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(RESEARCH ARTICLE)

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Formulation and evaluation of biodegradable floating drug delivery for solubility enhancement of diclofenac sodium

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Abstract

This learning's objective is to determine and investigate how pharmaceutical restrictions affect the characteristics of gastric floating tablets using diclofenac sodium (DICL) as a model for the solubility enhancement, sodium-bicarbonate (NaHCO3) or calcium-carbonate (CaCO3). Hydroxypropyl Methylcellulose (HPMC) as swelling polymer K100M or K15M is a gas-forming substance. BY direct-compression manufacturing is used to create floating DICL tablets. The tablet characteristics, swelling index, and in vitro resistance of compressed tablets were assessed. Under non-reducing circumstances, in vitro release was identified. Molecular interactions have been investigated using Fourier transform infrared spectroscopy and differential scanning calorimetry.

Keywords: Diclofenac sodium; Floating tablets; Gastric Residence Time (GRT); Gastro retentive

1. Introduction

The most popular method of administration is oral. For systemic effects, the route of administration is used. Patients use this stretch often because it is simple to apply and increases compliance. However, oral medication administration was influenced by a number of circumstances, such as: Drug physicochemical, duration of gastric residence (GRT) Drug distribution in the gastrointestinal tract. To increase the medication's bioavailability and lengthen the GRT of the dosage form, a floating drug delivery system (FDDS) has been created [2]. Due to the relatively low density compared to the density of gastric fluid, such a system Dosage form allows stomach contents to float for an extended period of time [3, 4]. The medication is gently released at the proper regulated rate, making it appear as though it is floating over the stomach contents. This results in a greater bioavailability, enhanced therapeutic efficacy, and shorter drug delivery interval, which in turn improves patient compliance [5]. FDDS is crucial for pharmaceuticals in particular. It affects the stomach locally (A). Mostly absorbed in the stomach; poorly soluble at alkaline pH. (D) My absorption window is narrow; (E) Colon environment or intestinal instability [6]. Additionally, the majority of drugs created via FDDS have a brief half-life and are often brief. Simple to dissolve in acidic media. A key component of the FDDS shower system is a swellable polymer, a gas-forming agent [7]. A non-steroidal anti-inflammatory medicine called diclofenac sodium (DICL) is used to treat pain and inflammation. Since DICL has a short half-life, it is often injected numerous times each day to maintain its therapeutic impact. [8]. A relatively weak acidic medication, DICL has a pKa of 4.0 [9]. In a setting with an acidic pH, solubility is quite low. This study intends to develop a creative career. Based on effervescent Diclofenac tablets with sustained release gastric retention technology. Diclofenac's bioavailability and general stability have been improved by the use of enteric-coated floating tablets. This method also lessens the need for frequent dosage, which improves patient compliance and lessens the likelihood of adverse effects. Baking soda was used as a gas generator in a dry granulation process based on foaming methods to create the tablets. As hydrophilic swelling polymers, hydroxypropylmethylcellulose (HPMC) and microcrystalline cellulose (MCC) were employed. Citric acid and baking soda were used to control buoyancy and medication release. Five formulations in all were created using various HPMC and MCC concentrations. The drug release from the improved formulation F5 was 33.17% at a floating lag time

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of 12 hours and 40 seconds. Increased polymer concentration can keep the medication release profile consistent, according to in vitro dissolution experiments. According to the study, HPMC might be used with gas generators to create gastric retention floating tablets that totally and gradually release the medicine.

2. Material and methods

Diclofenac sodium was a sample gift from Yash Pharmaceutical Company, Roorkee, India. Hydroxypropyl Methyl cellulose (HPMC K100 LV), crystallites Cellulose (MCC), baking soda, citric acid, Talc, magnesium stearate, polyvinylpyrrolidone (PVP) was available in laboratory SGRRU [Dehradun]. All The ingredients and reagents used were analytical in nature class.

Manufactured using direct compression method, floating tablets containing diclofenac. The formulation was completed using various ones for a total of 6. Microcrystalline Cellulose with Hydroxypropyl Methylcellulose Concentration (5%–25%) (HPMC K100 LV) (MCC). Citric acid was combined with PVP, magnesium stearate, talc, and added in a certain quantity. Formulation for use in medicine. In Table 1, the composition of all formulations is displayed.

2.1. Evaluation parameters of diclofenac sodium

2.1.1. Weight variation

20 tablets from each batch of drug randomly selected and individually weighed. The average weight is calculated, then compare to your individual weight. After that Percentage deviation is determined, then the results obtained were collated with the IP specifications.

2.1.2. Hardness and friability

Tablet hardness was determined by Monsanto 10 randomly selected tablet hardness testers Tablets from each batch. The fragility test Played by Roche Friabilator. 20 tablets Wklmeighed and put in a Wrap friabilator chamber that rotates at 25 rpm Drop tablets 6 inches high the tablets were dusted and reweighed for 4 minutes on each revolution to determine the percentage of crushability. Calculated after 100 rotations.

Formula…

$$\% \text{ Friability} = \frac{Wi - Wf}{Wi} \times 100 \ldots 1$$

Where

W_i= initial weight of tablets
W_f= final weight of tablets

2.1.3. Drug content

By crushing 10 tablets, the active component content of the produced diclofenac float tablets was ascertained. Comparable quantity of powder Diclofenac can be weighed up to 15 mg; transfer to a 100 mL volumetric flask. The volume was then carefully blended while being adjusted with ethanol. Alternatively, the fluid underwent pore-size (0.45) m filtration. The absorbance of the resulting solution was measured after diluting 10 ml of the obtained solution to 100 ml with ethanol. Using a Thermo Fisher UV-visible Spectrophotometer, UV visible at 275 nm. This linear equation was found. Used to calculate the dosage of Diclofenac in tablet form using the calibration curve [13, 14].

2.1.4. Tablet sizes

Tablet dimensions (thickness and diameter) I used a calibrated calliper to measure and consumed three pills of each formulation. Standard deviation and randomness Calculated [12]

2.1.5. In vitro buoyancy study

Place the ready diclofenac swimming lock in the water. In a 100mL beaker, add 0.1NHCl to the dissolution media. Duration for a tablet Rising to one-third of the resolution's surface, the medium's floating lag time was identified (FLT). Moreover, how long the tablet has been left alone Floating on the dissolving medium's surface is measured as total floating time (TFT) [13, 15].

2.1.6. In vitro dissolution study

Studies on in vitro dissolution USP Type II (Paddle) device operating at 100 revolutions per minute. Or a lysis jar was used to hold the tablets. Contains a solution of 900 ml of 0.1N HCl. media that keeps the temperature at 37.25 degrees Celsius. Five ml of a sample were drawn at a certain time point and exchanged for new Resolution media after a 12-hour delay. Sample absorbance was measured using a UV spectrophotometer at 275 nm. Release analysis 3 pills were used, with an average result. In opposition to time [13].

Table 1 All Dicloenac Sodium Floating Tabs' Formula Composition

INGREDIENTS [mg]	F-1	F-2	F-3	F-4	F-5	F-6
DICLOFENAC SODIUM	100.00	100.00	100.00	100.00	100.00	100.00
HPMC	40.00	50.00	60.00	70.00	80.00	90.00
PVP	9.25	9.25	9.25	9.25	9.25	9.25
SODIUM BICARBONATE	37.50	37.50	37.50	37.50	37.50	37.50
MG. STERATE	1.25	1.25	1.25	1.25	1.25	1.25
TALC	2.50	2.50	2.50	2.50	2.50	2.50
MCC	52.00	42.00	32.00	22.00	12.00	2.00
CITRIC ACID	7.5	7.5	7.5	7.5	7.5	7.5

3. Results and Discussions

Table 2 Organoleptic Properties

Color	White fine powder
Odor	Odourless
Taste	Bitter
Melting point	285-2900C

3.1. Melting point

Melting point was noted in triplicate and was found to be 285-290°C. It was similar to the pharmacopoeial standards. PH of Diclofenac Sodium solution (1%w/v) PH of 1%w/v solution of Diclofenac Sodium was found to be 6.8, which complies with standard pH value mentioned in pharmacopoeia.

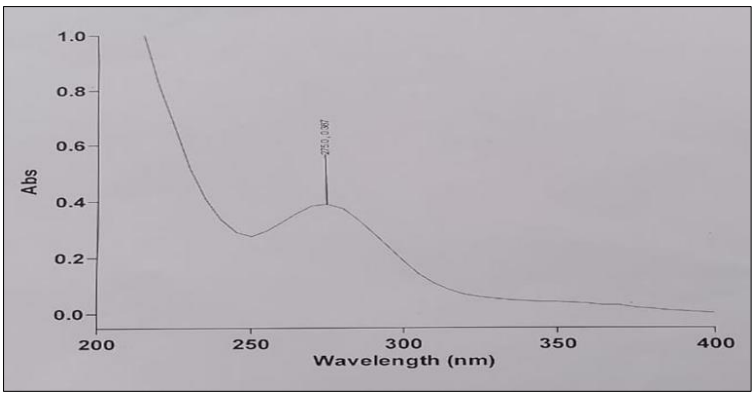

Figure 1 λmax of diclofenac sodium

The pre-formulation studies are the first step in the development of any formulation. The goal of this study is to establish physical characteristics. The absorption maxima shows the λ max at 275nm.

Table 3 Evaluation of Various Parameters from F1-F6

Batches	Wt. Variation	Thickness	Hardness	Friability	Drug content	Floating lag time
F1	250.75mg	4.1nm	2.5 kg/cm^2	1.84%	91.11%	68sec
F2	249.62mg	4.2nm	4.5 kg/cm^2	2.21%	98.12%	67sec
F3	250.51mg	4.1nm	5 kg/cm^2	3.97%	97.11%	66sec
F4	251.71mg	4.3nm	3.5 kg/cm^2	1.62%	96.44%	40sec
F5	249.61mg	4.3nm	4.5 kg/cm^2	4.15%	97.54%	45sec
F6	250.52mg	4.1nm	3 kg/cm^2	4.07%	96.21%	40sec

Table 4 *In Vitro* Dissoluation Study Of Formulation - 1

Model Fitting		Actual	%DR predicted by model fitting				
S. No.	Time	Avg. %DR	Zero	1st order	Matrix	Peppas	Hix.Crow.
1	0	0.00	0.00	0.00	0.00	0.00	0.00
2	5	0.44	1.27	0.58	7.63	2.79	1.31
3	10	1.55	2.54	1.16	10.79	7.55	2.61
4	15	2.90	3.81	1.73	13.21	13.50	3.90
5	20	4.26	5.08	2.30	15.26	20.41	5.18
6	25	5.67	6.35	2.87	17.06	28.11	6.44
7	30	6.93	7.62	3.44	18.69	36.51	7.70
8	35	8.28	8.89	4.00	20.19	45.55	8.94
9	40	9.61	10.16	4.55	21.58	55.18	10.17
10	45	10.92	11.43	5.11	22.89	65.34	11.39

Table 5 *In Vitro* Dissoluation Study Of Formulation - 3

Model Fitting		Actual	%DR predicted by model fitting				
S .No.	Time	Avg. %DR	Zero	1st order	Matrix	Peppas	Hix.Crow.
1	0	0.00	0.00	0.00	0.00	0.00	0.00
2	5	0.23	1.07	0.48	6.92	2.56	1.10
3	10	0.86	2.14	0.97	9.79	8.19	2.19
4	15	1.80	3.21	1.45	11.99	16.14	3.27
5	20	2.99	4.29	1.93	13.84	26.14	4.35
6	25	4.22	5.36	2.40	15.48	37.98	5.41
7	30	5.42	6.43	2.87	16.95	51.54	6.47
8	35	6.64	7.50	3.35	18.31	66.71	7.52
9	40	7.88	8.57	3.81	19.58	83.43	8.57
10	45	9.14	9.64	4.28	20.76	101.62	9.60

Table 6 *In Vitro* Dissoluation Study Of Formulation - 6

Model Fitting		Actual	%DR predicted by model fitting				
S. No.	Time	Avg. %DR	Zero	1st order	Matrix	Peppas	Hix.Crow.
1	0	0.00	0.00	0.00	0.00	0.00	0.00
2	5	0.11	0.62	0.28	5.29	1.96	0.63
3	10	0.37	1.24	0.55	7.49	6.75	1.26
4	15	0.78	1.87	0.83	9.17	13.92	1.89
5	20	1.35	2.49	1.10	10.59	23.25	2.51
6	25	2.04	3.11	1.38	11.84	34.62	3.13
7	30	2.85	3.73	1.65	12.97	47.92	3.75
8	35	3.71	4.36	1.92	14.01	63.09	4.36
9	40	4.48	4.98	2.19	14.97	80.06	4.98
10	45	5.38	5.60	2.46	15.88	98.78	5.59

Table 7 Partition Coefficient

Concentration (µg/ml)	Absorbance
1	0.0289
2	0.0363
3	0.0531
4	0.0737
5	0.0914

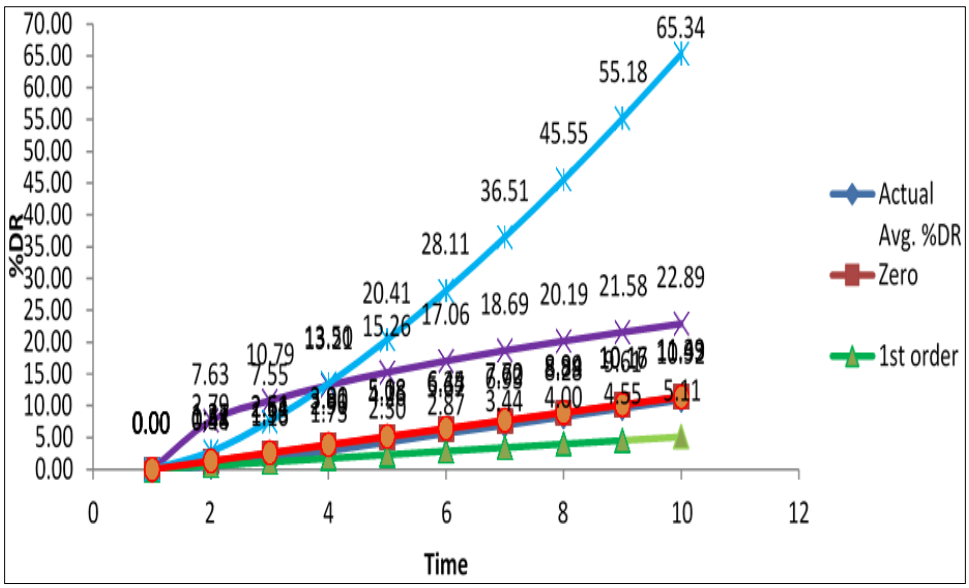

Figure 2 *In-Vitro* Dissolution Study-F1

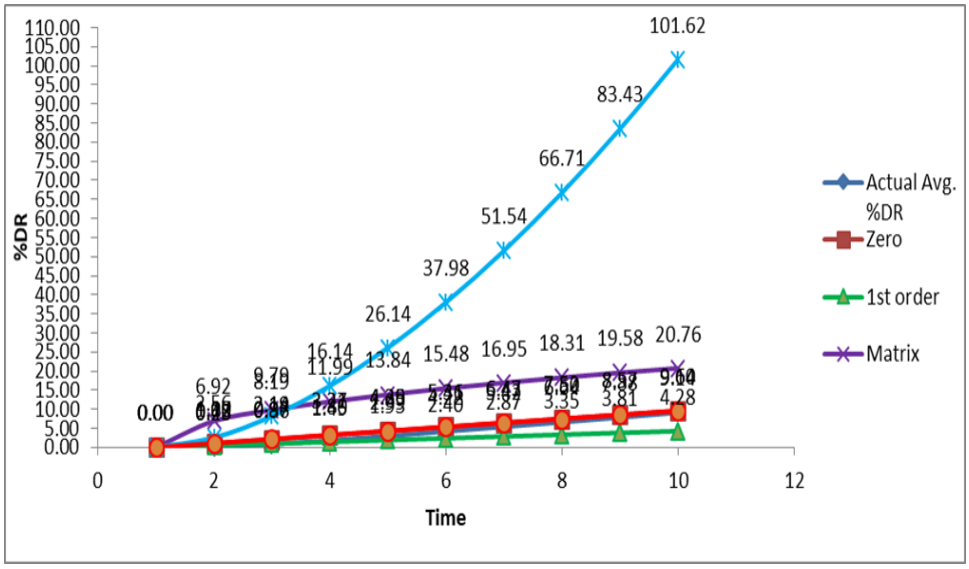

Figure 3 *In-Vitro* Dissolution Study-F3

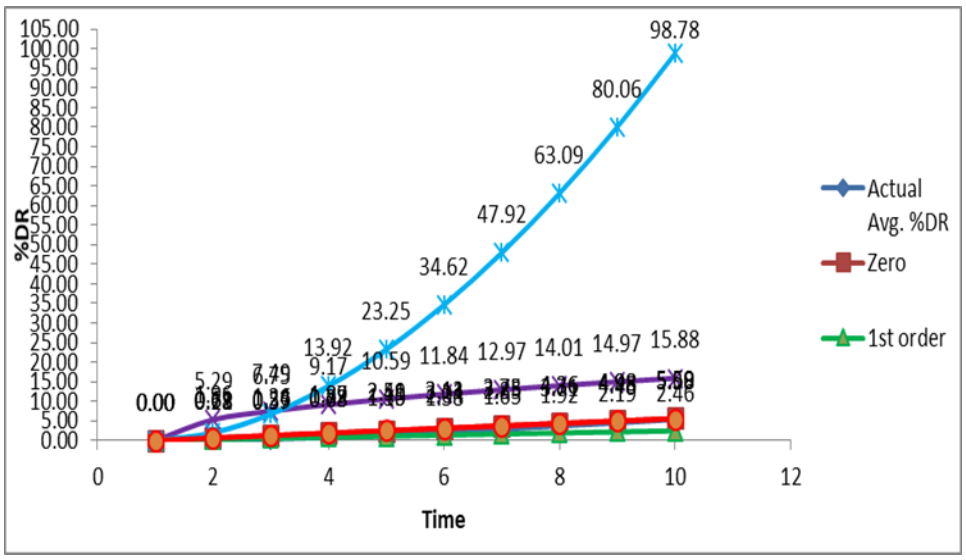

Figure 4 *In-Vitro* Dissolution Study-F6

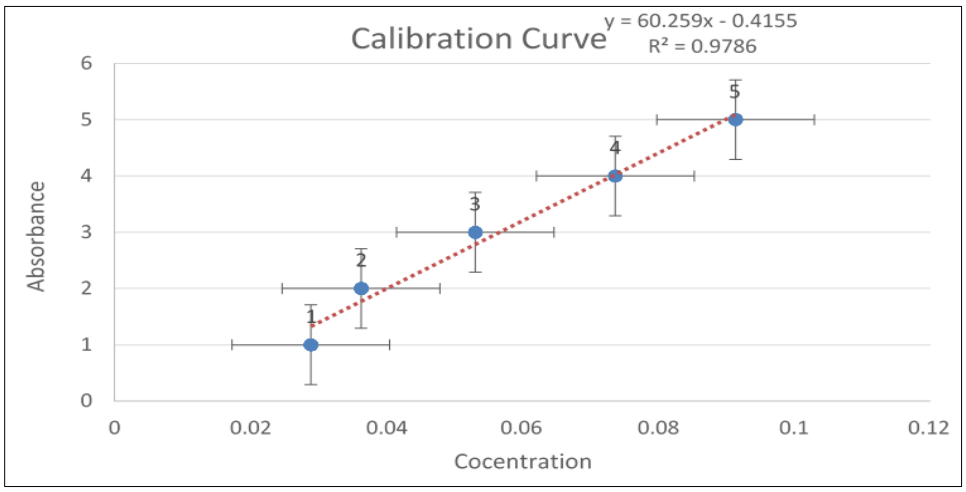

Figure 5 *Partition Coefficient*

3.2 in vitro buoyancy test

- At the initial time
- At 40 secs
- After 24 hrs

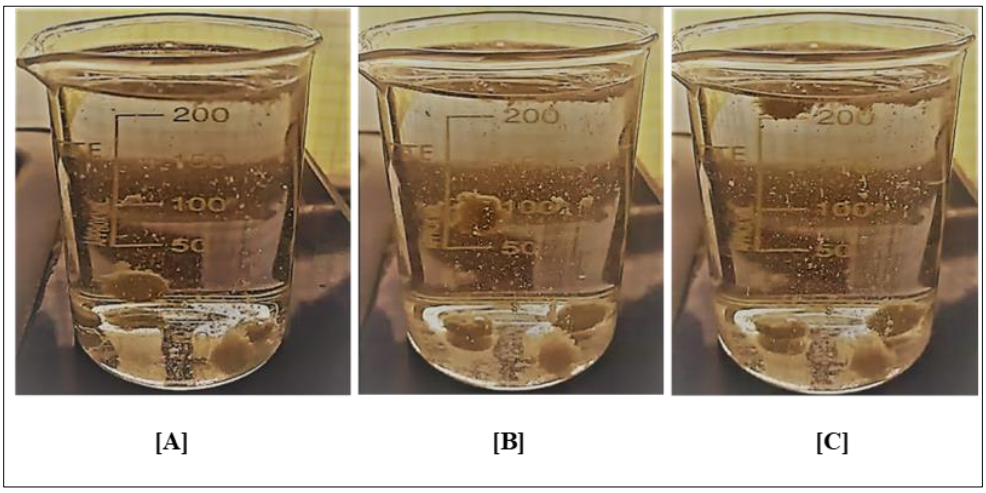

Figure 6 *In vitro buoyancy test of formulation*

These tablets were dissolved in 100ml in water, & the amount of time needed to completely dissolve it was recorded. Two tablets were randomly chosen from each batch of formulation, and an in-vitro dispersion test was performed.

4. Conclusion

The process of a medicine being absorbed in the gastrointestinal system is extremely varied, and the lengthening of stomach retention of the dosage form increases the amount of time the drug will be absorbed. In order to increase the bioavailability and manage the distribution of numerous medications, gastro-retentive floating drug delivery devices have become more popular. In order to maximize the delivery of molecules that display an absorption window, limited bioavailability, and substantial first pass metabolism, an increase in the number of gastroretentive drug delivery will be developed. Gastric retention may be addressed with FDDS. Many businesses are working to commercialize this approach, despite the fact that there are still a number of issues that need to be resolved in order to accomplish sustained gastric retention.

Compliance with ethical standards

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Disclosure of conflict of interest

All the author suggests there is no conflict of interest.

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