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Research Article

Formulation and Evaluation of Bilayered Floating Tablets of Aceclofenac

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Abstract

The objective of this study was to create and assess homogeneous bilayered floating tablets of aceclofenac in order to increase the drug's bioavailability and prolong its stomach release. One of the nonsteroidal anti-inflammatory drugs (NSAID) common side effects is poor solubility and minimal stomach retention, which makes it difficult to treat effectively. As matrix-forming polymers, ten formulations (F1–F10) were made with different amounts of HPMC K15 and additional excipients. Physical properties, buoyancy, in vitro drug release, and kinetic modelling were evaluated for each formulation. With a floating lag time of less than one minute and buoyancy maintained for more than 12 hours, Formulation 5 (F5) showed the most promising findings. With 97.01% of aceclofenac released over 12 hours, it showed a regulated drug release pattern that followed the Korsmeyer-Peppas release model well (R^2 = 0.9242). Pre-compression and post-compression values for the optimised formulation F5 were adequate, suggesting good flow characteristics and tablet integrity. FTIR spectroscopy was used to verify the drug-excipient compatibility, guaranteeing stability and the lack of interactions. According to these results, aceclofenac's homogenous bilayered floating tablets, specifically formulation F5, may be able to improve gastric retention time and offer a sustained release profile. This could mean that the medication can be used to treat chronic inflammatory conditions more effectively and with better patient compliance.

Keywords: gastric retention, bioavailability, drug excipient compatibility.

INTRODUCTON

The most common and recommended route of administering medication is orally. Because of its self-medication capabilities, patient compliance, convenience of administration, and variety of available dose forms, this route is well-known. The most practical oral dose form on the market, tablets are preferred by both physicians and patients. Novel formulations with altered medication release rates are being investigated in order to meet present needs. Formulations with controlled release are among them. To extend or maintain the dissolution of the formulation, they administer the drug at a predefined pace and location.[1-3].

The best formulation for a medication delivery device that delivers many pharmaceuticals is a bilayered tablet. Bilayer tablets, which combine many properties to enable drug administration, mark the beginning of a new chapter in the successful development of medication with controlled release formulations. The ideal solution for preventing chemical incompatibilities across APIs and facilitating the creation of various drug release patterns could be bi-layer tablets. Two medications can be delivered consecutively using bilayered tablets, where one layer offers extended release and the other provides quick release[4-5].

For anti-hypertensive, diabetic, anti-inflammatory properties, and analgesic drugs—many of which require combination therapy to be effective—the usage of bilayer tablets is significantly different[6].

With the use of innovative tablet technology, bilayer tablets allow for the simultaneous administration of one or more medications with varying rates of release. It is feasible to manage more than one rate-regulating polymer by layering different medications with them, which enables the distribution of different drugs.[7].

They have a sandwich-like appearance because of the exposed edges of each layer. When it comes to preventing chemical incompatibilities across APIs and enabling the creation of distinct drug release patterns, bi-layer tablets could be the best option. When two combination medications are released sequentially, bi-layer tablets are suitable. The loading dosage is found in the first layer of sustained-release tablets, whereas the maintenance dose is found in the second layer[8].

Bilayer tablet usage is significantly different for antihypertensive, diabetic, anti-inflammatory, analgesic, and antibiotic medications since these medications typically need combination therapy to be successful.[9].

A flexible result of monolithic partly coated or multilayered matrices is the bilayer tablet. In the case of bi-layered tablets, medication release can be rendered nearly unidirectional by placing the drug in the upper non-adhesive layer, where it is distributed throughout the mouth cavity.[10].

A combination of the bilayer tablet and floating technique is the floating bilayer drug delivery device. Floating bilayer matrix tablets are perfect for the sequential release of two drugs in combination, the separation of incompatible substances, and sustained release tablets. In the latter case, the second layer contains either the sustained-release dose of a different drug or the maintenance dose of the first drug, with the first layer being released immediately as the initial dose. Floating systems in bilayered layers are designed to help the formulation stay in the

stomach; these work especially well for drugs that are unstable or insoluble in intestinal fluids. Drugs are released by floating drug delivery devices gradually and at a regulated pace over a lengthy period of time while floating in the stomach [11].

Types of Bilayer Tablets

Heterogeneous (different) and homogeneous (same) bilayer tablets are also possible.

Homogenous type: Bilayer tablets with two distinct drug release profiles but the same drug in each layer. These tablets are bilayer, with an immediate release layer on one side and a prolonged release layer on the other[12].

Heterogeneous type: A bilayer tablet can be used to segregate two chemicals that are incompatible or to continuously release two medications in conjunction.

It's critical to choose a bi-layer tablet press with a high yield in order to make high-quality tablets in a verified and GMP manner.

- Preventing the bilayer tablet's two separate layers from capping and separating.
- Preventing the two layers from becoming contaminated by each other.
- Encouraging the two layers to be visibly separated from one another.
- Precise and distinct control over the two layers' weights [13-14]

MATERIALS AND METHODS

Table 1: Materials used in present investigation

S. No.	Materials	Name of the supplier
1.	Aceclofenac	UV scientific research lab
2.	HPMC K15	UV scientific research lab
3.	Na CMC	UV scientific research lab
4.	Methyl cellulose	UV scientific research lab
5.	Ethyl cellulose	UV scientific research lab
6.	Crospovidone	UV scientific research lab
7.	MCC	UV scientific research lab
8.	Lactose	UV scientific research lab
9.	Magnesium stearate	UV scientific research lab
10.	Talc	UV scientific research lab

All other chemicals used in the study were procured from local market and used without further purification.

Table 2: Equipment and instruments used

S. No.	Instruments	Source
1.	Electronic balance	SCALETEC Model SAB203L
2.	UV/Visible Spectrophotometer	UV Spectroscopy T-60
3.	FTIR Spectrophotometer	Globe scientific instruments
4.	Sonicator	Analab scientific instruments Pvt. Ltd
5.	Mortar and pestle	Stanford advanced materials
6.	USP Dissolution Apparatus	LABINDIA Instruments Pvt. Ltd
7.	Hot Air Oven	BIO-TECHNICS INDIA
8.	Bulk Density Apparatus	BIO-TECHNICS INDIA
9.	pH meter	GLOBE
10.	Compression unit	Cemach Machineries Ltd.
11.	Sieves	Swastik scientific intruments
12.	Friabilator	Milton enterprises
13.	Monsanto hardness tester	LABGO
14.	Tablet Disintegration Test Apparatus IP	Sunshine scientific equipments

PREFORMULATION STUDIES

Standard Curve of Aceclofenac:

Preparation of 0.1 N HCl

85 ml of concentrated hydrochloric acid was diluted up to 1000 ml with distilled water. 10 ml of resulting solution was further diluted to 100 ml with distilled water.

Scanning of Aceclofenac in 0.1 N hydrochloric acid (HCl)

The solution containing 10 g/ml of Aceclofenac in 0.1 N HCl was prepared and scanned over the wavelength range of 200 nm to 400 nm against 0.1 N HCl as a blank using double beam UV spectrophotometer. The plot of absorbance v/s wavelength was recorded using double beam UV spectrophotometer.

Preparation of standard curve in 0.1 N HCl

An accurately weighed quantity of Aceclofenac (100mg) was dissolved in 100 ml of 0.1 N HCl to generate a stock solution having concentration of 1mg/ml. 2 ml of stock solution was further diluted to 100 ml to produce standard solution having

concentration of 20g/ml. The standard solution was serially diluted with 0.1 N HCl to get working standard solution having concentration of 2, 4, 6, 8, 10, 12, 14, 16, 18, and 20 g/ml. The absorbance of the solutions was measured at 275 nm using double beam UV visible spectrophotometer against 0.1 N HCl as a blank. The plot of absorbance v/s concentration (µg/ml) was plotted and data was subjected to linear regression analysis in Microsoft Excel.

Compatibility FTIR Studies

Approximately 300mg of KBr was weighed and grind to a fine powder, and then approximately 1mg of pure drug/ combination of drug excipients was added and grinded well to mix the sample with the KBr and then press this KBr mixer and made a palate by using IR press at the pressure 80 tons.

Drug Identification Test:

Physical Appearance:

The physical characteristics of aceclofenac were appearance, colour, and odour. Each of these physiological markers was noted and its value was compared to existing research.

Organoleptic Character:

Table Org3:anoleptic Character

Colour	A white to almost white in colour
Taste	Bitter
State	Fine to crystal powder

Solubility Profile of Aceclofenac:

Solubility may be defined as the spontaneous interaction of two or more substances to form a homogenous molecular dispersion. Preformulation solubility analysis was done, which include the selection of suitable solvent system to dissolve the respective drug. The solubility of Aceclofenac was determined in different solvents. An excess quantity of the drug was added in 10 ml of each solvent in screw capped glass test tubes and shaken for 12 hours at room temperature. The solution was filtered, diluted and the solubility was determined by spectrophotometrically.[16]

Table 4: Solubility Profile of Aceclofenac

S. No.	Solvents	Solubility
1.	Distilled water	Practically insoluble
2.	Ethyl ether	Slightly soluble
3.	Methanol	Freely soluble
4.	Ethanol	Freely soluble

EXPERIMENTAL WORKS

Preparation of Bilayer Tablets [17-20]

Bilayer tablets are made with one layer of medication intended for quick release and another layer intended for a delayed release of the medication in the form of an extended-release formulation or a second dose8. In order to reduce the area of contact between two layers, distinct layers of each medicine can also be compressed to create bilayer tablets containing two incompatible pharmaceuticals. It's also possible to add an extra inert material intermediate layer.

Particular requirements, such having enough mechanical strength and the proper drug release profile, must be addressed in order to generate an acceptable tablet formulation. Sometimes it can be challenging for the formulator to meet these requirements, particularly when creating bilayer tablets and using the double compression approach. This is because the drug's poor flow and compatibility characteristics might lead to lamination or capping. A material's consolidation and compressibility are both factors in its compaction.

Compression: It is described as a decrease in bulk volume achieved by removing voids and putting particles closer together.

Consolidation: It is the characteristic of the material whereby interparticulate contact (bonding) results in an increase in mechanical strength. It was discovered that a significant element impacting tablet delamination was the compression stress on layer 1.

Formulation of Floating Tablets of Aceclofenac

When it comes to drug delivery systems (DDS), the term "new" refers to a need-driven quest for something. The goal is to optimise therapy while maximising patient comfort and minimising the drawbacks of the current dose form (DF). The phrase "drug delivery system," which is more recent than "dosage form," is used to characterise a drug-carrying mechanism. Creating a formulation with maximal bioavailability that is stable, safe, and efficacious is the primary goal of this phase. The traditional direct compression process was utilised to make the tablets.

Preparation of Floating Tablets

The direct compression method is being used in the present effort to create floating tablets. Before being evenly mixed using a mortar and pestle, the active ingredients, such as HPMC K15, sodium carboxy methyl cellulose, ethyl cellulose, methyl cellulose, and Micro crystalline cellulose, were sieved via sieve number 60. A rotating tablet punch machine was used to compress the powder into tablets after talc and magnesium stearate were added as lubricants.

Table 5: Formulation composition of sustained release layer

Ingredients (mg/tablet)	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Aceclofenac	100	100	100	100	100	100	100	100	100	100
HPMC K15	5	10	15	15	20	10	5	8	10	5
Sodium CMC	20	25	10	15	20	20	20	25	30	15
Ethyl cellulose	30	25	20	5	8	25	30	5	10	30
Methyl cellulose	10	--	5	5	2	5	10	2	10	15
MCC	25	30	40	50	40	30	25	50	30	25
Mg. stearate	5	6	7	8	9	10	--	1	2	3
Talc	5	4	3	2	1	--	10	9	8	7
Total	200	200	200	200	200	200	200	200	200	200

Table 6: Formulation composition of immediate release layer

Ingredients (mg/tablet)	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
Aceclofenac	50	50	50	50	50	50	50	50	50	50
Lactose	40	35	30	40	33	37	40	30	39	40
Crospovidone	10	8	6	5	9	7	4	10	9	3
Talc	5	7	5	5	8	6	16	10	2	7
Total	100	100	100	100	100	100	100	100	100	100

EVALUATION OF TABLETS

Pre-compression parameters

Tablets were made from blends by direct compression, dry granulation and wet granulation methods. The quality of tablet, once formulated by rule, is generally dictated by the quality of physicochemical properties of blends. There are many formulations and process variables involved in mixing step and all these can affect the characteristics of blend produced. The characterization of mixed blend done for the flow property of powder that are bulk density, tapped density, Hausner's ratio, Compressibility index, angle of repose.[21]

Angle of Repose

Angle of Repose was determined using funnel method. The blend was poured through a funnel that can be raised vertically until a maximum cone height (h) was obtained. Radius of the heap (r) was measured and angle of repose (θ) was calculated using the formula.

$$\mathbf{Tan\ (\theta) = h/r;}$$

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

Where, θ is Angle of Repose; h is height of cone; r is radius of cone [22]

Table 7: Angle of Repose as an Indication of Powder Flow Properties

Angle of repose	Type of flow
<25	Excellent
25-30	Good
30-40	Passable
>40	Very poor

Bulk Density

Density is defined as mass per unit volume. Bulk density, ρb, is defined as the mass of the powder divided by the bulk volume and is expressed as g/cm^3. It depends upon particle size distribution, particle shape and the particles adhere together. Apparent bulk density (ρb) was determined by pouring the blend into a graduated cylinder. The bulk density was calculated using the formula

$$\mathbf{\rho b = M/Vb}$$

Where, Vb is bulk volume, M is the weight of the powder

Tapped Density

The measuring cylinder containing a known mass of blend was tapped for a 100 times using density apparatus. The minimum volume (Vt) occupied in the cylinder and the weight (M) of the blend was measured. The tapped density (ρt) was calculated using the formula.[23]

$$\mathbf{\rho t = M/Vt}$$

Hausner ratio

Hausner ratio is an indirect index of ease of powder flow. It is calculated by the following formula.

$$\mathbf{HR = \rho t/\ \rho b}$$

Where ρt is tapped density and ρb is bulk density.

Lower Hausner ratio (< 1.25) indicates better flow properties than higher ones (> 1.25).

Compressibility Index

The simplest way for measurement of free flow of powder is compressibility, an indication of the ease with which a material can be induced to flow is given by compressibility index (I) which is calculated as follows.[24]

$$\frac{(\boldsymbol{I = \ \rho t - \ \rho b})}{\boldsymbol{\rho t}}$$

Where ρt = Tapped density ρb = Bulk density

Table 8: Compressibility Index as an Indication of Powder Flow Properties

Carr's index	Type of flow
>12	Excellent
12-16	Good
18-21	Fair to passable
23-35	Poor
33-38	Very poor
>40	Extremely poor

Post- Compression Parameters [25]

Appearance

The Prepared tablets were identified visually by checking the difference in colour.

Weight Variation

Twenty tablets were randomly selected from each batch and individually weighed. The average weight and standard deviation of 20 tablets was calculated. The batch passes the test for weight variation test if not more than two of the individual tablet weights deviate from the average weight by more than the percentage shown below and none deviate by more than twice the percentage shown. [26]

Table 9: The weight variation tolerance for uncoated tablets

Average weight of tablets (mg)	Maximum percentage difference allowed
130 or less	10
130-324	7.5
More than 324	5

Hardness

Hardness of tablet is defined as the force applied across the diameter of the tablet in order to break the tablet, the resistance of the tablet to chipping, abrasion or breakage under condition of storage transformation and handling before usage depends on its hardness. Hardness of the tablet of each formulation was determined using Monsanto Hardness Tester. It is expressed in kg/cm^2

Friability

Friability of the tablets was determined using Roche friabilator. This device subjects the tablets to the combined effect of abrasions and shock in a plastic chamber revolving at 25 rpm and dropping the tablets at a height of 6 inch in each revolution. Pre weighed sample of tablets was placed in the friabilator and were subjected to 100 revolutions. Tablets were de dusted using a soft muslin cloth and reweighed. The friability (F%) is given by the formula

$$\% \text{ Friability} = \frac{(W1-W2)}{W1} X100$$

Tablet Density

Tablet density is an important parameter for floating tablets. The tablet will float when its density is less than that of 0.1N HCl (1.004). The density was determined using following formula.

$$V = r^2h$$

d = m/v

v = volume of tablet (cm2)

r = radius of tablet (cm)

h = crown thickness of tablet (cm)

m = mass of tablet (mg)

Tablet Thickness

Tablet thickness is an important characteristic in reproducing appearance and also in counting by suing filling equipment. Some filling equipment utilizes the uniform thickness of the tablets as a counting mechanism. Ten tablets were taken and their thickness was recorded using micrometer.

Drug Content of Tablets (Content Uniformity)

Ten tablets were weighed and average weight is calculated. All the ten tablets were crushed in mortar. Powder equivalent to 100mg of ACECLOFENAC was dissolved in 250ml 0.1N HCl and shaken for 20 mins. Solution was filtered and 5 ml filtrate was diluted to the 100ml using a 0.1N HCl. Absorbance of resultant solution is measured at 275 nm using 0.1 N HCl as blank. Amount of drug present in one tablet is calculated. [27]

Buoyancy Lag Time and the Duration of Buoyancy

The buoyancy lag time and the duration of buoyancy were determined in the USP dissolution Apparatus II in an acid environment. The time interval between the introduction of the tablet into the dissolution medium and its buoyancy to the top of dissolution medium was taken as buoyancy lag time or floating lag time and the duration of buoyancy was observed visually.[28]

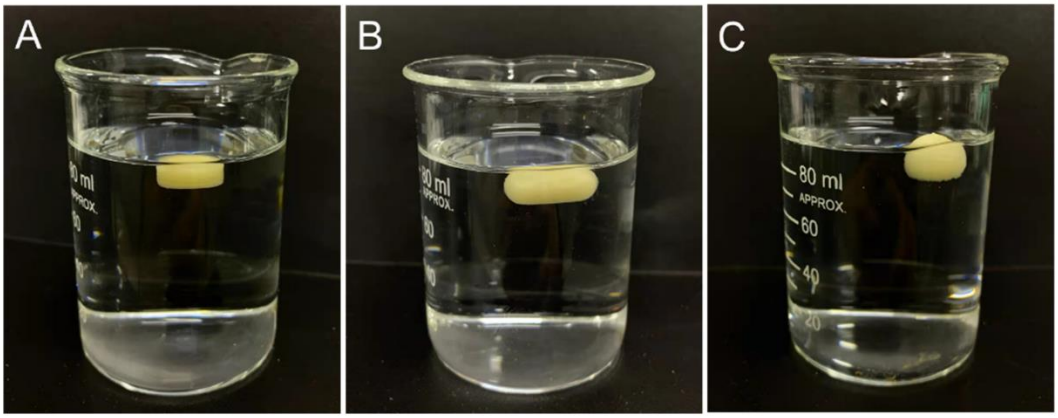

Figure 1: Floating mechanism of bilayered floating tablets of aceclofenac

Swelling index

The swelling index of tablets was determined n 0.1 N HCl (pH 1.2) at room temperature. The swollen weight of the tablets was determined at predefined time intervals. The swelling index was calculated by the following equation: [29]

$$\text{Swelling index} = (Wt - W_0) \times 100$$

Where, Wt = Weight of tablet at time t.

W0 = Initial weight of tablet

In Vitro Dissolution Study

The Release of Aceclofenac was studied using USP dissolution apparatus II. The dissolution medium was 0.1N HCl 900 ml, (37±0.50 C) at 50 rpm. Five ml of a liquid was withdrawn at predetermined time intervals of 1, 2, 3, 4, 6, 8, 10, 12, 14, 16, and 24 h and volume replaced with equivalent amount of dissolution medium. The samples were analyzed by using UV Spectroscopy at 275 nm. [30,31]

Drug Release Kinetics and Mechanism of Drug Release

To study the release kinetics, data obtained from in vitro drug release studies were plotted in various kinetic models: zero order as cumulative amount of drug released vs. time (Equation 1), first order (Equation 2) as log cumulative percentage of drug remaining vs. time, and Higuchi's model (Equation 3) as cumulative percentage of drug released vs. square root of time. Drug dissolution from pharmaceutical dosage forms that do not disaggregate and release the drug slowly can be described by Zero order kinetics.

$$Q_1 = Q_0 + K_0 t$$

Where Q1 is the amount of drug dissolved in time t, Q0 is the initial amount of drug in solution and K0 is the zero-order rate constant expressed in units of concentration/time and t is the time in hr. A graph of concentration vs. time would yield a straight line with a slope equal to K0 and intercept the origin of the axesFirst order model has been used to describe absorption and elimination of drugs. The following equation express this model.

$$\text{Log}Q_1 = \text{Log}Q_0 + (K_1 t/2.303)$$

Where Q1 is the amount of drug released in time t, Q0 is the initial amount of drug in the solution and K1 is the first order release constant. In this way a graphic of the decimal logarithm of the released amount of dug versus time will be linear. Higuchi developed several models to study the release of water soluble and low soluble drugs incorporating in semi-solid and or solid matrices. Thus gives following expression.

$$Q = KH\, t^{1/2}$$

Where Q is the amt of drug release at time t, KH is the Higuchi dissolution constant reflecting the design variables of the system and t is the time in hr. Hence, drug release rate is proportional to the reciprocal of the square root of time. Higuchi describes drug release as a diffusion process based in the Fick's law, square root time dependent.

Mechanism of Drug Release: To evaluate the mechanism of drug release from Aceclofenac Floating Tablets data from the dissolution study were plotted in Korsmeyer Peppas et al's equation as log cumulative percentage of drug released vs. log time, and the exponent n was calculated through the slope of the straight line.

$$F = (Mt/M) = Kmt^n$$

where Mt is the drug release at time t, M is the total amount of drug in dosage form, F is the fraction of drug release at time t, Km is a constant depend on geometry of dosage form, and 'n' is the slope of the linear plot, The value of n gives an indication of the release mechanism

When n = 0.5 for Fickian diffusion, and when between 0.5 and 1.0, then it is non-Fickian or anomalous diffusion. An exponent value of n=1 is indicative of Case-II Transport or typical zero-order release. [32-36]

RESULTS AND DISCUSSION

Preparation of standard calibration curve of aceclofenac

Table 10: Standard curve of Aceclofenac in 0.1 N HCl at 275.0 nm

S. No.	Concentration	Absorbance
1	0	0
2	2	0.101
3	4	0.191
4	6	0.295
5	8	0.387
6	10	0.500
7	12	0.584

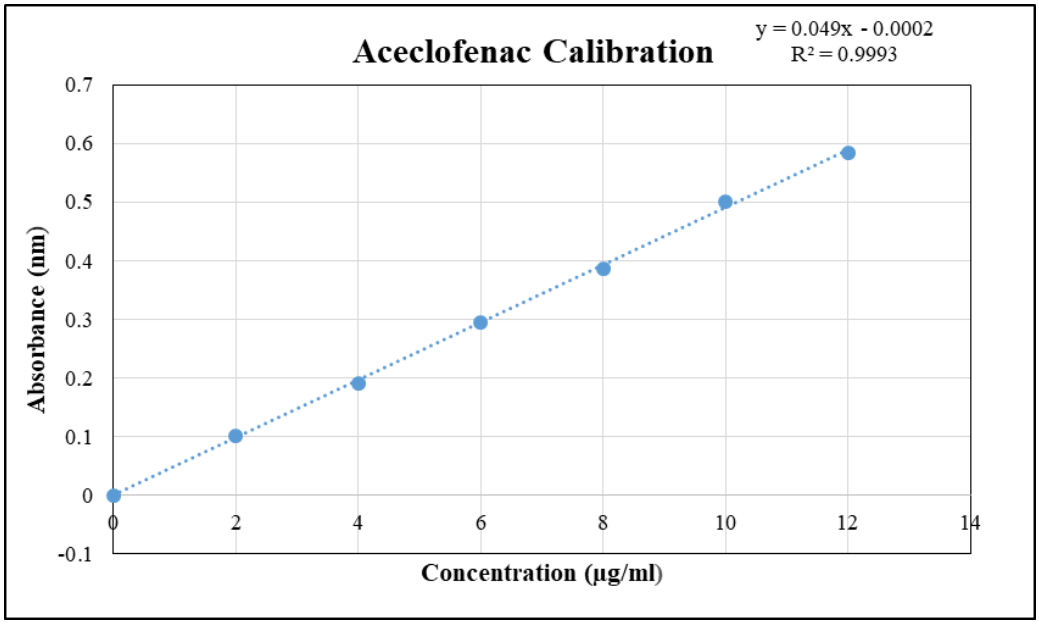

Figure 2: Standard Plot of Aceclofenac in 0.1 N HCl

FTIR Studies

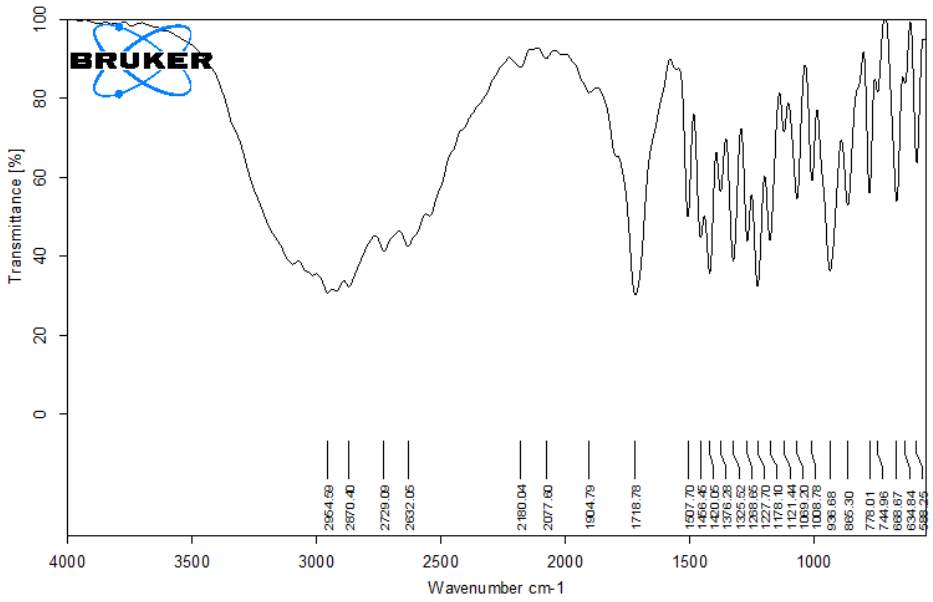

Figure 3: FTIR Spectrum of Aceclofenac

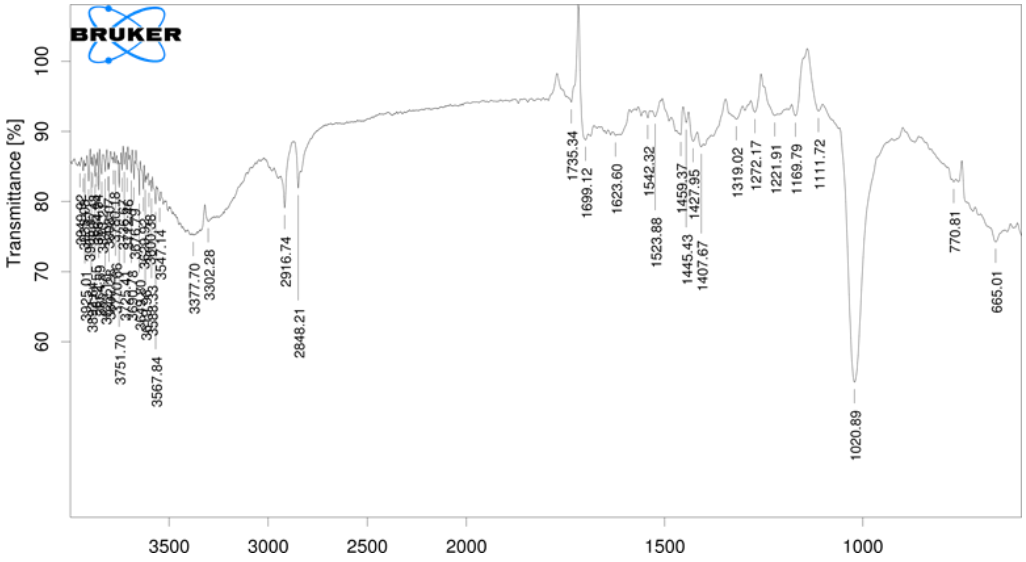

Figure 4: FTIR Spectrum of Mixture of drug and excipients (IR Release)

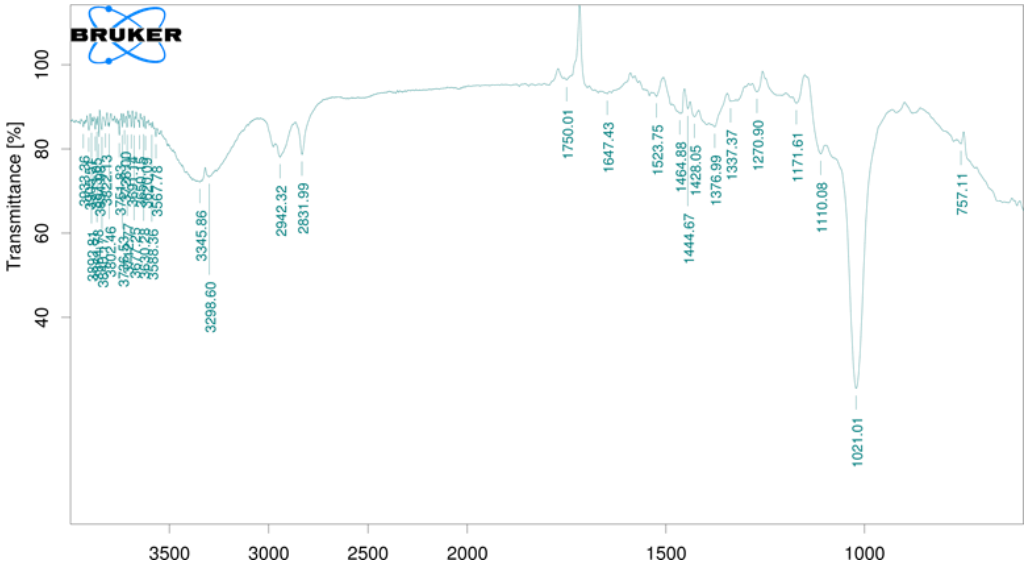

Figure 5: FTIR Spectrum of Mixture of drug and excipients (SR Release)

Table 11: Evaluation of Pre Compression Parameters

Formulations	Angle of repose	Bulk density	Tapped density	Compressibility index
F1	24.38±0.15	0.45±0.19	0.52±0.07	6.48±0.22
F2	25.29±0.17	0.48±0.14	0.55±0.017	4.57±0.19
F3	25.81±0.23	0.50±0.09	0.53±0.022	8.15±0.24
F4	25.35±0.14	0.52±0.11	0.57±0.019	7.63±0.17
F5	24.92±0.21	0.47±0.08	0.54±0.011	6.42±0.21
F6	23.75±0.19	0.49±0.17	0.56±0.020	7.46±0.14
F7	24.63±0.13	0.46±0.13	0.58±0.09	4.53±0.32
F8	25.52±0.16	0.51±0.07	0.55±0.021	6.25±0.25
F9	23.41±0.26	0.53±0.19	0.59±0.019	5.72±0.31
F10	25.48±0.20	0.44±0.20	0.60±0.08	6.68±0.28

Values are expressed as mean (S.D.), n = 3

Table 12: Post Compression Parameters

Formulations	Weight variation	Friability	Hardness	Thickness	Drug content
F1	300±0.04	0.25±0.01	4.1±0.1	4.5±0.17	98.83±0.23
F2	299±0.02	0.30±0.06	5.2±0.2	4.7±0.22	96.26±0.28
F3	298±0.02	0.45±0.04	4.5±0.14	4.9±0.20	96.61±0.17
F4	295±0.02	0.55±0.02	5.0±0.12	5.1±0.21	97.54±0.34
F5	297±0.03	0.21±0.03	4.2±0.09	5.3±0.17	98.72±0.12
F6	301±0.01	0.35±0.03	5.0±0.04	5.5±0.22	99.11±0.20
F7	300±0.05	0.40±0.02	4.1±0.09	5.7±0.23	97.19±0.26
F8	290±0.01	0.25±0.03	5.0±0.13	5.9±0.15	99.12±0.18
F9	275±0.03	0.55±0.01	6.6±0.15	6.1±0.19	95.81±0.21
F10	310±0.04	0.49±0.05	6.2±0.10	6.3±0.20	99.43±0.33

Values are expressed as mean (S.D.), n = 3

Table 13: Swelling Index

Time	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
1	39.07	38.73	41.99	39.50	37.40	39.55	41.29	41.24	40.19	39.09
2	65.74	54.14	56.90	57.25	53.34	57.25	57.61	56.81	57.98	55.40
3	79.95	66.61	67.35	70.26	69.42	67.17	68.26	66.65	65.21	69.34
4	82.59	79.17	81.88	82.59	79.37	76.15	76.67	83.31	78.90	75.28
5	83.31	83.55	80.82	84.03	96.05	82.58	81.90	88.09	82.08	89.05

Values are expressed as mean (S.D.), n = 3

Table 14: Tablet Density, Buoyancy Time, Total Floating Time

Formulations	Tablet density (g/cc)	Buoyancy time (seconds)	Floating time (hours)
1	0.912	65	32.7
2	0.861	87	34
3	0.892	95	32
4	0.865	91	31
5	0.812	121	37
6	0.821	78	34.5
7	0.893	65	30
8	0.872	83	32
9	0.910	101	33
10	0.890	93	29

Table 15: Disintegration Test

Formulations	Disintegration (in seconds)
1.	12.28 ± 2.12
2.	15.21± 1.98
3.	18.62±1.89
4.	17.41±2.33
5.	13.36±2.05
6.	16.25±1.48
7.	24.13±1.76
8.	19.18±1.82
9.	20.16±2.66
10.	14.72±2.23

Values are expressed as mean (S.D.), n = 3

Table 16: Dissolution Release Profile of Aceclofenac

Time	Cumulative percentage drug release									
	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
0	0	0	0	0	0	0	0	0	0	0
1	36.13	39.66	41.97	35.02	46.69	45.82	41.86	33.33	49.14	51.79
2	51.53	53.13	55.84	56.43	53.55	52.66	55.85	49.01	64.58	67.90
4	63.45	59.95	59.65	66.35	63.83	63.41	61.04	59.13	74.12	77.80
6	69.22	67.55	65.53	76.09	71.13	69.55	66.69	67.29	82.88	86.97
8	77.87	79.59	77.13	81.66	79.68	75.66	73.66	75.84	74.73	71.19
10	88.63	83.31	84.77	89.55	85.84	83.25	89.25	82.63	81.69	85.43
12	90.87	89.44	93.35	93.13	97.01	88.45	93.35	92.46	87.67	88.15

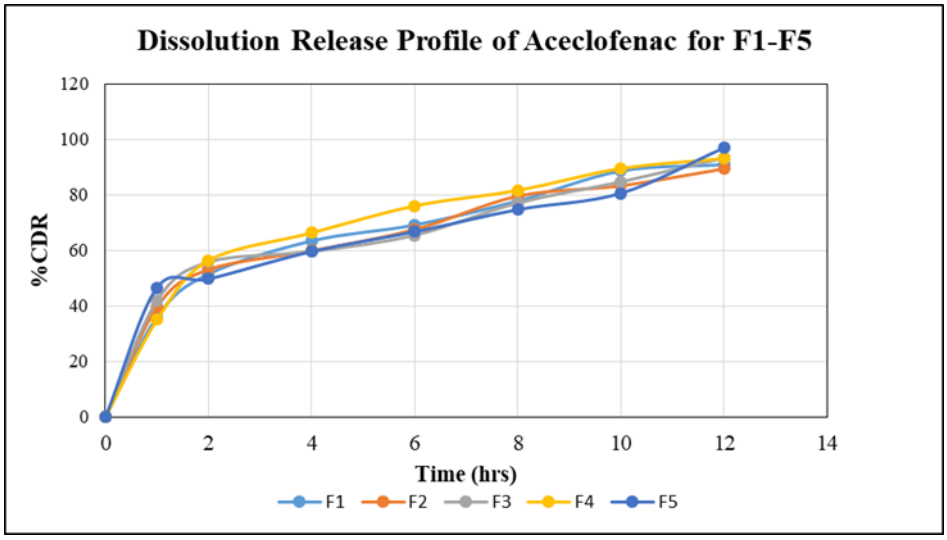

Figure 6: Dissolution release profile of aceclofenac F1-F5

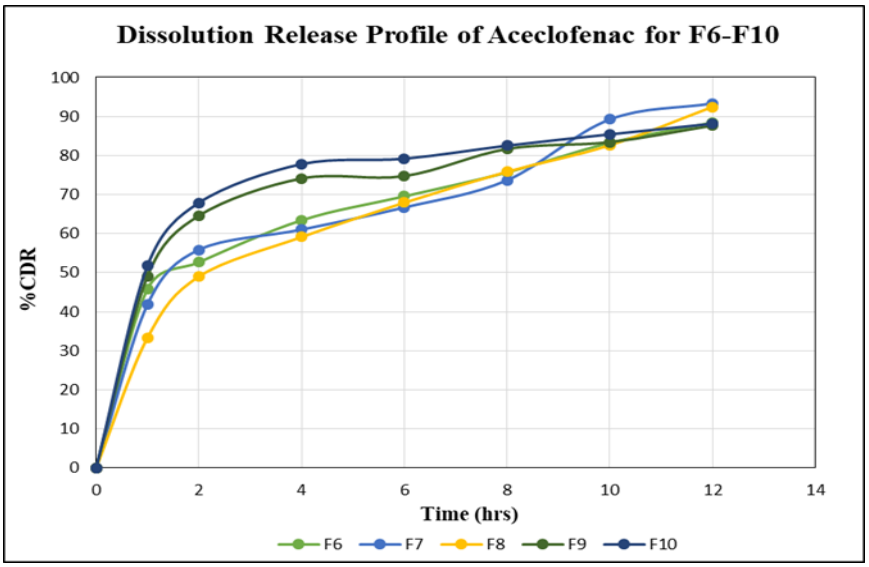

Figure 7: Dissolution release profile of aceclofenac F6-F10

RELEASE KINETICS

Drug release kinetics for F5 formulation

Zero order release

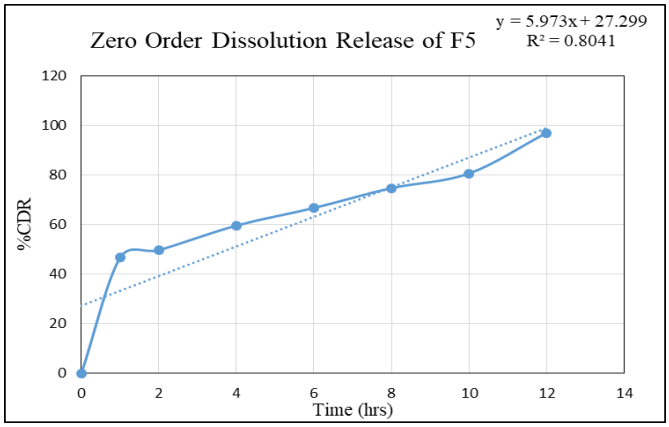

Figure 8: Zero order dissolution release of F5 formulation

Slope (n)	R² value
5.973x	0.8041

First order release

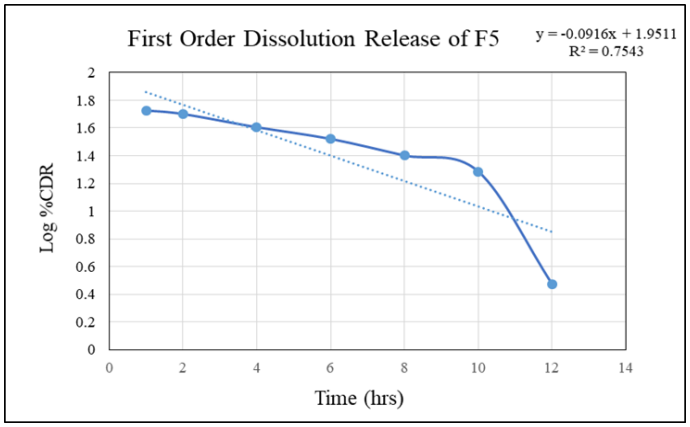

Figure 9: First order dissolution release of F5 formulation

Slope (n)	R² value
-0.0916x	0.7543

Higuchi plot

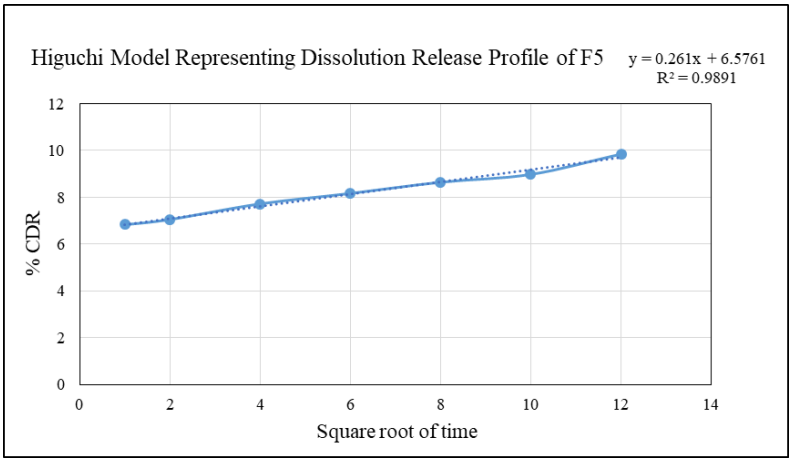

Figure 10: Higuchi model representing release profile of F5 formulation

Slope (n)	R² value
0.261x	0.9891

Korsmeyer- Peppas plot

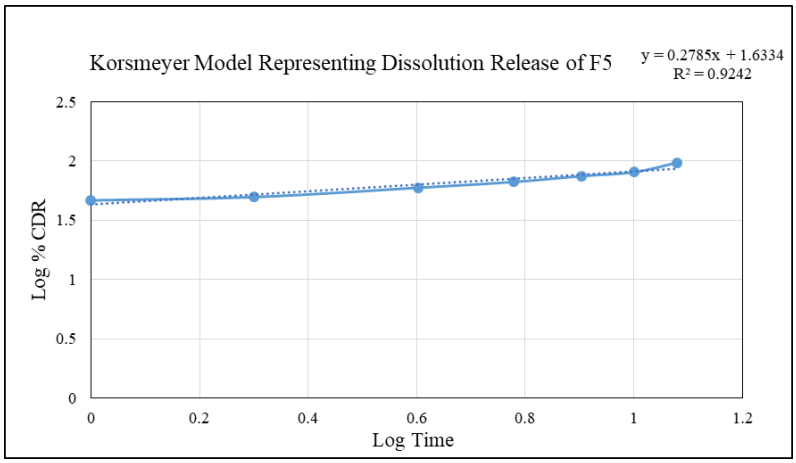

Figure 11: Korsmeyer model representing release profile of F5 formulation

Slope (n)	R^2 value
0.2785x	0.9242

CONCLUSION

Homogenous bilayered floating aceclofenac tablets were created and assessed in this study in an effort to increase the drug's bioavailability and boost stomach retention. Ten distinct formulations were created and put through a battery of tests, including as physicochemical parameters, medication release patterns, and in vitro buoyancy assessments. The top-performing formulation out of the 10 was Formulation 5.

With a total buoyant period of more than 12 hours, Formulation 5 showed the best floating behaviour, guaranteeing extended stomach retention. In order to successfully manage chronic pain situations, Formulation 5's drug release profile followed a desirable pattern, delivering a sustained release of aceclofenac over an extended period of time. Formulation 5 also demonstrated acceptable physicochemical characteristics that met pharmacopeial requirements, such as consistency of content, friability, and tablet hardness.

The exceptional floating capability and prolonged drug release properties of Formulation 5 can be ascribed to the best possible mix and concentration of excipients. Therefore, this formulation has the potential to enhance both therapeutic effectiveness and patient compliance in the treatment of disorders requiring steady plasma levels of aceclofenac.

In order to confirm the advantages of Formulation 5 and investigate its potential for commercial application, future research may concentrate on in vivo assessments and clinical trials. All things considered, the creation of this uniform bilayered floating aceclofenac pill signifies a noteworthy breakthrough in the realm of controlled drug delivery technologies.

A linear korsmeyer-peppas plot suggest that

1. Release mechanism: the drug release is governed by a combination of diffusion and relaxation mechanism.
2. Release exponent (n): the slope of the linear plot represents the release exponent (n), which characterizes the release mechanism:

- n ≤ 0.5: Fickian diffusion (Higuchi model) dominates
- n > 0.5: Non- Fickian diffusion (anomalous transport) dominates
- n = 1: zero order release (constant release rate)

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