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FORMULATION AND INVITRO EVALUATION OF FAMOTIDINE FLOATING TABLETS

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ABSTRACT

The objective of the present study was to prepare and evaluate gastroretentive floating drug delivery system containing Famotidine as a model drug. Famotidine tablets were prepared by wet granulation method using Hydroxypropylmethyl cellulose-HPMC E5 LV by effervescent technique. Sodium bicarbonate (SB) and citric acid (CA) were incorporated as gas-generating agents. Floating tablets were evaluated for uniformity of weight, thickness, hardness, friability, drug content, *in vitro* buoyancy and dissolution studies. The effect of effervescent agent on drug release profile and floating properties was also investigated. Prepared tablets exhibited controlled and prolonged drug release profiles while floating over the dissolution medium. Non–Fickian diffusion was confirmed as the drug release mechanism from these tablets, indicating that water diffusion and polymer rearrangement played an essential role in drug release. All the prepared tablets showed good *in vitro* buoyancy.

Keywords: Famotidine, Floating tablets, HPMC, *In vitro* buoyancy, Controlled release.

INTRODUCTION

Oral controlled release dosage forms have been developed for the past three decades due to their considerable therapeutic advantages and applications. The high level of patient compliance in taking oral dosage forms is due to the ease of administration and handling of these forms [1]. However, the development process is precluded by several physiological difficulties, such as an inability to confine the dosage form within desired region of the gastrointestinal tract, fluctuation in the gastric emptying process etc. This variability may lead to an unpredictable bioavailability of an orally administered dosage form [2]. To increase the gastric retention time of drugs, Gastroretentive floating dosage forms are developed which can remain in the gastric region for several hours [3]. Incorporation of the drug in these dosage forms prolong the retention time within the gastrointestinal tract (GIT) until all the drug is completely released at the desired period of time [4]. From the formulation and technological point of view, floating drug delivery system is considerably easy and logical approach in the development of gastroretentive dosage forms [5]. Gastroretentive floating drug delivery technology is one of the promising approach for enhancing the bioavailability and controlled delivery of drugs that exhibit narrow absorption window [6]. These drug delivery systems have been shown to possess better efficacy in controlling the release rate for drugs with site specific absorption [7].

Famotidine is a histamine H2 receptor antagonist which is widely prescribed in gastric ulcers, duodenal ulcers, Zollinger-Ellison syndrome and gastroesophageal reflux disease. This drug completely antagonises the parietal cell H2 receptor. It inhibits histamine, gastrin and acetylcholine stimulated acid secretion; pepsin secretion also falls with the reduction in volume of gastric juice. It increases the incidence and rate of healing of peptic ulcers [8,9]. In the present investigation, HPMC E5 LV and Xanthan gum were utilized along with gas generating agents such as sodium bicarbonate and citric acid for the formulation of floating tablets of famotidine which would increase the bioavailability, thereby improving the therapeutic efficacy and patient compliance.

MATERIALS AND METHODS

Famotidine was obtained from Geltec Labs Ltd., Bangalore, India. HPMC E5 LV was procured from Colorcon Pvt. Ltd, Goa, India. Sodium bicarbonate and Citric acid were received as gift samples from S.D. Fine-Chem Ltd., Mumbai, India. Polyvinyl pyrrolidone (PVP K-30), Magnesium stearate and Talc were obtained from HiMedia Laboratories Pvt. Ltd., Mumbai, India. Isopropyl alcohol was kindly provided by Qualigens Fine Chemicals, Mumbai, India.

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Preparation of Floating Tablets

All the ingredients were weighed and mixed thoroughly. 1%w/v of xanthan gum solution was prepared using water and PVPK30 was dissolved in sufficient quantity of IPA. These two solutions were used for preparing granules of famotidine. The prepared granules were dried at 45^0c in hot air oven for about 20 minutes. The dried granules were sized through 22 mesh and lubricated with magnesium stearate, talc and then punched on a 8 station rotary punching machine. The weight of the tablets was kept constant for formulations F1 to F8. The composition of all formulations was given in Table 1. Floating matrix tablets containing famotidine were prepared by wet granulation technique using varying concentrations of different grades of polymers with sodium bicarbonate and citric acid.

Compatibility Studies by FT-IR Studies

It is one of the most powerful analytical techniques for chemical identification of drug [10]. The pure drug and its formulation were subjected to IR studies. In the present study, the potassium bromide disc (pellet) method was employed.

Evaluation of Granules

Prior to compression, granules were evaluated for their characteristic parameters, such as Bulk density, tapped density, Carr's index, Hausner's ratio and angle of repose. The angle of repose was determined by the fixed funnel method. Bulk density, tapped density, Carr's index and Hausner's ratio were calculated using tap density apparatus (Electrolab, USP) [11].

Evaluation of Tablets

The prepared tablets were evaluated for uniformity of weight using 20 tablets. Hardness, thickness and friability were measured with Pfizer hardness tester, vernier calliper and Roche friabilator respectively. The results were expressed as mean ± Standard deviation [12-14].

Drug Content Uniformity

Twenty tablets were taken and powdered; powder equivalent to one tablet was accurately weighed and was allowed to dissolve in 100 mL of 0.1 N HCl, followed by stirring for 30 minutes. The solution was filtered through 0.45 µm membrane filter, diluted suitably and analysed using UV/Visible spectrophotometer at 265 nm using 0.1 N HCl as blank [15].

***In vitro* Buoyancy Studies**

The *in vitro* buoyancy was determined by floating lag time. The tablets were placed in a 100 mL beaker containing 0.1 N HCl. The time required for the tablet to rise to the surface and float was taken as the floating lag time. The mean ± S.D. values of buoyancy were calculated [16].

Determination of Swelling Index

The swelling index of tablets was determined in 900 mL of 0.1 N HCl at 37±0.5°C. The swollen weight of the tablet was determined at predefined time intervals [17]. The swelling index was calculated by the following equation:

$$\mathbf{SI\ (\%) = (w_t - w_0 / w_0)\ x\ 100}$$

W_t= Weight of dosage form at time t
W_0 = Weight of dosage form at time 0

***In-vitro* Dissolution Study** [18,19]

In vitro dissolution studies were carried out using USP dissolution apparatus type II at 50 rpm. The dissolution medium consisted of 900 mL of 0.1 N HCl, maintained at 37 ± 0.5°C. 10 mL of the sample was withdrawn at suitable time intervals and immediately replaced with an equal volume of 0.1 N HCl to maintain the volume constant. The samples were filtered through a 0.45 µm membrane filter, diluted sufficiently and analysed at 265 nm using UV/Visible double-beam spectrophotometer.

Kinetic Modelling of Drug Release

The suitability of several equations, which are reported in the literature to identify the mechanism(s) for the release of drug, was tested with respect to the release data [20,21].

Kinetic analysis of *in-vitro* release rates of floating tablets of famotidine

The results of *in vitro* release profile obtained for all the formulations were plotted in modes of data treatment as follows,

- Zero order kinetic model - cumulative % drug released versus T.
- First order kinetic model - Log cumulative % drug released versus T.
- Higuchi's model - cumulative % drug released versus square root of T.
- Korsemeyer equation or Peppa's model - Log cumulative % drug released versus log T.

1). Zero order kinetics

It describes the system in which the drug release rate is independent of its concentration.

$$\mathbf{C = C_0 - K_0\ t}$$

Where,
C = Concentration of drug to undergo reaction at time t
C_0 = Initial amount of drug in the solution, which is often zero and
K_0 = zero order release constant.

If the zero order drug release kinetic is obeyed, then a plot of C versus t will give a straight line with a slope of K_0 and an intercept at zero.

2). First Order Kinetics

It describes the drug release from the systems in which the release rate is concentration dependent.

$$\mathbf{Log\ C = log\ C_0 - k\ t/\ 2.303}$$

Where

C = amount of drug released in time t.

C_0 = initial amount of drug in the solution

k = first order release constant

If the first order drug release kinetic is obeyed, then a plot of log (C_0- C) versus t will be straight line with a slope of k/ 2.303 and an intercept at t=0 of log C_0.

3). Higuchi Model

It describes the fraction of drug release from a matrix is proportional to square root of time.

$$\mathbf{Mt / M\infty = kHt\ ½}$$

Where,

Mt and M∞ are cumulative amounts of drug release at time t and infinite time,

KH = Higuchi dissolution constant reflection formulation characteristics.

If the Higuchi model of drug release (i.e. Fickian diffusion) is obeyed, then plot of Mt / M∞ versus t1/2 will be straight line with slope of kH.

4). Korsmeyer-Peppas model (Power Law)

The power law describes the drug release from the polymeric system in which release deviates from Fickian diffusion, as expressed in following equation.

$$\mathbf{Mt / M\infty = kt^n}$$

$$\mathbf{Log\ [Mt / M\infty] = log\ k + n\ log\ t}$$

Where,

Mt and M∞ are cumulative amounts of drug release at time t and infinite time (i.e. fraction of drug release at time t),

k = constant incorporating structural and geometrical characteristics of CR device,

n = diffusional release exponent indicative of the mechanism of drug release for drug dissolution.

To characterize the release mechanism, the dissolution data {Mt / M∞ <0.6} are evaluated. A plot of log {Mt / M∞} versus log t will be linear with slope of n and intercept gives the value of log k. Antilog of log k gives the value of k. The value of release exponent changes with change in the geometry of tablets.

- In general if the exponent value n is 0.5, the release rate is termed "fickian" or square root of time dependent. Release is rapid at first, and then tailing off over time until 100 % of the drug is released. In this type of release, the dominant mechanism for release is diffusion.
- If n is between 0.5 and 1.0, the release rate is described as "non-fickian," or "anomalous." Release is rapid at first, although slower than the fickian release rate, and again tails off over time. Here a mixture of diffusion and swelling play a part in the release mechanism.
- If n = 1, "zero order" or "case II transport" has been achieved. This type of release is generally attributed to a swelling controlled mechanism.

Stability studies

Stability studies were carried out at 25^0 C and 40^0 C for the selected formulation for three months. The selected formulations were packed in amber-colored bottles, which were tightly plugged with cotton and capped. They were then stored at 25^0 C and 40^0 C for three months and evaluated for their physical appearance, hardness and in vitro drug release at specified intervals of time.

Table 1. Formulation of Famotidine floating tablets by using wet granulation method

Ingredients (mg)	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8
Famotidine	50	50	50	50	50	50	50	50
HPMC E5 LV	25	50	75	100	25	50	75	100
Xanthan gum	-	-	-	-	12	12	12	12
PVP k-30	25	25	25	25	-	-	-	-
Citric acid	15	15	15	15	15	15	15	15
Sodium bicarbonate	25	25	25	25	25	25	25	25
Lactose	105	85	60	35	118	93	68	43
Talc	2	2	2	2	2	2	2	2
Magnesium Stearate	3	3	3	3	3	3	3	3
IPA	q.s	q.s	q.s	q.s	q.s	q.s	q.s	q.s
Distilled Water	q.s	q.s	q.s	q.s	q.s	q.s	q.s	q.s
Total	250	250	250	250	250	250	250	250

Table 2. Pre-Compression Parameters of powder blend

Batch code	Angle of Repose (º)*	Bulk Density (g/cc)*	Tapped Density (g/cc)*	Carr's Index (%)*	Hausner's Ratio*
F_1	26.79 ±0.245	0.381±0.016	0.448± 0.012	14.95± 1.68	1.175±0.078
F_2	27.45 ±0.310	0.385±0.016	0.452 ±0.021	14.82± 1.76	1.174±0.022
F_3	27.32± 0.289	0.382±0.032	0.448± 0.032	14.73± 1.64	1.172±0.034

F_4	28.46± 0.356	0.386±0.018	0.440± 0.012	13.18± 1.69	1.158±0.021
F_5	26.42± 0.168	0.420±0.040	0.482± 0.026	12.86± 1.48	1.147±0.028
F_6	28.91± 0.376	0.394±0.012	0.478± 0.033	17.57± 1.69	1.213±0.035
F_7	26.23 ±0.240	0.429±0.042	0.492± 0.022	12.80± 1.22	1.146±0.066
F_8	24.28± 0.196	0.387±0.005	0.431± 0.037	11.83± 1.76	1.134±0.035

*All values are expressed as mean ± SD, n=3

RESULTS

Table 3. Characteristic peaks in FTIR spectra of Famotidine

Wave number in cm^{-1}	Functional groups	Pure drug Famotidine	Physical mixture
1535-1639	NH_2 Bending	1621.80cm^{-1}	1610.50 cm^{-1}
1550-1690	C=N Stretching	1665.30 cm^{-1}	1650.30 cm^{-1}
1480-1600	Ring Stretching	1580.95 cm^{-1}	1575.160cm^{-1}
1500-1562	N-C=N Stretching	1561.72 cm^{-1}	1545.11 cm^{-1}

Table 4. Post-Compression Parameters of batch F1 to F8

Batch Code	Hardness* (Kg/cm^2)	Friability* (%)	Thickness* (mm)	Weight variation* (mg)	Drug content* (%)
F1	3.0 ± 0.19	0.65±0.014	3.89±0.15	200.2±0.31	98.65±1.76
F2	3.4 ± 0.17	0.61±0.032	3.73±0.09	200.43± 1.9	99.12±1.52
F3	3.0 ± 0.16	0.63±0.010	3.89± 0.20	199.6±0.34	97.52±0.63
F4	3.5 ± 0.18	0.66±0.014	3.85± 0.14	199.82± 1.9	96.96±0.68
F5	2.9 ± 0.17	0.67±0.041	3.92 ± 0.21	198.1±0.28	98.32±0.86
F6	3.1 ± 0.11	0.66±0.027	4.07 ± 0.21	199.08±1.11	98.46±0.75
F7	3.6± 0.08	0.62±0.062	3.85 ± 0.13	199.3±0.47	97.79±1.43
F8	3.8 ± 0.12	0.64±0.021	3.82 ± 0.16	200.44± 0.5	99.26±0.79

*All values are expressed as mean ± SD, n=3

Table 5. Tablet Density, Buoyancy Lag Time, Total Floating Time

Batch code	Tablet density	Buoyancy lag time (sec)	Total floating time(Hrs)
F1	0.94	63	>6
F2	0.89	55	>8
F3	0.98	78	>10
F4	0.94	80	>12
F5	0.93	82	>12
F6	0.89	96	>12
F7	0.96	89	>10
F8	0.81	49	>12

Table 6. Swelling Index of Tablets of Batch F1 to F8

Batch code	Swelling Index (%)				
	1 hour	2hour	3hour	4hour	5hour
F1	27.62	43.53	58.75	77.41	89.68
F2	28.81	44.32	60.66	78.16	87.67
F3	29.52	42.49	58.32	73.49	82.16
F4	28.26	41.25	62.63	79.43	89.94
F5	28.79	46.28	63.35	79.26	91.82
F6	30.86	48.62	64.39	81.25	92.18
F7	30.44	47.18	62.38	83.42	83.43
F8	30.54	49.21	65.28	82.60	96.16

Table 7. Dissolution of tablets of batch F1 to F8

Time (hr)	F1	F2	F3	F4	F5	F6	F7	F8
1	26.23	22.23	22.08	24.42	25.42	23.73	24.84	21.75
2	48.67	34.52	31.54	33.49	36.72	38.47	40.57	30.45
3	59.43	49.00	42.43	45.88	47.72	49.84	53.25	43.60
4	67.56	60.14	53.85	52.00	56.57	60.71	69.81	50.45
5	81.98	78.67	60.95	62.14	65.12	71.59	76.53	61.67
6	90.70	88.98	69.83	69.38	70.56	78.28	82.75	69.82
7	99.23	92.74	76.98	75.67	77.94	86.59	88.50	74.23
8		99.31	84.91	83.53	81.07	89.35	92.40	81.65
9			90.93	89.26	88.97	93.43	94.57	85.34
10			95.90	93.27	92.64	95.72	97.73	91.45
11			97.94	96.43	96.43	97.43	99.48	94.76
12			99.86	98.45	98.52	99.67		96.52

Table No:8 Kinetic Values Obtained From F8 plot Formulation

Formulation	Zero order R^2	First order R^2	Higuchi R^2	Korsmeyer -Peppas R^2	Korsemeyer peppas slope 'n'
F8	0.958	0.982	0.962	0.995	0.647

Figure 1. FT-IR Spectrum of Famotidine

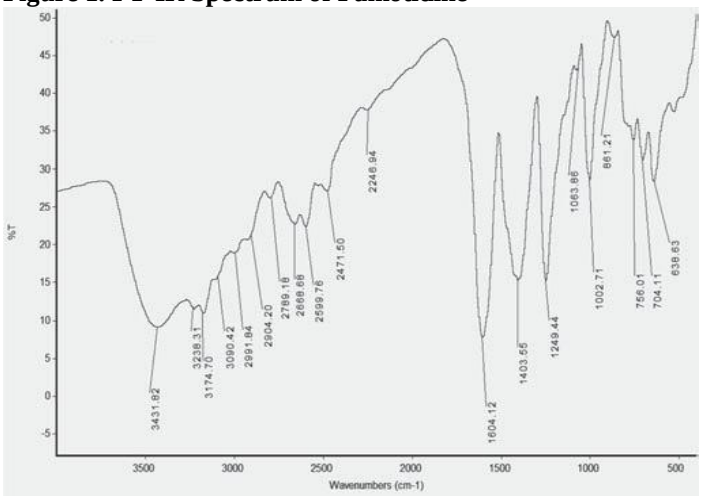


Figure 2. FT-IR Spectrum of Physical Mixture

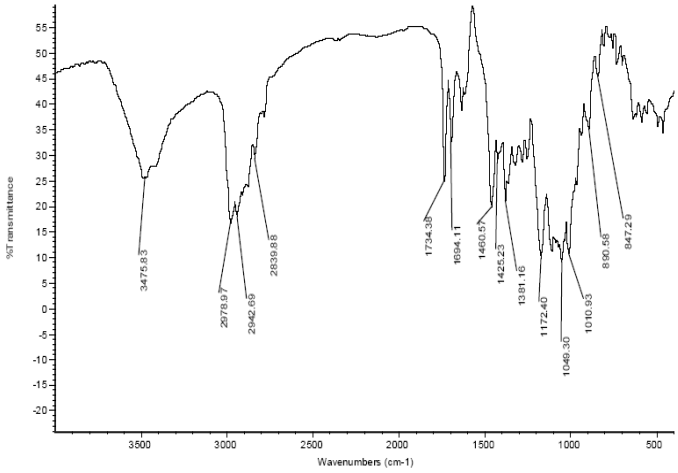


Figure 3. Percentage swelling index of formulation

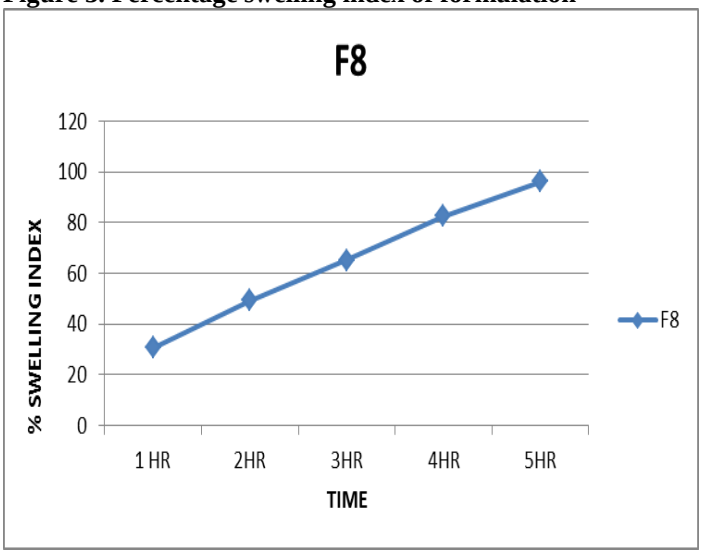
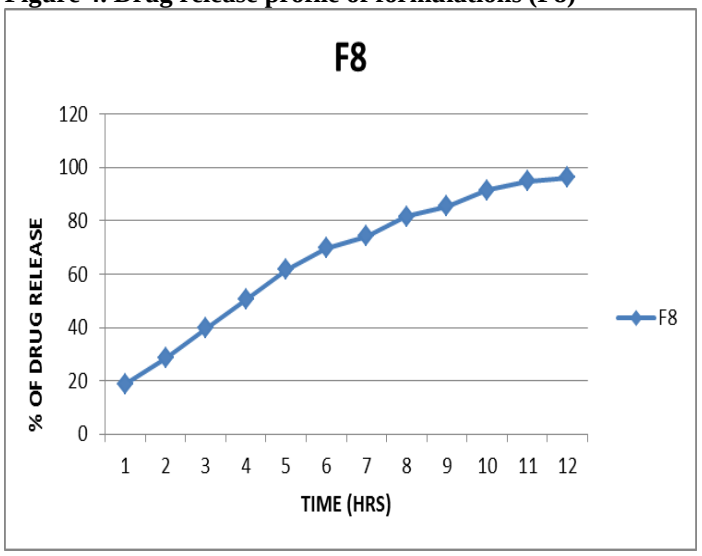


Figure 4. Drug release profile of formulations (F8)



Kinetic plots of formulation F8

Figure 5. Zero order plot

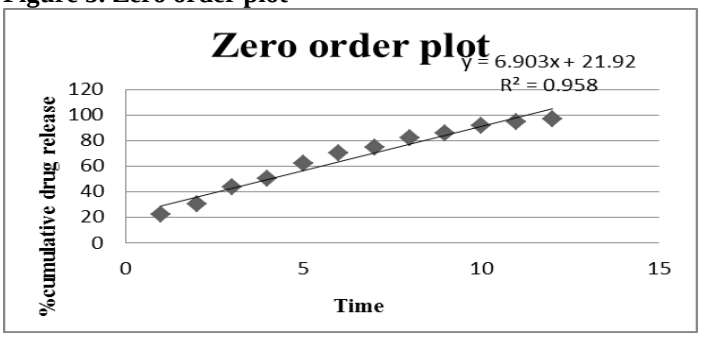


Figure 6. First order plot

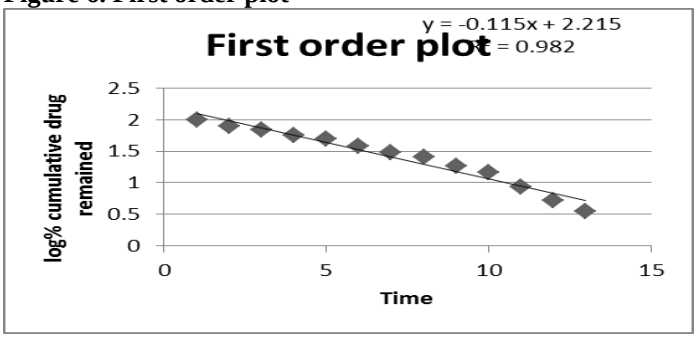


Figure 7. Higuchi plot

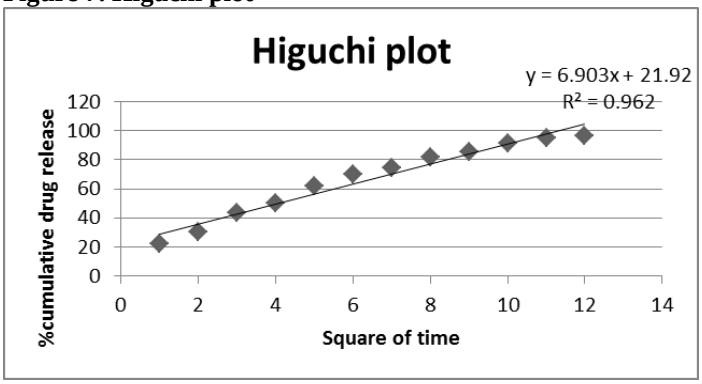
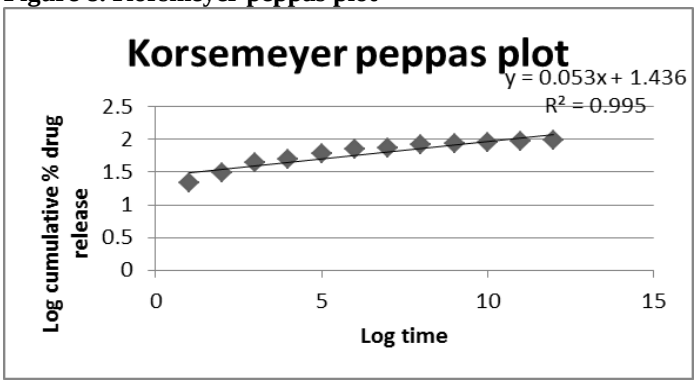


Figure 8. Korsmeyer peppas plot



Drug-Excipient Interactions Studies by FT-IR

The peaks obtained in the spectra of each formulation correlates with the peaks of drug spectrum. This indicates that the drug is compatible with the formulation components. The spectra for all formulations are shown in Fig. 1, 2.

Curve Fitting Analysis

The results of dissolution data fitted to various drug release kinetic equations. Peppas model was found to be best fitted in all dissolution profile having higher correlation coefficient (r value) followed by Higuchi model and Zero Order Release equation.

Korsemeyer-Peppas model indicates that release mechanism is not well known or more than one type of release phenomena could be involved. The results are reported in Table 9 and in the present study 'n' value ranges between 0.64 to 0.76 for all ten batches. It ranges between 0.5 to 1, so it was concluded that the drug release occurred via non-Fickian diffusion, which shows that the release from initially dry, hydrophilic glassy polymers that swell when added to water and become rubbery show anomalous diffusion as a result of the rearrangement of macromolecular chains.

Stability Study

The promising formulations (F8) were subjected to short term stability study by storing the formulations at 40±C/75% RH up to one month. After one month the tablets were again analyzed for the hardness, in vitro disintegration time, wetting time and percentage drug release. Some of the parameters are slightly changed is observed.

DISCUSSION

Pre-Compression Parameters

The results of angle of repose, bulk density, tapped density, carr's index and haunser's ratio are calculated and all the above said parameters were within the prescribed limits of IP. The results of all the preformulation parameters are given in Table 2.

Angle of repose (θ)

The data obtained from angle of repose for all the formulations were found to be in the range of 24.28±0.196 and 28.50±0.376. All the formulations prepared by showed the angle of repose less than 30, which reveals good flow property for compression into tablets.

Bulk density

Loose bulk density (LBD) and tapped bulk density (TBD) for the blend was performed. The loose bulk density and for the entire formulation blend varied from 0.381± 0.016 g/cm^3 to 0.429 ± 0.042 g/cm^3. The tapped density for the entire formulation blend varied from 0.431 ± 0.037 g/cm^3 to 0.492 ± 0.022 g/cm^3.

Hausner's ratio

Hausner's ratio of entire formulation showed between 1.134 ± 0.035 to 1.213 ± 0.035, indicates better flow properties.

Carr's Consolidation Index

The results of Carr's consolidation index or compressibility index (%) for the entire formulation blend ranged from 11.83 ± 1.76 % to 17.57 ± 1.69%. All the formulations show good results which indicate good flow properties.

FTIR Studies

The peaks obtained in the spectra of each sample of drug and excipient correlates with the peaks of drug spectrum. The spectra for pure drug and samples with pure drug & polymer were shown in figures 1,2 and their interpretation of peaks in Table No 3. All the bands associated with the pure drug are present in the FTIR spectra of drug in combination with Xanthan gum, HPMC E5 LV, povidone and lactose. This shows that there is no chemical interaction between drug and excipients, famotidine was compatible with excipients used in the formulation and there were no extra peaks observed.

Post-Compressional Parameters of Tablets

Friability Test

The friability values of formulations were found to be 0.61±0.032 and 0.67±0.041 0.75% to be well within the approved range (<1%). The friability study results were tabulated in Table 4.

Hardness Test

The hardness of the tablets was maintained within the range of 2.9 kg/cm^2 to 3.8 kg/cm^2.

Weight variation test

The weight variation for all the formulations was found to be in the range 198.10±0.28 to 200.44 ± 0.52 mg. The mean weight variation test results are tabulated in Table 4. All the tablets passed weight variation test as the average percentage weight variation was within 7.5% i.e. in the pharmacopoeial limits.

Thickness

The mean thickness was almost uniform in all the formulations and values ranged from 3.73 ± 0.09 mm to 4.07 ± 0.21 mm. The standard deviation values indicated that all the formulations were within the range. The results of thickness for tablets were shown in Table 4.

Drug Content

The drug content uniformity was performed for all the formulations and results are tabulated in Table 4. Three trials were performed for batches which were analyzed spectrophotometrically. The mean values and standard deviations of all the formulations were calculated. The percentage drug content of the tablets was found to be between 96.96 ±0.68 to 99.26±0.76% of Famotidine. The results were within the range and that indicated content uniformity of drug in all formulations.

Density

To provide good floating behavior in the stomach, the density of the device should be less than that of the gastric contents (1.004g/cm3). All the batches showed density of 0.81 to 0.96 which is less than that of gastric fluid (1.004). The values are shown in Table 5. When tablet contacts the test medium, tablet expanded (because of swellable polymers) and there was liberation of CO_2 gas (because of effervescent agent, $NaHCO_3$). The density is decreased due to this expansion and upward force of CO_2 gas generation. This plays an important role in ensuring the floating capability of the dosage form.

Buoyancy Study

On immersion in 0.1N HCl solution pH (1.2) at 37^0C, the tablets floated, and remained buoyant without disintegration. Table 5 shows the results of Buoyancy study & shows Buoyancy character of prepared tablet.

From the results it can be concluded that the batch containing only HPMC E5 LV polymer shows good Buoyancy lag time (BLT) and Total floating time (TFT). Formulation F8 containing HPMC E5 LV showed good BLT of 48 sec, while the formulation containing PVP K-30 showed highest BLT, and TFT of less than 12 hrs. This may be due to the amount of polymer and gas generating agent, which were kept constant in the present study.

Swelling Study

Swelling ratio describes the amount of water that is contained within the hydrogel at equilibrium and is a function of the network structure, hydrophilicity and ionization of the functional groups. Swelling study was performed on all the batches for 5 hr. The results of swelling index are given in Table 6. While the plot of swelling index against time (hr) is depicted in Fig.3. From the results it was concluded that swelling increases as the time passes because the polymer gradually absorb water due to hydrophilicity of polymer. The outermost hydrophilic polymer hydrates and swells and a gel barrier is formed at the outer surface. As the gelatinous layer progressively dissolves and/or is dispersed, the hydration swelling release process is repeated towards new exposed surfaces, thus maintaining the integrity of the dosage form.

In the present study, the higher swelling index was found for tablets of batch F8 containing HPMC E5 LV. Thus, the viscosity of the polymer had major influence on swelling process, matrix integrity, as well as floating capability, hence from the above results it can be concluded that linear relationship exists between swelling process and viscosity of polymer.

***In-vitro* Dissolution Study**

The *in-vitro* drug release profile of tablet from each batch (F1 to F8) was shown in Table 7. The plot of % cumulative drug release V/s time (hr) was plotted and depicted as shown in Fig. 4. For *in-vitro* dissolution study ring mesh device was used. The reason is that when paddle

apparatus is used, the tablets would rise and eventually stick to the flange of the rotating shaft resulting in partial surface occlusion. In case of basket apparatus, it ensures full exposure of all surfaces of hydrophilic swelling tablets that may stick to bottom of dissolution vessel if paddle apparatus was used. However, it was observed that after 5-7 hr the tablets had swollen to such an extent that they were completely constricted by the radius of the basket and completely filled the bottom of the basket. Once the dosage forms completely fill the basket, tablet is unable to swell further and move in unimpeded fashion leading to limited drug release. In order to overcome these drawbacks ring mesh device is employed in the study.

From the *in-vitro* dissolution data it was found that formulation F8 containing HPMC E5 LV alone released 96.52% of drug in 12 hr of the study indicating that the polymer amount is sufficient to control the drug release. Out of all the 8 formulations batch F8 showed better control over drug release indicating that the release was decreased when the concentration of the polymer was increased.

Kinetic studies

The results of *in vitro* dissolution data fitted to various drug release kinetic equations. Peppas model was found to be best fitted in all dissolution profile having higher correlation coefficient (r value) followed by first order, Higuchi model and Zero Order release equation. The kinetic values obtained for optimized formulation is tabulated in Table 8 and the kinetic plots were shown in figure 5-8.

The results are reported in Table 16. The n value ranges between 0.5 to 1, so it was concluded that the drug release occurred via non-Fickian diffusion or anamolous diffusion, which shows that the drug release is controlled by both diffusion as well as polymer relaxation process. Drug release mechanism also starts from initially dry, hydrophilic polymers that swell when added to water and become rubbery show anomalous diffusion as a result of the rearrangement of macromolecular chains.

Stability Study

There is no significant changes observed in the tablets of formulation F8, the formulation was within the acceptable limits.

The promising formulations were subjected to short term stability study by storing the formulation at 25^0C and 40^oC up to three months. The formulation F8 was selected. After three months the tablets were again analyzed for hardness, drug content, floating characters, percentage drug release. At 25^0C there is slight change in the buoyancy time was observed. Whereas 3 months and 25^0C and 45^oC were used during stability studies, small change was observed in the hardness, drug content, floating characters.

CONCLUSION

From the above studies, it has been observed that effervescent based floating drug delivery system is a promising approach to achieve controlled release behaviour and *in vitro* buoyancy profile. Floating tablets employing famotidine as a model drug can be prepared successfully using wet granulation technique. It was concluded that all formulations had acceptable physical parameters. The addition of gel-forming polymer HPMC E5 LVting agents was essential to achieve *in vitro* buoyancy. The type of polymer also affects the drug release rate. Polymer swelling is crucial in determining the drug release rate and is also important for floatation. Based on these findings, it has been revealed that floating type gastroretentive drug delivery system holds significant potential for better drug delivery and facilitates an enormous impact on health care. Moreover, it is anticipated that increased sophistication of this effervescent approach will ensure the successful delivery of therapeutic molecules in a more efficient manner.

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