INTERNATIONAL JOURNAL OF RESEARCH CULTURE SOCIETY
Monthly Peer-Reviewed, Refereed, Indexed Journal
Volume - 8, Issue - 7, July - 2024

ISSN(O): 2456-6683
[Impact Factor: 9.241]

IJRCS

DOIs:10.2017/IJRCS/202407011 --:-- Research Paper / Article / Review

In Vitro Dissolution Profile of Fenoverine Floating Tablets: Formulation Strategies and Performance

[1]Husna Afreen, [2]Mohammed Arsalan Sarmad

[1] B. Pharm, Azad college of Pharmacy, Moinabad, Telangana, India.
[2]Asst. Professor, Azad college of Pharmacy, Moinabad, Telangana, India.
Email – [1]husnaafreen789@gmail.com, [2]sarmadxlnc@gmail.com

Abstract: *The primary objective of the research was to formulate Fenoverine floating tablets (DFT) using a non-effervescent technique with various polymers through direct compression. Prior to compression, the powdered mixture underwent evaluation for pre-compression parameters. Compatibility among the formulation components was examined using FTIR studies, which confirmed no interaction between the drug and the polymers employed. The prepared Fenoverine floating tablets were subjected to assessment for post-compression parameters, swelling index, floating lag time, in vitro buoyancy, and drug release characteristics. The optimized formulation (F3) consistently floated in the stomach of rabbits, indicating an extended gastric retention time exceeding 8 hours. Consequently, the study's findings demonstrate that the developed Fenoverine floating tablets could be effectively utilized as a floating drug delivery system.*

Keywords: *Fenoverine, polymers, sodium bicarbonate, citric acid, Fourier Transform Infrared (FTIR) studies, direct compression method, in vitro dissolution studies.*

1. INTRODUCTION :

Oral drug administration has long been the preferred method of delivering medications. In recent decades, significant advancements in oral delivery systems have aimed to release drugs steadily over time, similar to intravenous infusions, to maintain consistent plasma levels once equilibrium is achieved. Despite advances, variability in drug absorption remains a challenge due to physiological factors like gastric residence time, impacting transit times in the gastrointestinal tract.

Developments in gastrointestinal retention technologies, such as floating, rafting, and bioadhesive systems, aim to enhance drug delivery to specific regions like the small intestine, improving bioavailability and efficacy. Modified release oral drug delivery systems, including delayed, extended, and programmed release, offer benefits such as reduced dosing frequency and improved therapeutic outcomes by maintaining steady drug levels.

However, challenges persist, including the variability of gastric emptying times and the need to optimize drug absorption throughout the gastrointestinal tract. Gastrointestinal retention systems show promise in overcoming these challenges by prolonging contact between drugs and mucosal surfaces, potentially enhancing bioavailability and patient compliance.

Absorption window

Absorption in the gastrointestinal (GI) tract is influenced by its diverse environment, including anatomical structures, physiological processes, and the composition of its fluids. These factors collectively affect the permeability of drug molecules, leading to variations known as the absorption window. This term refers to the phenomenon where drugs are selectively absorbed from specific regions of the GI tract.

ISSN(O): 2456-6683
[Impact Factor: 9.241]

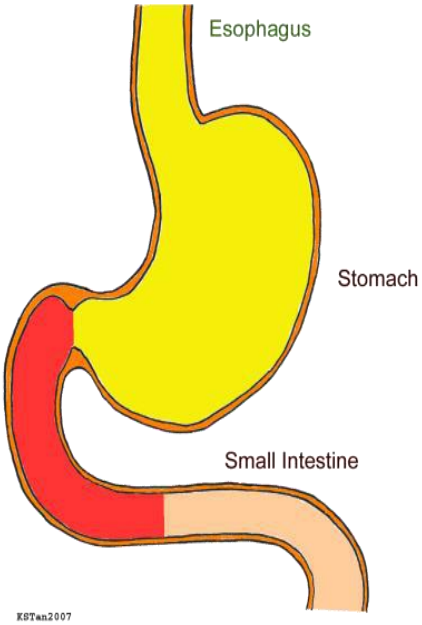

Fig-1: anatomy of stomach

Factors Influencing Gastric Retention

1. **Density** – Gastric retention time (GRT) depends on the buoyancy of the dosage form, which is determined by its density.
2. **Size** – Dosage forms larger than 7.5 mm in diameter have longer GRT compared to those under 7.5 mm.
3. **Shape** – Tetrahedral and ring-shaped devices with specific flexural moduli have shown excellent retention rates of 90% to 100% at 24 hours compared to other shapes.
4. **Single vs. multiple units** – Multiple-unit formulations offer more predictable release profiles and are less affected by unit failure, allowing co-administration of units with different release profiles or incompatible substances.
5. **Fed vs. unfed state** – Gastric motility during fasting, characterized by the migrating myoelectric complex (MMC) every 1.5 to 2 hours, results in shorter GRT if dosage form administration coincides with MMC. In the fed state, MMC delay prolongs GRT significantly.
6. **Nature of meal** – Meals containing indigestible polymers or fatty acids delay gastric emptying, prolonging drug release.
7. **Caloric content** – High-protein and high-fat meals can increase GRT by 4 to 10 hours.
8. Meal frequency – Successive meals can extend GRT by more than 400 minutes due to reduced MMC frequency.
9. **Gender** – Males generally have shorter ambulatory GRT (3.4±0.6 hours) compared to females (4.6±1.2 hours), independent of other factors.
10. **Age** – Elderly individuals, especially those over 70, experience longer GRT.
11. **Posture** – GRT can vary between supine and upright positions.
12. **Concomitant drugs** – Drugs affecting gastric motility, such as anticholinergics, opioids, and prokinetic agents, influence floating time.
13. **Biological factors** – Conditions like diabetes and Crohn's disease can affect GRT.

These factors collectively influence the performance of orally administered drug delivery systems, emphasizing the importance of developing systems that maintain extended gastric residence and consistent drug release profiles across varying patient conditions.

ISSN(O): 2456-6683
[Impact Factor: 9.241]

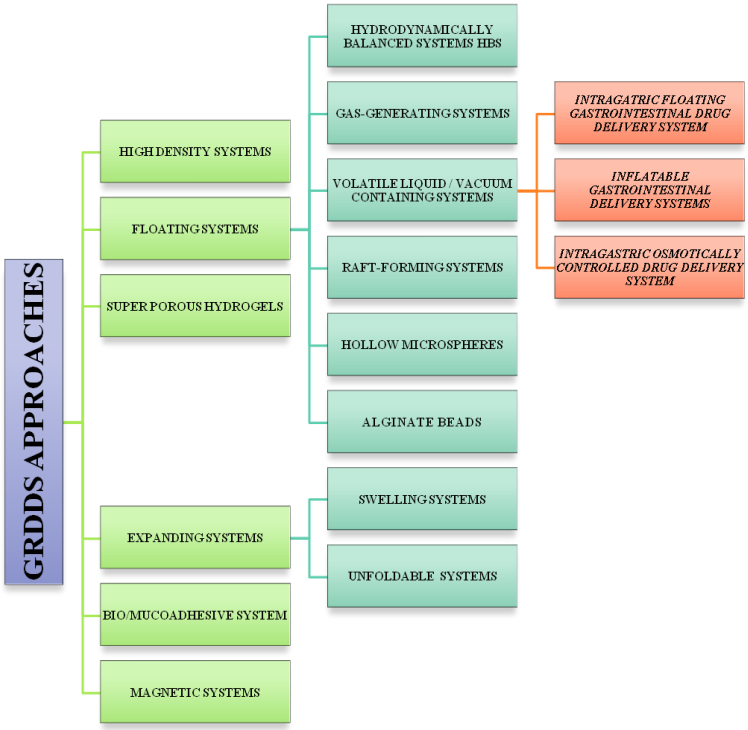

Fig-2: GRDDS Approaches

High Density Systems:

High-density pellets, which sink to the bottom of the stomach due to their density close to 2.5 g/cm³, get trapped in the folds of the antrum and resist stomach peristalsis. Examples of excipients used include barium sulfate, zinc oxide, iron powder, and titanium dioxide.

Floating Systems:

Floating systems have a bulk density lower than gastric contents, allowing them to remain buoyant in the stomach for an extended period. This category includes hydrodynamically balanced systems (HBS™), gas-generating systems, volatile liquid/vacuum-containing systems, raft-forming systems, hollow microspheres, and alginate beads. These systems offer potential for sustained drug release.

Hydrodynamically Balanced Systems (HBS):

These systems incorporate high levels (20-75% w/w) of gel-forming hydrocolloids such as hydroxyethylcellulose, hydroxypropylcellulose, HPMC, and sodium CMC into the formulation. The granules are then compressed into tablets or encapsulated in capsules. The hydrocolloids form a colloidal gel barrier around the surface, controlling the rate of solvent penetration and drug release while maintaining a bulk density less than 1.

Gas Generating Systems:

Incorporate carbonates or bicarbonates that react with gastric acid or other acids (e.g., citric or tartaric) to produce CO2, reducing the density of the system and allowing it to float on gastric media. Alternatively, these systems may contain matrices with portions of liquid that produce gas, which evaporates at body temperature.

Raft Forming Systems:

Used for delivering antacids and treating gastrointestinal disorders. These systems form a viscous cohesive gel upon contact with gastric fluids, swelling to form a continuous layer (raft). The low bulk density created by CO2 formation allows the raft to float in gastric fluids.

Hollow Microspheres/Microballoons:

These microballoons, loaded with drug in their polymeric shell, are prepared by solvent evaporation or diffusion. Common polymers used include polycarbonates, cellulose acetate, calcium alginate, Eudragit S, agar, and low methoxylated pectin. Buoyancy and drug release depend on polymer quantity, plasticizer-polymer ratio, and solvent used.

Alginate Beads:

Multi-unit floating dosage forms prepared using calcium and low methoxylated pectin or sodium alginate. Spherical beads, 2.5 mm in diameter, are formed by dropping a sodium alginate solution into a calcium chloride solution to precipitate calcium alginate, maintaining a porous system. Freeze-dried at -40°C for 24 hours.

Volatile Liquid/Vacuum Containing Systems:

a. Inflatable Gastrointestinal Delivery: Contains an inflatable chamber with liquid ether that gasifies at body temperature, causing the chamber to inflate in the stomach. The chamber is loaded with a drug reservoir, typically a drug-impregnated polymeric system encapsulated in a gelatin capsule.

b. Intragastric Osmotically Controlled Drug Delivery System: Combines an osmotically active compartment with an inflatable floating support in a biodegradable capsule. Upon stomach entry, the capsule disintegrates, releasing the osmotically controlled drug delivery device. The inflatable support contains liquid that gasifies to inflate the polymeric bag.

Superporous Hydrogels:

These swellable agents have pore sizes ranging from 10 nm to 10 µm. They rapidly swell upon contact with water due to capillary wetting through interconnected open pores. Designed to withstand gastric contractions, they incorporate hydrophilic particulate materials like Ac-Di-Sol (crosscarmellose) to achieve mechanical strength and rapid swelling to a large size.

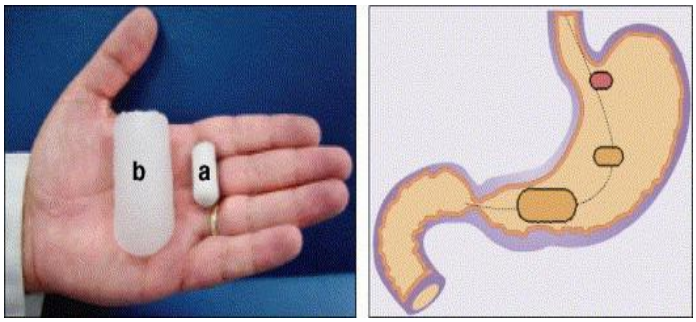

Fig-:3 On the left, superporous hydrogel in its dry (a) and water-swollen (b) state. On the right, schematic illustration of the transit of superporous hydrogel. From Gutierrez-Rocca, (2003).

Expandable Systems:

Expandable systems come in two types: unfoldable and swellable. Unfoldable systems utilize biodegradable polymers within carriers like capsules. Caldwell et al. introduced various geometric shapes (e.g., tetrahedron, ring, planar membrane) compressed within capsules.

Swellable systems rely on their mechanical properties and swell due to osmotic water absorption. As the drug and expanding agent deplete or the polymer erodes, the device decreases in volume and rigidity, facilitating its elimination.

Mucoadhesive Systems:

Mucoadhesion allows a dosage form to adhere to mucosal surfaces through hydration-mediated, bonding-mediated, or receptor-mediated mechanisms. Common materials for bioadhesion include poly(acrylic acid) (Carbopol®, polycarbophil), chitosan, Gantrez® (polymethyl vinyl ether/maleic anhydride copolymers), cholestyramine, tragacanth, and sodium alginate

Magnetic Systems:

These systems incorporate a small internal magnet within the dosage form. Placing an external magnet on the abdomen over the stomach enhances gastric retention time (GRT).

Floating Drug Delivery System (FDDS):

FDDS aims to retain dosage forms in gastric fluid to achieve controlled drug delivery. Unlike conventional oral dosage forms, which quickly enter systemic circulation, FDDS prolongs gastric retention.

Approaches to Design Floating Dosage Forms:

Various approaches exist for designing floating dosage forms, categorized into effervescent and non-effervescent systems:

1. Effervescent Floating Dosage Forms:

Prepared using swellable polymers (e.g., methylcellulose, chitosan) and effervescent compounds (e.g., sodium bicarbonate, tartaric acid, citric acid). Interaction with gastric acid releases carbon dioxide, which entraps within swollen hydrocolloids, providing buoyancy.

2. Non-effervescent Floating Dosage Forms:

Utilize gel-forming or swellable polymers (e.g., cellulose derivatives, polysaccharides, polycarbonates, polyacrylates). Upon contact with gastric fluids, these polymers swell to achieve a bulk density <1. Air trapped within the swollen matrix imparts buoyancy, facilitating sustained drug release through the gel-like structure.

2. MATERIAL AND EQUIPMENTS :

Excipient details

Table-1: List of excipients

S.no	Drug/excipients	Name of supplier
1	Fenoverine	Hetero labs, Hyd
2	HPMC	Synpharma Research Labs, HYD
3	Ethyl cellulose	Synpharma Research Labs, HYD
4	Citric acid	Synpharma Research Labs, HYD
5	Microcrystalline cellulose	Synpharma Research Labs, HYD
6	Sodium bi carbonate	Synpharma Research Labs, HYD
7	Magnesium stearate	Synpharma Research Labs, HYD
8	Talc	Synpharma Research Labs, HYD

Instruments details

Table-2: List of instruments

S. No	Equipment Name	Source
1	Digital weighing machine	Shimadzu aty 244
2	Tablet compression machine	Karnavathi mini press-II
3	Pfizer hardness tester	Cintex ind. Corporation, Mumbai
4	Friability tester	Electrolab pvt ltd. India
5	USP dissolution apparatus	Lab India DS 8000
6	Disintegration apparatus	Electrolab pvt ltd. India
7	Uv-visible double beam spectrophotometer	Lab India double beam spectrophotometer

3. METHODOLOGY:

Pre-formulation Studies:

Before formulation, the drug's color, odor, taste, and appearance were assessed using descriptive methods. The drug's melting point was determined using a capillary method in a melting point apparatus. Solubility was evaluated by adding excess drug to a solvent, determining equilibrium solubility using a Lab India double-beam spectrophotometer, and calculating solubility as a percentage.

UV-Visible Spectroscopy:

A calibration curve was constructed for Fenoverine using UV-visible spectroscopy. A stock solution of 10 mg Fenoverine was prepared in a 100 ml volumetric flask with methanol and 0.1N HCl. From this, solutions of 100 µg/ml and 10 µg/ml concentrations were prepared and scanned from 200-400 nm for λmax.

FT-IR Study:

FT-IR spectral analysis was conducted to assess compatibility between Fenoverine and excipients. This study aimed to detect any changes in the chemical composition of the drug after combining it with excipients.

Formulation Development:

Tablets containing Fenoverine were formulated in various compositions (F1 to F4) using synthetic polymers and excipients via direct compression method. Powders were sieved, mixed uniformly, and compressed into tablets using specified pressures to achieve desired hardness and weight.

Tablet Evaluation:

Physical Appearance:

Tablets were visually inspected for appearance, size, shape, color, and absence of odor or taste discrepancies to ensure consumer acceptance and uniformity.

Size & Shape:
Tablet dimensions, particularly thickness, were measured and controlled to within ±5% of the standard value using suitable devices.

Weight Variation Test:
Twenty tablets were individually weighed, and their average weight calculated. Tablet weights were compared to the average; not more than two tablets should differ significantly from the average weight.

Content Uniformity:
Thirty tablets were randomly selected, and ten were assayed individually. Tablets passed if nine out of ten contained between 85% to 115% of the labeled drug content, with the tenth tablet falling within 75% to 125%. If failed, remaining tablets were individually assayed.

Friability:
Tablets were subjected to abrasion in a friabilator. Percentage friability, indicating weight loss due to abrasion, was calculated using the formula (% friability = (W1 - W2) / W1 × 100), with a maximum acceptable loss of 1%.

Floating Lag Time:
The time for tablets to rise to the top third of the dissolution vessel after immersion in 0.1N HCl at 37°C was recorded as floating lag time. Floating time was also noted.

Drug Release Studies:
Release of Fenoverine from tablets was studied using USP-II (paddle) apparatus in 0.1N HCl at 50 rpm and 37°C. Samples were withdrawn at intervals, diluted, and analyzed using UV spectrophotometry.

Stability Studies:
Fenoverine tablets underwent stability testing for 90 days under defined conditions (ambient, 40±2°C, 2-8°C). Stability assessments aimed to ensure product safety, efficacy, and shelf-life maintenance.

4. RESULTS AND DISCUSSION:

In this study, four formulations containing different concentrations of polymer were prepared and assessed for physical and chemical properties, in vitro release characteristics, and stability.

Preformulation studies included:

a) Evaluating the sensory characteristics of the drug

Table-3: Organoleptic properties of Fenoverine

Properties	Results
Description	Powder
Taste	tasteless
Odour	odourless
Colour	white crystalline powder

b) Melting Point Determination
The melting point of Fenoverine was measured within the range of 141-142°C, confirming its purity as per standard specifications

c) Solubility of Fenoverine
Fenoverine demonstrated slight solubility in water and was practically insoluble in ethanol (96%). However, it exhibited high solubility in 1 M hydrochloric acid.

Standard Calibration Curve of Fenoverine in 0.1 N HCl
To establish the standard calibration curve of Fenoverine, 0.1 N HCl was used as the solvent medium. Fenoverine showed maximum absorbance at 242 nm. Various concentrations ranging from 10 µg/ml to 18 µg/ml were prepared, and their absorbance was measured using a UV-spectrophotometer at 278 nm. The resulting standard graph depicted absorbance on the Y-axis against concentrations on the X-axis.

Table-4: Calibration curve of Fenoverine

S. no	Concentration (µg/ml)	Absorbance
1	0	0
2	10	0.49
3	12	0.56

ISSN(O): 2456-6683
[Impact Factor: 9.241]

4	14	0.68
5	16	0.73
6	18	0.85

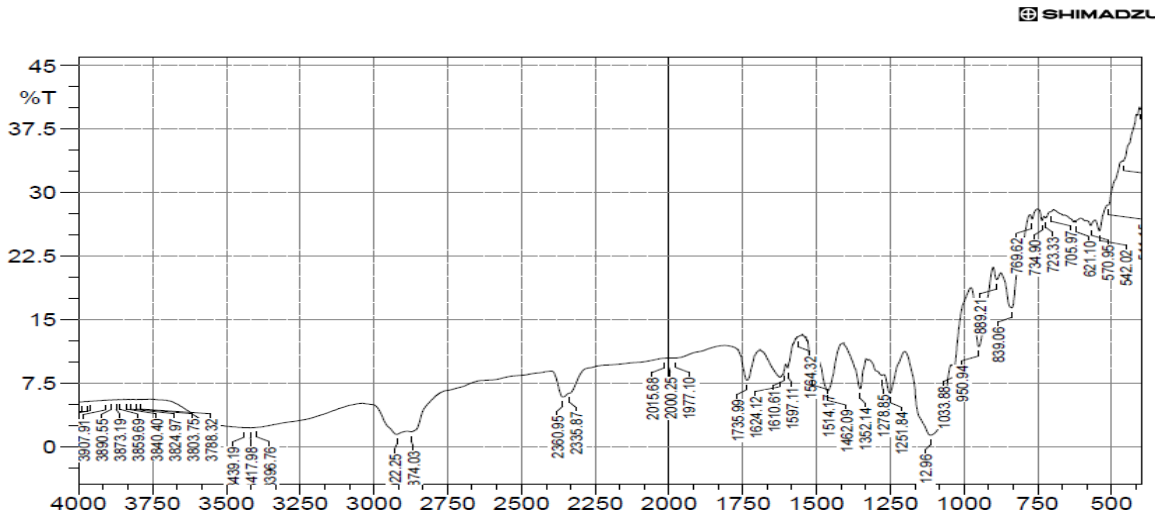

Fig-4: Calibration curve of Fenoverine

FT-IR Spectrum of Fenoverine

The FT-IR spectra of Fenoverine and the F3 formulation were analyzed. The peaks observed in both the formulation and physical mixture indicated no chemical interaction between Fenoverine and the polymer. This analysis also confirmed the stability of the drug during the microencapsulation process.

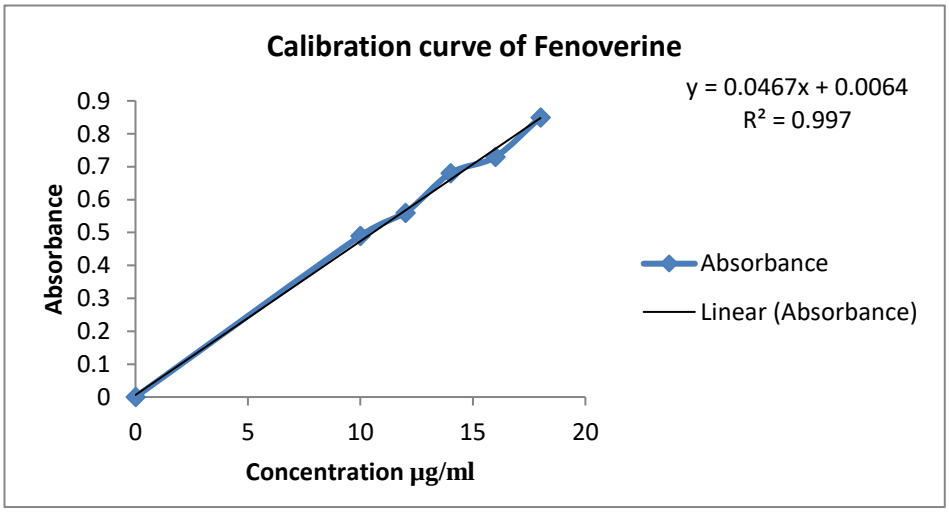

Fig-5: FT-IR Sample for Fenoverine

Table-5: Characteristic Peaks and frequency of Fenoverine

S. No.	Characteristic Peaks	Frequency range (cm-1)	Frequency (cm-1)
1	OH stretching	4000-3750	3824.27cm-1
2	OH Bending	3500-3000	3396.35 cm-1
3	C-H stretching	2500-2000	2335.68 cm-1
4	C-N stretching	1500-1000	1462.09 cm-1

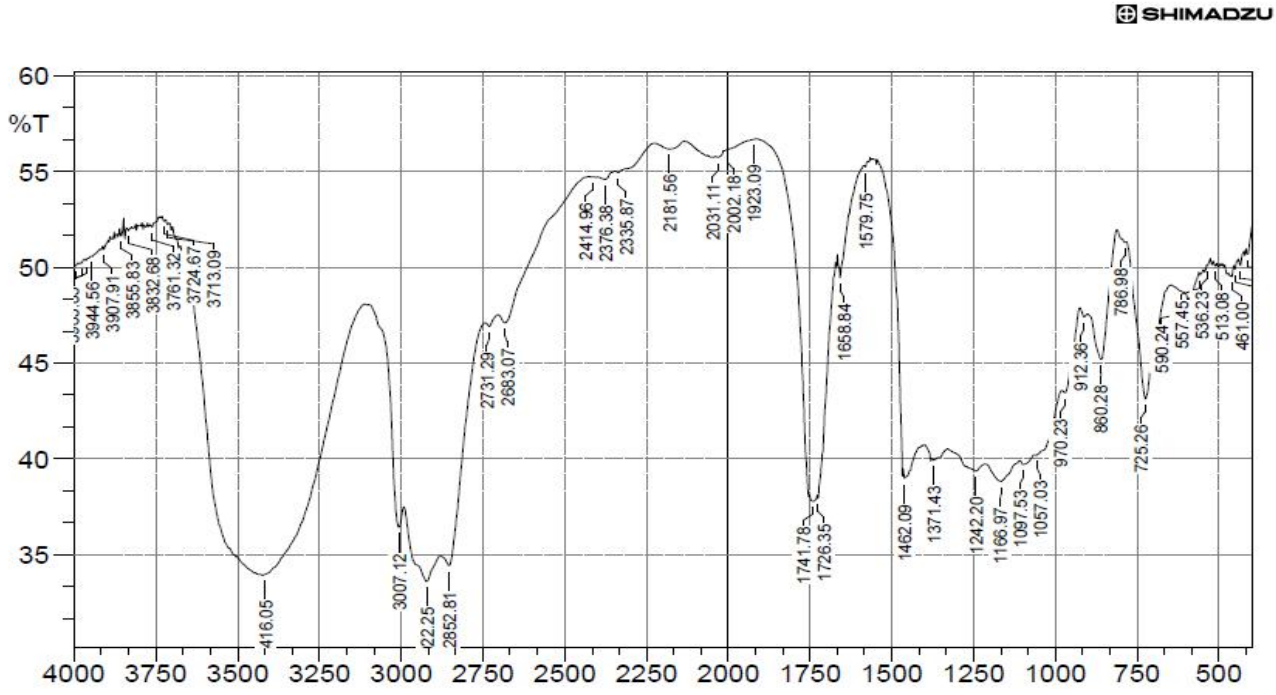

Fig-6: FT-IR Sample for physical mixture of drug and excipients

Table-6: Characteristic Peaks and frequency of physical mixture of drug and excipients

S.No.	Characteristic Peaks	Frequency range (cm-1)	Frequency (cm-1)
1	OH stretching	4000-3750	3907.91cm-1
2	OH Bending	3500-3000	3416.05 cm-1
3	C-N stretching	2500-2000	2376.38 cm-1
4	C-H stretching	1500-1000	1242.20 cm-1

The IR spectra of the drug and the drug-excipient mixture were presented. The study concluded that there was no chemical interaction between the drug and the polymers employed. Analysis of the spectra indicated no alterations in the major peaks of the drug-polymer mixture, suggesting the absence of physical interactions or bond formations between them. This reaffirms the purity of the drug and its compatibility with the excipients used.

Evaluation of Preformulation parameters

Table-7: Evaluation parameters of Fenoverine

S. no	Bulk density	Tapped density	Compressibility index	Hausner ratio	Angle of repose(0)
F1	0.493	0.589	15.62	1.20	30^0
F2	0.479	0.580	17.47	1.21	27^0
F3	0.484	0.582	16.83	1.20	30^0
F4	0.490	0.585	16.15	1.21	29^0

Evaluation of the Prepared Tablets for Physical Parameters

The tablets prepared in all formulations underwent evaluation for physical parameters including hardness, thickness, weight variation, and friability, and were found to meet the standards set by pharmacopeias. Results from these tests were documented in tabular form. The drug content in all formulations was also assessed and found to be within acceptable limits. Overall, this study confirms the quality and suitability of all the prepared formulations.

Table-8: Evaluation parameters of Fenoverine floating tablets

Parameter	F1	F2	F3	F4
Weight variation	499	500	500	500
Thickness (mm)	3.3	3.5	3.1	3.8
Hardness (kg/cm^2)	4.2	4.6	4.7	4.1
Friability	0.47	0.46	0.42	0.41
Content uniformity	79.82	80.12	82.14	81.54
Floating lag time (Sec)	52	50	48	49

Floating lag time

Floating tablets of Fenoverine were made using direct compression. Four formulations with different polymer ratios were tested for floating lag time and buoyancy. Sodium bicarbonate reacted with 0.1 N HCl to produce carbon dioxide, which was trapped within the polymer matrix, reducing tablet density and allowing it to float. The best formulation, F3, floated for 48 seconds before sinking.

Fig-7: Floating tablet

In vitro Dissolution studies

In vitro dissolution studies were conducted using USP apparatus II (Paddle) at 50 rpm in 900 ml of 0.1N HCl at 37.0 ± 0.5°C. Samples were withdrawn at specified intervals over 8 hours and analyzed spectrophotometrically at 278 nm wavelength.

Table-9: In vitro drug release of Fenoverine floating tablets

Time	F1	F2	F3	F4
0	0	0	0	0
1	15.29	16.38	17.93	15.98
2	37.80	35.48	38.96	34.75
3	43.89	45.92	47.81	45.98
4	58.97	59.51	59.52	57.84
5	63.90	65.74	66.79	68.62
6	78.54	79.85	78.95	73.71
7	82.35	84.67	86.91	84.53
8	93.68	94.18	95.36	94.10

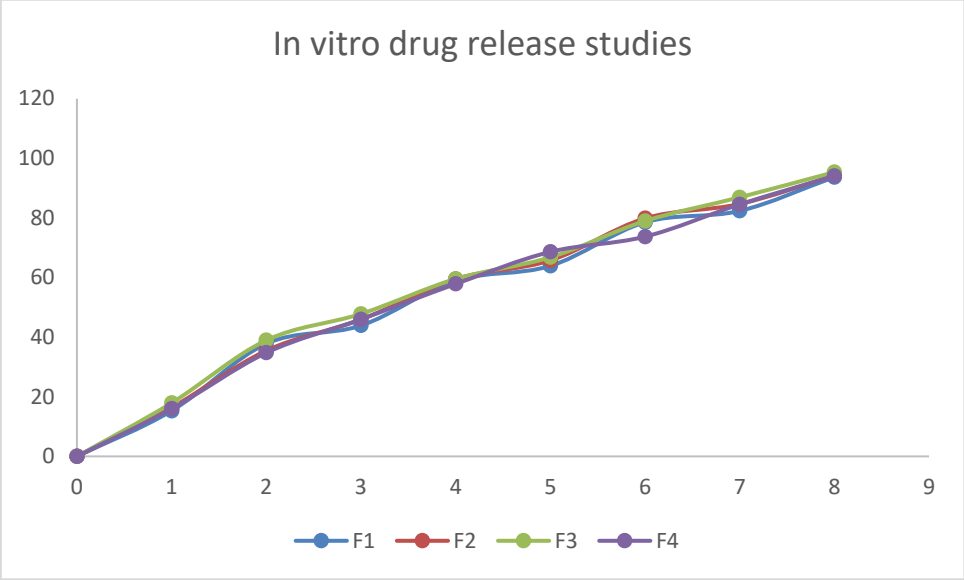

Fig-8: In vitro drug release for all the formulations

Stability test

Stability testing revealed that formulation F-3 tablets showed no notable alterations in their physical or chemical characteristics over the 90-day period. Parameters were monitored at intervals as specified. Following ICH guidelines, formulation F3 was chosen for accelerated stability studies. During these studies, a decrease in the cumulative drug release percentage from the floating tablets was observed.

Table-10: Stability study for optimized formulation

Formulation Code	Parameters	Initial	1st Month	2nd Month	3rd Month	Limits as per Specifications
F-3	**25^{0}C/60%RH % Release**	95.36	94.58	93.98	92.99	**Not less than 85 %**
F-3	**30^{0}C/75% RH % Release**	95.36	94.37	93.57	92.84	**Not less than 85 %**
F-3	**40^{0}C/75% RH % Release**	95.36	94.20	93.42	92.50	**Not less than 85 %**

5. CONCLUSION:

The aim of this study was to develop floating tablets of Fenoverine to enhance its gastrointestinal residence time, given its limited gastric retention. Various concentrations of polymer matrices were systematically studied to achieve extended drug release in the upper gastrointestinal tract. Preformulation studies were conducted to assess micromeritic properties, flowability, compressibility, and solubility, all of which yielded positive results. The formulated tablets met satisfactory criteria for physical parameters such as dimensions, hardness, friability, weight variation, buoyancy, and content uniformity.

Based on the evaluation of formulations (F1-F4), it was observed that Formulation-3 exhibited superior buoyancy and dissolution characteristics. Therefore, Formulation-3 was identified as the optimal formulation among the tested variants

REFERENCES:

1. Bagherwal A, Patidar DK, Sharma P. Formulation and evaluation of floating tablets of ciprofloxacin hydrochloride. Int J Comp Pharma 2010;1:1-4.
2. Kumar R. Development and *in-vitro* evaluation of sustained release floating matrix tablets of metformin hydrochloride. Int J Pharm Sci Res 2010;1:96-101.
3. Chodavarapu NP, Yendluri RB, Suryadevara H, Reddy P, Chhatoi P. Formulation and evaluation of abelmoschusesculentus mucilage based metformin hydrochloride floating matrix tablets. Int J Pharm Tech

2011;3:2725-45.
4. Kshirsagar RV, Jain V, Wattamwar S. Effect of different viscocity grade HPMC polymer on gastroretantive drug delivery of metformin hydrochloride. Int J Appl Pharm 2009; 1:44-50.
5. Chandiran IS, Kumar BP, Narayan V. Formulation and *in-vitro* evaluation of floating drug delivery system for salbutamol sulphate. Int J Pharm Biomed Sci 2010; 1(1):12-15.
6. Hu L, Li L, Yang X, Liu W, Yang J, Jia Y, *et al.*, Floating matrix dosage form for dextromethorphan hydrobromide based on gas forming technique. *In-vitro* and *in-vivo*evalvation healthy volunteers. Eur J Pharm Sci 2011;42:99-105.
7. Raju BD, Sreenivas R, Varma MM. Formulation and evaluation of floating drug delivery system of metformin hydrochloride. J Chem Pharm Res 2010;2(2):274-78.
8. Senthilkumar SK, Jaykar B, Kavimani S. Formulation and evaluation of gastroretentive floating drug delivery system of rabeprazole sodium. Int J Biopharm 2011;2(2):57-62.
9. Mohammed MS. Formulation and *in-vitro* evaluation of sustained release intragastric tablets of propranolol hydrochloride using natural polymer. J Pharm Biomed Sci 2011;10(10):1-10.
10. Goole J, Vanderbist F, Amighi K. Development and evaluation of new multi-unit levodopa sustained-release floating dosage forms. Ind J Pharm 2007;334:35-41.
11. Sauzet C, Bruno CM, Nicolas M, Kister J, Piccerdle P, Prinderre P. An innovative floating gastro retentive dosage system. Formulation and *in-vitro* evaluation. Int J Pharm 2009;378:23-29.
12. Abrahamsson, B., Alpsten, M., Hugosson, M., Jonsson, U.E., Sundgren, M., Svenheden, A., Tölli, J., 1993. Absorption, Gastrointestinal Transit, and Tablet Erosion of Felodipine Extended-Release (ER) Tablets. Pharm. Res. 10, 709-714.
13. Agrawal, A.M., Manek, R.V., Kolling, W.M., Neau, S.H., 2003. Studies on the interaction of water with ethylcellulose: effect of polymer particle size. AAPS Pharm. Sci. Tech. 4, E60.
14. Alvisi, V., Gasparetto, A., Dentale, A., Heras, H., Felletti-Spadazzi, A., D'Ambrosi, A., 1996. Bioavailability of a controlled release formulation of ursodeoxycholic acid in man. Drugs Exp. Clin. Res. 22, 29-33.
15. Amaral, M.H., Lobo, J.M., Ferreira, D.C., 2001. Effect of hydroxypropyl methylcellulose and hydrogenated castor oil on naproxen release from sustained-release tablets. AAPS Pharm. Sci. Tech. 2, E6.
16. Andrews, G.P., Laverty, T.P., Jones, D.S., 2009. Mucoadhesive polymeric platforms for controlled drug delivery. Eur. J. Pharm. Biopharm. 71, 505-518.
17. Atyabi, F., Sharma, H.L., Mohammad, H.A.H., Fell, J.T., 1996a. Controlled drug release from coated floating ion exchange resin beads. J. Control. Rel. 42, 25-28.
18. Atyabi, F., Sharma, H.L., Mohammad, H.A.H., Fell, J.T., 1996b. In vivo evaluation of a novel gastric retentive formulation based on ion exchange resins. J. Control. Rel. 42, 105-113.
19. Babu, V.B., Khar, R.K., 1990. In vitro and in vivo studies of sustained-release floating dosage forms containing salbutamol sulfate. Pharmazie 45, 268-270.
20. Badve, S.S., Sher, P., Korde, A., Pawar, A.P., 2007. Development of hollow/porous calcium pectinate beads for floating-pulsatile drug delivery. Eur. J. Pharm. Biopharm. 65, 85-93.
21. Bardonnet, P.L., Faivre, V., Pugh, W.J., Piffaretti, J.C., Falson, F., 2006. Gastroretentive dosage forms: Overview and special case of Helicobacter pylori. J. Control. Rel. 111, 1-18.
22. BASF, 2008. Technical Information Kollicoat® SR 30 D. BASF, Ludwighafen, Germany.
23. Bashaw, J.D.P.A., CA), Zaffaroni, Alejandro (Atherton, CA), Michaels, Alan S. (Atherton, CA), 1976. Self-monitored device for releasing agent at functional rate. ALZA Corporation (Palo Alto, CA), United States.
24. Bennett, C.E., Hardy, J.G., Wilson, C.G., 1984. The influence of posture on the gastric emptying of antacids. Int. J. Pharm. 21, 341-347.
25. Bley, O., Siepmann, J., Bodmeier, R., 2009a. Importance of glassy-to-rubbery state transitions in moisture-protective polymer coatings. Eur. J. Pharm. Biopharm. 73, 146-153.
26. Bley, O., Siepmann, J., Bodmeier, R., 2009b. Protection of moisture-sensitive drugs with aqueous polymer coatings: Importance of coating and curing conditions. Int. J. Pharm. 378, 59-65.
27. Arora S, Ali J, Ahuja A, Khar RK, Baboota S. Floating drug delivery systems: a review. AAPS PharmSciTech. 2005 Oct 19;6(3):E372-90.
28. Ms. Jyoti Rathore, formulation and evaluation of floating tablets of norfloxacin, International Journal of Pharma Sciences and Research (IJPSR), Pharm. Res. 11, 882-888.
29. Rashmitha, formulation and evaluation of fenoverine floating tablets, Asian J Pharm Clin Res, Vol 14, Issue 4, 2021, 175-180.
30. Gulam Mehmood Afzal, Formulation and Evaluation of Floating Fenoverine Tablets, Bull. Env. Pharmacol. Life Sci., Vol 12 [7] June 2023: 164-174.

31. Pahwa , Formulation and in-vitro evaluation of effervescent floating tablets of an antiulcer agent, January 2012, Journal of Chemical and Pharmaceutical Research 4(2):1066-1073.
32. K. Kavitha, International journal of pharmaceutical, chemical and biological sciences, formulation and evaluation of ranitidine floating tablets, IJPCBS 2013, 3(3), 761-766
33. Hand book of pharmaceutical excipients
34. Bolton, S.P.A., Cresskill, NJ, 07626), Izevbehai, Philip H. (169-15 89th Ave. - Apt. #2A, Jamaica, NY, 11432), Desai, Subhash (18-15 Deer Creek Dr., Plainboro, NY, 08536), 1989b. Floating sustained release therapeutic compositions, United States.
35. Bordaweka, M.S., Zia, H., Quadir, A., 2006. Evaluation of polyvinyl acetate dispersion as a sustained release polymer for tablets. Drug Deliv. 13, 121-131.
36. Bravo-Osuna, I., Vauthier, C., Farabollini, A., Palmieri, G.F., Ponchel, G., 2007. Mucoadhesion mechanism of chitosan and thiolated chitosan-poly(isobutyl cyanoacrylate) core-shell nanoparticles. Biomaterials 28, 2233-2243.
37. Brewer, M.D.N.C., GB2), Griffin, Gerald J. L. (London, GB2), 1980. Sustained release compositions. Beecham Group Limited (GB2), United States.
38. Brown, H.P., 1957. Carboxylic polymers. GOODRICH CO B F, United States.
39. Bulgarelli, E., Forni, F., Bernabei, M.T., 2000. Effect of matrix composition and process conditions on casein-gelatin beads floating properties. Int. J. Pharm. 198, 157-165.
40. Burton, S., Washington, N., Steele, R.J., Musson, R., Feely, L., 1995. Intragastric distribution of ion-exchange resins: a drug delivery system for the topical treatment of the gastric mucosa. J. Pharm. Pharmacol. 47, 901-906.
41. Ravi Kumar et al., Design and In vitro Evaluation of Oral Floating Matrix Tablets of Aceclofenac, Vol.1, No.4, pp 815-825, Oct-Dec 2009.
42. Sameer Singh et al., Formulation and Evaluation of Floating Tablet of Captopril, International Journal of PharmTech Research, Vol.3, No.1, pp 333-341.
43. Yadubansh Gupta et al., Formulation and Evaluation of Simvastatin Floating Tablets
44. Getyala et al., Formulation and evaluation of non-effervescent floating tablets of losartan potassium. Curr Drug Deliv. 2013 Oct;10(5):620-9.
45. M. Sampath Kumar et al., Formulation and in vitro Evaluation of Gastro Retentive Floating Tablets of Glipizide, International Journal of Innovative Pharmaceutical Research. 2011,2(3),151-155.
46. Carnali, J.O., Naser, M.S., 1992. The use of dilute solution viscometry to characterize the network properties of carbopolmicrogels. Colloid & Polymer Science 270, 183-193.
47. Ceballos-Baumann, A.O., Kummer, R., Eckert, W., Weicker, H., 1990. Controlled-release levodopa/benserazide (Madopar HBS): clinical observations and levodopa and dopamine plasma concentrations in fluctuating parkinsonian patients. J. Neur. 237, 24-28.