International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.12 No.04, pp 163-172, 2019

Formulation and Evaluation of Ranitidine Hydrochloride Fast Dissolving Tablets Using Fenugreek Seeds Mucilage

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Abstract : The aim of the present research work was to formulate fast dissolving tablets of ranitidine HCl by direct compression method and to evaluate *fenugreek* seeds mucilage as a natural superdisintegrating agent. The fast dissolving tablets were prepared by using *fenugreek* seed mucilage powder, crospovidone, croscarmellose sodium, sodium starch glycolate as superdisintegrants (2 and 4% w/w) and microcrystalline cellulose (34 and 36% w/w) as a directly compressible vehicle. All the prepared tablets were evaluated for hardness, friability, drug content uniformity, weight variation, disintegrating time, wetting time and *in vitro* drug release studies. All the prepared fast dissolving tablets formulations were within the Pharmacopoeial standards limits. Based on *in vitro* drug release studies (>90 % within 30 min), the two formulations were tested for the short term stability (40 ˚C/75% RH for 3 months) and drug excipient interaction (IR spectroscopy). From all the prepared formulations, the formulation FR8 prepared with 6% w/w *fenugreek* seeds mucilage and 34% w/w of MCC was optimised as the best formulation (>90 % within 30 min) compared to conventional commercial tablets formulation (>75 % within 30 min). There is no significant on drug content and *in vitro* drug release ($p < 0.05$) (Accelerated stability studies).

Keywords : Ranitidine HCl, *fenugreek* seeds mucilage, croscarmellose sodium, microcrystalline cellulose, fast dissolving tablets.

1 Introduction:

Among different routes of administration, oral route is the most common and applicable route of administration of drug due to various advantages including ease of administration, avoidance of pain, versatility and most importantly patient compliance. As solid formulations do not require any sterile conditions, they are less expensive[1]. In late 1970 fast dissolving drug delivery system (FDDS) was introduced as the alternative to oral dosage forms are useful in patients, like pediatric, geriatric, bedridden or mentally disabled, who may face difficulty in swallowing conventional tablets or capsules leading to ineffective therapy. Fast dissolving tablets (FDTs) disintegrate rapidly and release the drug within a short period of time. When local action in the mouth is

DOI= http://dx.doi.org/10.20902/IJCTR.2019.120420

desirable, FDTs are useful for toothaches, oral ulcers, cold sores. Ranitidine HCl Dimethyl [(5-{[(2-{[(E)-1-(methylamino)-2 nitroethenyl] amino} ethyl) sulfanyl] methyl} furan-2yl) methyl] amine is a H_2-receptor antagonist which blocks the action of histamine on parietal cells in the stomach, thus suppressing or reducing the normal secretion of acid by parietal cells[2-4]. The drug is 50% absorbed orally, but it undergoes hepatic metabolism. Ranitidine HCl (R-HCl) is used in the treatment of peptic ulcers. Thus, R-HCl is selected as a better option for the development of FDTs[5]. Natural *fenugreek* mucilage is most commonly used as an adjuvant as binding, disintegrating, suspending, emulsifying and sustaining properties in the manufacturing of various pharmaceutical dosage forms[6-8]. Due to various advantages like non-toxic, low cost, availability, emollient and non-irritating, natural mucilages are preferred over semi-synthetic and synthetic materials[9, 10]. The purpose of the present research work was to develop and characterize FDTs of R-HCl using various synthetic superdisintegrants such as crospovidone (CP), croscarmellose sodium (CCS), sodium starch glycolate (SSG) in comparison with natural superdisintegrant *fenugreek* seeds mucilage (FSM). These FDTs release the medicament with short duration of time which may result in quick onset of pharmacological action and increased bioavailability of the drug.

2 Materials and Methods:

2.1 Materials:

Ranitidine HCl, was obtained as a gift sample from Aurabindo Labs, Hyderabad, India. Crospovidone, Croscarmellose sodium and Sodium starch glycolate purchased from Yarrow Chem Product, Mumbai, India. Microcrystalline cellulose purchased from Chemica-biochemica reagents, Mumbai, India. *Fenugreek* seeds purchased from Local market, Vizianagaram, Andhra Pradesh, India. All the materials were of pharma grade.

2.2 Extraction of fenugreek seeds mucilage :

The seeds were powdered and passed through sieve #60. Then 100 gm of the powder was soaked in sufficient quantity of distilled water for 5 hr, boiled for 2 hr and then kept aside for 1 hr for complete release of mucilage into the water. Then the contents were squeezed through an 8-fold muslin cloth to remove the marc from the solution. To the filtrate added 3 volumes of ethanol to precipitate the *fenugreek* mucilage. Then the precipitated mucilage was filtered and dried at room temperature. Dried *fenugreek* mucilage was collected, grounded, passed through sieve # 80 and stored at room temperature in desiccators.

2.3 Preparation of R-HCl FDTs :

Each tablet containing 150 mg R-HCl were prepared by using direct compression method with 50 tablets for the batch. The compositions of various formulations of the tablets with their formulation codes were given in Table 1. All the materials were passed through sieve 80 # and mixed[11]. The blend was compressed into tablets using 10 mm flat round punches on 12 station tablet compression machine (Rimex MINI press, karnavathi engineering Pvt. Ltd. Gujarat, India).

Table 1: Formulation of ranitidine HCl fast dissolving tablets

S. No.	Ingredients (mg)	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8	FR9
1.	Ranitidine HCl	150	150	150	150	150	150	150	150	150
2.	Crospovidone	5	10	-	-	-	-	-	-	-
3.	Croscarmellose sodium	-	-	5	10	-	-	-	-	-
4.	Sodium starch glycolate	-	-	-	-	5	10	-	-	-
5.	*Fenugreek* seed mucilage	-	-	-	-	-	-	10	15	20
6.	Microcrystalline cellulose	90	85	90	85	90	85	85	80	75
7.	Magnesium stearate	5	5	5	5	5	5	5	5	5
	Total weight	**250**	**250**	**250**	**250**	**250**	**250**	**250**	**250**	**250**

2.4 Evaluations

Evaluation of pre-compression parameters:

Pre-compression parameters such as angle of repose, bulk density and tap density, Carr's compressibility index, and Hausner's ratio were determined[12, 13].

2.4.1 Angle of repose:

It was determined by the funnel method. The powder was allowed to flow through the funnel fixed to a stand at definite height. The angle of repose (θ) was calculated by measuring the height (h) and radius r of the heap of granules, using Eq. 1.

$$\theta = \tan^{-1}\left[\frac{h}{r}\right] \quad \text{Eq. 1}$$

2.4.2 Bulk density:

The bulk density and tapped density were determined by pouring the blend into a graduated cylinder of density apparatus. The bulk density apparatus was allowed to tap for a fixed time to obtain tapped volume (V_f). The bulk volume (V_0) and the weight of powder (M) were determined. The bulk density (ρ_o) and tapped density can be calculated using the formula given in Eq. 2 and Eq. 3.

$$Bulk\ density(\rho_0) = \frac{M}{V_0} \quad \text{Eq. 2}$$

$$Tapped\ density = \frac{M}{V_f} \quad \textbf{Eq. 3}$$

2.4.3 Carr's compressibility index:

The flow ability of powder can be evaluated by comparing the bulk density and tapped density of powder and the rate at which it packed down. The Carr's compressibility index is calculated by using the Eq. 4.

$$\%\ compressibility\ index = \frac{\rho_t - \rho_0}{\rho_t} \times 100 \quad \text{Eq. 4}$$

2.4.4 Hausner's ratio:

An indirect index of powder flow and calculated by using Eq.5.

$$Hausner's\ ratio = \frac{\rho_t}{\rho_0} \quad \text{Eq. 5}$$

2.4.5 Compatibility studies:

The compatibility studies were performed using IR spectrophotometer, DSC, XRD, and SEM.

Evaluation of post-compression parameters:

Post-compression parameters such as weight variation, thickness, hardness, friability, water absorption ratio, wetting time, disintegration test, *in vitro* dispersion time, content uniformity and *in vitro* dissolution study were determined.

2.4.6 Weight variation:

Randomly 20 tablets were taken from each batch, and their weight was determined individually and collectively on a digital weighing balance. The average weight of the tablet was determined by the collective weights[14].

2.4.7 Thickness:

Randomly 10 tablets from each formulation were taken, and their thickness was measured using a Vernier callipers, and the reading was recorded in millimetres[15].

2.4.8 Hardness:

Three tablets were randomly picked from each formulation batch, and the mean and standard values were calculated[15]. The hardness of the tablet was determined using the Monsanto hardness tester and expressed in kg/cm^2.

2.4.9 Friability:

A sample of whole tablets corresponding to about 6.5 g was weighed, and the initial weight was recorded (W_o) and placed in Roche friabilator and rotated at the speed of 25 rpm for 100 revolutions[14]. Then tablets were removed from the friabilator, dusted off the fines and again weighed and the final weight was recorded (W_f). Percentage friability was calculated by using the formula given in Eq. 6.

$$\%Friability = \left[\frac{W_o - W_f}{W_o}\right] X100 \quad \text{Eq. 6}$$

2.4.10 Wetting time and water absorption ratio:

A piece of tissue paper folded twice and placed in a small petridish containing 10 mL of water. Initially, tablet was weighed (W_b), placed on the paper and time for complete wetting was measured as wetting time[15]. The wetted tablet was weighted (W_a). Water absorption ratio R, was calculated using the formula given in Eq. 7.

$$R = \left[\frac{W_a - W_b}{W_b}\right] X100 \quad \text{Eq. 7}$$

2.4.11 Disintegration test:

The disintegration time was performed using USP disintegration test apparatus with 0.1 N HCl medium at 37 ±0.5 ˚C. A tablet was placed in each of six tubes of apparatus, and one disc was added to each tube. The time was recorded when all the fragments of the disintegrated tablet (6 tablets) passed through the screen of the basket[14].

2.4.12 Content uniformity:

The drug content was determined by taking 10 dosage units at random and powdered. The blend equivalent to 150 mg of R-HCl was weighed and dissolved in 100 mL of 0.1 N HCl buffer, stirred for 15 min and filtered. Absorbance was measured at 315 nm using a UV-Visible double beam spectrophotometer11 (UV-1700 Shimadzu)[15].

2.4.13 In vitro dissolution studies:

In vitro dissolution studies of R-HCl were performed in USP XXIII dissolution testing apparatus II (paddle type). The dissolution test was performed using 900 ml of 0.1 N HCl (pH-1.2), at 37±0.5 ˚C with 50 rpm speed. A sample of 5 mL solution was withdrawn from the dissolution apparatus at 5, 10, 15, 30, 45 and 60 min respectively and replaced with 5 ml of fresh dissolution medium. The samples were filtered and measured

spectrophotometrically at 315 nm. All the dissolution tests were carried out in triplicates. Cumulative percentage of drug release was drug release was calculated using an equation obtained from a standard curve[15].

2.4.14 Statistical analysis:

All the values are expressed as mean ± standard deviation (S.D). The t-test was used to study the significznce differnce between the control and test at 0.05% of level of significance. All the values are represented in three determinents. The value less than 0.05 was taken as no significance difference.

3 Results and Discussions

In the present investigation, FDT of R-HCl were prepared by using natural superdisintegrants (FSM powder). For comparison, tablets were also prepared by synthetic superdisintegrants (CP, CCS, and SSG). Initially, the FSM powder was extracted from 100 g of *fenugreek* seed powder around 65 g of FSM powder was obtained.

3.1 Identification of pure drug:

Physical characterization studies stated that R-HCl is a white or pale yellow crystalline powder with a bitter taste. The melting point of R-HCl was found to be in the range of 163–164 °C when tested using the capillary method in melting point apparatus in triplicate. All the studies were conducted in aqueous media (0.1 N HCl buffer). Identification of the drug was done from absorption maxima, IR and DCS studies. Absorption maxima of 315 nm confirmed that the drug was pure R-HCl as it was previously mentioned in associated literature[15].

3.2 Fourier transform infrared spectroscopy:

The FTIR analysis of the pure drug R-HCl, optimized formulation FR4 and FR8 were shown in the Figure 1. The IR spectrum of the pure drug showed a characteristic peak of aromatic C-H stretching vibration at 3408 cm^{-1}, C-H stretching vibration at 2923.3 cm^{-1}, NH_2 bending at 1621 cm^{-1} and –OH stretching at 1005.92 cm^{-1}, indicating the drug was pure. The FTIR spectra of optimized formulation FR4 containing 4% of croscarmellose sodium showed O-H stretching at 3422.83 cm^{-1}, C-H stretching vibration at 2916.6 cm^{-1} and C-O stretching vibration at 1107 cm^{-1}. The FTIR spectra of optimized formulation FR8 containing 6% of *fenugreek* seed mucilage powder showed O-H stretching at 3424.3 cm^{-1}, C-H stretching vibration at 2918.7 cm^{-1} and C-O stretching vibration at 1102 cm^{-1}. There were no major shifts in existing peaks or no additional peaks, which indicates that there was no chemical reaction between the components in the formulations. This confirms the stability of ranitidine HCl in formulations.

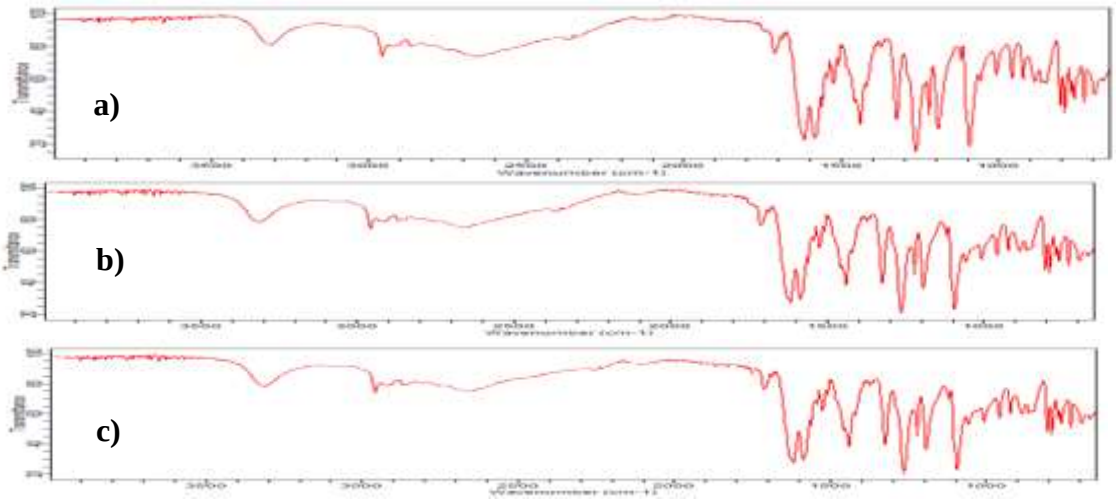

Figure 1: FTIR Spectrum of a) Ranitidine HCl, Optimised formulations b) FR4 containing 4% of CCS and c) FR8 containing 6% of FSM powder

3.3 Differential Scanning Calorimetric Studies (DSC):

The DSC thermograph of pure R-HCl, optimized formulations FR4 and FR8 shown in Figure 2. The DSC thermograph of ranitidine HCl showed a sharp endothermic peak at 132.7 °C due to the melting point of the drug with the enthalpy value of 9.11 J/g. The optimized formulation FR4 with 4% CCS showed a sharp endothermic peak at 132.6 °C with 9.11 J/g enthalpy value. The optimized formulation FR8 with 6% *fenugreek* seed mucilage powder showed a sharp endothermic peak at 133.4 °C with 17.11 J/g enthalpy value. This indicates the crystallinity nature of the drug converted to an amorphous state.

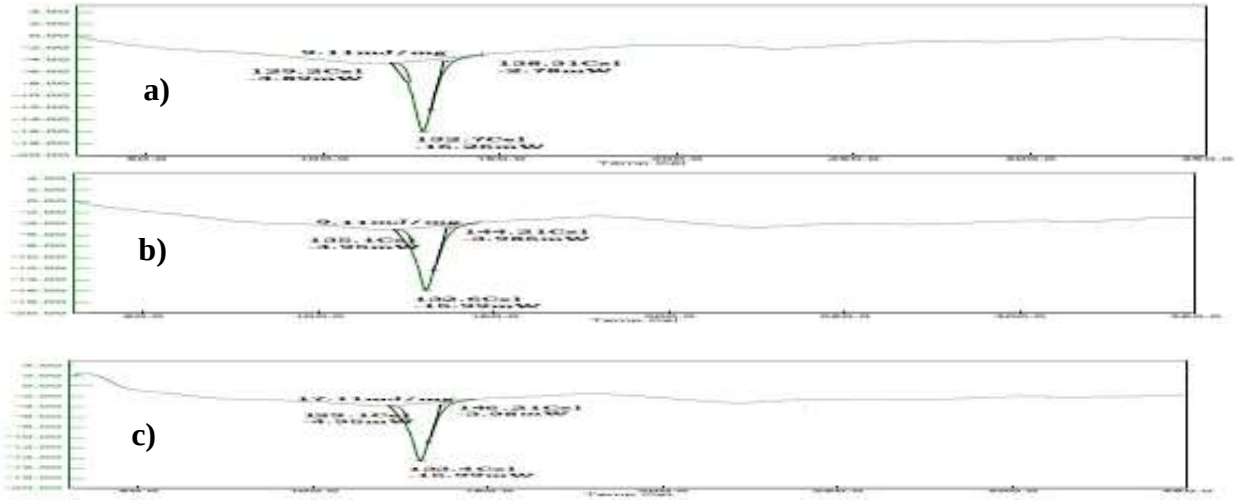

Figure 2: DSC thermogram of a) Ranitidine HCl, Optimised formulations b)FR4 containing 4% of CCS and c) FR8 containing 6% of FSM powder.

3.4 XRD studies:

The XRD pattern of R-HCl, optimized formulations FR4 with 4% CCS and FR8 with 6% *fenugreek* seed mucilage powder were shown in Figure 3. The XRD pattern of ranitidine HCl exhibited sharp and intense peaks at 2θ equivalent to 7.25 °, 11.64 °, 18.2 °, 25.3 °, and 44.7 ° showed the strong crystal habit of pure drug. This indicates the crystalline nature of the drug.

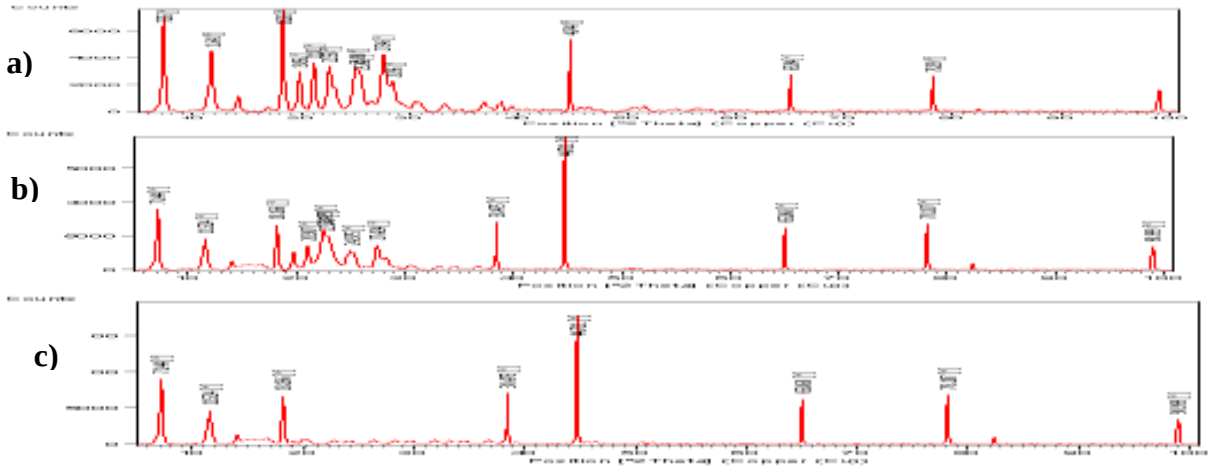

Figure 3: XRD studies of a) Ranitidine HCl, Optimised formulations b) FR4 containing 4% of CCS and c) FR8 containing 6% of FSM powder.

3.5 SEM analysis:

The SEM analysis of R-HCl, optimized formulations FR4 and FR8 were shown in Figure 4. The microphotograph of ranitidine HCl showed shaped crystalline structure. In the optimized formulations FR4 and

FR8, the crystallinity of the drug was lost that indicate the molecular mixing of the drug with CCS and FSM powder.

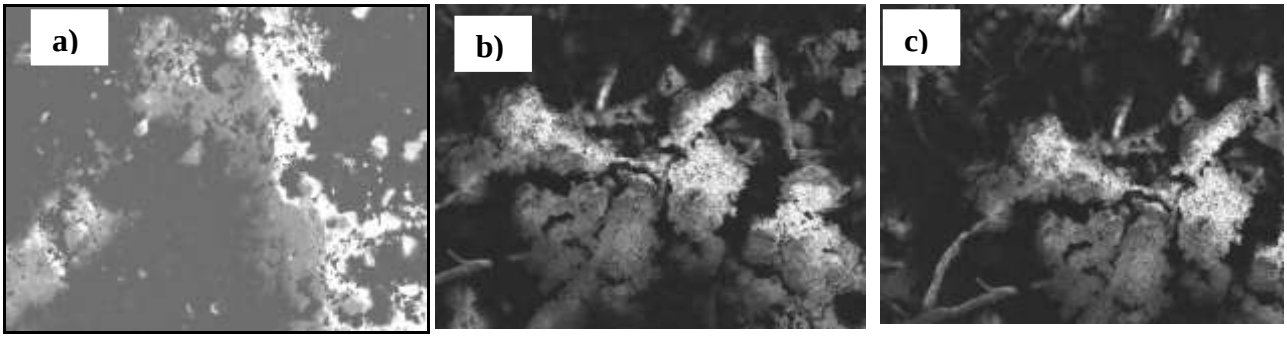

Figure 4: SEM analysis of a) Ranitidine HCl, b) Optimised formulation FR4 containing 4% of croscarmellose sodium and c) Optimised formulation FR8 containing 6% of *fenugreek* seed mucilage powder.

3.6 Evaluation of pre-compression studies:

Flow characteristics of the material being compressed were evaluated and the results are shown in Table 2.

Table 2: Pre-compression properties of prepared formulations

Formulation code	Angle of repose	Bulk density(gm/cm^3)	Tapped density(gm/cm^3)	Carr's index	Hausner's ratio
FR1	21.15±0.14	0.274±0.03	0.321±0.02	14.64	1.17
FR2	22.19±0.11	0.268±0.01	0.306±0.01	12.41	1.14
FR3	21.05±0.13	0.263±0.02	0.303±0.01	13.20	1.15
FR4	21.58±0.10	0.270±0.02	0.317±0.02	14.82	1.17
FR5	21.98±0.12	0.364±0.04	0.408±0.01	10.78	1.12
FR6	20.05±0.18	0.364±0.03	0.417±0.01	12.70	1.14
FR7	21.86±0.12	0.298±0.02	0.334±0.02	10.77	1.16
FR8	21.15±0.10	0.276±0.04	0.328±0.01	14.85	1.18
FR9	21.59±0.10	0.271±0.02	0.315±0.02	14.83	1.16

As the angle of repose values was within the range of 20.05° to 22.19° for FR1 to FR8 formulations respectively, they indicated excellent to good flow properties. The compressibility index values of all the formulations was within the range of 10.77 – 14.85 % respectively, with good compressibility index as all the values, are within 15% results in good to excellent flow properties and which describes the frictional and cohesive interactions of the polymers in the formulation. Hausner's ratio of all the formulations was in the range of 1.12 to 1.18 which indicated good flow characteristics for the prepared lubricated blends, as all the values are <1.25 indicating the polymers with low interparticle friction.

3.7 Evaluation of Post-compression parameters

3.7.1 Tableting characteristics of the ranitidine HCl tablets:

All the prepared tablets were evaluated for the post-compression parameters and results are given in Table 3 and 4. All the prepared R-HCl FDTs are greater than 250 mg (0.250 g) and are well within the range of 5% and hence qualify the test for uniformity of weight. The thickness of all the formulations was in the range of 2.82 to 2.97 mm. The hardness for all the formulations was in the range of 3 to 4 kg/cm^2. For all the batches the percentage of weight loss in the friability test was found to be less than 0.5%. The wetting time and water absorption ratio of all the formulations was in the range of 35 to 47 sec and 87.9 to 99.5 sec. The disintegration time of all the formulations was in the range of 80-122 sec. The assay of all the prepared R-HCl formulations

was found to be in the range of 98.91 to 101.23 %. Thus, R-HCl FDTs prepared with the selected superdisintegrants are regarded as good quality fulfilling the official requirements of tablets.

Table 3: Physicochemical properties of the ranitidine HCl FDTs

S. No	Weight variation (kg/cm^2)[a]	Thickness (mm)[b]	Hardness (kg/cm^2)[b]	Friability (%)[c]
FR1	250.08±0.14	2.83±0.14	3-4	0.39
FR2	250.07±0.14	2.97±0.16	3-4	0.42
FR3	250.17±0.14	2.82±0.18	3-4	0.38
FR4	251.97±0.14	2.91±0.24	3-4	0.45
FR5	250.83±0.14	2.84±0.23	3-4	0.37
FR6	251.01±0.14	2.92±0.15	3-4	0.35
FR7	250.95±0.14	2.93±0.18	3-4	0.42
FR8	250.21±0.14	2.89±0.22	3-4	0.40
FR9	251.01±0.14	2.93±0.15	3-4	0.35

Where a: mean±% deviation. (n=20); b:n=5; c:n≈6.5gm of total weight

Table 4: Physicochemical properties of the ranitidine HCl FDT

S. No	Wetting time (Sec)[a]	Water absorption ratio (%)[a]	Disintegration Time (Sec)[a]	Drug content (%)[b]
FR1	92±0.14	87.9±0.40	108±1.61	99.89±0.14
FR2	88±0.16	89.9±0.45	91±1.24	99.71±0.40
FR3	91±0.18	90.6±0.38	95±1.22	98.91±0.68
FR4	89±0.12	95.6±0.29	80±1.44	100.57±0.12
FR5	93±0.24	97.8±0.46	122±1.35	99.68±0.43
FR6	87±0.19	99.5±0.45	110±1.32	100.12±0.15
FR7	95±0.22	93.2±0.55	106±1.06	99.19±0.48
FR8	89±0.15	96.7±0.39	91±1.03	101.23±0.11
FR9	87±0.19	99.6±0.43	107±1.32	100.15±0.13

Where a: mean± s.d. (n=3); b: mean± s.d. (n=10)

3.8 In vitro dissolution studies:

The *in vitro* dissolution studies of FDTs were conducted in 0.1 N HCl for 1 hour. The results of the drug release studies of all the prepared formulations are shown in Figure 5. The drug release from FR1 and FR2 composed of CP 2% and 4% were found to be 62.65 and 75.12 % in 60 min. The drug release from FR3 and FR4 composed of CCS 2 % and 4 % were found to be 82.66 and 99.32 in 60 min. The drug release form formulations FR5 and FR6 were composed of SSG was found to be 75.62 and 95.73 in 60 min. The drug release form formulations FR7, FR8 and FR9 which were composed of FSM powder 4, 6, 8 % were found to be 80.96, 98.86 and 99.89 in 60 min. From the above, it can be concluded that as the concentration of FSM powder is increased the release rate of drug is also increased. Formulations FR4 prepared with 4 % of CCS and FR8 prepared with FSM powder with 6% showed more than 95 % of drug release within 1 h. Among these two optimized formulation FR8 showed 99.89 % drug release, and FR4 showed 99.32 % drug release in 1 hr, but by using natural superdisintegrant are better tolerated. Hence FR8, is selected as the best formulation among all the other formulations. The various kinetic models were applied to *in vitro* drug release profiles of R-HCl in order to evaluate the mechanism of drug release. The different kinetic models evaluated were zero order, first order, Higuchi, Hixson-Crowell. All the formulations followed First order release with Fickian mechanism of drug release, due to the dominant erosion pattern with burst drug release and the results are given in Table 8. This pattern may be due to the use of superdisintegrants both synthetic and natural.

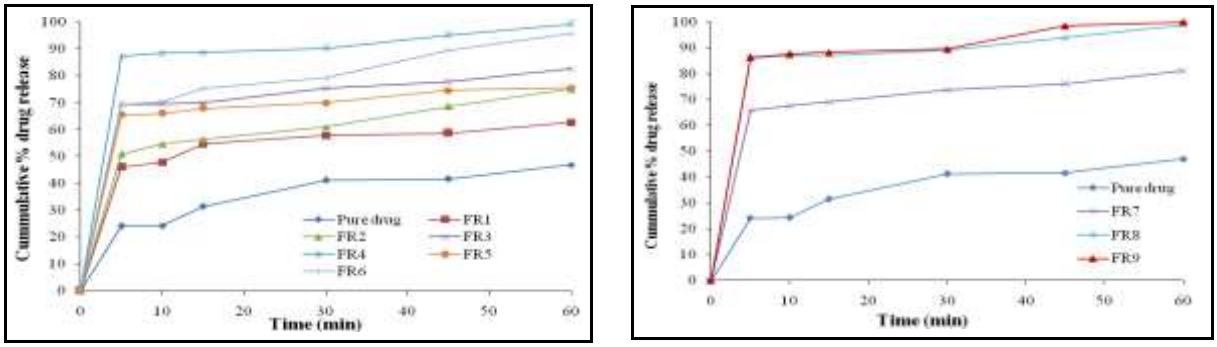

Figure 5: Cumulative % drug release of ranitidine HCl pure drug, formulations FR1 to FR6 prepared with synthetic superdisintegrants and formulations FR7 to FR9 prepared with natural superdisintegrants.

Table 8: Release kinetics data of ranitidine HCl prepared formulations FR1 to RF9

Formulation Code	Zero order (r)	First order (r)	Higuchi (r)	Korsmeyer-Peppas (r)	Hixson-Crowell (r)	Korsmeyer-Peppas (n)	Mechanism of release
FR4	0.324	0.787	0.586	0.798	0.617	0.047	Fickian
FR8	0.334	0.773	0.596	0.779	0.612	0.051	Fickian

3.9 Comparative studies:

The R-HCl pure drug, optimized formulations FR4 with 4 % CCS and FR8 with 6 % FSM powder was compared with the marketed product. The drug release profiles are shown in Figure 6. The drug release was found to be 72.01 % for the marketed product in 5 min, where as 87.28 % and 85.82 % for FR4 and FR8 formulations. Hence, the *in vitro* drug release for the prepared formulations was found to be better than the marketed product.

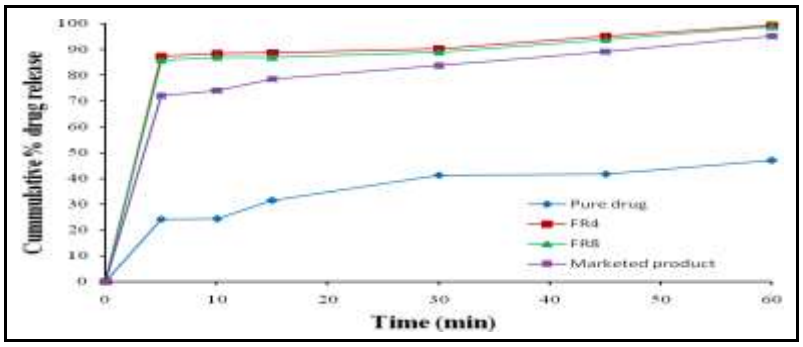

Figure 6: Cumulative % drug release of ranitidine HCl pure drug, optimized formulations FR4, FR8 in comparison with a marketed product

4 Conclusion:

The present study was carried out to develop the fast dissolving tablets of R-HCl by using various superdisintegrants at different ratios in comparison with a natural disintegrant. The formulations prepared with 4 % w/w concentration of CCS FR4 for FDTs and 6 % w/w FSM powder FR8 was found to be more suitable than the formulation prepared with other synthetic superdisintegrants and gave maximum drug release (%) within 5 min. It was found that the release rate was influenced by the nature of the superdisintegrant and the concentration of the disintegrant employed in the preparation of the tablets. FR8 drug release of FSM powder is slightly greater than that of the synthetic superdisintegrant.

5 Acknowledgments:

The authors are thankful to Aurobindo Pharmaceuticals, Hyderabad for providing ranitidine HCl as a gift sample. The authors are thankful to MANASA's trust for providing the necessary facilities to carry out this research work.

6 References

1. Navneet KV, Shivendra PS, Abhay PS, Praveen KR, Reena S. Formulation and characterization of fast dissolving tablet of domperidone. Der Pharmacia Sinica. 2015; 6(9): 21-28.
2. Ranitidine drug profile. [Internet]. [Cited 15th November 2013]. Ref- http://www.drugbank.ca/drugs/ DB00863.
3. Ranitidine tablets. [Internet]. [Cited 21th April 2012]. http://www.rxlist.com/zantac-drug/indications-dosage.htm.
4. Ranitidine [Unpublished dissertation] of Prof. K. Madhusudhana rao. 2013; Chapter 1:26.
5. Sachin S, Jitendra K, Arun A, Amrish C, Pankaj J. Formulation and evaluation of mouth dissolving tablets of ranitidine HCl. Int. J. of Pharm Tech Res. 2010; 2(2): 1574-1577.
6. Baveja SK, Gupta BM. Rheology of aqueous dispersions of Plantago ovata seed husk-II. Indian J. Pharm. Sci. 1968; 30: 247-251.
7. Mithal BM, Kasid JL. Evaluation of emulsifying properties of Plantago ovata (Ispaghula) seed husk. Indian J. Pharm. Sci. 1964; 26: 316-319.
8. Mithal BM, Kasid JL. Evaluation of the suspending properties of Plantago ovata (Ispaghula) seed husk. Indian J. Pharm. Sci. 1965; 27: 331-335.
9. Kulkarni GT, Gowthamarajan K, Rao BG, Suresh B. Evaluation of binding property of Plantago ovata and trigonella foenum gracecum mucilage. Indian Drugs. 2002; 39: 422-425.
10. Washi SP, Sharma VD, Jain VK, SinhaP. Plantago ovata, genetic diversity, cultivation, utilization and chemistry. Indian J. Nat. Prod. 1985; 1: 3-6.
11. Parmar RB, Baria AH, Tank HM. Formulation and evaluation of domperidone fast dissolving tablets. Int. J. of Pharm Tech Res. 2009; 1(3): 483- 487.
12. Subrahmanyam CVS. Text book of Physical Pharmaceutics. 2nd ed. New Delhi: Vallabh Prakashan. 2005; 210 - 228.
13. Lachman L, Lieberman A, Kinig JL. The Theory and practice of Industrial Pharmacy. 2nd ed. Varghese Publishing House. 1999; 67-74.
14. Govt. of India, Ministry of health and family welfare. Indian pharmacopoeia 2007. The Indian pharmacopoeia commission, Ghaziabad. 2007; 1: 177-187.
15. Padmaja B, Ramakrishna R, Goutham G. Formulation and evaluation of fast dissolving tablets of ranitidine hydrochloride. Journal of Pharmacy Research. 2015; 9(2):165-169.
16. Shahidulla SM, Mohib K, Jayaveera KN. Formulation and evaluation of fast disintegrating tablets of domperidone by using plantago ovata mucilage. Int. J. Chem. Sci. 2012; 10(3): 1521-1528.
17. Jhansi Rani M, Surendra A, Sudhakar AM, Nagoor A. Formulation and evaluation of domperidone fast dissolving tablets using natural superdisintegrants. International Journal of Research in Pharmaceutical and Nano Sciences. 2013; 2(2): 152- 157.
18. Subhashini R, Ramesh DR. Formulation and evaluation of domperidone fast dissolving tablets using plantago ovata mucilage. IJPSR. 2013; 4(9): 3489-3493.
19. Vinod Kumar M. Formulation and evaluation of meclizine HCl orally dispersible tablets by using natural super disintegrants. International Journal of Pharma Sciences and Scientific Research. 2016; 2(1): 53-80.

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