RESEARCH ARTICLE

Formulation and Evaluation of Floating Tablets of Ciprofloxacin Hydrochloride

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Abstract

Aim: Formulation and evaluation of floating tablets of ciprofloxacin hydrochloride. **Materials and Methods**: In the present study the formulations were prepared by wet granulation technique using different proportions of hydroxypropyl methylcellulose (HPMC) K100M, HPMC K15M and Carbopol 934 as Swellable polymers. Citric acid has stabilizing effect and sodium bicarbonate is used as buoyancy-imparting agent. **Results and Discussion:** The prepared formulations were evaluated for different parameters during its pre-compression and Post-compression stages. The release characteristics of the formulations were studied in *in-vitro* conditions. The *in-vitro* dissolution study of formulation F4 was 99.12% within 12 h for good release and was fitted to kinetics of drug release for R^2 value of korsmeyer-peppas model is 0.9854. The drug release was diffusion mediated and from the peppa's plot, it is confirmed that it is of non-fickian type. **Conclusion**: As an extension of this work for formulation F4, bioavailability, pharmacokinetic, and in vivo studies can be done in future to develop as suitable candidate for a novel drug delivery system.

Key words: Carbopol 934, ciprofloxacin HCl, floating tablets, hydroxypropyl methylcellulose, *in vitro* drug release, kinetics

INTRODUCTION

Oral delivery of drugs is by far the most preferred route of drug delivery due to the ease of administration, patient compliance, and flexibility in formulation.[1] Conventional oral dosage forms provide a specific drug concentration in systemic circulation without offering any control over drug delivery.[2] These systems achieve as well as maintain drug concentration within therapeutically effective range needed for treatment only when taken several times a day. This results in significant fluctuation in drug levels.[3] Nowadays, most of the pharmaceutical scientists are involved in developing an ideal drug delivery system (DDS). An ideal oral DDS should steadily deliver a measurable and reproducible amount of drug to the target site over a prolonged period.[4] Floating DDSs (FDDS) have shown to be of better significance in release rate for drugs having site-specific absorption.

FDDS have a bulk density which is lower than gastric fluids and thus remain buoyant in the stomach for a prolonged period of time, without affecting the gastric emptying rate. While the system is floating on gastric contents, drug is released slowly at a desired rate from the system. After the release of drug, the residual system is emptied from the stomach. This result is an increase in gastric residence time (GRT) and a better control of fluctuations in plasma drug concentrations. Floating systems can be classified into two types, non-effervescent system and effervescent systems.[5] Longer residence time in the stomach could be advantageous for local action in the upper part of small intestine, for example, treatment of peptic ulcer disease.

Ciprofloxacin HCl is a broad-spectrum antibiotic active against both Gram-positive and Gram-negative bacteria. The biological half-life of ciprofloxacin HCl is 3–5 h. The drug

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should be administered twice a day. The dosage is equivalent of 250–750 mg of ciprofloxacin twice daily (116 mg of ciprofloxacin hydrochloride is approximately equivalent to 100 mg of ciprofloxacin).[6] The aim of the present study is the formulation and evaluation of floating tablets of ciprofloxacin HCl using hydroxypropyl methylcellulose (HPMC) (K100M and K15M) and Carbopol 934 in different ratio with sodium bicarbonate, citric acid, lactose, and magnesium stearate and by direct compression techniques.

MATERIALS AND METHODS

Materials

Ciprofloxacin HCl was obtained from Drugs India, Hyderabad, India. HPMC (K100M, K15) was obtained from Ontop Pharmaceuticals, Bengaluru. Carbopol 934 and other chemical substances such as sodium bicarbonate, citric acid, lactose, magnesium stearate, hydrochloric acid, and alcohol were obtained from S.D fine chemicals, Boisar. All chemicals used were pharmacopeial grade.

Preparation of floating tablets of ciprofloxacin HCl

Floating tablets of ciprofloxacin HCl were prepared by direct compression technique using varying ratio of polymers such as HPMC (K100M, K15) and Carbopol 934 with sodium bicarbonate as buoyancy imparting agent, citric acid as stabilising agent, lactose as diluent, magnesium stearate as lubricant, and 2% polymer solution as granulating agent.

Ciprofloxacin HCl was passed through sieve no. 20. HPMC K100M, HPMC K15M, and sodium bicarbonate were passed through sieve no. 40. Magnesium stearate was passed through sieve no. 60. The sifted material of ciprofloxacin HCl was geometrically mixed with HPMC K100M, HPMC K15M, Carbopol 934, and sodium bicarbonate for 10 min. After sufficient mixing of drug as well as other component, magnesium stearate was added and further mixed for additional 2 min. The lubricated granules were compressed by rotary punch tablet compression machine (Chamunda, Ahmedabad, India). The weight (250 mg) of the tablet was kept constant for all formulations.

Preformulation studies[7]

Compatibility studies

Preformulation studies were carried out to study the compatibility of the pure drug ciprofloxacin with HPMC K100, HPMC K15, and Carbopol. Infrared (IR) spectra of pure drug and polymer individual and combination were obtained which is shown in Figures 1-4. The principle peaks obtained for the combinations were almost similar to that of the drug. There was no significant difference in the IR spectra of pure ciprofloxacin and physical mixtures of polymers and drug.[8-10] Fourier-transform IR (FTIR) spectroscopy analysis peak values are shown in Table 1.

Pre-compression parameters

Angle of repose

The frictional forces in a loose powder or granules can be measured by angle of repose. This is the maximum angle possible between the surface of a pile of powder or granules and the horizontal plane. The granules were allowed to flow through the funnel fixed to a stand at definite height (h). The angle of repose Θ was calculated by formula:

$$\text{Tan } \theta = h/r$$

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

Where θ is the angle of repose, h is the height in cm, and r is the radius in cm.

Table 1: Diffusion characteristics of ciprofloxacin HCl formulations

Formulation code	Regression for zero order plot	Regression for Higuchi's plot	Slope for Peppas plot
F1	0.9734	0.978	0.7771
F2	0.9542	0.9859	0.7369
F3	0.9612	0.9907	0.5881
F4	0.9649	0.9884	0.5755
F5	0.988	0.9545	0.8636
F6	0.9841	0.9644	0.7973
F7	0.9741	0.9831	0.6742
F8	0.962	0.9854	0.6264
F9	0.9417	0.9833	0.6938
F10	0.9466	0.9844	0.6631
F11	0.9453	0.9873	0.617
F12	0.9507	0.9921	0.5905

Bulk density

Apparent bulk density was determined by pouring pre-sieved drug excipient blend into a graduated cylinder and measuring the volume and weight "as it is." It is expressed in g/ml and is given as follows:

Db = M/Vo

Where M is the mass of powder and Vo is the Bulk volume of the powder.

Tapped density

It was determined by placing a graduated cylinder, containing a known mass of drug-excipient blend, on mechanical tapping apparatus. The tapped volume was measured by tapping the powder to constant volume. It is expressed in g/ml and is given by,

Dt = M/Vt

Where M is the mass of powder and Vt is the tapped volume of the powder.

Powder flow properties

The flow properties were determined by:

Carr's index (I)

Compressibility index is an important measure that can be obtained from the bulk and tapped densities. According to the theory, the less compressible material is more flowable. A material having values <20–30% is defined as the free-flowing material, and based on the apparent bulk density and tapped density, the percentage compressibility of the bulk drug was determined using the following formula. It is expressed in percentage and is expressed by:

I = Dt-Db/Dt×100

Where Dt is the tapped density of the powder and Db is the bulk density of the powder.

Hausner's ratio

It indicates the flow properties of the powder, and the ratio of tapped density-to-bulk density of the powder or granules is called Hausner's ratio. It is expressed in percentage and is expressed by:

H = Dt/Db

Where Dt is the tapped density of the powder and Db is the bulk density of the powder.

Post-compression Parameters[11]

Hardness

The hardness of the tablet was determined using a Monsanto hardness tester. It is expressed in kg/cm^2.

Thickness and diameter

The thickness and diameter of the tablets were measured by Vernier calipers. It is expressed in mm.

Weight variation

20 tablets were selected at random, and average weights were determined. Then, individual tablet was weighed and the individual weight was compared with the average.

Friability test

This was determined by weighing 10 tablets after dusting, placing them in the friabilator, and rotating the plastic cylinder vertically at 25 rpm for 4 min. After dusting, the total remaining weight of the tablets was recorded, and the percent friability was calculated according to:

$$\text{Friability} = \frac{\text{Final Weight} - \text{Initial Weight}}{\text{Initial Weight}} \times 100$$

Content uniformity

Twenty tablets were taken and amount of drug present in each tablet was determined. The tablets were crushed in a mortar and the powder equivalent to 100mg of drug was transferred to 100 ml standard flask. The powder was dissolved and made up to volume with 0.1N HCl. The sample was mixed thoroughly and filtered through a 0.45 µ membrane filter. The filtered solution was diluted suitably and analyzed for drug content by ultraviolet (UV) spectrophotometer at a by using 272 nm hydrochloric acid as blank.

Determination of swelling index (SI)

The SI of tablets was determined in 0.1 N HCl (pH 1.2) at room temperature. The swollen weight of the tablet was determined at predefined time intervals over 24 h. The SI was expressed as a percentage and was calculated from the following equation.

$$SI = \frac{\text{Weight of tablet at time } (t) - \text{Initial Weight of tablet}}{\text{Initial weight of tablet}} \times 100$$

In-vitro buoyancy studies

The *in vitro* buoyancy studies were determined by the floating lag time. The tablets were placed in a 100 ml beaker containing 0.1N HCL. The time required for the tablet to rise to the surface for floating was determined as the floating lag time, and further, floating duration of all tablets was determined by visual observation. The results for floating lag time are presented in Table 6. From the study of floating properties, it was observed that floating lag time ranges from 59 to 110 s, and tablets of batches ranging from F1 to F8 remain buoyant up to 12 h and the tablets of batches ranging from F9 to F2 remain buoyant up to 8 h, during which the tablets lost their integrity and the size of the swollen matrix gel drastically reduced.[12-17]

In vitro dissolution studies

In vitro drug release studies of ciprofloxacin HCl were studied using dissolution apparatus USP type II paddle method with a stirring speed of 50 rpm at 37°C ± 0.5 in 900 ml of simulated gastric fluid (pH 1.2) for 12 h. The samples were taken at pre-selected time intervals with the replacement of equal volume of dissolution media. The collected samples were diluted, and the absorbance was measured spectrophotometrically at 272 nm against blank. The percentage of ciprofloxacin HCL released at various time intervals was calculated from the standard graph. *In vitro* dissolution studies were carried out in simulated gastric fluid (pH1.2 buffer) for 12 h. The slope value and the degree of linearity of the above graphical treatments were considered as important statistical parameters to interpret *in vi*tro profile of all formulations.[18-24]

Stability studies[25-27]

The stability studies were carried out on optimized formulation, i.e. F4. The optimized formulation was sealed in aluminum foil and stored in different temperatures 4°C, 25°C/60% RH, and 40°C/75% RH, respectively, for 3 months. After an interval of 90 days, samples were withdrawn and retested for drug content, buoyancy lag-time, and buoyancy time. The amount of drug was detected by UV spectrophotometrically at 272 nm against blank. The results indicate that this formulation remained stable for 3 months.

RESULTS AND DISCUSSION

In the present study, the formulations were prepared using different proportions of polymer. The prepared formulations were evaluated for different physicochemical characteristics such as thickness and diameter, drug content, weight variation, hardness, and friability. The release characteristics of the formulation were studied in *in vitro* conditions. The composition of each formulation is given in Table 2.

FTIR spectra of pure ciprofloxacin, blend of polymer with drug, were determined. Ciprofloxacin showed that the principle IR peaks 3377.39, 3090.28, 2923.76, 2620.71, 1701.51, 1623.93, 1312.68, and 1187.2. Ciprofloxacin with excipients showed 3093.83, 2933.00, 2620.47, 1708.66, 1625.66, 1386.80, 1310.90, and 944.54. The IR spectra of all the tested samples showed the prominent characterizing peaks of pure ciprofloxacin which confirm that interactions between drug and polymers were unlikely to occur. FTIR data and spectra of drug and polymers are given in Table 3 and Figures 1-4.

Physical parameters such as specific surface area, shape, hardness, surface characteristics, and size can be significantly affect the rate of dissolution of drugs. The formulated blends of different formulations F1–F12 were evaluated for angle of repose, tapped density, bulk density, Carr's index, and Hausner ratio. The results of the angle of repose (<30) indicate good flow properties of entire formulated granule blend. The compressibility index value was recorded and was resulted in good-to-excellent flow properties. Evaluation data of pre-compression parameters are given in Table 4.

The prepared tablets in all the formulations possessed good mechanical strength sufficient hardness. The hardness of the tablets ranges from 3.99 to 4.86. The thickness and diameter of the tablets were found to be in the range of 7.01–7.11 mm and 9.42–9.44 mm, respectively. The friability loss of the tablet was found to be 0.26–0.88% determined by using

Table 2: Formula for preparation of floating tablets

Formulation code	Ingredients (mg)								Total (mg)
	Drug	HPMC K100	HPMC K15	Carbopol 934	Na_2CO_3	Citric acid	Lactose	Magnesium stearate	
F1	250	120	-	-	100	10	10	10	500
F2	250	100	-	-	100	10	30	10	500
F3	250	80	-	-	80	10	70	10	500
F4	250	60	-	-	80	10	90	10	500
F5	250	-	120	-	100	10	10	10	500
F6	250	-	100	-	100	10	30	10	500
F7	250	-	80	-	80	10	70	10	500
F8	250	-	60	-	80	10	90	10	500
F9	250	-	-	120	100	10	10	10	500
F10	250	-	-	100	100	10	30	10	500
F11	250	-	-	80	80	10	70	10	500
F12	250	-	-	60	80	10	90	10	500

HPMC: Hydroxypropyl methylcellulose

Table 3: FTIR data for drug and polymers

Name of compound	Wave number (cm^{-1})
Ciprofloxacin	3377.39, 3090.28, 2923.76, 2620.71, 1701.51, 1623.93, 1312.68, 1187.2
HPMC K100	2927.91, 1380.62, 1119.77, 1064.07, 945.79
HPMC K15	2931.25
Carbopol 934	1380.89, 1119.95, 1063.17, 946.5
Ciprofloxacin with polymers	3093.83, 2933.00, 2620.47, 1708.66, 1625.66, 1386.80, 1310.90, 944.54

FTIR: Fourier-transform infrared, HPMC: Hydroxypropyl methylcellulose

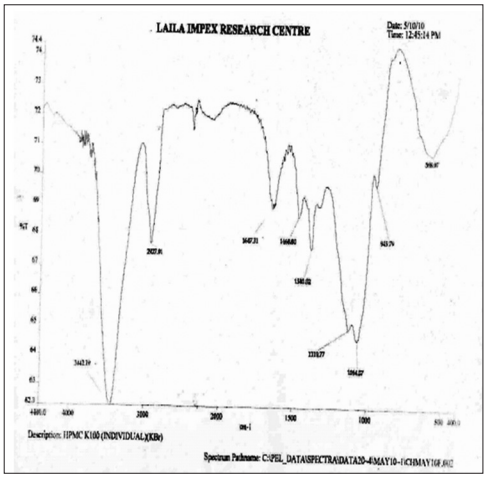

Figure 1: Fourier-transform infrared spectra of the pure hydroxypropyl methylcellulose

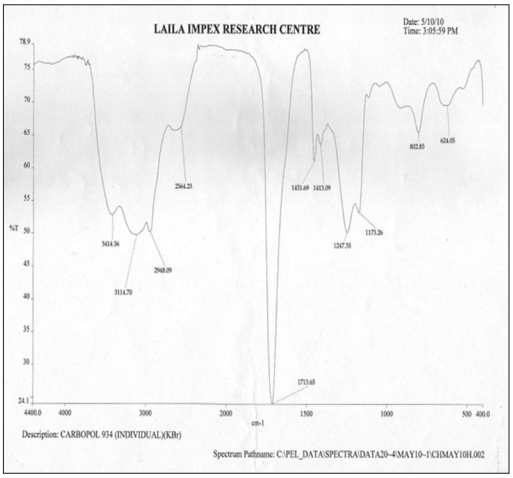

Figure 3: Fourier-transform infrared spectra of the pure Carbopol 934

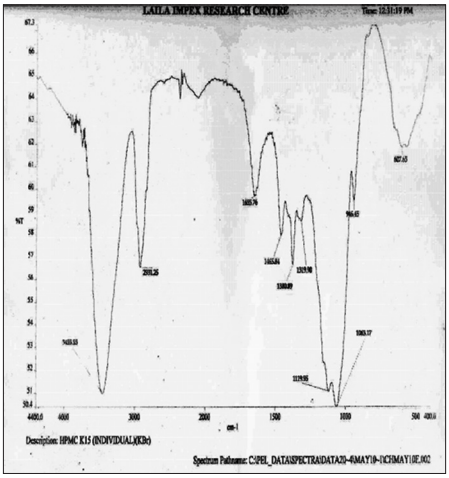

Figure 2: Fourier-transform infrared spectra of the pure hydroxypropyl methylcellulose K15

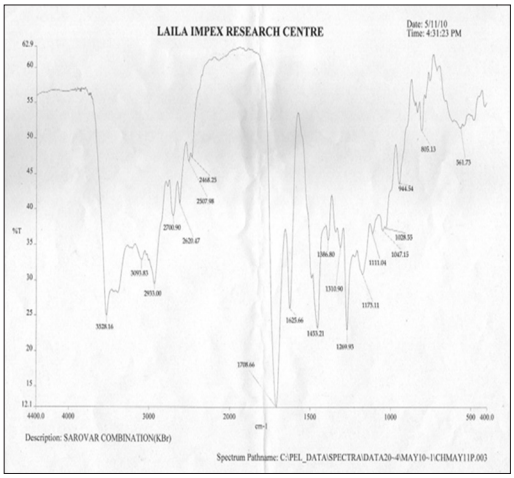

Figure 4: Fourier-transform infrared spectra of combination of drug and polymers

Roche Friabilator. All batches of tablets passed the test and are within the limits. It indicated that the tablets were mechanically stable. All the batches of tablets were found to pass the weight variation test. The percentage deviation of the individual tablet weight from the average tablet weight was found to be within the I.P limits ± 7.5%. The drug content uniformity was examined as per I.P specification. All the batches of tablets were found to comply with the uniformity of content test. None of the individual drug content values were outside the average content values. In formulations containing HPMC K100M, the SI ranges from 2.0 to 2.2, in the formulations containing HPMC K15M, the SI ranges from 1.3 to 1.9, and in the formulations containing Carbopol 934, the SI ranges from 2.0 to 2.3. Evaluation data of post-compression parameters are given in Table 5.

Floating lag time was observed that floating lag time ranges from 59–110 seconds for all the formulations. Duration of floating for prepared tablets of each batch remained buoyant up to 12 h, during which the tablets lost their integrity and the size

Table 4: Evaluation data of pre-compression parameters

Formulation code	Flow properties				
	Bulk density (g/ml)±SD	Tapped density (g/ml)±SD	Carr's index	Hausner's ratio	Angle of repose
F1	0.4327±0.00358	0.5263±0.0052	17.3167±1.270	1.2092±0.0021	27.4056±0.5775
F2	0.4414±0.01137	0.5068±0.0117	13.2400±0.3469	1.1483±0.0030	27.5533±3.0457
F3	0.4414±0.01137	0.5175±0.0151	15.9400±1.5114	1.1903±0.0348	28.0715±0.8658
F4	0.4479±0.01137	0.5090±0.0289	11.990±1.8578	1.1371±0.0362	27.0092±0.7691
F5	0.4617±0.01252	0.5556±0.0117	16.8967±1.2574	1.2038±0.0321	28.3280±0.7465
F6	0.4404±0.0113	0.5263±0.0052	16.1400±1.1650	1.1929±0.0302	28.1322±0.4142
F7	0.4414±0.01137	0.5175±0.01518	14.6900±2.5114	1.1728±0.0328	27.897±04333
F8	04414±0.01137	0.4921±0.01374	9.8896±1.8392	1.1105±0.0354	28.7632±0.7504
F9	0.4167±0.01137	0.4762±0.0289	12.49±0.9878	1.1455±0.0435	28.1353±0.4191
F10	0.41670±0.01252	0.4901±0.0172	14.900±1.0484	1.1761±0.0412	29.8967±0.7654
F11	0.4167±0.00358	0.4801±0.0172	13.14±1.0484	1.1522±0.0412	28.1353±0.4132
F12	0.400±0.01178	0.4696±0.0125	14.6633±1.3151	1.1724±0.0312	27.4422±1.5192

SD: Standard deviation

Table 5: Evaluation data of post-compression parameters

Formulation code	Parameters						
	Average hardness (kg/cm^2)±SD	Average thickness in (mm)±SD	Average diameter in (mm)±SD	Average friability (%)±SD	Average weight variation (mg)±SD	Average content uniformity (%)±SD	SI (%)
F1	3.99±0.15	6.11±0.03	9.44±0.02	0.74±0.1	496.6±0.55	95.5±0.15	2.0
F2	4.56±0.35	6.10±0.02	9.42±0.03	0.54±0.12	506.6±0.12	95.5±0.02	2.1
F3	4.73±0.41	6.11±0.02	9.43±0.01	0.67±0.11	496.6±0.15	96.5±0.19	2.2
F4	4.53±0.30	6.09±0.03	9.44±0.02	0.86±0.22	506.6±0.87	98.0±0.20	2.2
F5	4.36±0.17	6.01±0.02	9.42±0.01	0.26±0.11	503.3±0.55	97.0±0.15	1.3
F6	4.63±0.20	6.11±0.04	9.44±0.02	0.76±0.16	501.3±0.45	97.5±0.10	1.5
F7	4.66±0.28	6.11±0.03	9.44±0.02	0.45±0.17	506.6±0.11	98.5±0.02	1.7
F8	4.33±0.28	6.10±0.03	9.43±0.01	0.66±0.15	505.0±0.50	98.5±0.02	1.9
F9	4.76±0.05	6.11±0.03	9.43±0.01	0.88±0.11	501.5±0.15	97.5±0.20	2.0
F10	4.56±0.05	6.11±0.03	9.43±0.01	0.64±0.20	500.0±0.11	96.5±0.50	2.1
F11	4.53±0.05	6.12±0.03	9.44±0.02	0.46±0.20	503.3±0.55	94.5±0.20	2.2
F12	4.86±0.05	6.08±0.03	9.44±0.01	0.87±0.24	506.6±0.44	96.5±0.04	2.3

SD: Standard deviation, SI: Swelling index

of the swollen matrix gel drastically reduced. Floating properties of tablets and diffusion characteristics of ciprofloxacin HCl formulations are given in Tables 1 and 6, Figure 5.

The stability study was carried out using the best batch. After an interval of 90 days, samples were withdrawn and retested for drug content, buoyancy lag time, and buoyancy time. The results of these formulations remained stable for 3 months and are given in Table 7.

Dissolution apparatus USP Type II paddle method was used to carry out *in vitro* drug release studies on the prepared batches of floating tablets with a stirring speed of 50 rpm at 37°C ± 0.5 in 900 ml of simulated gastric fluid (pH 1.2) for 12 h. 5 ml of aliquots were withdrawn at time intervals of 1 h for 12 h. The samples were replaced by equivalent volume of dissolution medium. The samples were analyzed spectrophotometrically at 272 nm for the drug content against blank. The mean percentage of ciprofloxacin HCL released at various time intervals was calculated and plotted against time.

The formulation F4 formulated with HPMC K100M (60 mg) showed the release of 99.12%. The *in vitro* release plot has shown that the zero-order kinetics, which was evinced for the regression value of the above, mentioned plot. The Higuchi's plot has shown regression value of the 0.9884,

which indicates diffusion mechanism influencing the drug release. To confirm this fact, Peppas plot was drawn which has shown the slope of 0.5755, which confirms that the diffusion mechanism involved in the drug release was of non-Fickian diffusion type. The formulation F4 is the optimized formulation. The tablet which is composed of a polymeric matrix on contact with water builds a gel layer around the tablet core, which governs the drug release.

Table 6: Floating properties of tablets

Formulation code	Buoyancy lag time (s)	Duration of buoyancy
F1	92	>12
F2	87	>12
F3	98	>12
F4	105	>12
F5	59	>12
F6	88	>12
F7	109	>12
F8	98	>12
F9	110	8
F10	97	8
F11	105	8
F12	98	8

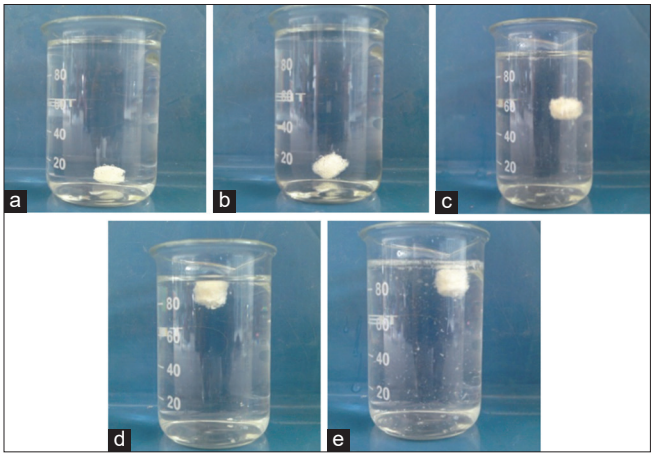

Figure 5: ***In vitro*** buoyancy study of formulation 4. (a) At initial time (b) after 5 s (c) after 40 s (d) after 2 min (e) after 12 h

Formulations F4 and F8 release 99.12% and 84.5% of drug at the end of 12 h, and F12 releases 97.4% at the end of 8 h. *In vitro* dissolution study of ciprofloxacin HCl floating tablets from F1 to F12 and its plot are mentioned in Table 8 and Figure 6.

From the results obtained, it was observed that the presence of HPMC- K100M with 60 mg has effective influence on the dissolution rate that can be occurred may be attributed to improve swelling of polymer by reducing interfacial tension and absorption of drug into the dissolution medium.

CONCLUSION

Over the years, various attempts have been made to control the time course of drug in the body through a variety of drug modifications and dosage forms. One of the most feasible approaches for achieving a prolonged and predictable drug delivery profile in the gastrointestinal tract is to control the GRT.

The approach of the present study was to formulate floating tablets of ciprofloxacin HCL and henceforth evaluate the release profiles of these formulations.

From the results obtained in the present study, the following conclusions are drawn:

- The IR spectrum of pure drug and drug-polymer mixture revealed that there was no interaction between polymer and drug. The prepared floating tablets are industrially feasible method.
- Bulk density and tapped density shown good packability, and Carr's index results shown excellent compressibility.

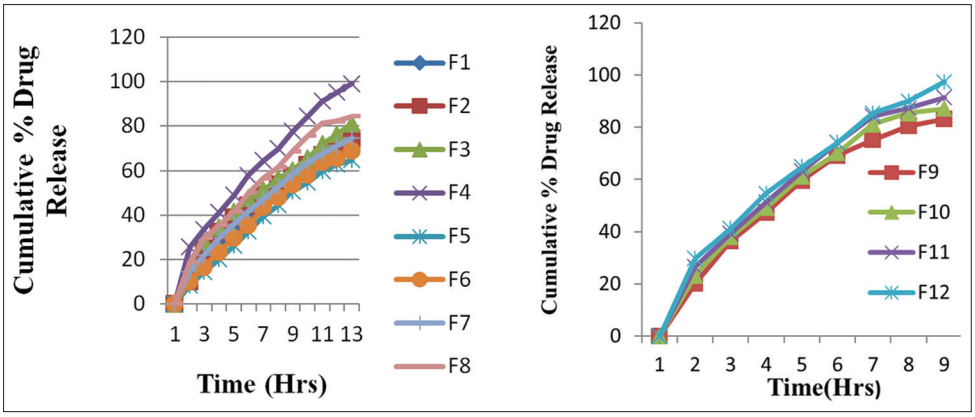

Figure 6: *In vitro* drug release of ciprofloxacin HCl tablets from F1 to F12

Table 7: Characteristics of F4 formulation after storage

Temperature	Time in days	Drug content (%)	Buoyancy lag time (min)	Duration of buoyancy
At 4°C	30	98.5±0.10	1.5	>12 h
	90	98.00±0.10	2	>12 h
At 25°C/60% RH	30	99.00±0.10	1	>12 h
	90	98.50±0.10	1	>12 h
At 40°C/75% RH	30	98.5±0.20	1	>12 h
	90	98.10±0.10	2.5	>12 h

Table 8: *In vitro* dissolution study of ciprofloxacin HCl floating tablets (F1–F12)

Time (h)	Cumulative % drug release											
	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
0	0	0	0	0	0	0	0	0	0	0	0	0
1	10.08	10.12	18.24	25.56	8.2	10.2	14.6	18.6	20.2	23.2	26.6	29.8
2	18.36	24.20	28.28	33.48	14.4	16.6	21.8	29.6	36.4	37.92	39.2	41.2
3	27.44	32.52	34.50	41.12	20.2	23.4	29.6	35.4	47.2	49.2	51.2	54.6
4	34.60	38.80	41.48	49.00	26.3	29.6	35.92	41.6	59.6	61.2	63.2	64.8
5	40.20	44.12	47.52	57.84	32.6	35.4	41.6	49.8	69.2	70.2	74.1	74.2
6	45.80	48.80	51.24	64.56	39.5	43.5	47.2	56.5	75.2	81.2	84.2	85.4
7	49.76	53.52	56.24	69.96	44.6	47.8	52.8	61.6	80.6	85.4	87.3	89.92
8	54.64	57.24	60.28	77.76	50.8	53.6	58.4	68.72	83.2	87.2	91.4	97.4
9	59.76	62.36	65.36	84.48	54.6	57.92	63.6	75.6	-	-	-	-
10	64.20	66.84	71.84	91.24	59.72	63.8	67.6	81.5	-	-	-	-
11	67.32	70.12	76.36	95.16	62.8	65.6	71.2	82.2	-	-	-	-
12	71.44	74.24	81.20	99.12	64.9	68.92	74.5	84.5	-	-	-	-

- Formulation F4 containing 60 mg of HPMC K100M was found to release a maximum of 99.12% at the 12th h.
- Comparison of all formulations of ciprofloxacin HCL revealed the fact that developed formulation F4 showed comparable release characteristics, and thus, it may have fair clinical efficacy. Hence, the formulation F4 has met the objectives of the present study.
- The results of stability studies indicate that this formulation remained stable for 3 months. Formulation F4 holds promise for further *in vivo* studies, which can be extrapolated for the development of FDDS.

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