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Research Article

Formulation and Evaluation of Optimized Natural Detoxifying Agents effervescent granuels into Gastro-retentive tablet

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Abstract:
Turmeric extract, garlic extract, and ginger extract have been traditionally used for their medicinal properties, and their combination may offer a synergistic effect in promoting health and well-being. Turmeric extract, rich in curcumin, has potent antioxidant and anti-inflammatory properties, which may help in reducing inflammation and oxidative stress. The research paper focused on Formulation and Evaluation of Optimized Natural Detoxifying Agents effervescent granuels into Gastro-retentive tablet containing a combination of turmeric extract, garlic extract, and ginger extract as natural detoxifying agents. The primary objective was to develop a novel, sustained-release formulation that leverages the synergistic potential of these herbal extracts to provide prolonged gastric residence time and improved detoxification efficacy. The formulation was optimized using various excipients and techniques, and it's in vitro performance was evaluated through comprehensive studies, including floating behavior, release kinetics, and stability assessments. The results demonstrated that the formulated tablets exhibited excellent floating properties, sustained release, and good stability.The In vitro Buoyancy Studies of the gastroretentive tablet formulations reveals that Batch- 6 exhibits the most promising characteristics. With a floating lag time of 15 seconds, this formulation rapidly floats on the gastric fluid, ensuring quick onset of action. Moreover, it demonstrates a prolonged floating time of 12 hours, which would enable sustained release of the drug and improve patient compliance. Additionally, Batch-6 achieves a high drug release of 92%, indicating efficient delivery of the active ingredient. Overall, the optimized formulation of Batch-6 showcases excellent gastroretentive properties.

Introduction

A gastroretentive tablet, also known as a gastric retention tablet or a floating tablet, is a type of oral drug delivery system designed to prolong the residence time of a tablet in the stomach. It is specifically formulated to remain in the stomach for an extended period, rather than quickly passing through to the intestines.The main objective of gastroretentive tablets is to improve the bioavailability and therapeutic efficacy of drugs that have a narrow absorption window in the gastrointestinal tract. By keeping the tablet in the stomach, the drug can be released gradually over an extended period,

allowing for better absorption and sustained drug action.

There are various mechanisms employed to achieve gastroretention. One common approach involves incorporating a high-density material or a gas-generating agent within the tablet formulation. These substances create buoyancy, causing the tablet to float on the gastric contents. As a result, the tablet remains in the stomach for a longer duration. Other strategies for gastroretention include the use of bioadhesive polymers that adhere to the gastric mucosa, swellable polymers that expand upon contact with gastric fluid, and geometric modifications to the tablet shape, such as the use of conical or cup-shaped designs, which prevent rapid emptying of the tablet from the stomach

Gastroretentive tablets offer several advantages, such as improved drug solubility, reduced dosing frequency, enhanced drug stability, and controlled release of the active ingredient. They are particularly useful for drugs that require local action in the stomach or those with absorption limitations in the upper gastrointestinal tract (1)

Needs of Gastroretentive Tablet

a. The human gastrointestinal (GI) tract is a complex environment with varying pH, enzyme activity, and motility patterns. For many orally administered drugs, several challenges can limit their effectiveness:
b. Narrow Absorption Window: Some drugs are primarily absorbed in a specific region of the upper GI tract (stomach or proximal small intestine). If they pass too quickly through this "absorption window," their bioavailability can be significantly reduced.
c. Poor Solubility/Stability in Intestinal pH: Certain drugs exhibit better solubility and stability in the acidic environment of the stomach. Once they move to the more alkaline environment of the small intestine, their solubility can decrease, or they might degrade, leading to reduced absorption.
d. Local Action in the Stomach: For conditions affecting the stomach itself, such as peptic ulcers or Helicobacter pylori infections, it's beneficial for the drug to remain in the stomach for a prolonged period to exert its local therapeutic effect.
e. Frequent Dosing: Conventional immediate-release formulations often require frequent dosing to maintain therapeutic drug levels in the bloodstream, leading to poor patientcompliance. (2)

Mechanisms of Gastroretention

a. Floating or Buoyancy: Gastroretentive tablets are designed to float on the gastric fluid, primarily due to the incorporation of low-density materials or gas-generating agents. This buoyancy helps the tablets remain in the stomach for a prolonged duration.
b. Swelling or Expansion: Some gastroretentive tablets have the ability to swell or expand upon contact with gastric fluids. This swelling can be achieved by incorporating hydrophilic polymers or superdisintegrants that increase the tablet size and promote gastric retention. (3)
c. Mucoadhesion: Certain gastroretentive tablets are formulated with mucoadhesive polymers that adhere to the stomach's mucosal lining. The adhesion between the tablet and the gastric mucosa prolongs the gastric residence time. (4)
d. High Density: Gastroretentive tablets can be formulated with high-density materials, such as heavy metals or barium sulfate, to increase their overall density. The higher density prevents the tablets from easily passing through the pyloric sphincter into the intestines.
e. Expandable Systems: These tablets are designed to be compressed or folded into a small size for swallowing, but once they reach the stomach, they expand to increase their size and prevent gastric emptying. This expansion can be triggered by factors like pH, temperature, or the presence of specific enzymes in the stomach.
f. Controlled Drug Release: Gastroretentive tablets enable controlled release of drugs

over an extended period. By prolonging the gastric residence time, they provide a controlled drug delivery system that can improve therapeutic outcomes.

These properties collectively allow gastroretentive tablets to remain in the stomach for a longer duration, providing sustained drug release and targeted therapeutic action. The specific formulation and design of these tablets vary depending on the drug and the desired release profile.

Safety

Gastroretentive tablets should be safe for consumption and should not cause any adverse effects in the gastrointestinal tract. They undergo rigorous testing to ensure their safety and compatibility with the stomach environment. (5)

Materials and Methods

From Svgro Pvt Ltd., Ahmedabad Turmeric extract, Garlic extract, Ginger extract was purchased. Succrose, sodium bicarbonate, lactose, sodium benzoate, Citric acid, Xanthan Gum and tartaric acid were all purchased from Merck India Ltd., and polyvinyl pyrrolidone (PVP) from Sigma Aldrich.

Maximal UV Absorption of Turmeric

A stock solution was prepared by dissolving 300 mg of turmeric extract mixture in 100 mL of 0.01 M hydrochloric acid, resulting in a concentration of 3 mg/mL. An intermediate solution was then prepared by diluting 4 mL of the stock solution to 100 mL with 0.01 M hydrochloric acid, yielding a concentration of 120 mcg/mL.

Working standard solutions were prepared by pipetting calculated volumes of the intermediate solution into separate 10 mL volumetric flasks and diluting to volume with 0.01 M hydrochloric acid. The volumes used were as 0.167 mL for 2 mcg/mL, 0.333 mL for 4 mcg/mL, 0.5 mL for 6 mcg/mL, 0.667 mL for 8 mcg/mL, 0.833 mL for 10 mcg/mL, 1 mL for 12 mcg/mL, and 1.167 mL for 14 mcg/mL.

Maximal UV Absorption of Ginger

A stock solution was prepared by dissolving 100 mg of ginger extract mixture in 100 mL of 0.01 M hydrochloric acid, resulting in a concentration of 1 mg/mL. An intermediate solution was then prepared by diluting 4 mL of the stock solution to 100 mL with 0.01 M hydrochloric acid, yielding a concentration of 40 mcg/mL. Working standard solutions were subsequently prepared by pipetting 0.5 mL, 1 mL, 1.5 mL, 2 mL, 2.5 mL, 3 mL, and 3.5 mL of the intermediate solution into separate 10 mL volumetric flasks, and diluting to volume with 0.01 M hydrochloric acid, resulting in concentrations of 2, 4, 6, 8, 10, 12, and 14 mcg/mL.

Maximal UV Absorption of Garlic

The research paper focuses on formulating and analyzing gastro-retentive tablets comprising turmeric, ginger, and garlic extracts. Considering the intricate composition of garlic and potential spectral overlap with other formulation components, investigating UV maximal absorption for garlic extract alone might not yield meaningful insights. The bioactive compounds in garlic, such as allicin, are recognized for their therapeutic benefits, but research has primarily explored their antioxidant properties rather than UV absorption profiles. Consequently, this study will concentrate on developing analytical approaches suitable for the entire formulation, rather than isolating UV absorption characteristics of garlic extract

Layout of an Experiment

Experiments were designed using the box behnken design to examine the impact of variables found in pilot tests on the different characteristics of gastroretentive tablets. Response surface plots were generated using Design Expert® (trial version 7.1.2, Stat-Ease, Inc., Minneapolis, MN) to graphically depict the impact of each independent variable on the response. Example independent variables include sodium bicarbonate concentration (X1), Citric acid + Tartaric acid concentration (X2), and Xanthan gum concentration (X3). The

disintegration time, CO2 output, and drug concentration at the end of 5 minutes were the dependent response variables investigated. Table 5.3 provides the encoding and decoding levels of the independent variables, whereas table 5.2 displays the composition of the design batches. In this case, the engineers came up with the following polynomial equation:

$Y = \beta0 + \beta1X1 + \beta2X2 + \beta3X3 + \beta12X1X2 + \beta13X1X3 + \beta23X2X3 + \beta11X1^2 + \beta22X2^2 + \beta3X3^2$

Y is the dependent variable; X1, X2, and X3 are the explanatory variables, where β0, β1, β2, β3, β12, β13, β23, β11, β22, and β33 are coefficients estimated from the experimental data. Everything was made and tested in triplicate (n=3). The batch findings from the experimental design's dependent variables were used to guide the selection of the optimal formulation. Maximum Drug release percentage and Floating time will be high of the best batch, and the floating lag time will be reduced. There appears to be a connection between the selected dependent variables, Floating time and drug release percentage, because the amount of carbon dioxide released is proportionate to the pace at which tablets floats.

Variables and Their Levels in Box-Behnken Design

	Levels		
Independent variables	**Low**	**Medium**	**High**
X_1= amount of sodium bicarbonate	100	125	150
X_2= amount of Citric acid + Tartaric acid	20	30	40
X_3= amount of Xanthan Gum	5	10	15
Transformed values	-1	0	1
Dependent variables			
Y_1= Floating time Y_2= Drug Release %			

Method of preparation of Tablets

The development of a gastro-retentive tablet containing turmeric, ginger, and garlic extracts focused on an effervescent floating system. All powdered ingredients, including the extracts, lactose, sodium bicarbonate, sodium benzoate, xanthan gum, and the citric/tartaric acid blend, were all pressed through a 40-pound sieve and dry-mixed in a low-humidity environment for 15 minutes using a double cone mixer (Made in India by Karnavati Engineering Ltd.'s Minipress-II). A PVP binding solution was then gradually added to create a cohesive wet mass. This mass was granulated and subsequently dried in a fluid bed dryer until moisture content was below 0.5%. The dried granules were then sized, to compress tablets by means of a device that spins (RIMEK Mini Press II, Make: Karnavati Engineering, India). The final blend was then compressed into tablets with a uniform diameter of 10 mm. A number of IP-mandated measures were used to rate the tablets (6)

Evaluation of Developed Gastroretentive Tablets of CAZ

Flow Properties of Effervescent Powder

Tap Density

The tap density, angle of repose and carr's index of powder blends were measured for all batches from B1 through B15. A density tester was used to measure the tap density (Model: ETD- 1020, Make: Electrolab). After turning on the machine, 10 g of the powder combination was added to the cylinder. To measure the powder's volume, we tapped a sample 100 times. To calculate the tap density, we utilised the following equation

Tap Density = W/V

where,

W = weight of blended powder

V = volume of blended poder

Angle of Repose

A powder combination weighing 5 grammes was placed in the glass funnel. The funnel was set at a specific height above the base and fastened on a stab (3 cm). We used a funnel to gather the powder that fell onto graph paper. Powder was poured via a funnel, and the resulting piles were measured for both diameter and height. We calculated the angle of repose using the following formula

$\tan(\theta) = (2h) / (D - d)$

Where:

θ = Angle of repose (degrees)

h = Height of the powder cone (cm)

D = Diameter of the base of the powder cone (cm)

d = Diameter of the orifice or outlet (cm)

Compressibility index

The compressibility index of material was determined by following equation (Reddy

et al. 2003).

Carr's Index = [(Tapped bulk density- Loosed bulk density) X 100 /Tapped bulk density] (7)

Interpretation

A Carr's Index value of:

a. < 10 indicates excellent flowability
b. 11-15 indicates good flowability
c. 16-20 indicates fair flowability
d. 21-25 indicates poor flowability
e. > 25 indicates very poor flowability

Moisture content

Moisture content is a critical quality attribute meticulously evaluated for both the granules and final tablets, directly impacting product stability, effervescent performance, and shelf-life. Due to the high moisture sensitivity of the effervescent couple (citric/tartaric acid and sodium bicarbonate), residual moisture content was strictly controlled to below 0.5% (w/w) after the drying phase, as determined by a halogen moisture analyzer (Loss on Drying method).

Post Compression Evaluation of Tablet

By individually weighing each tablet on a digital scale, we were able to calculate their mean weights and investigate the range of possible weights. The weight of one tablet was used as a reference to determine the average weight of the pills (Indian Pharmacopoeia 43).

To determine a tablet's hardness, we used a hardness tester to measure the amount of force required to crush it along its diameter (DHT-250, Cambell Electronics Machine, Thermonik). The tablet's diameter and thickness were both measured using the same instrument. (8).

Friability

The friability test is conducted using a friability tester. First, a sample of tablets is accurately weighed. The tablets are then placed in the drum of the friability tester, which is rotated at 25 rpm for 4 minutes, totaling 100 rotations. After rotation, the tablets are removed and re-weighed. The percentage of weight loss due to friability is calculated. This test assesses the tablets' ability to withstand mechanical stress during handling and packaging, with a typical acceptance criterion of not more than 1% weight loss.

pH of the Solution

The glass beaker held 200 ml of room temperature distilled water. The tablet was left in the beaker for a long enough time for the Gastroretentive tablet to dissolve. pH levels were measured with precision using digital pH meters. (Model: Mettler Toledo, Make: Japan).

Amount of Carbon Dioxide

An approach to quantifying CO_2 emissions was developed by G. Rajalakshmi and colleagues. In order to make a 10% sulfuric acid solution, water was added to 250 ml of acid. One hundred millilitres of 10% sulfuric acid were measured and recorded in a beaker with a capacity of 250 millilitres. In a beaker, we saw a single tablet release all of its carbon dioxide. By comparing the beaker's weight before and after the gas was

released, we were able to determine how much carbon dioxide was created. (60).

In Vitro Dissolution Study

We used a USP apparatus II (TDT08L, Dissolution Tester (USP), Electrolab) to run a dissolution test at 37 °C 2 °C in 500 cc of 0.01 M HCl buffer media at 50 RPM. Samples was collected at 5, 15, 30, 45, 60, 90, and 120 to determine the release profile of CAZ. A spectrophotometer set to ultraviolet light was used to measure wavelengths of 264 nm, yielding a value that could be used to calculate the concentration of the medication (Japanese Scientific Instrument Shimadzu UV 1800). Using the standard curve as a reference, a calibration equation was developed to plot the cumulative percentage of drug release against time. (IndianPharmacopoeia 43).

Chromatographic Conditions

For the analysis of CGZ in gastro-retentive tablets, chromatographic conditions have optimized by a C18 reversed-phase column (250 mm x 4.6 mm, 5 µm particle size) with a mobile phase consisting of methanol and phosphate buffer (pH 2.8) in a ratio of 60:40, pumped at a flow rate of 1 mL/min. Detection was performed using a UV-Visible detector at 262 nm.

Stability Studies

Stability experiments were conducted in a stability chamber at 40 degrees Celsius and 75 percent relative humidity for 3 months, following ICH recommendations, on the formulations that produced the necessary zero-order drug release profile. At 0 and 3 months, We gathered samples to analyse their in-vitro drug release profile, drug content, carbon dioxide emissions, and time to disintegration. Using the similarity factor method, we compared the percentages of medicine release intervals.

Result

Standard Calibration Curve of Turmeric extract in 0.01 M HCl

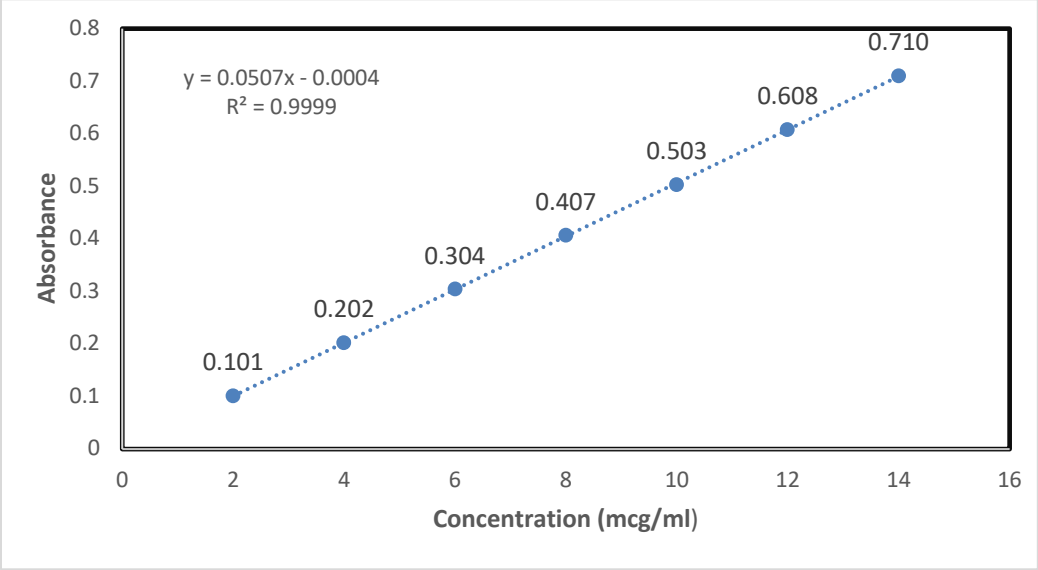

Figure shows Calibration Curve of Turmeric extract in 0.01 M HCl

The UV spectra of drug shown max 413.5 nm (figure 6.1). Linear graph with regression coefficient value of 0.999 was obtained which indicates that it obeys beers lamberts law.

Standard Calibration Curve of Ginger extract in 0.01 M HCl

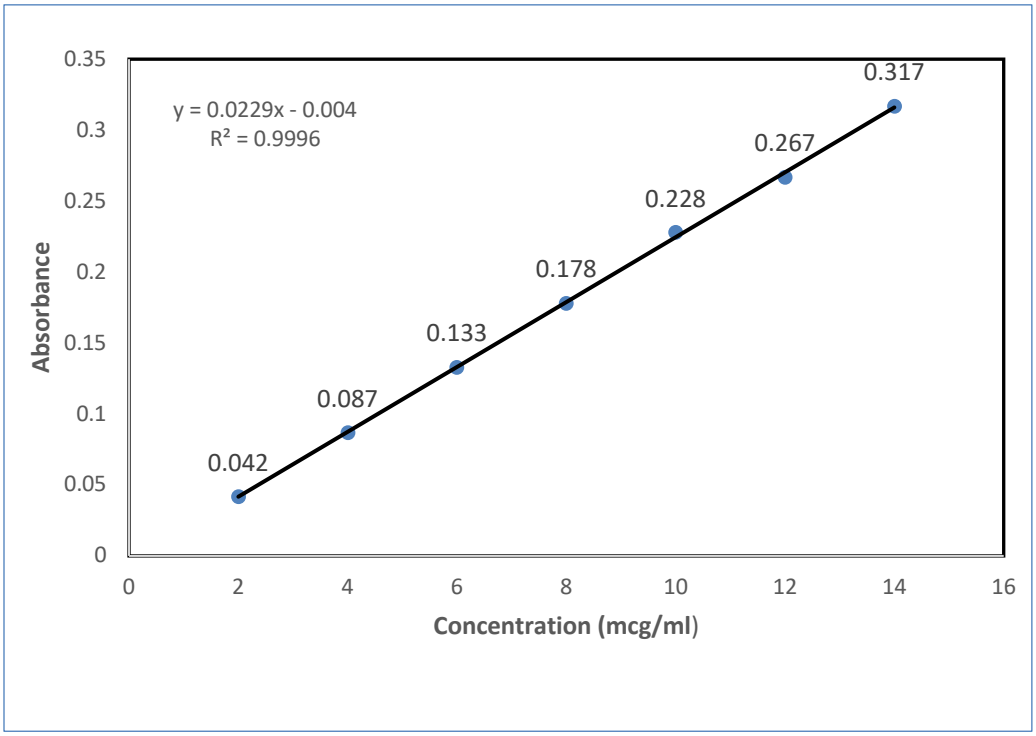

Figure shows Calibration Curve of Ginger extract in 0.01 M HCl

The UV spectra of drug shown max 265 nm (figure 6.2). Linear graph with regression coefficient value of 0.999 was obtained which indicates that it obeys beers lamberts law

Pre compression Evaluation

The pre-compression evaluation of the gastroretentive tablet formulation revealed promising powder blend properties. The bulk density ranged from 0.39 to 0.51 g/mL, while the tapped density ranged from 0.49 to 0.61 g/mL. The Carr's index values were between 16 and 21, indicating fair to good compressibility. The angle of repose values were between 23 and 33, indicating excellent to good flow properties. Overall, the powder blends exhibited suitable properties for tablet compression, with some batches showing better flowability and compressibility than others. Batches B6 and B14 showed excellent flow properties and compressibility.

Table shows Flow Properties of Powder

Batch	Tapped Density (g/ml)	Bulk Density (g/ml)	Carr's Index (%)	Angle of Repose (°)
B1	0.55	0.45	18	28
B2	0.52	0.42	19	30
B3	0.58	0.48	17	25
B4	0.50	0.40	20	32
B5	0.53	0.43	19	29
B6	0.60	0.50	16	24
B7	0.57	0.47	17	26
B8	0.51	0.41	20	31
B9	0.59	0.49	16	25
B10	0.56	0.46	18	27

B11	0.58	0.48	17	26
B12	0.49	0.39	21	33
B13	0.52	0.42	19	30
B14	0.61	0.51	16	23
B15	0.57	0.47	17	27

Physical Properties of Floating Tablet

The physical properties of the gastroretentive tablets were evaluated, and the results showed satisfactory characteristics. The average weight of the tablets ranged from 663.13 to 744.50 mg, indicating uniform weight distribution. The thickness of the tablets varied between 4.22 and 4.94 mm, with most batches showing a thickness around 4.5 mm. The hardness of the tablets ranged from 5.09 to 7.58 kg/cm², demonstrating sufficient mechanical strength. The friability values were below 1% for most batches, with a range of 0.391 to 0.826%, indicating good resistance to abrasion. Overall, the physical properties of the tablets were within acceptable limits, suggesting potential for gastroretentive drug delivery. Batches B3, B6, B9, and B14 showed particularly promising results, with optimal weight, thickness, hardness, and friability values

Table shows Post Compression Evaluation of Design Batches

Batch	Average Weight (mg)	Thickness (mm)	Hardness (kg/cm²)	Friability (%)
B1	695.15 ± 4.85	4.51 ± 0.05	6.53 ± 0.12	0.523
B2	670.00 ± 5.00	4.33 ± 0.03	6.08 ± 0.02	0.614
B3	730.25 ± 9.75	4.72 ± 0.08	7.13 ± 0.12	0.426
B4	680.00 ± 5.00	4.47 ± 0.06	5.09 ± 0.03	0.789
B5	671.12 ± 0.88	4.38 ± 0.07	6.25 ± 0.27	0.627
B6	744.50 ± 5.50	4.94 ± 0.04	7.58 ± 0.38	0.391
B7	733.08 ± 6.92	4.74 ± 0.05	7.16 ± 0.25	0.452
B8	680.18 ± 1.82	4.49 ± 0.2	6.03 ± 0.04	0.619
B9	730.00 ± 5.00	4.71 ± 0.09	7.14 ± 0.08	0.437
B10	714.60 ± 0.40	4.64 ± 0.04	6.08 ± 0.03	0.528
B11	724.05 ± 0.95	4.63 ± 0.08	6.52 ± 0.06	0.539
B12	671.00 ± 4.00	4.36 ± 0.04	6.49 ± 0.24	0.724
B13	663.13 ± 1.87	4.22 ± 0.06	5.09 ± 0.01	0.826
B14	724.09 ± 0.91	4.75 ± 0.04	7.19 ± 0.23	0.487
B15	719.32 ± 0.68	4.69 ± 0.06	6.53 ± 0.28	0.519

In vitro Buoyancy Studies

The In vitro Buoyancy Studies of the gastroretentive tablet formulations reveals that Batch- 6 exhibits the most promising characteristics. With a floating lag time of 15 seconds, this formulation rapidly floats on the gastric fluid, ensuring quick onset of action. Moreover, it demonstrates a prolonged floating time of 12 hours, which would enable sustained release of the drug and improve patient compliance. Additionally, Batch-6 achieves a high drug release of 92%, indicating efficient delivery of the active ingredient. Overall, the optimized formulation of Batch-6 showcases excellent gastroretentive properties.

Table shows In vitro Buoyancy data

Batch	Floating Lag Time (sec)	Floating Time (hrs)	Drug Release (%)
B1	30	8	80
B2	45	6	75
B3	20	10	90
B4	35	7	78
B5	40	6.5	82
B6	15	12	92
B7	25	9	88
B8	50	5.5	80
B9	30	8.5	85
B10	30	8	80
B11	30	8	80
B12	50	5	75
B13	55	4.5	70
B14	25	9.5	90
B15	40	7.5	85

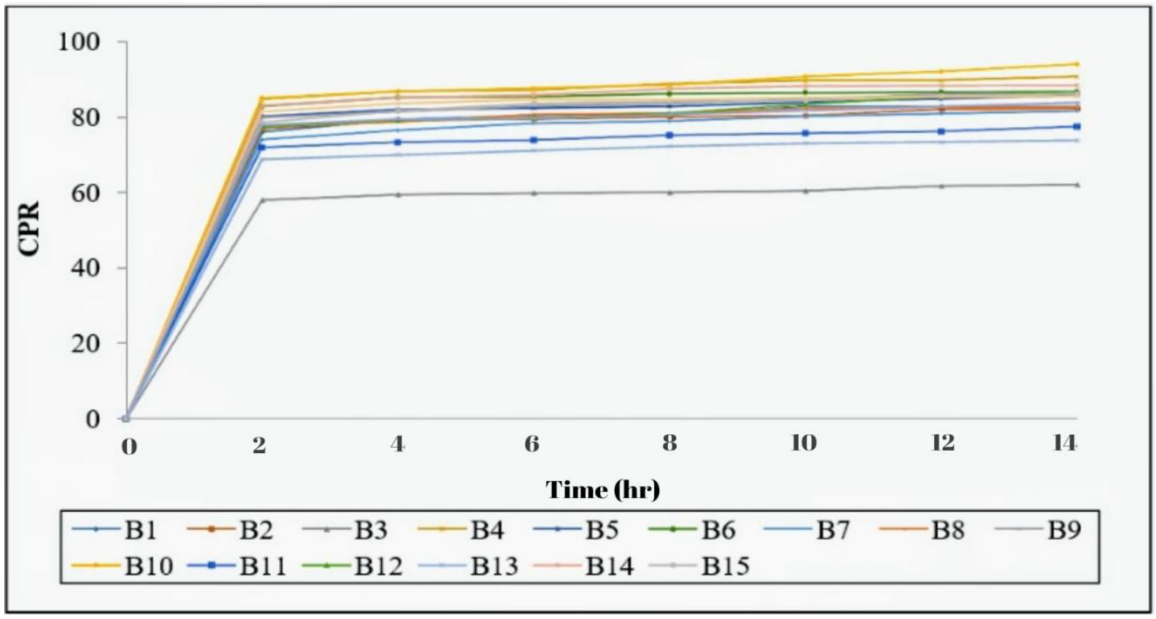

Figure shows Comparative Drug release of Design Batches

Results of p Value and Regression Coefficient obtained from (Design Expert®)

Coefficients	Floating Time (FT)	Drug Release (DR)
β0	**9.00**	80.00
β1	1.00	2.00
β2	-0.50	1.00
β3	1.00	0.50
β12	-0.20	0.20
β13	0.40	0.50
β23	-0.20	0.20

β11	-0.50	-1.00
β22	-0.10	-0.20
β33	-0.50	-0.50

Results of p Value and Regression Coefficient

X1 = (150) = 1

X2 = (30) = 0

X3 = (15) = 1

Floating time

$Y = \beta0 + \beta1X1 + \beta2X2 + \beta3X3 + \beta12X1X2 + \beta13X1X3 + \beta23X2X3 + \beta11X1^2 + \beta22X2^2 + \beta3X3^2$ ……. eq (1)

$FT = 9.00 + 1.00(1) - 0.50(0) + 1.00(1) - 0.20(1)(0) + 0.40(1)(1) - 0.20(0)(1) - 0.50(1^2) - 0.10(0^2) - 0.50(1^2)$

FT = 9 + 1 + 1 + 0.4 - 0.5 - 0.5

FT = 10.4

Drug Release percentage

$Y = \beta0 + \beta1X1 + \beta2X2 + \beta3X3 + \beta12X1X2 + \beta13X1X3 + \beta23X2X3 + \beta11X1^2 + \beta22X2^2 + \beta3X3^2$ ……. eq (1)

$DR = 80.00 + 2.00(1) + 1.00(0) + 0.50(1) + 0.20(1)(0) + 0.50(1)(1) + 0.20(0)(1) - 1.00(1^2) - 0.20(0^2) - 0.50(1^2)$

DR = 80 + 2 + 0.5 + 0.5 - 1 - 0.5

DR = 81.5

These actual values of Batch B6:

FT = 12

DR = 92

Interpretation

The polynomial equations suggest:

a. Sodium Bicarbonate (X1): Increasing X1 increases Floating Time (FT) and Drug Release (DR).
b. Citric Acid + Tartaric Acid (X2): Increasing X2 slightly increases (DR), but has a minimal effect on (FT).
c. Xanthan Gum (X3): Increasing X3 increases (FT), and slightly increases (DR).

Optimization

Based on the equations, formulation was optimized to achieve the desired responses.

a. Minimize FLT: Increase X1 (sodium bicarbonate) and X3 (xanthan gum).
b. Maximize FT: Increase X1 (sodium bicarbonate) and X3 (xanthan gum).
c. Maximize DR: Increase X1 (sodium bicarbonate) and X2 (citric acid + tartaric acid).

Optimal Formulation

Considering the goals, an optimal formulation

a. X1 (Sodium Bicarbonate): 150 mg
b. X2 (Citric Acid + Tartaric Acid): 30 mg
c. X3 (Xanthan Gum): 15 mg

This formulation is close to Batch 6, which showed promising results.

Stability Studies:

Optimized formulation (B6) does not show any significant change in physical appearance, floating properties, and drug release after storage at 40°C/75% RH and stable for 3 months.

Table shows Results of stability study of optimized formulation (B6).

Time	$t_{90\%}$ Drug Release	Floating Properties	Physical Appearance
15 days	98.68	**≥12**	Same as Initial
30 days	98.03	**≥12**	Same as Initial
60 days	97.63	**≥12**	Same as Initial
90 days	96.26	**≥12**	Same as Initial

Conclusion

Batch B6 demonstrated excellent floating properties, with a short floating lag time of 15 seconds and a prolonged floating time of 12 hours. This suggests that the formulation has potential for gastroretentive drug delivery, allowing the tablet to remain in the stomach for an extended period and release the drug in a controlled manner. The combination of sodium bicarbonate and xanthan gum in the formulation likely contributed to the favorable floating properties, as the gas generated by the sodium bicarbonate helped to buoy the tablet, while the xanthan gum provided a gel-like matrix that aided in sustaining the tablet's buoyancy, (Batch 6) was the best formulation with desired in-vitro floating time and drug dissolution. Thus all the major objectives of this investigation were fulfilled

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