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Research Article

Formulation And Evaluation Of Floating Tablet Of Isradipine

Naveen Nagar[1*], Priya Kushwah[2], Yogendra Malviya[3], Narendra Gehalot[4], Vikas Jain[5]

[1*,2,3,4,5]Mahakal Institute of Pharmaceutical Studies naveennagar4321@gmail.com Naveen Nagar Contact No.: 9630525845

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ABSTRACT

Floating tablets of isradipine aim to improve drug bioavailability and therapeutic efficacy by prolonging gastric residence time and ensuring controlled release. Utilizing the natural polymer karaya gum, these tablets remain buoyant in the stomach, thereby extending the time for drug absorption and reducing degradation in the acidic environment. The tablets are prepared using a direct compression method, combining isradipine, HPMC, karaya gum, and sodium bicarbonate to generate gas, which helps the tablets float. Pre-compression evaluations showed good flow properties, while post-compression assessments confirmed consistent weight, hardness, and low friability. In vitro studies demonstrated sustained drug release over 12 hours, optimizing hypertension and angina treatment by maintaining stable drug levels and minimizing side effects. Stability tests indicated no significant changes in drug content and release profile over time, confirming the formulation's reliability.

Keywords: Floating tablets, Isradipine, Bioavailability, Karaya gum, Controlled release, Gastric residence time, HPMC, Sodium bicarbonate, Sustained drug release.

Introduction

Tablets stand out as the most prevalent dosage forms in pharmaceuticals, primarily owing to their user-friendly nature, compact design, ease of handling, and straightforward manufacturing process. Despite their widespread use, oral administration encounters limitations, particularly for crucial drugs across various pharmacological categories.[1,2] This limitation arises from the challenge of achieving optimal oral bioavailability, as certain drugs experience partial absorption or degradation within the gastrointestinal (GI) tract. Consequently, the need for alternative drug delivery systems arises to overcome these barriers and enhance the effectiveness of pharmaceutical agents with compromised bioavailability in oral administration scenarios. Floating tablets tackle the issue of partial absorption or degradation in the gastrointestinal tract by extending their stay in the stomach. Their buoyant nature ensures a prolonged residence time, offering increased exposure to absorption sites. Formulated with controlled-release mechanisms, these tablets prevent rapid drug release and degradation in the acidic stomach environment. Acting as a protective barrier, the floating matrix shields the drug, preserving its integrity.[3,4] This strategy not only enhances absorption in the intestines but also proves beneficial for drugs susceptible to stomach-related challenges.[1,3]

Isradipine, a dihydropyridine calcium channel blocker, is commonly used to treat hypertension and angina. The development of floating tablets of isradipine is motivated by the desire to extend the residence time of the drug within the stomach, thereby improving its bioavailability and sustaining its therapeutic effects.

Floating tablets of Isradipine incorporating the natural polymer, karaya gum, offer several advantages. The inclusion of karaya gum ensures a sustained and controlled release of Isradipine, leading to an extended therapeutic duration.[5] The buoyant nature of karaya gum contributes to prolonged gastric residence, optimizing drug absorption. Additionally, the natural properties of karaya gum act as a protective shield, reducing the risk of Isradipine degradation in the stomach. The overall stability of the tablet is improved, and being a natural polymer, karaya gum enhances biocompatibility and aligns with environmentally friendly pharmaceutical practices.[6] The sustained release and prolonged gastric residence facilitated by karaya gum contribute to a consistent and controlled delivery of Isradipine. This extended duration of therapeutic action ensures a steady reduction in blood pressure, effectively managing hypertension. Moreover, the stable and controlled release minimizes fluctuations in drug levels, reducing the likelihood of side effects and enhancing patient tolerance.

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The protective role of karaya gum against degradation in the stomach enhances the bioavailability of Isradipine, leading to optimized efficacy in addressing both hypertension and angina, ultimately improving the overall treatment outcomes.[5,7]

Materials and Methods

Isradipine and HPMC-K15 M were kind gift samples from Glenmark Pharmaceutical Ltd. (Mumbai, India) and Ranbaxy Research Laboratory (Himachal Pradesh, India), respectively. Magnesium stearate, sodium bicarbonate, and lactose were purchased from SD. Fine Chemicals Ltd. (Ahmedabad, India). All other excipients were of analytical reagent (AR) grade.

Method of preparation of powder blend

The Isradipine floating tablets were created using the direct compression method. Each tablet formulation involved blending the drug, HPMC K15M, karaya gum, sodium bicarbonate, and diluents together for 10 minutes until achieving a homogeneous mixture, followed by the addition of magnesium stearate. Each tablet weighed 200 mg in total. The amount of karaya gum ranged from 40 to 50mg, while the concentration of HPMC varied from 20 to 40mg. All tablets contained 40 to 60 mg of sodium bicarbonate. After blending, the powder mixture underwent an additional 5 minutes of mixing in a mortar. The resulting mixture was then compressed into tablets using a Rimek rotary tablet machine with a compression force of 8 KN.[18,19]

Evaluations of powder blend for flow properties

Bulk Density:

To determine the bulk density, a precisely weighed powder blend from each formula was gently shaken to disperse any agglomerates, and it was then placed into a measuring cylinder. The volume occupied by the powder was measured, providing the bulk volume. The bulk density of the powder blends was calculated using the following formula:[9,12]

$$\rho bulk = m/Vo$$

Tapped Density:

To establish the tapped density, an accurately weighed powder blend from each formula was lightly shaken to disrupt any agglomerates, and it was introduced into a measuring cylinder. The measuring cylinder was tapped until no further change in volume was observed, yielding the tapped volume. The tapped densities (TD) of the powder blends were determined using the following formula:[12]

$$\rho t = m/V_t$$

Angle of Repose:

The angle of repose is a measure used to assess the flow properties of solids. It is a characteristic linked to the friction or resistance between particles. The angle of repose (θ) for the powder was determined by pouring the powder through a funnel. The tip of the funnel's orifice was fixed at a height of 1 cm above a horizontal surface, and the powder was allowed to flow solely due to gravity. The angle of repose, θ, was calculated using the following relationship.[16,17]

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

The angle of repose (θ) is calculated using the formula: tan θ = h/r, where 'h' represents the height of the pile of powder (h=1) and 'r' is the radius of the base of the cone.

Hausner Ratio:

Hausner's ratio is determined using the equation: Hausner's Ratio = Tapped bulk density / Loose bulk density. A Hausner ratio less than 1.12 indicates good flow, while a ratio greater than 1.35 suggests poor flow.[9,16]

$$\text{Hausner's Ratio} = \rho t / \rho bulk$$

Compressibility Index:

The compressibility index is a straightforward measure that can be determined with small quantities of powder. In theory, materials that are less compressible tend to flow more easily. The compressibility index of the powder blends is determined using the following formula: [8]

$$CI = \rho t - \rho bulk / \rho t \times 100$$

Table :1 Formulation Table of isradipine floating tablet

Ingredients(mg)	F1	F2	F3	F4	F5	F6	F7	F8	F9
Isradipine	10	10	10	10	10	10	10	10	10
Karaya gum	40	40	40	45	45	45	50	50	50
HPMC K15M	20	20	20	30	30	30	40	40	40

$NaHCO_3$	40	40	40	50	50	50	60	60	60
PVP K30	10	10	10	10	10	10	10	10	10
Mg. Stearate	20	20	20	20	20	20	20	20	20
Lactose	60	60	60	35	35	35	10	10	10
Total	200	200	200	200	200	200	200	200	200

Preparation of Isradipine floating tablets using direct compression technique

After evaluating the powder blend, floating tablets were manufactured using the direct compression technique employing a 10-station rotary tablet compression machine equipped with flat-faced 6 mm punches. Before compression, both the die and punch surfaces were coated with magnesium stearate for lubrication. Nine formulations were devised with different amounts of diluents. All the produced tablets were then sealed in airtight containers and kept at room temperature for future analysis.[8,9]

Evaluation of Isradipine floating tablet:

Weight variation test

The weight variation test involved taking 20 tablets and individually weighing each one using an electronic balance. The average weight of a tablet was then calculated and considered the standard weight for each tablet. Subsequently, all tablets were weighed individually, and the percentage weight variation was determined using the formula:[9]

% weight variation=(Individual weight−Average weightAverage weight)×100%
weight variation=(Average weightIndividual weight−Average weight)×100

This calculation helped determine whether the weight of each tablet fell within an acceptable range. According to the USP test, the tablets pass if no more than two tablets exceed the specified percentage limit and if no tablet differs by more than twice the percentage limit.

Hardness test:

To assess tablet hardness, a Monsanto hardness tester was utilized. This device comprises a barrel housing a compressible spring situated between two plungers. Initially, the lower plunger made contact with the tablet, and a zero reading was noted. Then, by turning a threaded bolt, the upper plunger was pressed against a spring until the tablet fractured. As the spring compressed, a pointer moved along a gauge within the barrel, indicating the force applied. The force at which the tablet fractured was recorded, and the zero-force reading was subtracted from it for accurate measurement.[10]

Friability test:

The Roche friabilator was employed to assess the friability of the tablet. This apparatus exposes a batch of tablets to both abrasion and shock by utilizing a plastic chamber that rotates at 25 rpm, causing the tablets to drop a distance of six inches with each revolution. Initially, a pre-weighed sample of tablets was placed in the friabilator, which was then operated for 100 revolutions. Afterward, the tablets were dusted and reweighed. As per USP standards, the tablets should not lose more than 1% of their total weight during this process. The percentage friability is determined using the formula:[12]

% Friability=(Weight before friability−Weight after friabilityWeight before friability)×100**% Friability**=(Weight before friabilityWeight before friability−Weight after friability)×100

Diameter & Thickness test:

The diameter of the tablets was measured using Vernier calipers, enabling precise measurements and offering insights into tablet variation. Each tablet was placed in the Vernier caliper, and the reading was recorded when the main scale and Vernier scale coincided. The tablet diameter was maintained within a ±5% variation of a standard value.[3,4]

To determine tablet thickness, a micrometer screw gauge was utilized. Ten tablets were randomly selected from each batch, and each tablet was placed between the spindle and anvil of the micrometer screw gauge. The thickness reading was then obtained in millimeters.

Swelling study:

Swelling studies were conducted to evaluate the molecular characteristics of swollen polymers. The swelling behavior of a dosage unit was assessed by measuring its weight gain. Tablets were placed in 100 ml beakers containing 0.1 N HCl pH, and at 1, 2, 4, 6, and 8-hour intervals, each beaker containing a tablet was removed for analysis.[7] The swelling index was calculated using the following formula

Swelling index = (Wt. of wet tablet – Wt. of dry tablet) / Wt. of dry tablet ×100

Floating behaviour: -
In this study, to enhance the localized effect of Isradipine , a floating strategy was employed in the design of the delivery system. This was achieved by incorporating gas-generating salts like sodium bicarbonate into a swellable hydrophilic layer. When the isradipine tablet comes into contact with the acidic dissolution medium, carbon dioxide is produced within the tablet due to the presence of the effervescent agent. Additionally, the polymer's gelling capacity aids in floating the tablet by trapping carbon dioxide.[6,10]

Floating lag time:
The time it takes for a dosage form to rise to the surface of the medium is known as the floating lag time. In this study, the floating lag time of the tablets was determined by measuring the time it took for the tablet to float to the surface of the medium (0.1N HCl, pH 1.2) in a 500mL beaker where the tablets were positioned.[18,16]

Floating duration time:
The total duration of time during which a dosage form remains buoyant is referred to as the total floating time. This can be determined by placing the tablet in a 500mL beaker containing 0.1N HCl with pH 1.2. The duration for which the dosage form consistently stays on the surface of the medium is identified as the floating duration time.[11]

In vitro drug release study: The In Vitro dissolution studies for all prepared tablets were conducted using the USP paddle method. Initially, 900 ml of the dissolution medium (0.1 N HCl) was placed into the vessel of the apparatus. The program was set up according to the requirements, and the dissolution medium was warmed to 37° C. Following this, the tablet was placed in the vessel, and the dissolution test apparatus was immediately started at a speed of 50 rpm.[20,18]
Samples were withdrawn at 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12-hour intervals from a zone midway between the surface of the dissolution medium and the top of the rotating paddle, ensuring a distance of not less than 10 mm from the wall of the vessels. To maintain a constant volume throughout the test, an equal volume of pre-warmed (37°C) fresh medium was replaced into the dissolution medium after each sampling.[20]
The withdrawn sample solution was promptly filtered through a membrane filter disc with an average pore diameter not exceeding 1.0 micrometer. The initial few milliliters of the filtrate were discarded, and the absorbance was noted spectrophotometrically at 332 nm. Subsequently, the cumulative percentage of drug release was calculated and represented graphically.[21]

Stability study: Stability studies were exclusively performed on the optimized formulation. The formulations were packaged with aluminum foil and subjected to stability assessments under various temperature and humidity conditions as per the ICH guidelines, including room temperature (28°C) and 40°C / 75% RH. Samples were withdrawn at intervals of 30, 60, and 90 days for evaluation.[13,14]
These samples were assessed for potential weight variation, hardness, percentage drug content, and in vitro drug release. In vitro release was examined using a spectrophotometric method.

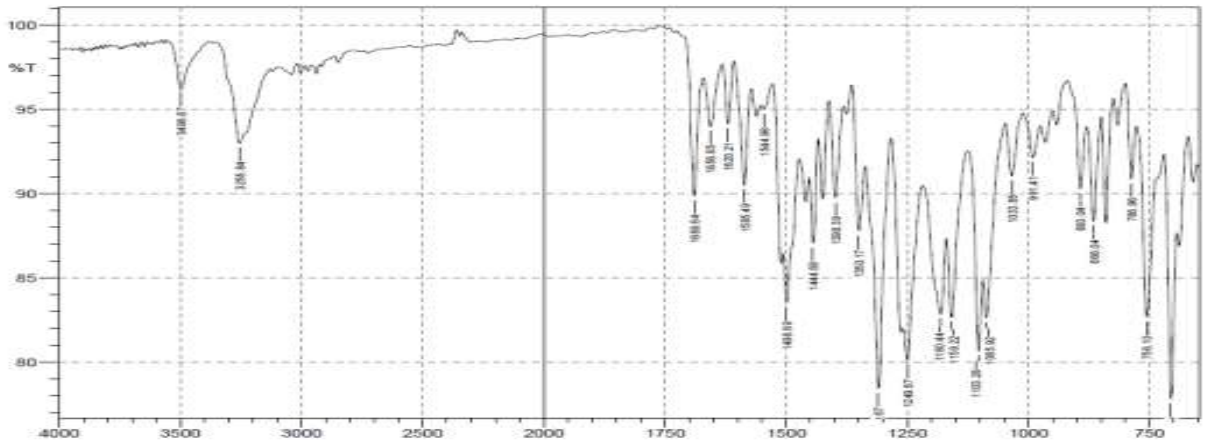
Result and Discussion

FTIR spectra

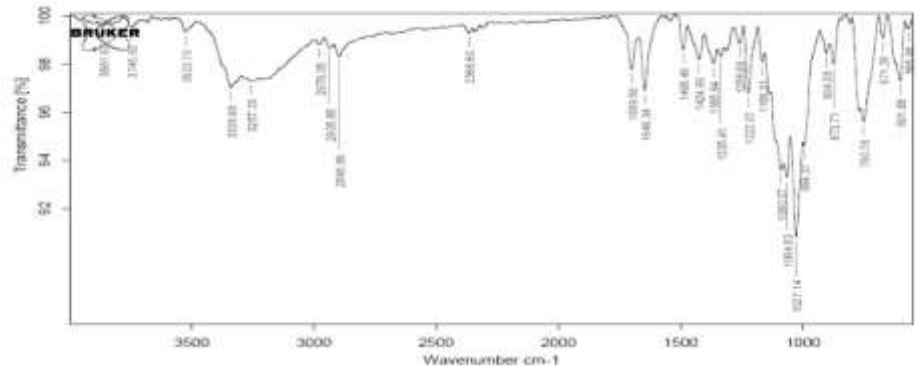
Fourier Transform Infrared (FTIR) spectroscopy

Studies were conducted on both the pure drug and the optimized formulations F3, F6, and F9. The findings indicated that there was no interaction observed between the drug and the excipients used in the formulations.

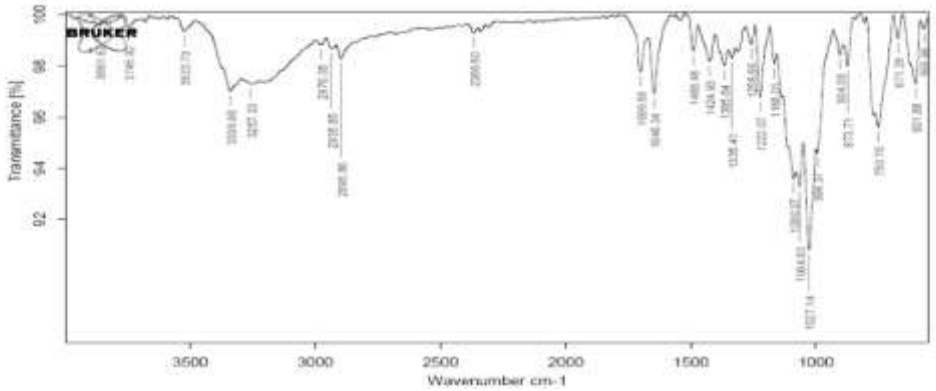
FTIR of isradipine pure drug



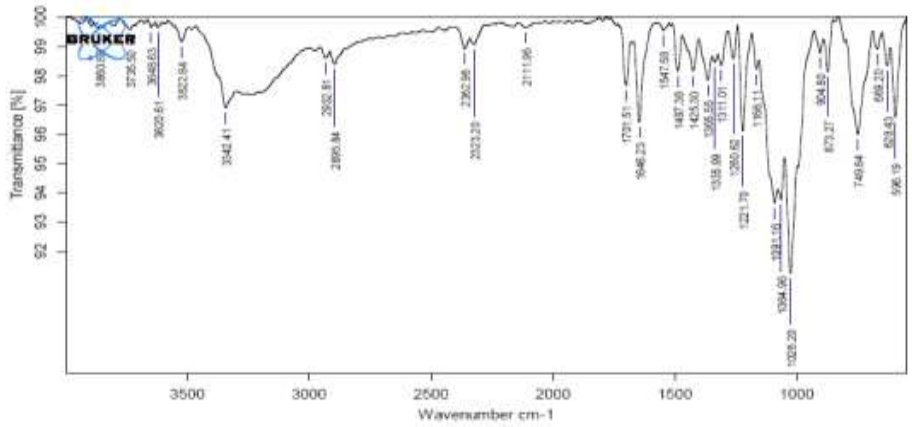
FTIR of optimized formulation F3



FTIR of optimized formulation F6



FTIR of optimized formulation F9



PRE COMPRESSION PARAMETERS

The Micromeritic properties (bulk density, tapped density, hausner's ratio, compressibility index andangle of repose) of the formulated powder blends.

Bulk density and tapped density

Bulk density and tapped density for all formulations varied from 0.31±0.04 to 0.48±0.01 gm/ml and 0.40±0.03 to 0.59±0.04 gm/ml respectively. The obtained figures lie within acceptable range and a large difference does not exist between the bulk density and tapped density.[17]

Hausner's ratio Hausner's ratio was determined from bulk density and tapped density. The Hausner's ratios lie between 1.5±0.06 to 1.27±0.05 According to USP specifications all formulation blends showed good flow properties.[17]

Compressibility index The percentage compressibility of powder was determined using Carr's compressibility index. Compressibility index values determined were within 15.00±1.10 to 22.05±0.80 demonstrating good compressibility.

Angle of repose The values for angle of repose of powder ranging within 27.8±0.45 to 28.8±0.68 indicating good flow property.[14]

Formulation code	Bulk Density(gm/ml) Mean±SD n=3	Tapped Density (gm/ml) Mean±SD n=3	Hausner's ratio Mean±SD n=3	Compressibility Index Mean±SD n=3	Angle of repose (^{o}) Mean±SD n=3
F1	0.37±0.01	0.44±0.04	1.18±0.02	15.90±1.14	28.6±0.59
F2	0.38±0.02	0.45±0.04	1.19±0.08	16.90±1.12	27.9±0.66
F3	0.33±0.03	0.45±0.04	1.27±0.05	21.42±1.13	27.8±0.45
F4	0.32±0.05	0.41±0.05	1.26±0.04	21.95±0.75	28.4±0.45
F5	0.31±0.04	0.40±0.03	1.24±1.1	22.05±0.80	28.6±0.70
F6	0.34±0.01	0.40±0.09	1.17±0.09	15.00±1.10	28.3±0.80
F7	0.35±0.02	0.43±0.07	1.22±0.05	18.6±0.34	28.8±0.68
F8	0.47±0.02	0.57±0.05	1.5±0.06	17.54±0.58	27.9±0.58
F9	0.48±0.01	0.59±0.04	1.22±0.06	18.6±1.11	27.8±0.99

POST COMPRESSION PARAMETERS

Weight variation, hardness, thickness, diameter and friability of floating tablet

As per usual protocol, the produced tablets were evaluated for percent weight variation, hardness, thickness, diameter, and friability. All 9 formulations exhibited good results in terms of weight variation (ranging from 2.75 to 3.96 percent), hardness (ranging from 4.34 to 5.25 kg/cm2), thickness (4.4-4.6mm), and friability (ranging from 0.22-0.41 %) according to pharmacopoeial standards[13,10]

Formulation code	Weight variation (%) Mean±SD n=3	Hardness (Kg/cm^2) Mean±SD n=3	Thickness (mm) Mean±SD n=3	Diameter (mm) Mean±SD n=3	Friability (%) Mean±SD n=3
F1	3.66 ±0.33	5.25±0.11	4.4±0.650	11.21±0.011	0.22±0.02
F2	3.96 ±0.30	5.11±0.41	4.5±0.759	11.21±0.010	0.41±0.02
F3	3.34± 0.50	5.1±0.31	4.6±0.161	11.21±0.010	0.37±0.08
F4	3.91± 0.53	5.1±0.23	4.5±0.813	11.21±0.012	0.33±0.03
F5	2.91± 0.34	5.11±0.10	4.5±0.651	11.21±0.014	0.32±0.01
F6	3.72± 0.31	5.12±0.32	4.6±0.521	11.21±0.012	0.40±0.06
F7	2.92± 0.40	5.11±0.24	4.4±0.570	11.21±0.013	0.32±0.04
F8	3.21± 0.36	4.34±0.51	4.5±0.090	11.22±0.013	0.41±0.03
F9	2.75± 0.61	4.40±0.71	4.6±0.521	11.21±0.012	0.37±0.08

Floating behavior & floating duration time

The floating lag time of the tablets were measured by immersing the tablets in 500ml of 0.1N HCl, pH 1.2. The floating duration of time and tablet density by which all the formulations remain buoyant were noted. Drug content was determined by UV spectrophotometer using methanol as solvent (at 332 nm). The detail of outcome is depicted in Table[17,20]

Formulation code	Tablet density (gm/cm2)	Floating lag time (sec)	Floating duration(hrs)	Drug Content (%)
F1	0.97 ±0.01	47±0.02	11±0.05	97.48±0.005
F2	0.97 ±0.01	50±0.02	11±0.12	97.37±0.003
F3	0.93 ±0.02	52±0.04	12.5±0.1	98.28±0.030
F4	0.96± 0.02	40±0.06	12.50±0.03	97.87±0.031
F5	0.90 ±0.03	45±0.02	12.49±0.11	99.77±0.004
F6	0.93± 0.03	55±0.03	12.20±0.13	98.01±0.005
F7	0.97 ±0.04	53±0.02	12.50±0.11	97.00±0.007
F8	0.95 ±0.04	57±0.04	11±0.1	97.17±0.004
F9	0.97 ±0.03	53±0.03	11.12±0.12	98.56±0.005

Swelling index study of Isradipine

Swelling studies were performed in order to investigate the molecular properties of swollen polymers. The swelling index of tablets was calculated by immersing them in 100 ml of 0.1 N HCl pH 1.2 and removing them

after 1, 2, 4, 6, and 8 hours, for each time point. The swelling index was computed using the conventional method.[11,7]

Swelling index = (Wt. of wet tablet – Wt. of dry tablet) / Wt. of dry tablet ×100

Formulation code	Swelling index of formulated floating tablets					
	0h	1h	2h	4h	6h	8h
F1	0	75.71	111.41	133.79	157.98	192.78
F2	0	65.05	93.05	122.62	143.16	162.27
F3	0	74.44	96.2	119.69	156.15	163.33
F4	0	67.57	113.23	133.3	165.35	169.41
F5	0	62.95	95.1	116.97	148.75	170.94
F6	0	64.22	69.47	80.75	112.38	175.44
F7	0	99.54	130.89	156.67	183.19	202.62
F8	0	95.66	114	127.01	142	150.32
F9	0	89.5	100.36	113.5	127.54	135.33

In vitro drug release study:

All of the tablets were subjected to a 12-hour in vitro dissolution study utilizing the USP basket apparatus at 50 rpm and 0.1 N HCl as the dissolution media. The overall percentage of drug release was calculated and depicted graphically[11]

Formulation Code	% Cumulative drug release											
	0h	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	11h	12h
F1	0	1.38	6.92	11.08	18.02	23.58	30.52	38.87	49.99	58.35	68.11	76.49	82.11
F2	0	2.76	8.31	12.473	22.18	27.74	34.69	44.42	54.16	66.69	77.84	80.69	90.47
F3	0	11.07	19.39	26.34	37.44	43.02	49.99	54.20	62.57	75.10	83.49	94.66	98.15
F4	0	9.69	15.24	27.72	34.67	44.40	48.60	52.81	57.02	61.24	76.54	89.08	97.49
F5	0	8.30	15.24	23.56	31.89	40.24	48.59	58.34	66.71	76.47	83.48	93.27	94.75
F6	0	12.46	20.78	33.26	38.84	45.80	54.16	65.30	72.3	80.68	87.7	93.33	97.97
F7	0	11.07	19.39	24.95	34.67	41.63	54.14	62.51	69.50	79.27	84.90	93.30	97.56
F8	0	6.92	11.08	15.25	20.80	30.52	37.47	44.44	59.72	65.32	73.70	82.09	87.72
F9	0	12.46	19.39	26.34	34.68	38.87	45.83	54.19	63.94	69.55	76.55	82.18	89.19

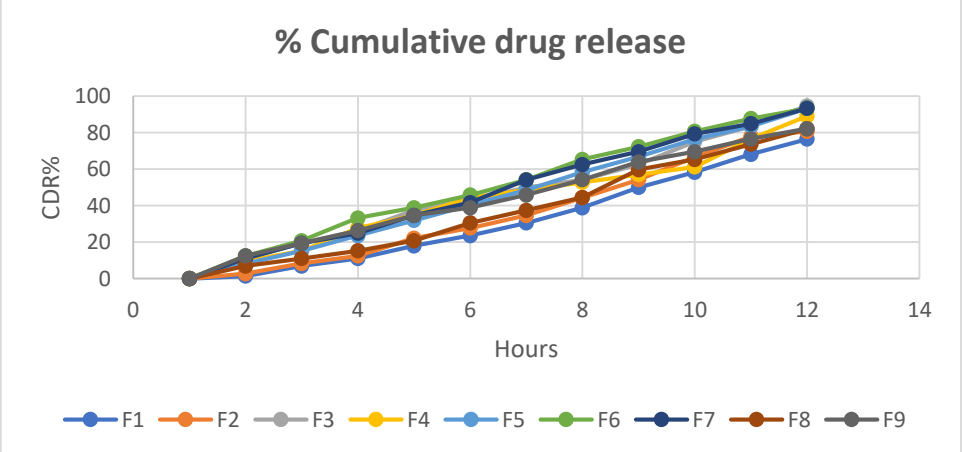


Figure: 5 % Cumulative drug release

Kinetic modeling of drug

In this study, various release kinetic models, including zero order, first order, the Higuchi model, and the Korsmeyer Peppas release model, were examined. The Higuchi model exhibited a good fit to all dissolution profiles across formulations, with regression coefficient R^2 values ranging from 0.92 to 1. Changes in polymer concentration minimally affected the regression results. As the Higuchi model best predicted the cumulative drug release, it suggests diffusion and erosion mechanisms rather than zero order. Results from the Korsmeyer-Peppas equation indicated diffusion exponent "n" values.[18,19]

Sl.no	Batch No	Zero order		First order		Higuchi		korsmeyer peppas	
		R^2	k	R^2	k	R^2	k	n	k
1	F1	0.4981	0.0938	0.4942	-0.0009	0.9782	1.3721	0.1279	1.1712
2	F2	0.5814	0.0974	0.5838	-0.0010	0.9740	1.3649	0.1840	1.0947
3	F3	0.5240	0.0976	0.5265	-0.0010	0.9729	1.3784	0.1452	1.1495
4	F4	0.0179	-0.1532	0.0202	0.0018	0.9073	4.6723	0.1439	1.3732
5	F5	0.6732	0.1149	0.6760	0.0012	0.9478	1.4089	0.2451	1.0447
6	F6	0.5047	0.0955	0.5082	-0.0010	0.9761	1.3752	0.1356	1.1639
7	F7	0.4799	0.0939	0.4821	-0.0010	0.9786	1.3814	0.1284	1.1779
8	F8	0.7669	0.1270	0.7691	-0.0013	0.9332	1.4371	0.3946	0.8978
9	F9	0.7244	0.1231	0.7265	-0.0012	0.9375	1.4338	0.3813	0.9125

Figure:6 *In vitro* studies of floating tablet of isradipine

In vitro buoyancy studies

In vitro buoyancy studies were conducted to evaluate the floating behavior of the formulated tablets. These studies involved placing the tablets in a 0.1 N HCl solution maintained at 37 ± 0.5°C to simulate gastric conditions.[17] The floating lag time, defined as the time taken for the tablet to rise to the surface and remain buoyant, was measured. Additionally, the total floating duration, which is the time the tablet remained buoyant, was recorded. Formulations containing varying ratios of karaya gum and HPMC exhibited immediate buoyancy with floating lag times of less than 1 minutes and remained buoyant for over 12 hours.[18] The incorporation of sodium bicarbonate as a gas-generating agent effectively contributed to the buoyancy by releasing CO_2, thus enhancing the gastric retention time of the tablets. These buoyancy characteristics are crucial for ensuring prolonged gastric residence and controlled drug release, enhancing the bioavailability of Isradipine for the treatment of hypertension.[20]

F3	**Duration of Time**			
Formulation Parameters	Initial	1 Month	2 Month	3 Month
Appearance	white	white	white	white

% Weight Variation	3.34± 0.50	3.0±0.23	3.08±0.44	3.2±0.04
Hardness	5.1±0.31	5.3±0.66	5.2±0.66	5.2±0.33
% CDR	98.15±0.031	99.13±0.07	98.83±0.018	98.93±0.02

Stability study data

Conclusion

The research focused on creating floating tablets of Isradipine, leveraging Karaya gum as a natural polymer to prolong gastric retention. Different formulations were developed using the direct compression method, varying concentrations of Karaya gum, HPMC K15M, and sodium bicarbonate. Powder blend evaluations, including bulk and tapped density, angle of repose, and Hausner ratio, were conducted to assess flow properties. The tablets were designed to optimize drug release kinetics, ensuring sustained and controlled release for enhanced therapeutic efficacy in managing hypertension and angina. Furthermore, the study explored the interaction between Isradipine and excipients using FTIR spectroscopy, confirming compatibility. In vitro studies assessed floating behavior, showing immediate buoyancy and prolonged duration in simulated gastric conditions, crucial for improved bioavailability. Stability evaluations demonstrated consistent tablet properties over time, affirming formulation robustness. The research culminated in identifying an optimized formulation with desirable characteristics, promising improved patient outcomes in hypertension treatment.

Conflict of interest The authors declare no Conflict of interest

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