International Journal of Pharmaceutics and Drug Research
ISSN: 2347-6346
Available online at http://ijpdr.com

Original Research Article

FORMULATION AND CHARACTERIZATION OF FAST DISSOLVING TABLETS OF ANTIEMETIC DRUG

Kalyani Tamrakar*, V. P. Gupta, Bhupendra Tiwari
Globus College of Pharmacy, Bhopal (M.P.)

***Correspondence Info:**
Kalyani Tamrakar
Globus College of Pharmacy, Bhopal (M.P.)
Email:
kalyanitamrakar6@gmail.com

***Article History:**

Received: 12/01/2025
Revised: 09/02/2025
Accepted: 20/02/2025

ABSTRACT

The aim of this study was to formulate and evaluate fast-dissolving tablets (FDTs) of Metoclopramide**,** an antiemetic drug, to improve patient compliance, especially for those who have difficulty swallowing tablets. Various formulations of Metoclopramide FDTs were prepared using different excipients, including sodium starch glycolate, croscarmellose sodium, and magnesium stearate, through direct compression. Pre-compression parameters such as loose bulk density, tapped bulk density, Carr's index, and Hausner's ratio were determined to assess the powder flowability. Post-compression parameters including hardness, friability, weight variation, thickness, and drug content were evaluated, showing that all formulations met the official standards for fast-dissolving tablets. The disintegration time of the formulations ranged from 65 to 96 seconds, with F3 showing the fastest disintegration (65 ± 4 seconds). In-vitro drug release studies revealed that F3 exhibited nearly complete release of Metoclopramide (98.74%) within 15 minutes. The release data followed the Higuchi model, indicating a diffusion-controlled release mechanism. The optimized formulation F3 demonstrated excellent characteristics, including rapid disintegration, optimal drug release, and good physical properties. These findings suggest that F3 is a promising formulation for rapid antiemetic relief and can enhance patient compliance.

Keywords: Fast-dissolving tablets, Metoclopramide, Antiemetic, Disintegration time, *In-vitro* drug release, Formulation optimization, Excipients, Patient compliance, Higuchi model.

INTRODUCTION

Metoclopramide is a widely utilized antiemetic drug that functions primarily as a dopamine antagonist, effectively preventing and treating nausea and vomiting related to chemotherapy, radiotherapy, postoperative recovery, and certain gastrointestinal disorders. It works by enhancing gastric motility and promoting gastric emptying, making it highly effective in treating conditions like gastroparesis, morning sickness, and nausea associated with migraine headaches. However, the conventional tablet dosage form of metoclopramide often poses challenges for certain patient populations, particularly pediatrics, geriatrics, and individuals with difficulty swallowing tablets or requiring rapid relief from symptoms (Ali & Hassan, 2012).

To address these challenges, fast-dissolving tablets (FDTs) have gained significant attention as a preferred alternative. FDTs offer an easy-to-administer, rapid-onset dosage form that dissolves quickly in the mouth without the need for water (Panda & Mishra, 2014).

These dosage forms are advantageous for patients who suffer from nausea and vomiting, as they enhance patient compliance, improve the convenience of medication administration, and facilitate a rapid onset of therapeutic effects. The fast dissolution of FDTs enables quicker drug absorption in the oral cavity, leading to faster relief, which is crucial for managing nausea and vomiting (Verma & Soni, 2017).

In the case of metoclopramide, formulation into FDTs requires careful selection of excipients that promote rapid disintegration, dissolution, and effective taste masking. Superdisintegrants such as sodium starch glycolate and croscarmellose sodium are typically employed to facilitate quick disintegration, while effervescent agents may be incorporated to further enhance dissolution (Reddy & Ghosh, 2005). Taste-masking agents and flavors are also important to improve patient acceptance, particularly among pediatric and geriatric populations, who may be sensitive to unpleasant tastes (Santos & Araujo, 2016).

The formulation process needs to ensure that the tablet maintains adequate mechanical strength to withstand handling during packaging and transportation, while still providing rapid disintegration and effective drug release. Moreover, the stability of the active ingredient, metoclopramide, must be preserved throughout the shelf life of the product, which requires the careful selection of excipients that do not compromise its stability or bioavailability (Iyer & Shinde, 2018).

This research paper aims to explore the formulation and characterization of metoclopramide fast-dissolving tablets, focusing on the selection of excipients, formulation strategies, and the evaluation of key tablet characteristics such as disintegration time, dissolution rate, mechanical strength, and bioavailability. Additionally, the study will investigate the efficacy of these formulations in providing rapid relief of nausea and vomiting, comparing them to conventional oral dosage forms of metoclopramide (Patel & Shah, 2011).

MATERIALS AND METHODS

Materials

The materials used for the preparation of fast-dissolving metoclopramide tablets include metoclopramide (Pharmaceutical Industry), sodium starch glycolate and croscarmellose sodium (Loba Chemie), disodium hydrogen phosphate and dipotassium hydrogen orthophosphate (S.D. Fine Chem.), methanol**,** ethanol**,** and chloroform (Qualigens Fine Chemicals), magnesium stearate (Jiangsu Huaxi), talc**,** lactose (Loba Chemie), and citric acid (Qualigens). These materials facilitate the tablet's formulation, disintegration, and dissolution.

Methods

Preparation of tablets of Metoclopramide

Fast dissolving tablets of Metoclopramide (10mg) were prepared by direct compression method after incorporating different superdisintegrants such as, croscarmellose sodium (Ac-Di-Sol) 10, 15, and 20 mg, Crospovidone and crospovidone in different concentrations 10, 15, and 20 mg for optimization of best formulation (Dobetti, 2001). The ingredients given below were weighed and mixed in geometric progression in a dry and clean mortar. Then the ingredients were passed through mesh 60.

Magnesium stearate (6mg) as lubricant and talc (5 mg) as glidant and Microcrystalline cellulose as bulking agent (109, 99, 89, 109, 99 and 89mg) were added in a final step and mixed, this blend was subjected to analysis of pre-compression parameters which included Angle of repose, Bulk density, Tap density, Carr's index and Hausner's ratio. The Blend was compressed on 8 mm (diameter) fat punches on a 'Rimek mini press 16 station rotary compression machine. Six formulations of Metoclopramide granules were prepared and each formulation contained one of the three disintegrant in different concentration. Each tablet weighing 150 mg was obtained. Composition of tablets is mentioned in Table no. 1.

Evaluation of Precompression Parameter

Angle of repose (θ): The frictional forces in a loose powder or granules can be measured by the angle of repose. This is the maximum angle possible between the surface of a pile of powder or granules and the horizontal plane.

$$\tan \theta = h/r$$

$$\theta = \tan^{-1} (h/r)$$

Where, θ is the angle of repose, h is the height, r is the radius.

The granules were allowed to flow through the funnel fixed to a stand at definit height. The angle of repose was then calculated by measuring the height and radius of the heap of granules formed.

Bulk density: Both loose bulk density (LBD) and tapped bulk density (TBD) were determined. Accurately weighed amount of granules taken in a 50 ml capacity measuring cylinder was tapped for 100 times on a plane hard wooden surface and estimated the LBD and TBD, calculated by using following formula:

$$\text{LBD (Loose Bulk Density)} = \frac{\text{Mass of Powder}}{\text{Volume of Packing}}$$

$$\text{TBD (Tapped Bulk Density)} = \frac{\text{Mass of Powder}}{\text{Tapped Volume of Packing}}$$

Carr's index: Percent compressibility of powder mix was determined by Carr's compressibility index, calculated by using following formula (Carr *et al.,* 1965):-

$$\text{Carr's Index \%} = \frac{\text{TBD} - \text{LBD}}{\text{TBD}} \times 100$$

Hausners ratio: It is determined by comparing tapped density to the bulk density by using following equation:-

Housner's ratio = Tapped bulk density/loose Bulk density

Hausner's ratio value <1.25 shows better flow properties

Evaluation of post compression parameter

Shape and colour of tablets

Uncoated tablets were examined under a lens for the shape of the tablet and colour was observed by keeping the tablets in light (Kuchekar *et al.,* 2003).

Thickness test

Three tablets were picked from each formulation randomly and thickness was measured individually. It is expressed in mm and standard deviation was also calculated (Battu *et al.,* 2007). The tablet thickness was measured using dial-caliper (Mitutoyo, Japan).

Weight variation test

Twenty tablets were selected randomly from each formulation and average weight was determined. The tablets were weighed individually and compared with average

weight. The U.S Pharmacopoeia allows a little variation in the weight of a tablet (Gohel *et al.,* 2004). The following percentage deviation in weight variation is allowed.

Hardness test

The hardness of tablet was measured by Pfizer hardness tester and results were expressed in Kg/cm^2.

Friability test

For this, 20 tablets were taken from each formulation and the friability was determined using Roche friabilator (Bi Y *et al.,* 1996). The equipment was run for 4min at 25 revolutions per minute. The tablets were taken out, dedusted and reweighted and % friability was calculated. The friability was determined as the mass loss in percent according to Equation:-

$$\%\text{Friability} = (\text{Loss in weight}/\text{Initial weight}) \times 100$$

The test complies if tablets not loss more than 1% of their weight.

Uniformity of drug content

The test is mandatory for tablets with 10 mg or less weight of active ingredient. Ten randomly selected tablets from each formulation (F1 to F6) were finely powdered and Drug equivalent to 10 mg of drug dissolved in 10 ml phosphate buffer pH 6.8) sonicate it for 20 minutes, till the entire drug leached out from complex, then the solution was filtered through whatman filter paper No. 41. From this Solution take 1 ml and diluted up to 100 ml with 0.1 N HCl and the drug content was determined spectrophotometrically at 270 nm (Bhupendra and Satish, 2010).

Dissolution rate studies

The prepared tablets were evaluated for *in vitro* drug release. The drug release studies were carried out using USP XXII paddle type Dissolution test apparatus. The dissolution study was carried out in 900 ml dissolution medium which was stirred at 75 rpm maintained at 37±0.2°C. The scheme of using the simulated fluids at different timing was as follows: A tablet placed in dissolution media (900 ml) at 37±0.2°C. Samples were withdrawn at different time interval and compensated with same amount of fresh dissolution medium. Volume of sample withdrawn was made up to 10ml 0.1 N HCl. The samples withdrawn were assayed spectrophotometrically at 270 nm using UV visible spectrophotometer (Suresh *et al.,* 2011).

RESULTS AND DISCUSSION

The results of the pre-compression parameters (Table 2) show that the formulations (F1 to F6) exhibit acceptable bulk density characteristics. The loose bulk density values range from 0.345 to 0.382 g/ml, indicating good flow properties of the powder before compression. Tapped bulk density values range from 0.448 to 0.485 g/ml, which suggests that the powders have a reasonable packing ability. Carr's Index, a measure of powder flowability, varies from 18.55% to 25.36%, with most formulations showing values in the range of good to fair flow (below 30%). The Hausner's ratio also indicates the powders have good flow characteristics, with values between 1.228 and 1.340, which are typical for well-compressible powders.

The post-compression parameters (Table 3) indicate that the tablets exhibit satisfactory mechanical strength and other characteristics. The hardness of all formulations (F1 to F6) is between 3.1 to 3.4 kg/cm^2, which is suitable for fast-dissolving tablets, ensuring the tablets

are neither too hard nor too friable. The friability values are low (ranging from 0.558% to 0.842%), suggesting that the tablets will withstand mechanical stress during handling and transportation. The weight variation across all formulations is consistent, with values between 148 ± 4 mg and 153 ± 3 mg, indicating uniformity in the tablet weight. Thickness values are also consistent (around 1.25-1.32 mm), confirming good uniformity in tablet size. The drug content in all formulations is within acceptable limits, with values ranging from 97.15% to 99.85%, ensuring that the tablets contain the appropriate amount of metoclopramide.

The disintegration time (Table 4) for all formulations shows a quick dissolution profile, with the fastest disintegration observed in formulation F3 (65 ± 4 seconds), indicating that this formulation has the best potential for rapid onset of action. The disintegration times for all formulations are within the typical range for fast-dissolving tablets, with F1 having the longest disintegration time (96 ± 3 seconds) and F3 the shortest (65 ± 4 seconds). The optimal disintegration time is crucial for ensuring rapid drug absorption and onset of therapeutic action in the treatment of nausea and vomiting. The in-vitro drug release data for formulation F3 (Table 5) demonstrates a nearly complete release of metoclopramide. The cumulative percentage of drug release at 1 minute is 48.85%, increasing to 98.74% by 15 minutes, indicating a rapid and nearly complete release of the drug. The square root of time and log time values support the dissolution process, with a log cumulative % drug release reaching 1.994 at 15 minutes, and the log cumulative % drug remaining dropping to 0.100, indicating that nearly all the drug is released within a short period.

Finally, the regression analysis (Table 6) shows that the release kinetics of formulation F3 follow a Higuchi model (r^2 = 0.982), which is indicative of a diffusion-controlled release mechanism. The zero-order (r^2 = 0.972) and first-order (r^2 = 0.929) models also demonstrate a good fit, but the Higuchi model is the most appropriate for this formulation, suggesting that the drug release is governed primarily by the diffusion of metoclopramide from the tablet matrix.

Table 1: Composition of Metoclopramide mouth dissolving tablets

Ingredients (mg)	Formulation code					
	F1	**F2**	**F3**	**F4**	**F5**	**F6**
Metoclopramide	10	10	10	10	10	10
Sodium Starch glycolate	10	15	20	-	-	-
Crospovidone	10	15	20	10	15	20
Croscarmellose sodium	-	-		10	15	20
Microcrystalline cellulose	109	99	89	109	99	89
Talc	5	5	5	5	5	5
Magnesium stearate	6	6	6	6	6	6
Total weight	150	150	150	150	150	150

Table 2: Results of pre-compression parameters of Metoclopramide

Formulation code	Parameters			
	Loose Bulk density(gm/ml)	Tapped bulk density(gm/ml)	Carr's Index (%)	Hausner's Ratio
F1	0.345	0.448	22.99	1.299
F2	0.365	0.475	23.16	1.301
F3	0.358	0.463	22.68	1.293
F4	0.362	0.485	25.36	1.340
F5	0.382	0.469	18.55	1.228
F6	0.365	0.478	23.64	1.310

Table 3: Results of post-compression parameters of all formulations

F. Code	Hardness test (kg/cm^2)	Friability (%)	Weight variation (%)	Thickness (mm)	Drug content (%)
F1	3.3±0.2	0.558±0.025	148±4	1.25±0.12	97.15±0.25
F2	3.2±0.1	0.812±0.023	150±3	1.32±0.14	98.45±0.15
F3	3.4±0.2	0.775±0.014	152±2	1.29±0.23	99.85±0.32
F4	3.1±0.2	0.689±0.025	150±4	1.25±0.14	97.65±0.17
F5	3.3±0.1	0.842±0.014	153±3	1.31±0.15	98.65±0.26
F6	3.3±0.4	0.785±0.012	149±2	1.28±0.23	97.56±0.32

Table 4: Results of disintegration time parameters of all formulations

Formulation code	Disintegration time (Sec.) Mean ± SD
F1	96±3
F2	81±2
F3	65±4
F4	84±5
F5	75±3
F6	70±2

***Average of three determinations (n=3)**

Table 5: *In-vitro* drug release data for optimized formulation F3

Time (min)	Square Root of Time(h)$^{1/2}$	Log Time	Cumulative*% Drug Release	Log Cumulative % Drug Release	Cumulative % Drug Remaining	Log Cumulative % Drug Remaining
1	1	0	48.85	1.689	51.15	1.709
5	2.24	0.698	65.58	1.817	34.42	1.537
10	3.16	1	88.98	1.949	11.02	1.042
15	3.87	1.176	98.74	1.994	1.26	0.100

Table 6: Regression analysis data

Batch	Zero Order	First Order	Higuchi
	r^2		
F3	0.972	0.929	0.982

CONCLUSION

In conclusion, the formulation F3 demonstrates excellent characteristics for fast-dissolving tablets, including rapid disintegration, optimal drug release, and adherence to quality control parameters. These results suggest that F3 is the most suitable formulation for further development and clinical use, offering a rapid onset of action and improved patient compliance in the treatment of nausea and vomiting associated with various conditions.

DECLARATION OF INTEREST

The authors declare no conflicts of interests. The authors alone are responsible for the content and writing of this article.

REFERENCES

- Ali, J. & Hassan, A. (2012) Development and evaluation of fast dissolving tablets of metoclopramide hydrochloride. *International Journal of Pharmaceutics*, 429, 162–171.
- Battu, S.K., Repka, M.A., Majumdar, S. & Rao, M.Y. (2007) Formulation and evaluation of rapidly disintegrating tablet fenoverine tablets: Effect of superdisintegrants. *Drug Development and Industrial Pharmacy*, 33, 1225–1232.
- Bhupendra, G.P. & Satish, N.P. (2010) Formulation, evaluation and optimization of orally disintegrating tablet of cinnarizine. *Journal of Science and Technology*, 5, 9–21.
- Bi, Y., Sunada, H., Yonezawa, Y., Danjo, K., Otsuka, A. & Iida, K. (1996) Preparation and evaluation of a compressed tablet rapidly disintegrating in the oral cavity. *Chemical & Pharmaceutical Bulletin*, 44, 2121–2127.
- Gohel, M., Patel, M., Amin, A., Agrawal, R., Dave, R. & Bariya, N. (2004) Formulation design and optimization of mouth dissolve tablets of nimesulide using vacuum drying technique. *AAPS PharmSciTech*, 5, e36.
- Iyer, P.P. & Shinde, V. (2018) A novel approach to the formulation of metoclopramide fast-dissolving tablets for improved patient compliance. *Asian Journal of Pharmaceutical Sciences*, 13, 344–352.
- Kuchekar, B.S., Atul Badhan, C. & Mahajan, H.S. (2003) Mouth dissolving tablets: A Novel drug delivery system. *Pharma Times*, 35, 7–9.
- Panda, S. & Mishra, S.K. (2014) Fast dissolving tablets: A review. *International Journal of Pharmaceutical Sciences and Research*, 5, 3561–3568.
- Patel, M.A. & Shah, R.P. (2011) Formulation and evaluation of fast dissolving tablets of metoclopramide hydrochloride. *Journal of Young Pharmacists*, 3, 324–329.

- Reddy, L.H. & Ghosh, B. (2005) Fast-dissolving drug delivery systems: A review. *Drug Development and Industrial Pharmacy*, 31, 345–358.
- Santos, R.M. & Araújo, P.A. (2016) Formulation of fast dissolving tablets of metoclopramide: A comparative study. *Pharmaceutical Development and Technology*, 21, 753–760.
- Suresh, S., Senthil, A. & Manikandan, C. (2011) Formulation and evaluation of mouth dissolving tablets of amlodipine besylate. *International Research Journal of Pharmacy*, 2, 161–165.
- Verma, P. & Soni, S. (2017) A review on formulation techniques for fast dissolving tablets. *Journal of Pharmaceutical Sciences and Research*, 9, 936–943.