Ind. J. Pharm. Edu. Res., 2026; 60(3):1037-1045.
https://www.ijper.org

Original Article

Formulation and Evaluation of Polymeric Ornidazole Floating Microspheres: A Comprehensive Approach

Raghwendra Waghmode[1,*], Rushikesh Hingmire[2], Veerendra Yeligar[3], Sandeep Barde[2]

[1]Department of Pharmaceutics, Krishna Institute of Pharmacy, Krishna Vishwa Vidyapeeth (Deemed to be University), Karad, Maharashtra, INDIA.
[2]Department of Pharmaceutics, Govindrao Nikam College of Pharmacy, Sawarde, Maharashtra, INDIA.
[3]Department of Pharmaceutical Chemistry, Krishna Institute of Pharmacy, Krishna Vishwa Vidyapeeth (Deemed to be University), Karad, Maharashtra, INDIA.

ABSTRACT

Aim/Background: Ornidazole is primarily used to treat peptic ulcer. Ornidazole laden floating microspheres were developed to boost bioavailability of the therapeutic moiety and its appropriate therapeutic performance. **Materials and Methods:** Solvent evaporation approach was utilised to fabricate the gastroretentive floating microspheres using different polymers such as HPMC K100M, Eudragit RS100 and ethyl cellulose. It was also brought to light that the formulation of the ornidazole microspheres delayed therapeutic release for 12 hr. Prepared formulation characterised for SEM, micromeritic characteristics, *in vitro* release experiments, short-term stability studies, (%) yield, drug content, drug entrapment efficiency, drug loading. All characteristics showed promising results at wrap of the study. **Results:** Investigations revealed that, formulations containing Eudragit RS100 showed superior floating microspheres and drug release characteristics. The optimised formulation F3 show 83.45±0.47% entrapment efficiency, 170.3 µm particle size, and 94.58% cumulative percent drug release. Results were confirmed experimentally. **Conclusion:** The study concluded that the developed floating microspheres for ornidazole exhibited enhanced cumulative drug release, ultimately enhancing bioavailability.

Keywords: Particulate Drug Delivery, Floating microspheres, Synthetic polymers, Solvent Evaporation method.

Correspondence:
Mr. Raghwendra Waghmode
Assistant Professor, Department of Pharmaceutics, Krishna Institute of Pharmacy, Krishna Vishwa Vidyapeeth (Deemed to be University), Karad 415539, Maharashtra, INDIA.
Email: raghwanwaghmode@gmail.com

Received: 12-02-2026;
Revised: 03-03-2026;
Accepted: 17-04-2026.

INTRODUCTION

Particulate Drug Delivery Systems (PDDS) are designed to improve drug distribution, targeting, and release to specific locations within the body. In PDDS, drugs are incorporated within carriers to enhance drug stability, enable controlled release, and facilitate targeted delivery to specific tissues or cells. Compared to conventional drug formulations, PDDS offer several advantages. Encapsulating drugs within particles can enhance their stability, protecting them from degradation and premature release. This allows for the use of drug candidates that may be unstable or have short half-lives *in vivo*.[1] As well, PDDS enable the sustained and controlled release of drugs, resulting in prolonged therapeutic effects. By modifying particle size, composition, and surface properties, rate of release and duration of action can be tailored to meet specific therapeutic needs. This gradual release profile minimizes possibilities like adverse effects, improves patient compliance, and reduces dosing frequency.[2] Ultimately, PDDS can target drugs to specific tissues or cells. By turning the particle surface or incorporating targeting ligands, these systems can actively or passively target specific sites, such as tumours or inflamed tissues. This targeting capability increases drug accumulation at the target site, amplifying therapeutic efficacy and reducing systemic exposure and side effects.[3]

Microspheres are natural, solid, orb-shaped, free-flowing powders ranging from 1 µm to 1000 µm in size and composed of biodegradable natural materials. Commercially available microspheres also include those made of glass and ceramic. The varying densities of empty and solid microspheres have numerous applications. Solid microspheres, depending on their composition and size, used in numerous ways.[4] Microspheres represents a multiparticulate formulation approach that can be delivered to target drug delivery to specific sites, maintain extended drug release for considerable time with contrast to conventional dosage forms, and enhance drug stability or bioavailability.[5] Several types of microspheres exist, including floating microspheres, magnetic microspheres, radioactive microspheres, and polymeric microspheres. Floating microspheres, also known as buoyant microspheres or gastroretentive microspheres, represent a novel

DOI: 10.5530/ijper.20266552

drug delivery technology designed to prolong drug residence in the stomach, consequently adding drug absorption and extending therapeutic effects. These microspheres, due to their unique properties, float on the gastric fluids, remaining within the stomach and ensuring prolonged contact with the gastric mucosa.[6] Floating microspheres are small, spherical particles ranging from a few micrometres to several millimetres in size. They are composed of low-density, highly buoyant, biocompatible polymers or hydrocolloids.[7] Floating microspheres offer several advantages for drug delivery. By extending gastric residence time, they provide extended drug release, which improves therapeutic efficacy and reduces dosing frequency.[8] In addition, they can augment the bioavailability of hydrophobic therapeutic moiety by retaining them in the stomach, the primary site of absorption. This is remarkably favourable for a molecule with a narrow absorption window or those susceptible to enzymatic degradation in the digestive tract.[9]

MATERIALS AND METHODS

Materials

Ornidazole was procured from Dhamtec Pharma and Consultants (Navi Mumbai), HPMC K100 M, Ethyl Cellulose, Sodium Bicarbonate, Tween 80, Dichloromethane, Ethanol and Eudragit RS-100 were collected from LOBA Chem. Pvt. Ltd., All reagents and chemicals employed for the research comply to the Pharmacopoeial standard.

Methods

Preparation of Floating Microspheres by Solvent Evaporation Method

Ornidazole, Eudragit RS 100, HPMC K100 M, and ethyl cellulose were accurately weighed and then added to a 1:1 combination of ethanol and dichloromethane at standard temperature. The progressive mixture was agitated at 50 rpm for 30 min using a magnetic stirrer to corroborate a homogeneous solution. The resultant solution was added steadily to 100 mL of water containing sodium bicarbonate and Tween 80, which was maintained at room temperature, and stirred for 2 hr. The prompt floating microspheres were sieved using Whatman filter paper and dried at ambient temperature. Table 1 presents the formulation composition of ornidazole floating microspheres.[10]

Evaluation of ornidazole floating microsphere

Fourier transforms infrared (FTIR) spectroscopy

Drug and excipient interaction effectuates using FT-IR. FT-IR spectra for the model drug with excipient were explored.[19]

Differential Scanning Calorimetry (DSC)

The thermogram study was bring off by using DSC (Perkin, DSC 4000). The drug and excipients were to look over. The thermogram was acquired, examined and analysed.

Micromeritics properties

To look over the flow behaviour of the microspheres, several parameters were appraised, including Bulk Density (BD), Tapped Density (TD), angle of repose, and Compressibility Index (CI). BD and TD were intent on using bulk density apparatus. Calibrated measuring cylinders were used to record initial and final volumes before and after tapping.[11,12] The angle of repose brought off using the funnel method and calculated as claimed by following formula:

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

Where *r* is the radius and *h* is the height of pile. From the measured BD and TD values, the CI and Hausner's ratio were calculated.

Post-formulation parameters

Percent yield determination

The percent yield of the ornidazole microspheres was done on purpose by dividing the final mass of the drained product to the initial dry mass of starting material.[13] The % yield was calculated using formula:

$$\% \text{ Yield} = (\text{Final mass of Microsphere/Initial mass of starting material}) \times 100$$

Drug content and Entrapment Efficiency (EE)

The EE of ornidazole within the floating microspheres was resolved on using the following procedure. 50 mg of the floating microspheres were accurately weighed, triturated in a mortar and pestle, and then dispersed in a pH 1.2 phosphate buffer. A calibration curve was established to quantify the drug content. Absorbance was measured at a wavelength of 277 nm using a UV-Visible Spectrophotometer (UV-1800, Shimadzu, Japan).[14] The amount of ornidazole encapsulated within the floating microspheres was later found. EE was claimed by formula:

$$EE = (\text{Mass of Drug in Microspheres/Initial Mass of Drug Used}) \times 100$$

Particle size determination

Particle size was count up using optical microscopy. A small amount of ornidazole powder was strewed onto a glass slide, and a thin dispersion in paraffin oil was prepared. The slide was then look into under various magnifications. An eyepiece micrometre, pre calibrated using a stage micrometre, was used to measure particle size based on eyepiece divisions.[15]

Floating lag Time determination

The spell required to took emerge on surface of the dissolution medium is termed the floating lag time, while the spell it remains floating is defined as the floating time. Total floating time was

determined in a dissolution vessel accommodate 900 mL of 0.1 N HCl (pH 1.2) maintained at 37°C with agitation at 50 rpm.[16]

Floating time determination

Duration of buoyancy refers to the period during which the microspheres remain consistently floating superficially. To appraise the floating behaviour of the fabricated floating microspheres, 0.1 N HCl was considered as a medium. 500 mL of medium were incorporated in separate glass beakers, and individual microspheres were placed to each beaker. The duration of buoyancy measured and the results were compared.[16]

Drug loading determination

To have an effect on drug loading, microspheres were crushed using a mortar and pestle. The triggered powdered microspheres were then added to 0.1 N HCl, sonicated for 15 min, and left to stand overnight at ambient temperature. The dispersion was cleaned and refined through Whatman filter paper, and inspect using a UV spectrophotometer at 277 nm. The concentration of encapsulated ornidazole was interpreted using a previously generated standard calibration curve.[17] Drug loading was claimed by using formula:

$$\text{Drug Loading} = (\text{Mass of Drug Recovered} / \text{Mass of Microspheres Used}) \times 100$$

Scanning Electron Microscopy (SEM)

SEM of Ornidazole floating microspheres was represent to look into the morphological traits.[18]

In vitro drug release study

The *in vitro* dissolution of ornidazole floating microspheres was monitor using USP paddle type II dissolution apparatus (Electrolab India Pvt. Ltd., Mumbai) in 900 mL of 0.1 N Hydrochloric Acid (HCl) buffer at 50 rpm.[19] The dissolution medium temperature was preserved at 37°C throughout the study. At preset intervals, sample aliquots (5 mL) were withdrawn, instantaneously filtered through a membrane filter, and restore with same proportions of recent medium. The ornidazole concentration in each sample was ascertained spectrophotometrically at 277 nm (λ_{max}).[20] The part of dissolved ornidazole was interpreted using standard curves.

Stability study

A stability investigation of optimized (F3) floating microsphere was conducted according to ICH (International Council for Harmonisation) guidelines. Briefly, the F3 formulation was kept for six months at binary different conditions: 25°C±2°C/60% RH±5% RH and 40°C±2°C/75% RH±5% RH. At preset intervals of 30, 60, 90, and 180 days, tests were screened for drug content and physical appearance to estimate the integrity of the floating microspheres.[21]

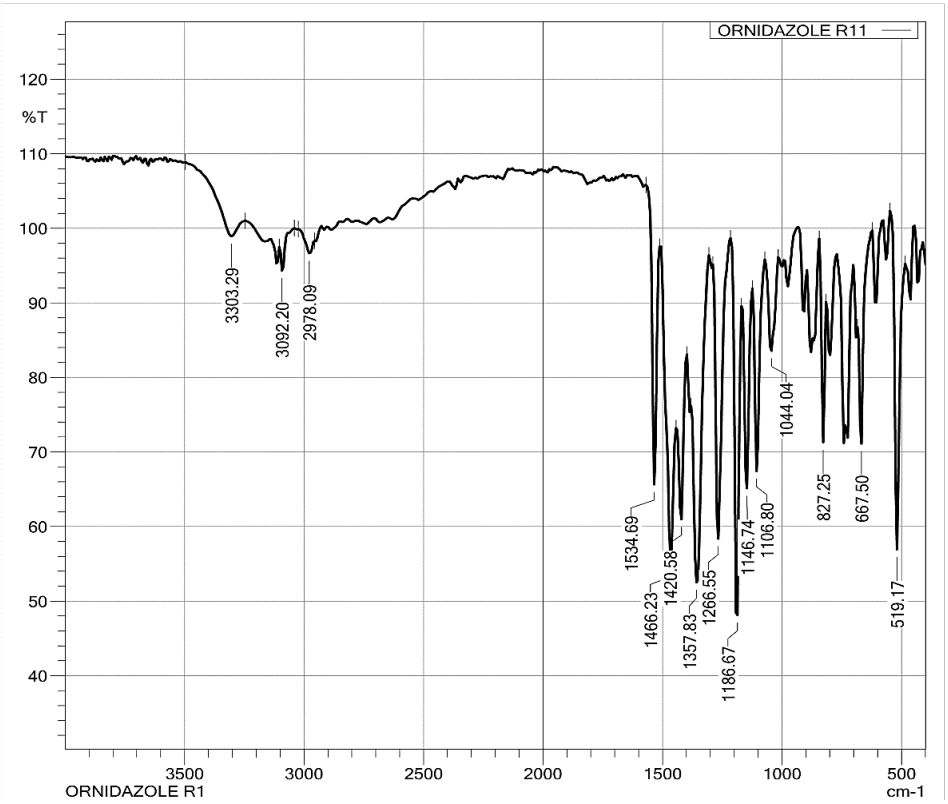

Figure 1A: FTIR spectra of ornidazole.

RESULTS AND DISCUSSION

Preformulation study

Ornidazole floating microspheres were analyse using various preformulation parameters, including organoleptic properties, melting point, solubility profile, and drug-excipient compatibility. The drug was characterized as a tasteless, odourless powder, soluble in dichloromethane, methanol, and ethanol, and sparingly soluble in water. The observed melting point was found between 85°C-98°C.

Compatibility studies

ornidazole-excipient compatibility was check out using FT-IR and DSC. The FT-IR and DSC spectra of the API and physical mixture expresses no interaction between the API and excipient. The prepared physical mixture exemplify compatibility.

FTIR spectroscopy

The ornidazole (Figure 1A) and physical mixture of excipients (Figure 1B) underwent FTIR analysis. The recorded spectra were weighed up for potential interactions to substantiate compatibility.

Table 1: Formulation table of ornidazole floating microspheres.

	F1	F2	F3	F4	F5	F6	F7	F8
Ornidazole	0.5 g	0.5 g	0.5 g	0.5 g	0.5 g	0.5 g	0.5 g	0.5 g
Ethyl Cellulose	0.15 g	0.25 g	0.35 g	0.45 g	0.15 g	0.25 g	0.35 g	0.45 g
Eudragit RS-100	0.25 g	0.350 g	0.45 g	0.55 g	-	-	-	-
HPMC K-100M	-	-	-	-	0.25 g	0.350 g g	0.45 g	0.55 g
Sodium Bicarbonate	1 g	1 g	1 g	1 g	1 g	1 g	1 g	1 g
Tween 80	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Dichloromethane: Ethanol	1:1	1:1	1:1	1:1	1:1	1:1	1:1	1:1
DW	100 mL	100 mL	100 mL	100 mL	100 mL	100 mL	100 mL	100 mL

Table 2: Results of bulk density, tapped density, Compressibility index, Hausners ratio and angle of repose.

Formulation	Bulk density (g/mL)	Tapped density (g/mL)	Compressibility index (%)	Hausner's Ratio	Angle of repose (θ)
F1	0.1485±0.0005	0.1733±0.002	14.31±2.84	1.16±0.02	33.07±0.20
F2	0.1412±0.002	0.168±0.0011	15.95±0.15	1.18±0.03	34.51±0.15
F3	0.1488±0.003	0.168±0.0015	11.42±0.57	1.12±0.01	28.46±0.30
F4	0.1716±0.001	0.198±0.005	13.33±0.63	1.15±0.08	33.08±0.66
F5	0.1125±0.005	0.15±0.001	25 ±1.2	1.33±0.07	35.83±0.45
F6	0.15±0.0035	0.18±0.003	16.66±0.55	1.20±0.05	35.70±1.30
F7	0.1431±0.0003	0.1635±0.007	12.47±0.69	1.14±0.02	39.26±0.89
F8	0.1561±0.0015	0.1845±0.0013	15.39±1.14	1.18±0.09	35.15±0.23

n=3; SD: ±

Table 3: Results of % yield, particle size, % drug entrapment and % drug loading.

Formulation	%Yield	Particle size (µm)	Drug entrapment (%)	Drug loading (%)
F1	55.06±1.25	80.5±1.09	72.19±0.44	79.20±0.30
F2	70±0.88	116.1±0.94	80.16±0.21	87.57±0.10
F3	90±0.94	170.3±0.60	83.45±0.47	93.80±0.47
F4	85.71±1.33	195.8±1.50	81.69±0.69	89.25±0.63
F5	51.3±0.55	90.02±0.80	72.68±1.66	80.09±0.08
F6	65.45±1.33	128.9±1.20	82.1±1.55	84.62±0.24
F7	81.1±1.77	172±0.89	82.32±0.36	88.44±0.14
F8	76.19±0.23	198.7±1.02	79.25±0.14	86.19±0.52

n=3; SD: ±

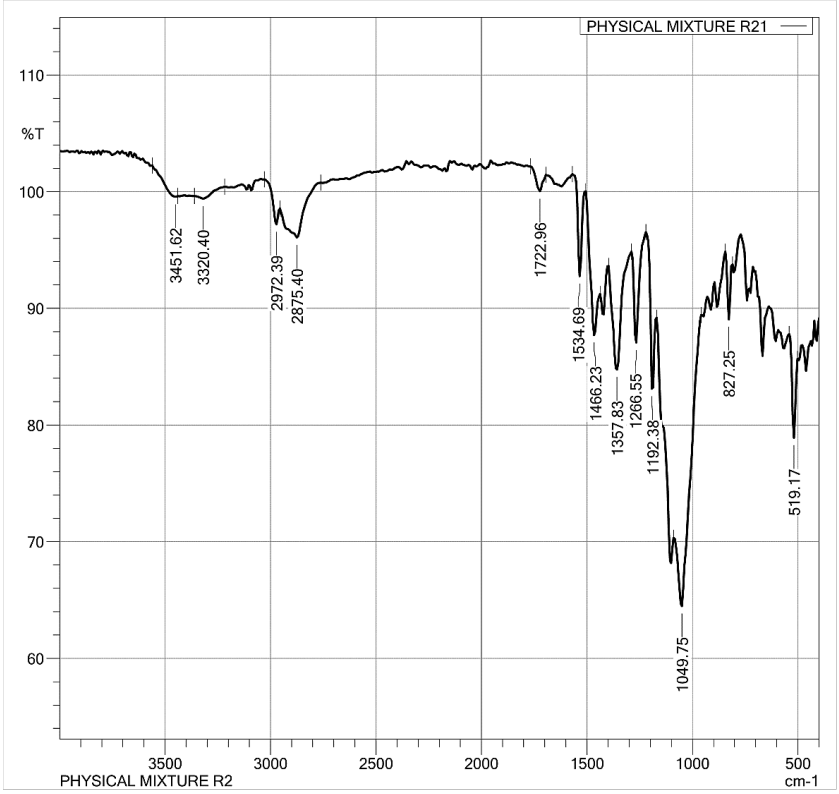

Figure 1B: FTIR spectra of physical mixture.

Table 4: Results of drug content, floating lag time, and floating time.

Formulation	Drug content	Floating Lag Time (sec)	Floating Time (Hr)
F1	76.34±0.22	4.88±0.10	>12
F2	85.38±0.12	4.80±0.15	>12
F3	92.89±0.33	4.50±0.12	>12
F4	88.9±0.87	5.00±0.23	>12
F5	74.55±1.23	5.06±0.06	>12
F6	86.74±1.55	5.14±0.09	>12
F7	90.49±0.29	5.09±0.19	>12
F8	88.23±0.56	5.19±0.04	>12

n=3; SD: ±

All significant drug peaks were taken in FTIR spectrum of the ornidazole microspheres (Figure 1C), indicating no chemical interaction between API and excipients. A trivial shift in the FT-IR spectra was perceived, but this was considered negligible and not indicative of any interaction. This minor shift may be attributable to weak physical interactions, such as dipole-dipole interactions or van der Waals forces. The presence of attribute peaks for both ornidazole and excipients further supports absence of chemical changes. While insignificant, these physical interactions may contribute to ornidazole prolonged release from the microsphere formulation.

Differential scanning calorimetry

The thermogram of model drug (ornidazole) is shown in Figure 2A. A sharp endothermic peak at 88.5°C corroborate the crystalline nature of ornidazole. The thermogram of the optimized formulation is shown in Figure 2B. An endothermic peak at 87.6°C authenticate the presence of ornidazole in the floating microspheres. The reduced intensity of this peak in the optimized formulation, compared to genuine ornidazole, indicates decrease in ornidazole crystallinity. This reduction might be due to molecular dispersion of ornidazole within the polymer matrix, which can improve its solubility and, consequently, its bioavailability.

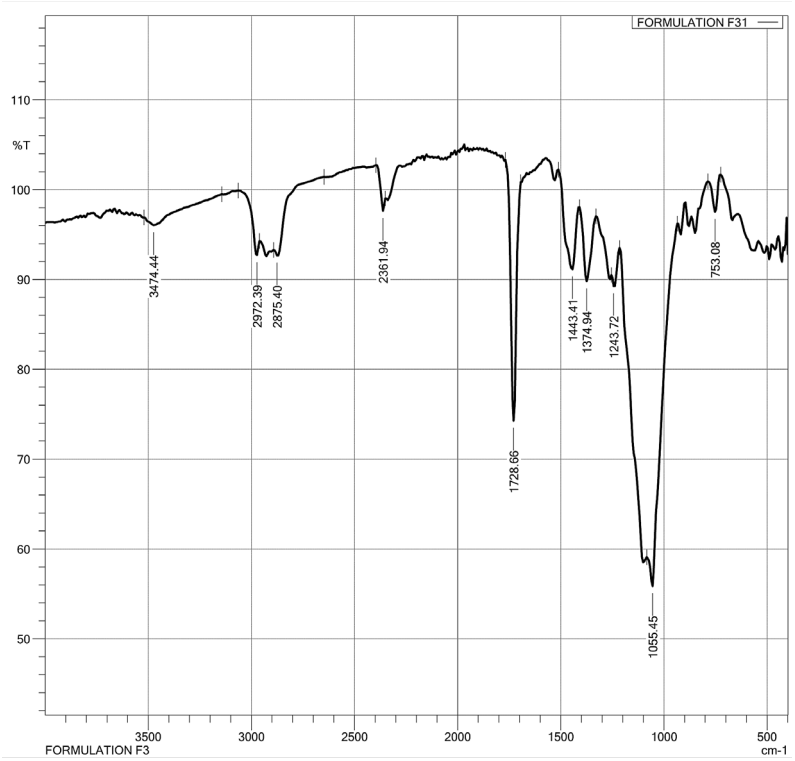

Figure 1C: FTIR spectrum of optimized ornidazole floating microsphere (F3).

Table 5: Release kinetics of *in vitro* drug release from prepared microspheres.

Formulation Release Kinetic Model	F1	F2	F3	F4	F5	F6	F7	F8	Pure Drug
Zero order	0.994	0.9823	0.990	0.978	0.991	0.996	0.997	0.996	0.982
First order	0.992	0.978	0.961	0.917	0.991	0.980	0.997	0.996	0.975
Higuchi	0.786	0.959	0.929	0.957	0.797	0.882	0.858	0.804	0.916
Hixon-Crowell	0.427	-1.002	-0.724	-1.431	0.364	-0.134	0.062	0.342	-0.497
Korsmeyer-Peppas model	0.997	0.993	0.981	0.969	0.993	0.988	0.998	0.997	0.985
Release exponent	1.096	0.643	0.693	0.578	1.058	0.827	0.901	1.043	0.733

Table 6: Results of stability study.

Sl. No.	Temperature	No. of days	Physical appearance	Drug content optimized formulation F3 (%)
1	At 25°C ±2°C (60% RH±5% RH)	0	No change	92.89±0.89
		30		92.27±1.02
		60		91.68±1.03
		90		90.89±1.02
		180		89.05±1.02
2	At 40°C±2°C (60% RH±5% RH)	0	No change	92.89±0.85
		30		91.49±0.90
		60		90.74±0.87
		90		90.09±0.89
		180		90.20±0.89

n=3; SD: ±

Micromeritic studies

The bulk density of microspheres ranged from 0.1485±0.0005 to 0.1561±0.0015 g/mL, with F5 exhibiting the lowest density (0.1125±0.005 g/mL) and F4 the highest (0.1716±0.001 g/mL). The angle of repose ranged from 28.46±0.30° (F3) to 39.26±0.89° (F7), indicating good flowability. Hausner's ratio ranged from 1.12±0.01 to 1.33±0.07, also convey good flow characteristics. The Carr's index ranged from 11.42±0.57% (F3) to 25±1.2% (F5). Table 2 represents the BD, TD, compressibility index, Hausner's ratio, and angle of repose for the formulated floating microspheres. Overall, all floating microsphere formulations revealed decent flow properties and compressibility.

Percent yield, particle size, % drug entrapment and % drug loading

Table 3 shows the results of percentage yield, particle size, drug entrapment efficiency, and drug loading of ornidazole floating microspheres. The percent yield of the floating microspheres ranged from 51.3±0.55% (F5) to 90±0.94% (F3). Particle size ranged from 80.5±1.09 µm (F1) to 198.7±1.02 µm (F8), validate the formation of polymeric microspheres. Drug entrapment ranged from 72.19±0.44% (F1) to 83.45±0.47% (F3), divulge good entrapment of ornidazole within the polymeric matrix. Drug loading ranged from 79.20±0.30% (F1) to 93.80±0.47% (F3).

Drug content, floating lag time, and floating time

Table 4 presents the results of drug content, floating lag time, and total floating duration of the prepared microspheres. The current study showed drug content from 74.55±1.23% (F5) to 92.89±0.33% (F3). The optimized batch (F3) exhibited high drug content uniformity, likely due to the uniform distribution of ornidazole within the polymeric matrix of the floating microspheres. Floating lag time and floating time are critical parameters for buoyant drug delivery systems. In this study, the floating lag time observed from 4.50±0.12 sec (F3) to 5.19±0.04 sec (F8). Additionally, the floating period for all formulations observed greater than 12 hr, confirming the good floating profile of the designed microspheres.

In vitro drug release

The formulations exhibited between 75.57% and 94.58% ornidazole release from the floating microspheres after 12 hr. Batch F3 showed the highest drug release (94.58%) from the formulated microspheres, significantly greater than the other formulations. Release kinetic assessment publicised that optimized formulation (F3) followed zero-order release (R^2 = 0.990). Table 5 summarizes the release kinetics of *in vitro* drug release from the formulated microspheres. The release exponent (n) of 0.693 confirmed anomalous (non-Fickian) transport as the drug release mechanism. This may be attributed to the polymer

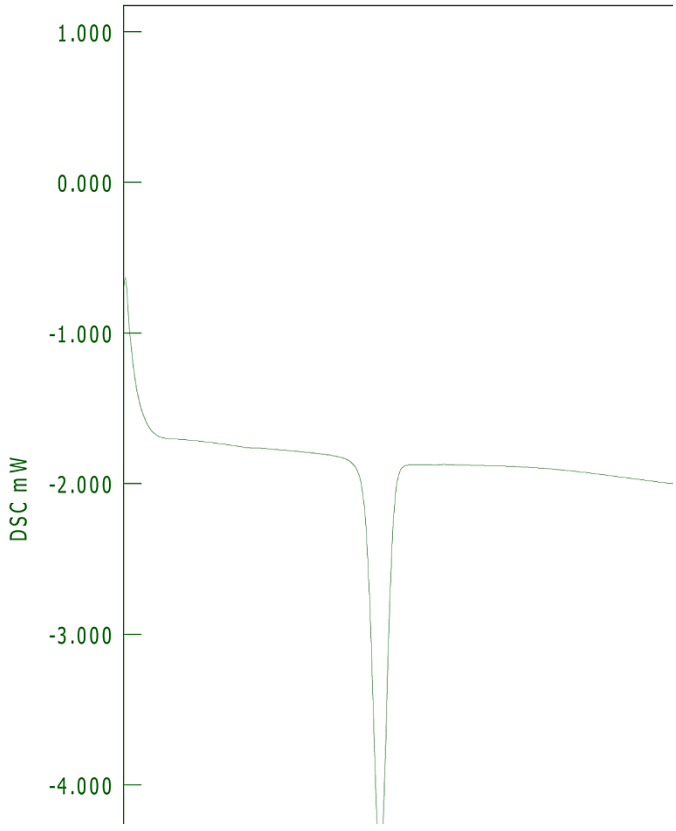

Figure 2A: Thermogram of ornidazole.

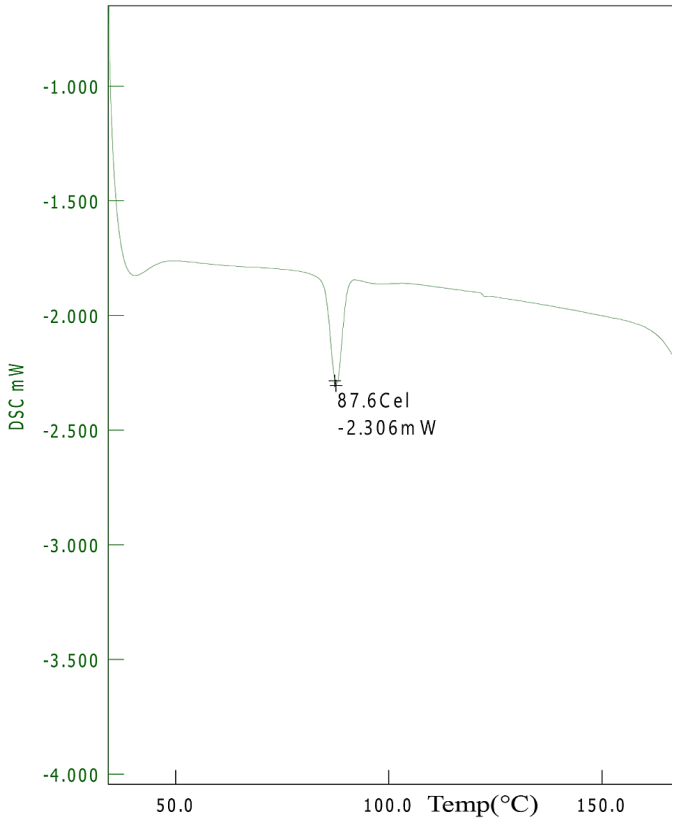

Figure 2B: Thermogram of ornidazole floating microsphere (F3)

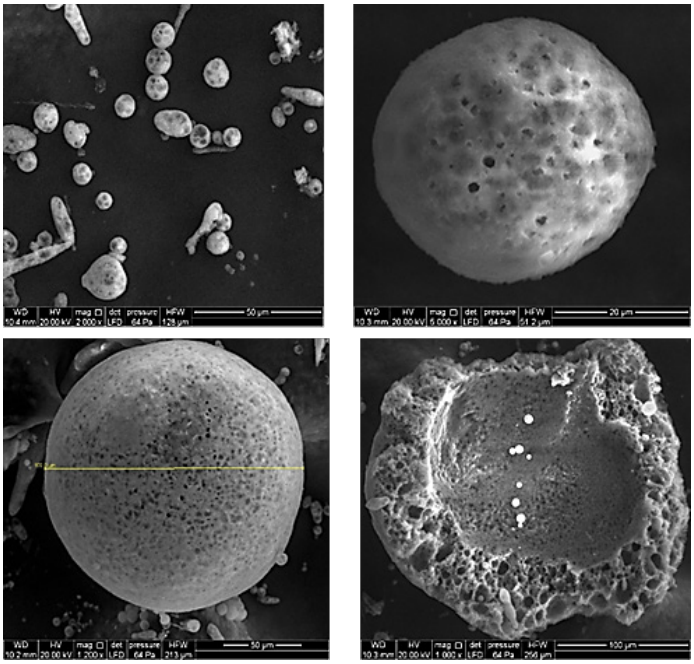

Figure 3: SEM of prepared floating microspheres.

matrix of ethyl cellulose and Eudragit RS 100, where adequate concentrations of both polymers enhance the permeability of the dosage form, leading to controlled release. Besides, the absence of HPMC helps to avoid dense gel formation. Felicitous particle size also contributes to the notably customized release. The higher drug release from larger particles (F3) is possible due to the polymer matrix (especially Eudragit RS-100 and ethyl cellulose) in these larger particles, which facilitates a controlled yet efficient release, potentially allowing for greater overall release. Conversely, smaller particles, despite their larger surface area, may be arrested by thicker polymer barriers or the formation of gel layers (from HPMC or ethyl cellulose), which slow down release. Overall, polymer composition, matrix formation, and other formulation components, such as HPMC, may influence the dissolution rate, leading to slower release from smaller particles.

Scanning Electron Microscopy (SEM)

The morphology of the optimized microsphere formulation (F3) was checked out using SEM (Figure 3). The SEM images revealed a spherical shape with a smooth exterior surface. The particle size of the floating microspheres was also shown to be less than 50 µm. In summary, the SEM analysis verifies the formation of spherical, micro-sized floating microspheres.

Stability study

A stability study of optimized floating microsphere formulation was accomplished for six months, evaluating drug content and physical appearance. At 25°C±2°C and 60% RH±5% RH, drug content of optimized formulation was attained to be 92.89±0.89%, 90.89±1.02%, and 89.05±1.02% at 0, 90, and 180 days, respectively. At 40°C±2°C and 60% RH±5% RH, the drug content was 92.89±0.85%, 90.09±0.89%, and 90.20±0.89% at 0, 90, and 180 days, respectively (Table 6). All-inclusive, the formulated floating microspheres demonstrated good stability under the various temperature and relative humidity conditions tested, in accordance with ICH guidelines.

CONCLUSION

This study intends to prepare, optimize, and evaluate floating microspheres for sustained drug release. Ornidazole formulations were fabricated using variable concentrations of diverse polymers, namely ethyl cellulose, Eudragit RS 100, and HPMC K100 M. The solvent evaporation approach, well-suited for BCS class II drugs like ornidazole, was employed for formulation development. The microspheres manifest particle sizes ranging from 80.5±1.09 µm to 198.7±1.02 µm. The F3 formulation was point out as the optimized formulation, releasing 94.58% of ornidazole over 12 hr. This release rate was considerably higher compared with other formulations, suggesting potentially acceptable clinical efficacy. All developed formulations demonstrated good floating properties. Drug entrapment and drug loading were significant across all formulations. Therefore, formulation F3 successfully achieved the objectives of this study. Stability study results suggested no significant changes in drug content or physical characteristics.

ACKNOWLEDGEMENT

We would like to thank the management of Krishna Institute of Pharmacy, Karad, and Govindrao Nikam College of Pharmacy, Sawarde, for providing access to the research facilities. The authors gratefully acknowledge Dr. Sopan Nangare for his valuable assistance in revising the research work.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

PDDS: Particulate drug delivery systems; **UV:** Ultraviolet; **DW:** Distilled water; **RPM:** Rotation per minute; **FTIR:** Fourier transforms infrared spectroscopy; **SEM:** Scanning Electron Microscopy; **DSC:** Differential scanning calorimetry; **HCl:** Hydrochloric acid. **API:** Active Pharmaceutical Ingredient.

SUMMARY

This research focused on developing ornidazole-laden floating microspheres using a solvent evaporation method to enhance its bioavailability for peptic ulcer treatment. Different polymers, including HPMC K100M, Eudragit RS100, and ethyl cellulose, were explored to achieve a sustained therapeutic release over 12 hr. Comprehensive characterization of the microspheres involved SEM, micromeritic analysis, *in vitro* release, and stability studies. Formulation F3, incorporating Eudragit RS100, emerged as the

optimized candidate, exhibiting an 83.45% entrapment efficiency, a particle size of 170.3 µm, and 94.58% cumulative drug release. This superior release profile suggests significant clinical potential. All formulations displayed excellent floating properties and substantial drug entrapment. Stability studies confirmed the formulations' robustness, indicating no significant changes in drug content or physical characteristics. This work successfully achieved its objective of developing an effective and stable sustained-release system for ornidazole.

REFERENCES

1. Fathima A, Vedha Hari BN, Ramya Devi D. Micro particulate drug delivery system for anti-retroviral drugs: A review. Int J Pharm Clin Res. 2012;4(2):11-6. URL: https://impactfactor.org/PDF/IJPCR/4/IJPCR,Vol4,Issue2,Article1.pdf.
2. Umeyor C, Kenechukwu F, Uronnachi E, Chime S, Reginald-Opara J, Attama A. Recent advances in particulate anti-malarial drug delivery systems: A review. Int J Drug Deliv. 2013;5(1):1-14. URL: https://ijdd.arjournals.org/index.php/ijdd/article/view/176
3. Chahibi Y, Pierobon M, Song SO, Akyildiz IF. A molecular communication system model for particulate drug delivery systems. IEEE Trans Biomed Eng. 2013;60(12):3468-83. doi:10.1109/TBME.2013.2271503
4. Yawalkar AN, Pawar MA, Vavia PR. Microspheres for targeted drug delivery-A review on recent applications. J Drug Deliv Sci Technol. 2022;75:103659. doi: 10.1016/j.jddst.2022.103659
5. Kumar A, Chanda S, Agarwal S, Singh M, Sharma S, Vasant Bonde G, *et al*. Formulation and evaluation of gastro-retentive Tinidazole loaded floating microsphere for sustained release. Materials today Proc. 2023;80:1810-5. doi: 10.1016/j.matpr.2021.05.616
6. Aute SM, Payghan SA, Mali SS, Patrekar PV. Development of floating microspheres of anti-ulcer drug as a gastroretentive drug delivery system. Der Pharm Lett. 2015;7(7):364-77. URL: http://scholarsresearchlibrary.com/archive.html
7. B CG, R SS, M VKV, M SR, M SK. Formulation and evaluation of Indomethacin microspheres using natural and synthetic polymers as controlled release dosage forms. 2010;2(1):8-16. URL: https://bioinfopublication.org/files/articles/2_1_2_IJDD.pdf
8. Aqther A, Kumar BP, Basha P. Formulation and *in vitro* evaluation of ornidazole gastroretentive tablets by using low-density swellable polymers. Indian J Res Pharm Biotechnol. 2013;1(5):597-601. URL: https://www.ijrpb.com/issues/Volume%201_Issue%205/ijrpb%201(5)%205%20abeda%20597-601.pdf
9. Hajare PP, Rachh PR. Gastroretentive microballoons: a novel approach for drug delivery.Int J Pharm Sci Res. 2020;11(3):1075-83. doi:https://www.pharmaexcipients.com/wp-content/uploads/2020/03/Gastroretentive-Microballoons-A-Novel-Approach-For-Drug-Delivery.pdf
10. Umamaheshwari RB, Jain S, Bhadra D, Jain NK. Floating microspheres bearing acetohydroxamic acid for the treatment of Helicobacter pylori. 2003;55(12);1607-13. doi: 10.1211/0022357022223
11. Sahu A, Chouksey K, Ganju K. Formulation and evaluation of ciprofloxacin hydrochloride sustained release tablets using Hibiscus Rosa Sinensis mucilage. J Adv Sci Res. 2022;13(8):71-78. doi: 10.55218/JASR.202213811
12. Rajurkar GV. Tablet formulation and enhancement of aqueous solubility of efavirenz by solvent evaporation co-crystal technique. Med Chem (Los Angeles). 2015;8(2). URL: 10.4172/2161-0444.1000002
13. Pantwalawalkar J, Nangare S. Formulation of silk fibroin-based single polymeric floating microspheres for sustained release of lafutidine. Indian J Pharm Educ Res. 2022;56(2):396-404. doi: 10.5530/ijper.56.2.59.
14. Bhattacharyya S, Reddy P. Effect of surfactant on azithromycin dihydrate loaded stearic acid solid lipid nanoparticles. Turk J Pharm Sci. 2019;16(4):425-31.doi: 10.4274/tjps.galenos.2018.82160
15. Wedd M, Ward-Smith S, Rawle A. Particle size analysis. Encycl Anal Sci. 2019;144-57. doi: 10.1016/B978-0-12-409547-2.14522-6
16. Jagan Mohan Reddy NVV, Vijayalakshmi D, Poorna G, Saispandana G, Saisirisha G, Harikamani G. Formulation and evaluation of floating tablets of tinidazole. Int J Res Pharm hem. 2022;12(2);164-77. doi: 10.33289/IJRPC.12.2.2022.12(24)
17. Wang Y, Li H, Wang L, Han J, Yang Y, Fu T, *et al*. Mucoadhesive nanocrystal-in-microspheres with high drug loading capacity for bioavailability enhancement of silybin. Colloids Surf B Biointerfaces. 2021;198:111461. doi: 10.1016/j.colsurfb.2020.111461
18. Karak N. Fundamentals of nanomaterials and polymer nanocomposites. In: Nanomaterials and Polymer Nanocomposites: Raw Materials to Applications. Elsevier Inc.; 2019;1-45. Available from: doi:10.1016/B978-0-12-814615-6.00001-1
19. Parida P, Mishra SC, Sahoo S. FTIR spectroscopic in-vitro drug interaction study of nifedipine microsphere. Int J Pharm Stud Res. 2012;3(1):1-4. URL: https://www.researchgate.net/publication/375497303_FTIR_SPECTROSCOPIC_INVITRO_DRUG_INTERACTION_STUDY_OF_NIFEDIPINE_MICROSPHERE
20. Dubey M, Kesharwani P, Tiwari A, Chandel R, Raja K, Sivakumar T. Formulation and evaluation of floating microsphere containing anti-diabetic drug. Int J Pharm Chem Sci. 2012;1(3):1038-47. URL: https://www.researchgate.net/publication/267638395_Formulation_and_evaluation_of_floating_microsphere_containing_anti_diabetic_drug
21. Narayana Charyulu, Basavaraj BV, Madhavan V. Microballoons of famotidine: a non-effervescent gastroretentive controlled drug delivery system using Eudragit L-100. Der Pharmacia Lettre. 2010;2(6):176-89. URL: https://www.scholarsresearchlibrary.com/articles/microballoons-of-famotidine-a-noneffervescent-gastroretentivecontrolled-drug-delivery-system-using-eudragit-l100.pdf.

Cite this article: Waghmode R, Hingmire R, Yeligar V, Barde S. Formulation and Evaluation of Polymeric Ornidazole Floating Microspheres: A Comprehensive Approach. Indian J of Pharmaceutical Education and Research. 2026;60(3):1037-45.