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Development and Evaluation of Gastro Rententive Tablet for Anticonvulsant Drugs

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Abstract: ***Background:*** *The present study aimed to formulate and evaluate floating gastroretentive tablets containing Gabapentin and Nortriptyline to achieve prolonged gastric residence and sustained drug release.* ***Methods:*** *Floating tablets were prepared by the direct compression method using hydrophilic polymers such as HPMC K4M and Carbopol 934P along with sodium bicarbonate and citric acid as gas-generating agents. Preformulation parameters including bulk density, tapped density, compressibility index, Hausner's ratio, and angle of repose were evaluated to determine flow properties of the powder blend. The compressed tablets were characterized for weight variation, hardness, friability, buoyancy lag time, total floating time, swelling index, and in-vitro drug release.* ***Results:*** *Preformulation studies demonstrated satisfactory flow properties with compressibility index values ranging from 16.00–18.33% and Hausner's ratio between 1.19–1.22. The prepared tablets showed acceptable hardness (4.8–6.1 kg/cm²) and low friability (<1%), indicating good mechanical strength. Floating lag time ranged from 44–82 seconds, while total floating duration extended up to 14.2 hours, confirming effective buoyancy. Swelling studies revealed progressive polymer hydration with swelling indices reaching up to 134.7% after 6 hours. Dissolution studies demonstrated sustained drug release for 12 hours, with the optimized formulation achieving nearly complete drug release.* ***Conclusion:*** *The developed floating gastroretentive tablets demonstrated satisfactory physicochemical properties, prolonged buoyancy, and controlled drug release behavior. The optimized formulation exhibited promising potential for enhancing gastric retention and improving therapeutic efficacy of the drugs.*

Keywords: Floating tablets; Gastroretentive drug delivery system; Gabapentin; Nortriptyline; Swelling index; In-vitro buoyancy; Sustained drug release; Direct compression.

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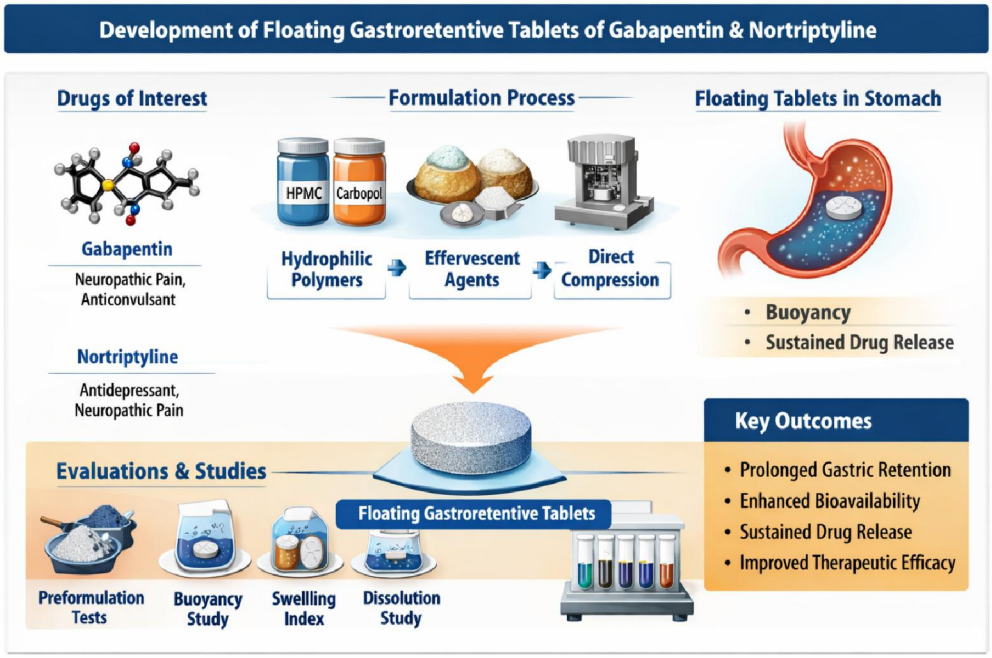
GRAPHICAL ABSTRACT:



I. INTRODUCTION

Oral drug delivery remains the most widely preferred route of drug administration due to its convenience, cost effectiveness, and high patient compliance. However, many drugs exhibit limited bioavailability because of poor absorption in the lower gastrointestinal tract, short gastric residence time, and instability in intestinal conditions. To overcome these limitations, gastroretentive drug delivery systems (GRDDS) have been developed to prolong the residence time of dosage forms in the stomach, thereby improving drug absorption and therapeutic efficacy. Among various GRDDS approaches, floating drug delivery systems have gained significant attention because they remain buoyant on gastric fluids for extended periods and provide controlled drug release.[1,2]

Floating tablets are designed to have a lower density than gastric fluid, enabling them to float and remain in the stomach without affecting gastric emptying rate. These systems generally utilize gas-generating agents such as sodium bicarbonate and citric acid along with hydrophilic polymers that swell upon contact with gastric fluid. The generation of carbon dioxide reduces tablet density and allows the dosage form to float on the gastric contents, resulting in prolonged gastric retention and improved drug absorption.[3]

Gabapentin is an anticonvulsant and neuropathic pain medication that is widely used in the treatment of epilepsy, postherpetic neuralgia, and other neurological disorders. Gabapentin is primarily absorbed in the upper part of the gastrointestinal tract through a saturable transport mechanism. Due to its narrow absorption window and relatively short half-life, conventional dosage forms may lead to incomplete drug absorption and reduced bioavailability. Therefore, developing a gastroretentive formulation of Gabapentin could significantly enhance its absorption by prolonging its residence time in the stomach and upper intestinal region.[4,5]

Similarly, Nortriptyline is a tricyclic antidepressant commonly used for the treatment of depression, chronic pain, and neuropathic conditions. Nortriptyline requires controlled and sustained drug release to maintain therapeutic plasma concentrations and minimize side effects associated with peak drug levels. A gastroretentive floating system can help

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achieve sustained drug release and improved therapeutic effectiveness by maintaining the drug in the stomach for an extended period.[6]

Hydrophilic polymers such as hydroxypropyl methylcellulose (HPMC) and Carbopol are commonly employed in floating drug delivery systems to provide matrix integrity, swelling behavior, and controlled drug release. Upon contact with gastric fluid, these polymers hydrate and form a gel layer around the tablet, which regulates drug diffusion and matrix erosion. The combination of swelling polymers with gas-generating agents facilitates rapid tablet flotation and prolonged gastric retention.[7]

In the present study, an attempt was made to develop and evaluate floating gastroretentive tablets containing Gabapentin and Nortriptyline using the direct compression technique. Various formulations were prepared using different concentrations of hydrophilic polymers and effervescent agents. The prepared tablets were evaluated for precompression parameters such as bulk density, tapped density, compressibility index, Hausner's ratio, and angle of repose to determine flow characteristics of the powder blend. Post-compression parameters including hardness, friability, weight variation, buoyancy lag time, total floating time, swelling behavior, and in vitro drug release were also investigated.

The objective of this research was to develop a stable floating gastroretentive tablet formulation capable of providing prolonged gastric residence and sustained drug release, thereby improving the therapeutic effectiveness and bioavailability of the selected drugs.

II. MATERIALS AND METHOD

Materials

Gabapentin and Nortriptyline hydrochloride were obtained as gift samples from a reputed pharmaceutical manufacturing company. Hydroxypropyl methylcellulose (HPMC K4M), Carbopol 934P, Sodium bicarbonate, Citric acid, Microcrystalline cellulose (MCC), Magnesium stearate, and Talc were procured from standard pharmaceutical suppliers and were of analytical grade. All other reagents and solvents used in the study were of analytical grade.

Preparation of Floating Gastroretentive Tablets

Floating gastroretentive tablets containing Gabapentin (F1–F6) and Nortriptyline (F7–F12) were prepared using the direct compression method. All the ingredients were accurately weighed according to the formulation design. The drug, polymers (HPMC K4M and Carbopol 934P), sodium bicarbonate, citric acid, and microcrystalline cellulose were passed through #60 sieve to obtain uniform particle size. The powders were mixed thoroughly using the geometric dilution method to achieve a uniform blend. Magnesium stearate and talc were finally added as lubricants and glidants and mixed for 3–5 minutes. The prepared powder blend was compressed into tablets using a rotary tablet compression machine equipped with standard flat-faced punches. Each tablet was adjusted to obtain an approximate weight of 500 mg. The prepared tablets were then evaluated for pre-compression and post-compression parameters.

Formulation

Table 1: Composition of Floating Tablets

Ingredients (mg)	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
	(Gabapentin)						(Nortriptyline)					
Drug	300	300	300	300	300	300	50	50	50	50	50	50
HPMC K4M	60	70	80	90	100	110	60	70	80	90	100	110
Carbopol 934P	20	25	30	35	40	45	20	25	30	35	40	45
Sodium bicarbonate	40	40	40	40	40	40	40	40	40	40	40	40
Citric acid	20	20	20	20	20	20	20	20	20	20	20	20

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MCC	50	35	20	10	0	0	310	295	280	265	250	235
Talc	5	5	5	5	5	5	5	5	5	5	5	5
Magnesium Stearate	5	5	5	5	5	5	5	5	5	5	5	5
Total Weight (mg)	500	500	500	500	500	500	500	500	500	500	500	500

Evaluation of Powder Blend (Precompression Parameters)

The prepared powder blends were evaluated for the following micromeritic properties.

1. Bulk Density

Bulk density was determined by pouring the powder blend into a graduated measuring cylinder and measuring the volume occupied by the powder.

2. Tapped Density

Tapped density was determined using a tapped density apparatus by tapping the cylinder until a constant volume was obtained.

3. Carr's Compressibility Index

Compressibility index was calculated using the equation:

4. Hausner Ratio

Hausner ratio was calculated using the formula:

$$Hausner\ Ratio = \frac{Tapped\ Density}{Bulk\ Density}$$

5. Angle of Repose

Angle of repose was determined using the **fixed funnel method** to evaluate flow properties.

Evaluation of Floating Tablets (Post Compression)

The compressed tablets were evaluated for the following parameters:

- Weight variation
- Hardness
- Friability
- Drug content
- Disintegration time
- Buoyancy lag time
- Total floating time
- Swelling index
- In-vitro drug release

In-vitro Buoyancy Study

The buoyancy study was conducted in **900 mL of 0.1 N HCl (pH 1.2)** at **37 ± 0.5°C** using a USP dissolution apparatus. Two parameters were recorded:

Floating Lag Time (FLT): Time required for the tablet to rise to the surface.

Total Floating Time (TFT): Total duration the tablet remained floating.

Swelling Index Study

The swelling behavior of tablets was studied by placing tablets in **0.1 N HCl solution (pH 1.2)** at **37°C**. Tablets were removed at predetermined time intervals and weighed after removing excess surface liquid.

The swelling index was calculated using:

$$Swelling\ Index = \frac{W_t - W_0}{W_0} \times 100$$

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Where
W_t= weight of swollen tablet at time t
W_0= initial weight of tablet

In-Vitro Drug Release Study

The drug release study was performed using the **USP Type II dissolution apparatus (paddle method)**.
Conditions used:
Dissolution medium: **900 mL 0.1 N HCl (pH 1.2)**
Temperature: **37 ± 0.5°C**
Paddle speed: **50 rpm**
Samples were withdrawn at predetermined time intervals and replaced with fresh dissolution medium. The samples were analyzed using UV-Visible spectrophotometer for determination of drug release. [8-13]

III. RESULTS AND DISCUSSION

The standard calibration curve of Gabapentin was constructed using different concentrations ranging from 2–20 µg/mL. The peak area increased proportionally with the increase in drug concentration, indicating a strong linear relationship between concentration and detector response. The peak area values ranged from 5,420 mV at 2 µg/mL to 54,470 mV at 20 µg/mL. The obtained calibration curve demonstrated excellent linearity within the studied concentration range, confirming the suitability of the analytical method for the quantitative estimation of Gabapentin in dissolution samples. The linear increase in peak area indicates the reliability and reproducibility of the analytical method used for further drug release analysis.
Similarly, the calibration curve for Nortriptyline was prepared within the concentration range of 1–14 µg/mL. The peak area values showed a consistent increase from 4,820 mV at 1 µg/mL to 68,540 mV at 14 µg/mL. The results confirmed a strong linear correlation between concentration and peak area, demonstrating the accuracy and sensitivity of the analytical method employed. The calibration curve established a reliable method for the determination of Nortriptyline during in-vitro dissolution studies of the prepared floating tablets.

Preformulation Studies of Powder Blend

Bulk density of the powdered blends ranged from **0.42 ± 0.01 to 0.56 ± 0.02 g/mL** for formulations F1–F12. The observed variation in bulk density may be attributed to differences in polymer concentration and excipient composition. The results indicate that all powder blends possessed acceptable packing characteristics, which are essential for uniform die filling during tablet compression.
The tapped density values ranged from **0.50 ± 0.02 to 0.68 ± 0.01 g/mL**. The difference between bulk density and tapped density reflects the compressibility and packing ability of the powder blends. The obtained results suggested that the powders were capable of undergoing rearrangement upon tapping, indicating satisfactory compressibility characteristics required for tablet formulation.
The compressibility index values were found to be between **16.00 ± 0.40% and 18.33 ± 0.37%** for all formulations. According to standard pharmacopeial limits, compressibility index values below 20% indicate **good flow properties**. Therefore, the powder blends exhibited satisfactory flow behavior, ensuring uniform tablet weight and consistent drug distribution.
Hausner's ratio values ranged from **1.19 ± 0.02 to 1.22 ± 0.02**. Hausner's ratio values less than 1.25 are generally considered indicative of good flow properties. The obtained results confirmed that the powder blends had acceptable flow characteristics, making them suitable for direct compression.
The angle of repose values ranged between **27.8 ± 0.6° and 33.1 ± 0.6°**. These values fall within the range of **excellent to good flow properties**. The relatively low angle of repose values indicated minimal inter-particulate friction and confirmed the suitability of the blends for tablet manufacturing.

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Post Compression Parameters

The floating lag time of the tablets ranged from **82 ± 3 seconds to 44 ± 2 seconds**, while the total floating time ranged from **10.4 ± 0.3 hours to 14.2 ± 0.4 hours**. As the concentration of hydrophilic polymers increased, the floating lag time decreased and the total floating duration increased. Among all formulations, **F10 exhibited the shortest floating lag time (44 seconds) and the longest floating duration (14.2 hours)**, indicating superior buoyancy characteristics. The presence of sodium bicarbonate and citric acid in the formulation contributed to the generation of carbon dioxide, which enabled the tablets to float effectively in gastric fluid.

The average tablet weight ranged from **498.6 ± 4.2 mg to 509.1 ± 4.2 mg**. All formulations complied with pharmacopeial limits for weight variation, indicating uniform die filling during compression and consistent distribution of the drug and excipients.

The hardness of the tablets ranged from **4.8 ± 0.21 kg/cm² to 6.1 ± 0.18 kg/cm²**. These values indicated that the tablets possessed adequate mechanical strength to withstand handling, packaging, and transportation without breaking.

Friability values for all formulations ranged from **0.62 ± 0.03% to 0.42 ± 0.02%**, which are well below the pharmacopeial limit of 1%. This confirmed that the prepared tablets possessed sufficient resistance to abrasion and mechanical stress.

The disintegration time of tablets ranged from **9.8 ± 0.4 minutes to 6.4 ± 0.3 minutes**. Formulations containing higher concentrations of polymer exhibited relatively longer disintegration times due to increased gel layer formation around the tablet.

The buoyancy lag time ranged from **1.36 ± 0.08 minutes to 0.79 ± 0.03 minutes**. Formulation **F10 demonstrated the lowest lag time**, indicating faster floating behavior. This improved buoyancy can be attributed to efficient gas generation and polymer hydration.

All formulations remained buoyant for **more than 10 hours**, indicating the effectiveness of the gas-generating agents and swelling polymers in maintaining prolonged gastric retention.

The swelling index of tablets increased progressively with time for all formulations. The swelling ratio ranged from **18.2% at 1 hour to 134.7% at 6 hours**. Formulations containing higher polymer concentrations (F9–F12) exhibited greater swelling behavior. This swelling is primarily due to hydration and expansion of hydrophilic polymers, which form a gel barrier controlling drug diffusion and prolonging drug release.

The dissolution study demonstrated sustained drug release behavior over a **12-hour period**. Drug release gradually increased with time for all formulations. At the end of 12 hours, drug release ranged from **89.8% to 99.8%**. Among the formulations, **F10 showed an optimal release profile with approximately 99.5% drug release within 12 hours**, indicating effective sustained release characteristics.

The controlled drug release behavior can be attributed to the formation of a viscous gel layer by hydrophilic polymers such as HPMC, which regulates drug diffusion and matrix erosion. The combination of swelling, buoyancy, and sustained release properties confirms the potential of the developed floating tablets for prolonged gastric residence and improved therapeutic efficacy.

Standard Calibration Curve of Gabapentin

Table 2: **Standard Calibration Curve of Gabapentin**

Sr. No.	Concentration (µg/mL)	Peak Area (mV)
1	2	5,420
2	4	10,860
3	6	16,240
4	8	21,730
5	10	27,180
6	12	32,640
7	14	38,120

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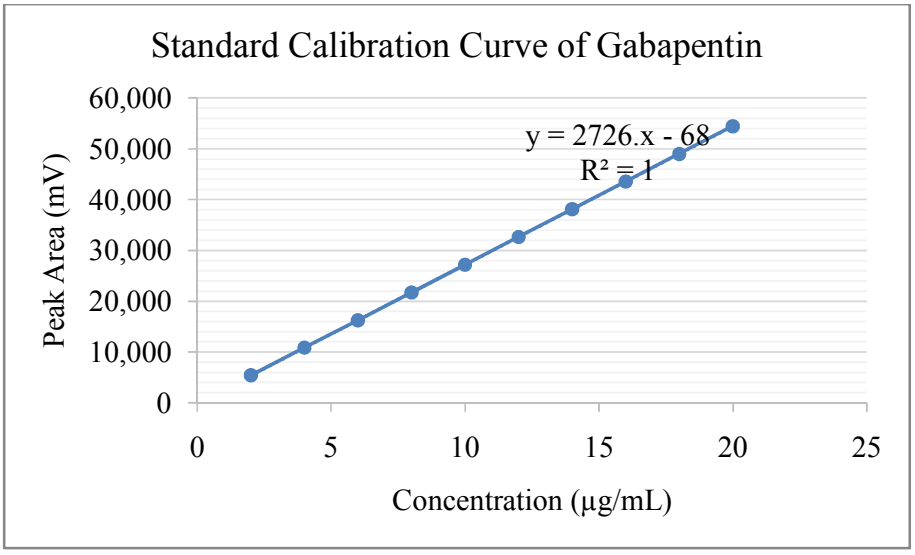
8	16	43,560
9	18	49,010
10	20	54,470



Standard Calibration Curve of Nortriptyline

Table 3: Standard Calibration Curve of Nortriptyline

Sr. No.	Concentration (µg/mL)	Peak Area (mV)
1	1	4,820
2	2	9,740
3	3	14,680
4	4	19,520
5	5	24,460
6	6	29,310
7	7	34,260
8	8	39,140
9	9	44,080
10	10	48,960
11	12	58,820
12	14	68,540

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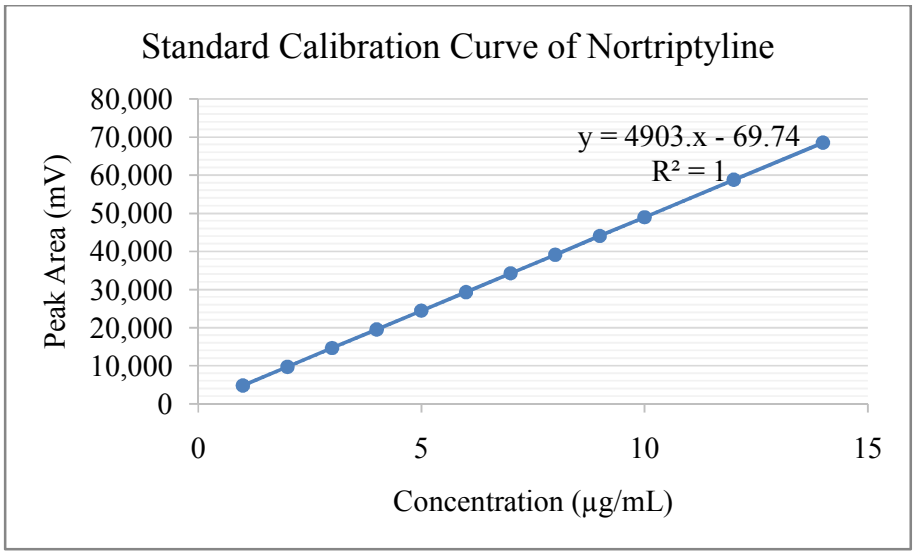

PREFORMULATION STUDIES OF POWDERED BLEND

Bulk density (gm/mL)

Table 4: Bulk density (gm/mL)

Formulation	Bulk Density (g/mL)
F1	0.42 ± 0.01
F2	0.44 ± 0.02
F3	0.46 ± 0.01
F4	0.48 ± 0.02
F5	0.50 ± 0.01
F6	0.47 ± 0.02
F7	0.49 ± 0.01
F8	0.52 ± 0.02
F9	0.54 ± 0.01
F10	0.56 ± 0.02
F11	0.53 ± 0.01
F12	0.55 ± 0.02

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Tapped density (gm/mL)

Table 5: Tapped density (gm/mL)

Formulation	Tapped Density (g/mL)
F1	0.50 ± 0.02
F2	0.53 ± 0.01
F3	0.55 ± 0.02
F4	0.58 ± 0.01
F5	0.61 ± 0.02
F6	0.57 ± 0.01
F7	0.60 ± 0.02
F8	0.63 ± 0.01
F9	0.66 ± 0.02
F10	0.68 ± 0.01
F11	0.64 ± 0.02
F12	0.67 ± 0.01

Compressibility index (%)

Table 6: Compressibility index (%)

Formulation	Compressibility Index (%)
F1	16.00 ± 0.40
F2	16.98 ± 0.35
F3	16.36 ± 0.42
F4	17.24 ± 0.38
F5	18.03 ± 0.44
F6	17.54 ± 0.41
F7	18.33 ± 0.37
F8	17.46 ± 0.40
F9	18.18 ± 0.39
F10	17.65 ± 0.36
F11	17.19 ± 0.41
F12	17.91 ± 0.38

Hausner's ratio

Table 7: Hausner's ratio

Formulation	Hausner's Ratio
F1	1.19 ± 0.02
F2	1.20 ± 0.01
F3	1.20 ± 0.02
F4	1.21 ± 0.01
F5	1.22 ± 0.02
F6	1.21 ± 0.01
F7	1.22 ± 0.02
F8	1.21 ± 0.01
F9	1.22 ± 0.02
F10	1.21 ± 0.01

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F11	1.21 ± 0.02
F12	1.22 ± 0.01

Angle of repose (θ)

Table 8: Angle of repose (θ)

Formulation	Angle of Repose (θ°)
F1	27.8 ± 0.6
F2	28.6 ± 0.5
F3	29.2 ± 0.7
F4	30.1 ± 0.6
F5	31.4 ± 0.5
F6	29.8 ± 0.6
F7	30.5 ± 0.7
F8	31.2 ± 0.6
F9	32.0 ± 0.5
F10	33.1 ± 0.6
F11	31.6 ± 0.7
F12	32.4 ± 0.6

POST COMPRESSION PARAMETERS

Table 9: In-vitro Buoyancy Study

Formulation	Floating Lag Time (sec)	Total Floating Time (hrs)
F1	82 ± 3	10.4 ± 0.3
F2	76 ± 4	10.9 ± 0.4
F3	71 ± 3	11.3 ± 0.3
F4	66 ± 3	11.8 ± 0.4
F5	58 ± 2	12.6 ± 0.3
F6	63 ± 3	11.5 ± 0.4
F7	55 ± 2	12.8 ± 0.3
F8	52 ± 2	13.1 ± 0.4
F9	48 ± 3	13.6 ± 0.3
F10	44 ± 2	14.2 ± 0.4
F11	50 ± 3	13.4 ± 0.3
F12	46 ± 2	13.9 ± 0.4

Avg Weight (Mean ± S.D.)

Table 10: Avg Weight (Mean ± S.D.

Formulation	Avg Weight (mg) (Mean ± S.D.)
F1	498.6 ± 4.2
F2	501.3 ± 3.8
F3	499.7 ± 4.5
F4	503.1 ± 3.9
F5	504.6 ± 4.1
F6	500.8 ± 4.3
F7	502.4 ± 3.7

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F8	505.2 ± 4.0
F9	507.6 ± 3.8
F10	509.1 ± 4.2
F11	506.3 ± 3.9
F12	508.4 ± 4.1

Hardness (kg / cm²)

Table 11: Hardness (kg / cm²)

Formulation	Hardness (kg/cm²) (Mean ± S.D.)
F1	4.8 ± 0.21
F2	5.0 ± 0.18
F3	5.2 ± 0.24
F4	5.4 ± 0.20
F5	5.6 ± 0.19
F6	5.3 ± 0.22
F7	5.5 ± 0.17
F8	5.7 ± 0.23
F9	5.9 ± 0.21
F10	6.1 ± 0.18
F11	5.8 ± 0.20
F12	6.0 ± 0.19

Friability

Table 12: Friability

Formulation	Friability (%)
F1	0.62 ± 0.03
F2	0.58 ± 0.02
F3	0.55 ± 0.03
F4	0.52 ± 0.02
F5	0.49 ± 0.03
F6	0.54 ± 0.02
F7	0.50 ± 0.03
F8	0.47 ± 0.02
F9	0.45 ± 0.02
F10	0.42 ± 0.02
F11	0.46 ± 0.03
F12	0.44 ± 0.02

% Drug content (mg)

Table 13: % Drug content (mg)

Formulation	Disintegration Time (min)
F1	9.8 ± 0.4
F2	9.2 ± 0.3
F3	8.7 ± 0.4
F4	8.1 ± 0.3

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F5	7.4 ± 0.3
F6	8.5 ± 0.4
F7	7.8 ± 0.3
F8	7.2 ± 0.3
F9	6.8 ± 0.2
F10	6.4 ± 0.3
F11	7.0 ± 0.3
F12	6.6 ± 0.2

Buoyancy Lag time (min)

Table 14: Buoyancy Lag time

Formulation	Buoyancy Lag Time (min)
F1	1.36 ± 0.08
F2	1.28 ± 0.07
F3	1.21 ± 0.06
F4	1.14 ± 0.05
F5	1.05 ± 0.05
F6	1.18 ± 0.06
F7	0.98 ± 0.04
F8	0.92 ± 0.05
F9	0.85 ± 0.04
F10	0.79 ± 0.03
F11	0.88 ± 0.05
F12	0.82 ± 0.04

Total floating Time (hrs)

Table 15: Total floating Time (hrs)

Formulation	Total Floating Time (hrs)
F1	10.2 ± 0.3
F2	10.8 ± 0.4
F3	11.3 ± 0.3
F4	11.9 ± 0.4
F5	12.6 ± 0.3
F6	11.5 ± 0.4
F7	12.8 ± 0.3
F8	13.2 ± 0.4
F9	13.7 ± 0.3
F10	14.4 ± 0.4
F11	13.4 ± 0.3
F12	13.9 ± 0.4

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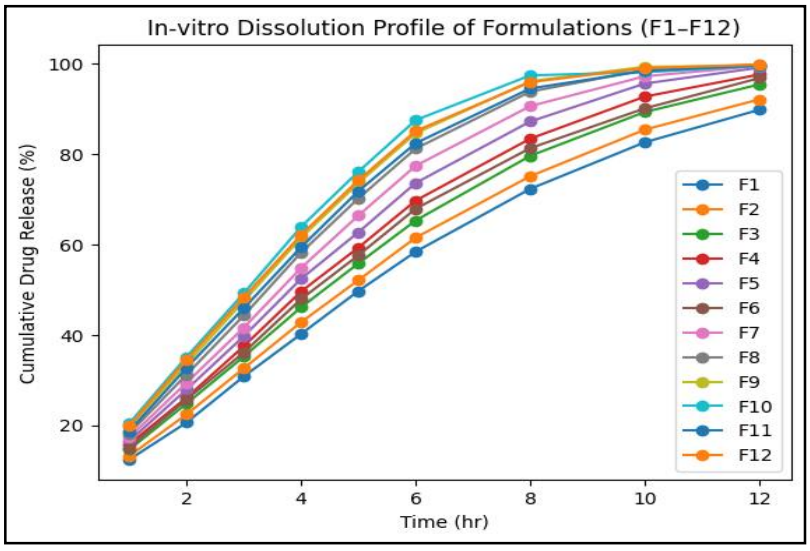
Swelling index ratio (%)

Table 15: Swelling index studies of celecoxib floating Tablets

Time (hr)	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
1	18.2	20.4	22.1	24.3	26.7	23.5	27.9	29.4	31.2	33.6	30.8	32.4
2	32.6	35.1	37.8	40.4	43.9	39.2	45.7	48.6	50.2	53.8	49.4	51.6
3	46.4	50.2	54.6	58.7	62.1	56.9	65.8	69.2	72.5	76.4	70.3	74.1
4	60.3	65.7	70.8	75.9	81.6	73.4	85.2	89.7	94.6	99.8	92.3	96.1
5	72.5	78.4	84.7	90.3	96.8	88.6	101.4	106.9	112.3	118.6	109.8	114.2
6	82.4	88.7	95.2	102.6	110.8	97.4	115.6	121.9	128.4	134.7	123.5	130.2

Table 16: Dissolution studies

Time (hr)	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
1	12.4	13.2	14.6	15.8	16.5	15.1	17.3	18.2	19.6	20.4	18.7	19.9
2	20.6	22.4	24.8	26.1	27.9	25.7	29.4	31.2	33.6	35.1	32.7	34.5
3	30.8	32.6	35.2	37.5	39.7	36.1	41.6	44.3	47.5	49.2	45.9	48.3
4	40.2	42.8	46.1	49.6	52.4	47.9	54.8	58.2	61.5	63.9	59.4	62.1
5	49.7	52.1	55.8	59.3	62.7	57.6	66.4	70.2	73.6	76.1	71.8	74.2
6	58.4	61.5	65.3	69.7	73.6	67.9	77.4	81.2	84.6	87.5	82.4	85.1
8	72.3	75.1	79.6	83.4	87.2	81.3	90.6	93.8	96.1	97.4	94.5	95.9
10	82.6	85.4	89.3	92.7	95.6	90.1	97.2	98.6	99.3	98.1	98.4	99.0
12	89.8	92.1	95.4	97.6	99.1	96.8	99.5	99.8	99.5	99.5	99.6	99.8



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IV. CONCLUSION

The present study successfully developed and evaluated floating gastroretentive tablets containing Gabapentin and Nortriptyline using the direct compression technique. Preformulation studies indicated good flow properties of the powdered blends, ensuring uniform tablet compression. The prepared tablets exhibited acceptable post-compression characteristics including uniform weight, adequate hardness, and low friability, confirming their mechanical stability. Buoyancy studies demonstrated that the tablets exhibited short floating lag times and prolonged floating durations exceeding 10 hours, which is essential for effective gastric retention. Swelling studies revealed that hydrophilic polymers played a crucial role in the formation of a gel layer that controlled drug release and maintained tablet buoyancy. Dissolution studies confirmed sustained drug release over a 12-hour period, indicating the effectiveness of the polymer matrix system in controlling drug diffusion. Among all formulations, the optimized batch showed superior buoyancy characteristics, adequate swelling behavior, and nearly complete drug release within the study duration. Overall, the developed gastroretentive floating tablet system can be considered a promising approach for enhancing gastric residence time and improving the therapeutic performance of the incorporated drugs.

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