesh, India.

Received: 26th July, 2025; Revised: 25th Aug, 2025; Accepted: 27th Sep, 2025; Available Online: 30th Nov, 2025

ABSTRACT

Rapidly dissolving tablets, also known as orally disintegrating tablets (ODTs) are solid unit dosage forms that disintegrate or dissolve rapidly in the mouth without chewing and water. They offer an advantage particularly for pediatric and geriatric populations who have difficulty in swallowing conventional tablets and capsules. The present study focuses on the formulation and evaluation of Diltiazem HCl rapidly dissolving tablets using both natural and synthetic superdisintegrants, including Sodium Starch Glycolate, Croscarmellose Sodium, Guar Gum, and ground banana flour. Tablets were prepared via dry granulation. The formulations (F1–F8) were developed and subjected to pre-compression (bulk density, tapped density, angle of repose, Hausner's ratio) and post-compression (hardness, friability, drug content, water absorption ratio, wetting time, dissolution, and disintegration time) evaluations. All parameters met the acceptable limits prescribed by the Indian Pharmacopoeia (IP). Among all formulations, F2 exhibited the shortest disintegration time of 28 seconds and the highest drug release of 98% within 30 minutes. The results demonstrate that natural superdisintegrant like ground banana flour can be effectively used in combination with synthetic agents to formulate efficient ODTs of Diltiazem HCl.

Keywords: Herbal nanoemulsion, Urinary Tract Infection, Synergistic antibacterial activity, *Vaccinium macrocarpon*, *Cinnamomum verum*, *Tribulus terrestris*, *In-vitro*

How to cite this article: Varma MM, Sai M, Prasanna E, Devi KC, Lathangi MK. Preparation and assessment of rapidly dissolving tablets of diltiazem HCl using native and synthetic superdisintegrants. *Int J Drug Deliv Technol.* 2025;15(4):1488-1494, DOI: 10.25258/ijddt.15.4.5

Source of support: Nil.

Conflict of interest: None

INTRODUCTION

Route of administration of drugs impacts the whole formulation, including drug disintegration and dissolution¹⁻¹⁰. Oral cavity is the site for most of the drugs because of the vast advantages by this route. So, Oral cavity is the site for administration of drugs. In oral administration of drugs, different processes takes place in a short period of time it includes: disintegration, dissolution, drug absorption¹¹⁻²¹. The tablet then quickly dissolves in the mouth, thereby absorbing it into the bloodstream²¹⁻³⁰. This Rapidly dissolving tablets, also called as Orally Disintegrating Tablets (ODTs) or Rapid Disappearing Tablets, are a type of pharmaceutical dosage form that is supposed to easily dissolve or disintegrate in the mouth, most commonly in seconds to a minute, with no intake of water³¹⁻⁴⁵. Such tablets promise an improved effectiveness of drug absorption and better patient compliance, particularly for those who experience a lot of difficulty in swallowing tablets or capsules⁴⁵⁻⁵⁵. Natural superdisintegrants⁵⁶ are plant-derived or natural substances used in the formulation to enhance the ease of disintegration and dissolution of tablets⁵⁶. Synthetic superdisintegrants are chemically synthesized materials that aim at improving the fast disintegration of tablets, leading to drug release followed by an improvement in bioavailability. Diltiazem is a semi-lipophilic drug, exhibiting roughly equal proportions of

both hydrophilic and lipophilic properties. Its physicochemical nature enables it to penetrate lipid membranes similar to those of cells-and simultaneously exhibit moderate water solubility. Diltiazem Hydrochloride or Diltiazem HCl is one of the calcium channel blocking drugs prescribed for HTN, angina, and certain arrhythmias. Diltiazem HCl is mostly soluble in water because of its salt form, making it suitable for immediate release formulations.

MATERIALS AND METHODS:

Diltiazem hydrochloride was obtained from Pellets Pharma Pvt Limited as a gift sample from Hyderabad, Banana powder from Hamps Bio Pvt Ltd, Gujarat, Guar gum from SD Fine Chemicals, Mumbai. Croscarmellose sodium from Vijlak Pharma Limited, Hyderabad. Lactose from Merck Specialties, Mumbai. Talc from SD Fine Chemicals, Mumbai. Magnesium stearate from SD Fine Chemicals, Mumbai. Sodium Starch Glycolate was procured from Vijlak Pharma Limited, Hyderabad.

2.1 Preparation of Standard Curve of Diltiazem Hydrochloride in pH 6.8 Phosphate Buffer: The 100 mg of Drug was weighed and dissolved in Phosphate Buffer pH 6.8, in a 100mL volumetric flask, the volume was diluted to 100 ml along with pH 6.8 PB (1000 µg/ml) solution. The

*Author for Correspondence: mohansaimaragani@gmail.com

10 ml was taken from the above stock solution, & it was diluted with Phosphate Buffer pH 6.8 and the volume was adjusted up to 100 ml. The solution was diluted with Phosphate Buffer pH 6.8 to get a series of dilutions 2,4,6,8,10,&12 µg/ml. The dilutions were quantified for the absorbance using the UV Spectrophotometer (Lab India) at 237 nm using Phosphate Buffer pH 6.8 solution as the blank (Figure 1).

2.2 PREPARATION OF DILTIAZEM HCl RAPIDLY DISINTEGRATING TABLETS:

After precisely weighing DTZ HCl, other diluents were added & properly mixed. Finally, remaining agents were also added and blended for 5 min, thoroughly to get a uniform mixture. All the bulking agents were passed through 60 mesh sieves. Using a single-stage compression machine, these blends were compressed with an 8mm punch to a hardness of 3 kg/cm² to secure a 200 mg unit tablet.

2.3 Assessment of pre-compression parameters:

2.3.1 Bulk Density:

Measurement of mass in material per unit volume, which is found to include all solid particles and air spaces within the material, is called bulk density. common units are (g/cm³) or kilograms per cubic meter (kg/m³).

$$\text{Bulk density} = \frac{\text{mass of powder (w)}}{\text{Bulk volume}} \quad (\text{Table 2})$$

2.3.2 Tapped density (TD):

Tapped density is the density of a granular or powdered material after it has been compacted by tapping or vibrating the container holding material. This parameter may give insights into compressibility and packing behavior of the material.

$$\text{Tapped density} = \frac{\text{weight of powder}}{\text{tapped volume of powder}} \quad (\text{Table 2})$$

2.3.3 Assessment of post-compression methods:

2.3.4 Hardness:

It is to survey the mechanical potency of the tablets so that it can stand the test of handlings and transports without breaking down prematurely. Monsanto method is used to determine the tablet toughness, and it is expressed in Kg/cm². (Table 3)

2.3.5 Friability:

The friability test results were examined using the Roche friabilator (Electrolab). for every batch the machine ran at 25 rpm for 4 minutes. After removing, dedusting, and reweighing the tablets, the percentage of delicacy was determined.

$$\text{Percentage Friability} = \frac{[\text{Initial weight (W1)} - \text{End weight (W2)}]}{[\text{Initial weight (W1)}] \times 100}$$

Where W1 – Initial weight of the tablets; W2 - End weight of the tablets (Table 3)

2.3.6 Weight variation test (%):

Measuring and calculating the tablet's mass deviates from its average. Twenty tablets were chosen at random from each formulation, weighed separately, and their Mean weight was determined. The average weight was determined and contrasted with the Pharmacopoeia's standard values. The following formula serves to establish the percentage weight deviation of each individual pill from the average weight.

$$\text{Percentage weight variation} = \frac{(\text{Each tablet wt} - \text{Avg wt of 20 tablets})}{\text{Average weight of 20 tablets}} \times 100 \quad (\text{Table 3})$$

2.3.7 Wetting time (S):

Wetting time will replicate how saliva acts in the mouth cavity on a tablet. It is related to contact angle and the hydrophilicity of excipients. It is defined as the time taken for water to reach the tablet's top surface. Before placing a tablet on a piece of tissue paper that has been folded twice and placed in a glass plate with six milliliters of water, its weight is recorded. The duration to completely wet the tablet's top layer is then measured. Low wetting time indicates faster tablet disintegration, whereas high wetting time indicates slower tablet disintegration (Table 3).

2.3.8 Water Absorption ratio:

The measurement of amount of water a material can absorb relative to its weight or volume is known as the water absorption ratio, it depends on material porosity, structure, and water retention capability.

$$\text{Water Absorption Ratio} = 100 (W_a - W_b) / W_b$$

Where, W_b = wt of the tablet prior to water absorption, W_a = weight of the tablet after water absorption (Table 3).

2.3.9 Drug content uniformity test (%):

The drug content uniformity test ensures that the amount of active ingredients in each tablet is consistent and within the acceptable limits. It should be close to the theoretical value (100%) with minimal deviation. The 3 tablets of each formulation are weighed accurately & crushed. The Powder ≅100mg of drug was dispersed in pH 6.8 pH buffer & the volume was adjusted up to 100 ml. Dilute the solution with distilled water & record the absorbance for the drug by using the ultraviolet- spectroscopy at 237nm. (Table 3).

2.4.0 Disintegration time:

Disintegration means breaking down of a tablet into smaller pieces. This test determines the disintegration time or how long it takes for tablets to break into small pieces. Each test tube will contain one tablet. The assembly is submerged in one liter of distilled water and the system is run at 37°C ± 2°C.

2.4.1 Dissolution studies:

The *in-vitro* dissolution studies of the tablet gives information on how well the formulation releases the medication swiftly for systemic absorption. To measure the rate at which Diltiazem HCl dissolved in each formulation, the paddle method was utilized at 37°±0.5°C and 50 rpm. The 900ml of pH 6.8 buffer was used as the dissolution medium. The five mL of the dissolution fluid was removed at different time interval (5, 10, 15, 20, 25, and 30 minutes),

further diluted as applicable, the Diltiazem HCl content was assayed using UV spectroscopy by measuring the absorbance at 237 nm.(Table 4,5).

2.42 FTIR Spectroscopy studies:

The compatibility of the API with the excipients was checked by noting down the Fourier transform IR spectrum of the optimized batches of FDTs of Diltiazem HCl. The FTIR spectrophotometer used potassium bromide pellets to get the FTIR spectroscopy with a 1-minute scan interval as its scanning range, the spectrum of the optimal batch formulation and the pure medication.(Figure - 7,8,9,10,11,12)

2.43 Differential Scanning Calorimetry studies:

The DSC thermogram of the optimized formulation (10mg sample) was noted using the automated thermal analyzer. Evaluation of the drug–excipient interaction was done using the differential scanning calorimetry (Figure 13).

2.44 DSC was operated as below:

Scanning rate for 10°C/ minute.

Scanning range for 0°C to 250°C in a nitrogen environment

3. RESULTS AND DISCUSSION

The Orally Disintegrating Tablets were prepared using different excipients like natural and synthetic super disintegrants. The various formulations F1 to F8 were prepared & assessed for the different quality control tests

3.1 Composition of different formulations of Rapidly disintegrating Tablets

Excipients in mg	FORMULATIONS							
	F1	F2	F3	F4	F5	F6	F7	F8
(F1-F8)								
Diltiazem HCL	100	100	100	100	100	100	100	100
Banana flour	-	-	-	-	-	-	8	16
Guar gum	-	-	8	16	-	-	-	-
Na- starch glycolate	-	-	-	-	-	-	-	-
Croscarmellose sodium	8	16	-	-	-	-	-	-
Lactose	86	78	86	78	86	78	86	78
Talc	3	3	3	3	3	3	3	3
Mg-Stearate	3	3	3	3	3	3	3	3
Tablet weight in mg	200	200	200	200	200	200	200	200

Table 1: Diltiazem HCl Calibration Curve using pH 6.8 buffer

Concentration(µg/ml)	Absorbance
2	0.148
4	0.278

6	0.425
8	0.565
10	0.721
12	0.875

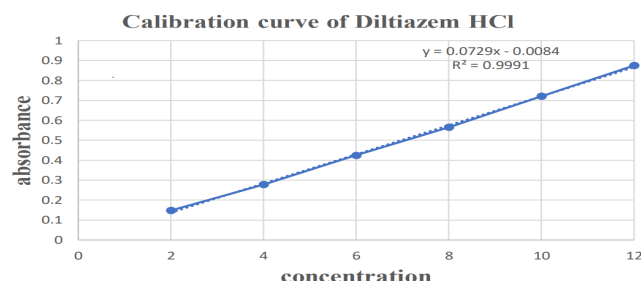


Figure 1: Calibration curve of Diltiazem hydrochloride in pH 6.8 buffer solution.

Table 2: Evaluation of Pre Compression Tests

Product code	Packed Density/(g/ml)	Volume-base density /B.D (g/ml)	Angle of repose	Hausner ratio	Carr's compressibility Index (%)
F1	0.74	0.65	27	1.13	12.16
F2	0.66	0.59	29	1.11	10.60
F3	0.42	0.36	33	1.16	14.28
F4	0.71	0.60	33	1.18	15.49
F5	0.64	0.55	31	1.16	14.0
F6	0.70	0.62	27	1.12	11.42
F7	0.70	0.61	32	1.14	12.85
F8	0.60	0.52	30	1.15	13.33

Table 3: Evaluation of Post Compression Tests.

Formulation code	Hardness (kg/cm ²)	Friability (%)	Weight variation (n=3)	Water absorption ratio (n=3)	Weighting time (sec)	Disintegration time (sec)	Drug content uniformity test (%) (n=3)
F1	3.12	0.56	199.48±1.94	79.12±0.32	49±1.40	37	97.69±0.86
F2	2.9	0.52	200.25±1.67	76.21±0.20	42±1.44	28	99.08±0.014

F3	3.14	0.7 0	201.7 0±1.4 5	56±1 .54	56 ±1. 54	50	98.90 ±0.04 2
F4	3.53	0.6 8	198.5 4±1.8 4	95.3 6±0. 89	59 ±1. 36	56	96.92 ±0.00 7
F5	3.37	0.6 1	201.5 4±1.2 8	84.4 9±0. 25	51 ±1. 28 39	39	98.75 ±0.00 8
F6	2.89	0.5 9	198.1 9±1.4 2	78.1 7±0. 22	47 ±1. 39	34	97.18 ±0.01 5
F7	3.16	0.6 6	200.1 2±1.3 2	90.6 3±0. 31	55 ±1. 77	49	95.27 ±0.02 0
F8	3.28	0.6 4	199.6 5±2.0 3	88.1 4±0. 38	53 ±1. 63	44	96.77 ±0.00 6

Table 5: Dissolution parameters of the formulated tablets.

Bat ch	% of drug released in		T50(m in)	T75(m in)	T90(m in)
	10m in	20m in			
F1	46.1 2	75.5 0	11.49	19.85	27.79
F2	55.8 6	85.5 8	7.06	17.32	25.17
F3	51.4 8	70.4 9	9.37	29.22	29.57
F4	44.3 0	73.8 9	10.81	20.50	29.34
F5	55.9 8	72.1 0	8.61	21.22	27.74
F6	44.8 7	76.9 4	12.07	18.84	26.97
F7	52.3 3	74.0 5	9.44	20.43	28.71
F8	55.3 0	76.0 3	8.76	19.44	27.33

Table 4: Dissolution studies of all formulations.

Cumulative % drug released							
Fo rm ula tion co de	Time in mins						
	0	5	10	15	20	25	30
F1	0	33.8 4±0. 56	46.1 2±0. 63	59.1 5±0. 59	59.1 5±0. 59	82.5 5±0. 98	95.9 0±1. 27
F2	0	37.2 5±0. 23	55.8 6±0. 47	55.8 6±0. 47	85.5 8±0. 34	89.6 9±0. 57	98.8 9±0. 77
F3	0	30.1 ±0.1 9	51.4 8±0. 34	63.3 1±0. 23	70.4 9±0. 75	70.4 9±0. 75	91.5 8±0. 18
F4	0	25.4 ±0.4 5	44.3 ±0.2 3	60.6 ±0.5 2	73.8 ±0.4 2	85.9 ±0.3 3	90.6 2±0. 45
F5	0	34.4 2±0. 23	55.9 8±0. 42	68.0 8±0. 21	72.1 0±0. 34	83.9 2±0. 45	95.0 2±0. 56
F6	0	35.2 5±0. 63	57.2 5±0. 77	57.2 5±0. 77	76.9 4±0. 65	85.3 0±0. 52	97.2 2±0. 64
F7	0	31.7 ±0.3 4	52.3 2±0. 27	62.8 7±0. 45	74.0 5±0. 34	83.9 2±0. 37	92.1 1±0. 50
F8	0	33.9 7±0. 52	55.3 ±0.4 3	66.7 8±0. 52	76.0 3±0. 56	85.9 2±0. 75	94.3 1±0. 42

3.3 Dissolution profiles of the formulated tablets with natural and synthetic super disintegrants:

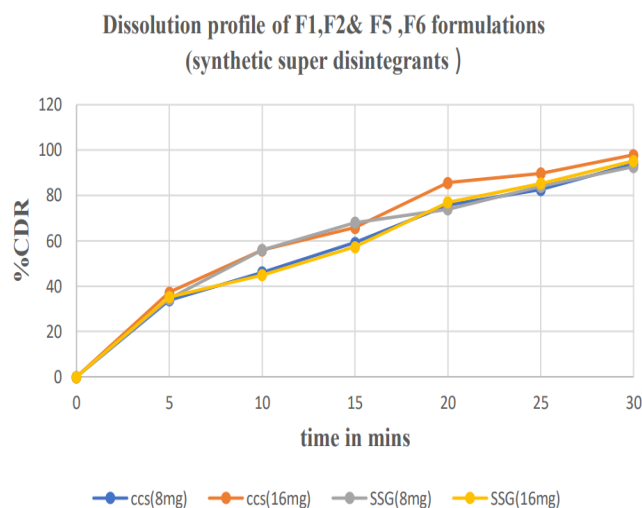


Figure 2: Dissolution profile for F1 & F2 and F5 & F6 formulations (used synthetic super disintegrants)

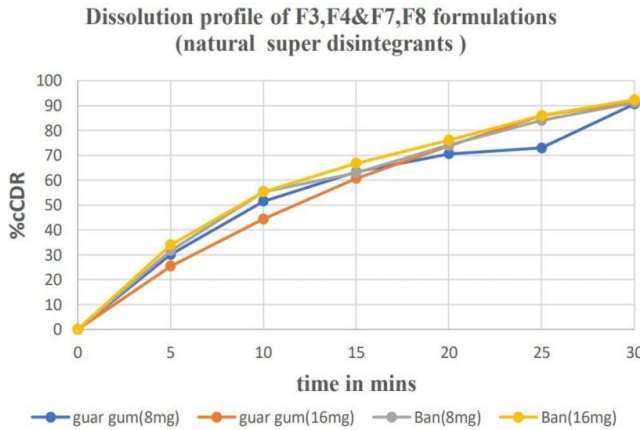


Figure 3: Dissolution profile for F3 & F4 and F7 & F8 formulations (used natural super disintegrants).

Figure 4 : FTIR Studies

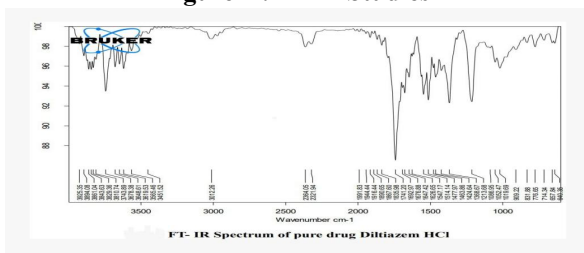


Figure 5: FTIR Studies

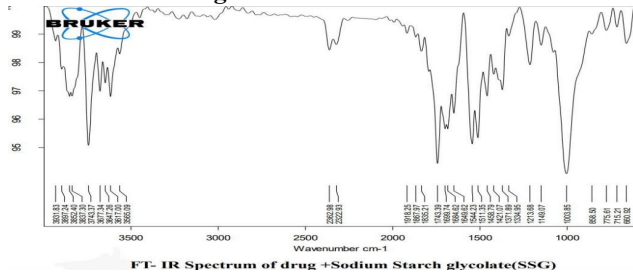


Figure 6: FTIR Studies

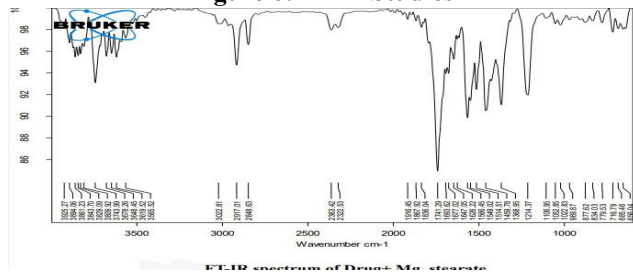
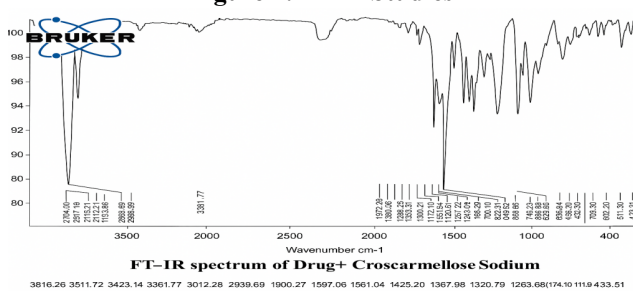
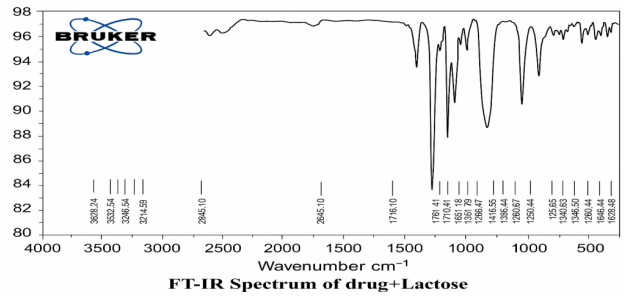


Figure 7: FTIR Studies

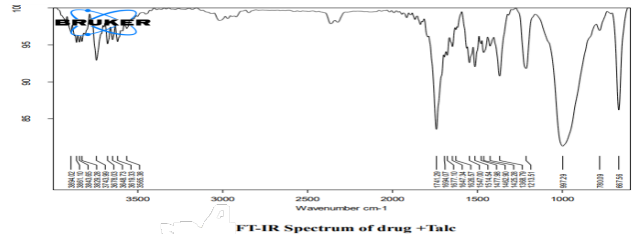


3816.26 3511.72 3423.14 3361.77 3012.28 2939.69 1900.27 1597.96 1561.04 1425.20 1367.98 1320.79 1263.66(174:10)1119.433.51

Figure 8: FTIR Studies



FT-IR Spectrum of drug+Lactose



FT-IR Spectrum of drug +Talc

Figure 09: FTIR Studies

3.6 DSC studies:

The Figure. 13 displays the DSC thermograms for both the formulation F2 and the pure medication. The pure drug's Diltiazem hydrochloride showed a dramatic melting transition at 216.20°C. The melting endotherm in formulation F2 was found to be 214.08°C. This demonstrated that the drug's nature was unaffected by the presence of other excipients and that it was properly preserved in the optimized formulation

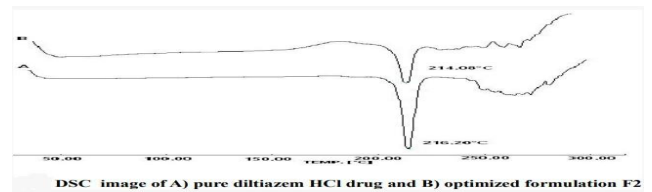


Figure 10: DSC Thermograms of pure drug & the optimized formulation

CONCLUSION

The direct compression process was used to create the quickly dissolving Diltiazem HCl tablets. According to the drug release experiments, the croscarmellose sodium (16 mg) F2 dissolved quickly and provided the maximum drug release / dissolution in a brief amount of time. The disintegration time of formulations F1–F2 was shown to decrease with increasing croscarmellose sodium concentrations; the disintegration time for these formulations was 28 seconds. Diltiazem HCl does not interact with the excipients used in the formulation, according to the interaction studies confirmed by the DSC and FT-IR spectra.

REFERENCE

1. Pandurangan DK, Vuyuru T, Kollipar D. Fast dissolving tablets – an overview. Int J Res Pharm Sci. 2012;3(2):348-55.

2. Manivannan R. Oral disintegrating tablets: a future compaction. *Drug Invent Today*. 2009;1(1):61-5.
3. Shukla D, Chakraborty S, Singh S, Mishra B. Mouth dissolving tablets: an overview of evaluation techniques. *Sci Pharm*. 2009;77(1):327-41.
4. Rao Y, Bandari S, Mittapalli R, Gannu R. Orodispersible tablets: an overview. *Asian J Pharm*. 2008;2(1):1-10.
5. Deshmukh VN. Mouth dissolving drug delivery system: a review. *Int J PharmTech Res*. 2012;4(2):412-21.
6. Reddy LH, Ghosh B, Rajneesh. Fast dissolving drug delivery system: a review on literature. *Indian J Pharm Sci*. 2002;64(3):331-6.
7. Prajapati BG, Ratnakar N. A review on recent patents on fast dissolving drug delivery systems. *Int J PharmTech Res*. 2009;1(3):790-8.
8. Singh S, Tiwari A. Fast dissolving tablets: a review. *Int J Curr Pharm Res*. 2017;9(2):8-18.
9. Badgujar B, Mundada A. The technologies used for developing orally disintegrating tablets: a review. *Acta Pharm*. 2011;61(2):117-39.
10. Shukla D. Mouth dissolving tablets I: an overview of formulation technology. *Sci Pharm*. 2009;77(2):309-26.
11. Bhowmik D. Fast dissolving tablet: an overview. *J Chem Pharm Res*. 2009;1(1):163-77.
12. Panigrahi MR. A review on fast dissolving tablets. *Webmed Cent Pharm Sci*. 2010;1(11):1-15.
13. Pahwa R, Piplani M, Sharma PC, Kaushik D, Nanda S. Orally disintegrating tablets – friendly to pediatrics and geriatrics. *Arch Appl Sci Res*. 2010;2(2):35-48.
14. Seager H. Drug-delivery products and the Zydis fast-dissolving dosage form. *J Pharm Pharmacol*. 2011;50(4):375-82.
15. Harish D, Shiv B, Jyoti D. Fast dissolving tablets: an overview. *Novel Sci Int J Pharm Sci*. 2012;1(5):228-32.
16. Patil PB, More VN, Tour NS. Recent trends in orodispersible tablets – an overview of formulation technology and future prospects. *Int J Pharm Sci Res*. 2015;6(7):1056-66.
17. Ringard J, Guyot-Hermann AM. Calculation of disintegrant critical concentration in order to optimize tablets disintegration. *Drug Dev Ind Pharm*. 1988;14(15-17):2321-39.
18. Heer D, Aggarwal G, Kumar SLH. Recent trends of fast dissolving drug delivery systems. *Pharmacophore*. 2013;4(1):1-9.
19. Mhaske NS, Wagh PP. Fast dissolving tablets: a review of formulation and evaluation strategies. *Int J Creat Res Thoughts*. 2024;12(5):440-53.
20. Kumar RS, Devi MG. Review of fast dissolving tablets. *Int J Health Sci*. 2022;6(S2):13684-98.
21. Kumar S, Garg SKR. Fast dissolving tablets: current status, new market opportunities, recent advances in manufacturing technologies and future prospects. *Int J Pharm Pharm Sci*. 2014;6(7):22-35.
22. Sastry SV, Nyshadham JR, Fix JA. Recent technological advances in oral drug delivery – a review. *Pharm Sci Technol Today*. 2000;3(4):138-45.
23. Nand P, Vashist N, Anand A, Drabu S. Mouth dissolving tablets – a novel drug delivery system. *Int J Appl Biol Pharm Technol*. 2010;1(3):1-7.
24. Gauri S, Kumar G. Fast dissolving drug delivery and its technologies. *Pharma Innov J*. 2012;1(2):34-9.
25. Garg G, Sharma P. Fast dissolving tablets: preparation, characterization and evaluation. *Int J Pharm Sci Rev Res*. 2010;4(2):87-96.
26. Baghel P, Roy A, Chandrakar S, Bahadur S. Fast dissolving drug delivery systems: a brief review. *Res J Pharm Technol*. 2013;6(6):597-602.
27. Alam MDT, Parvez N, Sharma PK. Novel technology for formulation of mouth dissolving tablet: a review. *Adv Biol Res*. 2014;8(5):180-6.
28. Rahane R, Rachh PR. A review on fast dissolving tablets. *J Drug Deliv Ther*. 2018;8(5):50-5.
29. Kumari A, Bansal DM, Kumar MJ. Formulation, development and evaluation of mouth-melting tablets of famotidine using natural and synthetic superdisintegrants. *Int J PharmTech Res*. 2021;9(1):21-35.
30. Rao NR, Patel T. Development and evaluation of carbamazepine fast dissolving tablets prepared with a complex by direct compression technique. *Asian J Pharm*. 2009;3:97-103.
31. Gosai AR, Patil SB, Sawant KK. Formulation and evaluation of oro-dispersible tablets of ondansetron hydrochloride by direct compression using superdisintegrants. *Int J Pharm Sci Nanotechnol*. 2008;1(1):106-11.
32. Alburyhi MM, Saif AA, Noman MA, Mohamed YAS, Hamidaddin MA. Formulation and evaluation of lisinopril orally disintegrating tablets. *World J Pharm Pharm Sci*. 2023;12(9):357-69.
33. Mulla J, Dasankoppa FS, Vilas G, Sholapur H. Fast dissolving tablets of promethazine: a novel oral formulation for fractionated radiotherapy-induced nausea and emesis. *Indian Drugs*. 2008;45:314-7.
34. Nazma S, Shabber S, Shahida B, Abbulu K. Formulation and evaluation of dispersible sparfloxacin tablets. *Int J Pharm Sci*. 2012;1(3):1-14.
35. Aithal KB, Harish NM, Rathnanand M, Shirwaikar A, Dutta M. Once-daily fast dissolving tablets of granisetron hydrochloride – formulation and in vitro evaluation. *Indian Drugs*. 2006;43:576-81.
36. Parmar S, Thakka S. Formulation and evaluation of domperidone fast dissolving tablets. *Int J PharmTech*. 2009;1(3):483-7.
37. Sharma S, Bharadwaj S, Gupta GD. Fast dissolving tablets of promethazine theoclate using natural superdisintegrants. *Res J Pharm Technol*. 2008;1(3):218-24.
38. Patel B, Patel D, Parmar R, Patel C, Serasiya T, Sanja SD. Development and in vitro evaluation of fast dissolving tablets of glipizide. *Int J Pharm Pharm Sci*. 2009;1(1):145-50.

39. Abbas Z, Swamy NGN, Sachin N. Design and characterization of oral dispersible tablets of enalapril maleate using a co-processed excipient. *J Appl Pharm Sci.* 2012;2(11):40-9.
40. Aglawe SB, Gayke AU, Sancheti VP, Metkar PS. Formulation and evaluation of mouth dissolving tablets of oxcarbazepine. *World J Pharm Res.* 2017;6(1):1130-7.
41. Sharma V, Chopra H. Formulation and evaluation of taste-masked mouth-dissolving tablets of levocetirizine hydrochloride. *Iran J Pharm Res.* 2012;11(2):457-63.
42. Earle RR, Ayalasomayajula LU, Raju AN, Kumari KT, Kumar PR. Formulation and evaluation of diclofenac sodium oro-dispersible tablets using different superdisintegrants. *Schol Res Libr.* 2016;8(8):227-38.
43. Jha S, Vijayalakshmi P, Karki R, Goli D. Formulation and evaluation of melt-in-mouth tablets of haloperidol. *Asian J Pharm.* 2008;2(4):255-60.
44. Drugs.com. [Internet]. Accessed 2025 Jun 22.
45. Shah RB, Tawakkul MA, Khan MA. Comparative evaluation of flow for pharmaceutical powders and granules. *AAPS PharmSciTech.* 2008;9(1):250-8.
46. Lindberg N, Pålsson M, Pihl A, Freeman R, Freeman T, Zetzener H, et al. Flowability measurements of pharmaceutical powder mixtures with poor flow using five different techniques. *Drug Dev Ind Pharm.* 2004;30(7):785-91.
47. Kiran NR, Palanichamy S, Rajesh M, Rajadhas TG, Anusha V, Parasakthi N, et al. Formulation and evaluation of orodispersible piroxicam tablets. *J Pharm Sci.* 2010;2(10):615-21.
48. Patel DM, Patel NM, Shah RR, Jogani PD, Balapatel AI. Studies in the formulation of orodispersible tablets of Refocoxib. *Indian J Pharm Sci.* 2004;66(5):621-5.
49. Lachman L, Lieberman A, Kinig JL. The theory and practice of industrial pharmacy. Bombay: Varghese Publishing House; 1991. p. 67-8.
50. Priyadharshini R, Murali DR. Orally disintegrating tablets: an overview. *Int J Life Sci Res.* 2021;9(2):7-13.
51. Shaikh S, Khirsagar RV, Quazi A. Fast disintegrating tablets: an overview of formulation and technology. *Int J Pharm Pharm Sci.* 2010;2(5):9-15.
52. Fini A, Bergamante V, Ceschel GC, Ronchi C, De Moraes CAF. Fast-dispersible/slow-releasing ibuprofen tablets. *Eur J Pharm Biopharm.* 2008;69(1):335-41.
53. Pradhan D, Chakraborty P, Halder S, Bagchi A. An overview on FDA-approved natural super disintegrants efficacy in a fast dissolving drug delivery system. *J Appl Pharm Res.* 2021;9(3):1-7.
54. Rathore D, Jain V, Gehalot N. Formulation and evaluation of fast dissolving tablets of aceclofenac using natural superdisintegrant. *Int J Pharm Sci Med.* 2022;7(10):39-64.
55. Barethiya V, Dixit G, Deshpande S, Rajbhar K. Formulation, evaluation and comparison of natural and synthetic superdisintegrants used in the fast-dissolving tablet by direct compression techniques. *Int J Pharm Sci Res.* 2024;15(1):120-30.
56. Mohamed AA. Natural disintegrants in pharmaceutical formulations. *J Pharmacological Pharmaceut Res.* 2025;2(1):15-9.