

Research Article

Formulation and Evaluation of microsphere of Rebiprazole Sodium

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Abstract

Microspheres include microparticles and microcapsules (having a core of the drug) of 1-1000 μ m in diameter and consisting either entirely of a bioadhesive polymer or having an outer coating of it. In this work an effort was made to formulate microsphere of Rabiprazole sodium by using different polymers. Prepared formulations are evaluated for bulk density, tapped density, percent mucoadhesion, Percent compressibility, hausners ration, percentage yield, size and surface morphology, interaction study by Differential scanning calorimeter and in vitro drug release. Formulation which passed all the evaluation parameters was considered as best formulation of Rabiprazole sodium.

1. Introduction

GRDFs are those dosage forms which can remain in the gastric region for several hours and hence prolong the gastric residence time of drug. One of the most feasible approaches for achieving a prolonged and predictable drug delivery in the GI tract is to control the gastric residence time (GRT), by using gastro-retentive dosage forms (GRDFs). GRDFs offers several advantages over immediate release dosage form, including the minimization of fluctuations in drug concentration in plasma, and at the site of action over prolonged periods of time, resulting in optimized therapeutic efficiencies and reduce the side effect, reduction of total dose administered, (while providing similar therapeutic effect) and reduction of administration frequency, leading to improved patient compliances.[1-2]

The drug of choice, Rabeprazole sodium, is an effective anti ulcer drug. Rabeprazole Sodium belongs to the class of anti-secretory compounds that do not exhibit anticholinergic or histamine H₂-receptor antagonist properties, but suppress gastric acid secretion by inhibiting the gastric H⁺/K⁺ATPase at the secretory surface of the gastric parietal cell. Rabeprazole blocks the final step of gastric acid secretion, which is widely used for the management of peptic ulcer. It has a short biological half-life of 1-2 hours and bioavailability is 52%, which make it more suitable to be designed as a controlled release formulation. The main purpose of the present research was to develop mucoadhesive microspheres of Rabeprazole sodium for oral administration using biocompatible HPMC and carbopol polymers in order to increase its biological half life and to determine the influence of formulation and preparation variables on microparticles characteristics, such as drug incorporation and in vitro drug release [3-5].

Conventional oral dosage forms such as tablets provide systemic circulation without offering any control over the drug delivery and also cause great fluctuation in the plasma drug levels. To avoid this drawback, mucoadhesive microspheres have been developed and have the advantage that they pass uniformly through the GIT to avoid the variation of gastric emptying and provide adjustable release, thereby reducing the intersubject variability in absorption and risk of local irritation.[6-7]

The stability of Rabeprazole sodium is a function of pH; it is rapidly degrading acid media, and is more stable under alkaline conditions. Therefore exposure of Rabeprazole sodium to the acidic content of the stomach would lead to significant degradation of the drug and hence, reduced bioavailability. Therefore, the drug should be targeted in to intestine, to bypass the stomach.

2. Material and method

Rabeprazole sodium obtained as a gift sample Hydroxy methyl cellulose, Span and liquid paraffin were purchased from Chemical Drug House, New Delhi. Other chemical used were of analytical grade.

2.1 Preparation of Microspheres:

Microspheres were prepared by emulsification solvent evaporation technique. Briefly, Rabeprazole sodium and polymers were mixed in 50ml distilled water. A different polymer ratio 1:1, 1:2, 1:3, and 1:4, used to prepare the different formulations. Polymeric aqueous solution was made in which the drug was dispersed and then the solution was added drop wise into 200 ml of light liquid paraffin containing 0.5% span-80 as an emulsifying agent. The aqueous phase was emulsified in oily phase by stirring the system in a 500ml beaker, Constant stirring at 500 rpm was carried out using magnetic stirrer at 80°C, stirring and heating were maintained for 4hrs, Until The aqueous phase was evaporated. The microspheres were washed 5 times with n-hexane, filtered through whattman's filter paper and dried in hot air oven at 50°C for 2 hours.

Table 1: Formulation of the microspheres prepared

Formulation Code	Rabeprazole sodium (mg)	HPMC15cps +Carbopol934p(ratio)	HPMC15000cps +Carbopol 934p(ratio)	Liquid paraffin(ml)	Span-80 (0.5%)
F1	100	1:1	-	200	0.5
F2	100	1:2	-	200	0.5
F3	100	1:3	-	200	0.5
F4	100	1:4	-	200	0.5
F5	100	-	1:1	200	0.5
F6	100	-	1:2	200	0.5
F7	100	-	1:3	200	0.5
F8	100	-	1:4	200	0.5

2.2 Evaluation of Mucoadhesive microspheres

2.2.1 Percentage yield:

The prepared microspheres were collected and weighed from different formulations. The measured weight was divided by the total amount of all non-volatile components which were used for the preparation of the microspheres.

$$\% \text{ Yield} = \frac{\text{Actual weight of microspheres}}{\text{Total weight of drug and polymer}} \times 100$$

2.2.2 Particle size determination:

Optical microscope was used to determine the size of the microspheres. This method involves the calibration of eye piece micrometer for which the stage micrometer is used. In stage micrometer one mm is divided into 100 equal divisions and hence, each division is equal to 10 mm and the particles are measured chosen fixed line across the center of the particle. The average diameter of was calculated using following formula. **Average diameter** = $\Sigma nd/n \times C.F.$

Where n = number of microspheres, d =diameter of microspheres, C.F =calibration factor

2.2.3 Shape and surface morphology:

Morphology of microspheres was investigated by using optical Leica microscopy. The photographs of the optimized formulations taken by Leica microscope are shown in the figure-6 and figure-7. The results of Leica microscope revealed that the microspheres of Rabeprazole sodium using HPMC15000cps combination with carbopol934p as a polymer (F5) were spherical and their surface was smooth and devoid of cracks giving them a good appearance.



2.2.4 Drug Entrapment efficiency (DEE %):

The drug Entrapment efficiency of rabeprazole Sodium microspheres was determined by taking accurately weighed 100mg of microspheres in a glass mortar and powdered by a glass pastel and treated with 100ml of Phosphate buffer of pH 7.4 in a closed volumetric flask and left over night. Then it was transferred into a 250ml beaker and stirred by magnetic stirrer using Teflon coated magnetic bead, the temperature was maintained at 37°C ±0.5°C. At the end of 1 hour, it was centrifuged and supernatant was filtered, the filtrate was analyzed spectrophotometrically at 284nm (Jasco- V-530). Dilution was done whenever required using Phosphate buffer pH 7.4, Corresponding drug concentrations in samples was calculated from calibration plot. Entrapment efficiency of the microspheres was calculated using the formula.

$$\text{DEE \%} = \frac{\text{Practical Drug Loading}}{\text{Theoretical Drug Loading}} \times 100.$$

Table 2: Percentage yield, Mean particle Size, shape and drug entrapment efficiency of Different Batches of Mucoadhesive microspheres of rabeprazole sodium.

S.No.	Formulation code	Yield (%)	Mean particle size (µm)	Shape	% Drug entrapment efficiency
1.	F1	87.16	323.12	Oval	71.14
2.	F2	85.29	342.10	Oval	68.12
3.	F3	82.18	427.14	Irregular	64.28
4.	F4	80.37	453.46	Irregular	58.14
5.	F5	92.83	253.26	Round	80.07
6.	F6	90.82	363.86	Oval,round	69.21
7.	F7	89.63	437.78	Oval	66.42
8.	F8	88.59	518.56	Irregular	62.28

2.2.5 Bulk Density:

A accurately weighed sample of microspheres was carefully introduced into a 10 ml graduated cylinder with the aid of funnel. Typically, the initial volume was noted. Carefully level the microspheres without copacting, if necessary, and read the unsettled apparent volume V_0 , to the nearest graduated unit. Calculate the bulk density in g/cm^3 by the formula.

$$D_f = \frac{M}{V_0}$$

Where D_f is bulk density, M is weight of samples in grams and V_0 is volumes of sample in cm^3 .

2.2.6 Tapped Density:

The tapped density was obtained by dividing the mass of a powder by the tapped volume in cm^3 . The sample of microspheres is carefully introduced into a 10 ml graduated cylinder. The cylinder was dropped at 2- second intervals onto a hard wood surface 100 times from a height of 1 inch. The tapped density of each formulation was then obtained by dividing the weight of sample in grams by the final tapped volume in cm^3 of the sample contained in the cylinder. It was calculated by using equation given below

$$D_0 = \frac{M}{V_p}$$

Where D_0 is bulk density, M is weight of samples in grams and V_p is final tapped volumes of granules in cm^3 .

Table 3: Bulk density of Different Batches of Mucoadhesive microspheres

S. No.	Formulation code	Bulk density (gm/cm^3)	Tapped density (gm/cm^3)
1.	F1	0.277	0.322
2.	F2	0.294	0.344
3.	F3	0.312	0.370
4.	F4	0.322	0.384
5.	F5	0.285	0.322
6.	F6	0.303	0.357
7.	F7	0.344	0.416
8.	F8	0.357	0.434

2.2.7 Carr's Index:

The compressibility index and the hausner ratio are determined by measuring both bulk volume and tapped volume of microspheres. The percentage compressibility of microspheres was calculated according to equation given below.

$$\% \text{ Compressibility Index} = \frac{(V_t - V_0)}{V_t} \times 100$$

Where V₀ is bulk density and V_t is Tapped density.

2.2.8 Hausner ratio:

Hausner ratio of microspheres was calculated according to equation given below (USP NF 2007).

$$\text{Hausner ratio} = \frac{V_t}{V_0}$$

where Where V₀ is bulk density and V_t is Tapped density.

2.2.9 Swelling index:

Preweighed rabeprazole sodium microspheres (W₀) formulated with HPMC and Carbopol by employing different coat:core ratios were placed in pH 7.4 phosphate buffer which was maintained at 37°C±0.5°C. After 6th hour, the microcapsules were collected and blotted to remove excess water and weighed (W_t). The swelling index was calculated with the following formula.

$$\text{Swelling index} = \frac{W_t - W_0}{W_0} \times 100$$

Where W_t = weight of microspheres observed at 6th hour; W₀ = initial weight of microspheres.

2.2.10 Mucoadhesion test:

The mucoadhesive property of microspheres was evaluated by an *in-vitro* adhesion testing method known as wash-off method, Freshly excised pieces of goat intestinal mucosa (2 × 2cm²) were mounted on to glass slides with cotton thread. About 50 microbeads were spread on to each prepared glass slide and immediately thereafter the slides were hung to USP tablet disintegration test apparatus, When the test apparatus was operated, the sample is subjected to slow up and down movement in the test fluid at 37°C±0.5°C contained in a 1-liter vessel of the apparatus. At an interval of 1 hours up to 6 hours the machine is stopped and number of microspheres still adhering to mucosal surface was counted. The test was performed at intestinal (Phosphate buffer pH 7.4) condition.

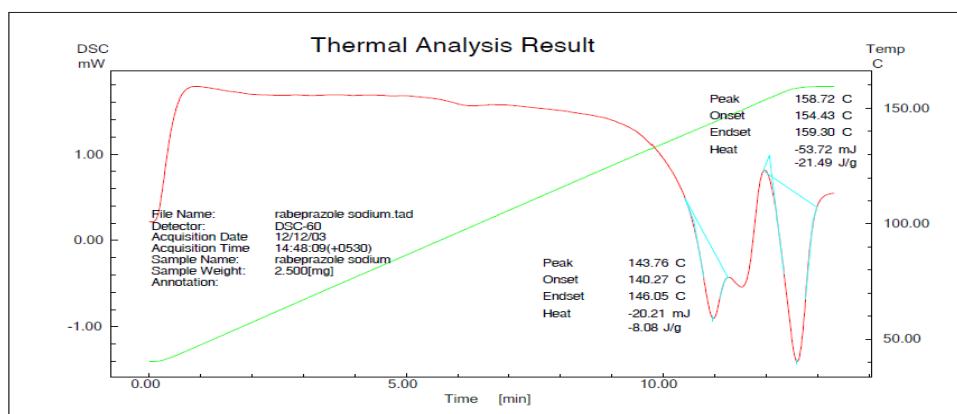
$$\% \text{ Mucoadhesion} = \frac{\text{Total no. of microspheres remains}}{\text{Total no. of applied microspheres}} \times 100$$

Table 4: Percent compressibility, Hausner ration, Swelling index and percent mucoadhesion of different Batches of Mucoadhesive microspheres.

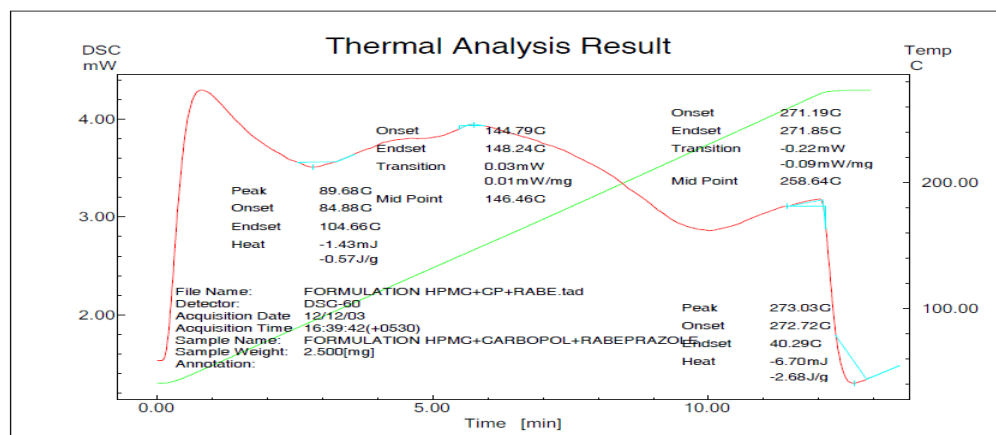
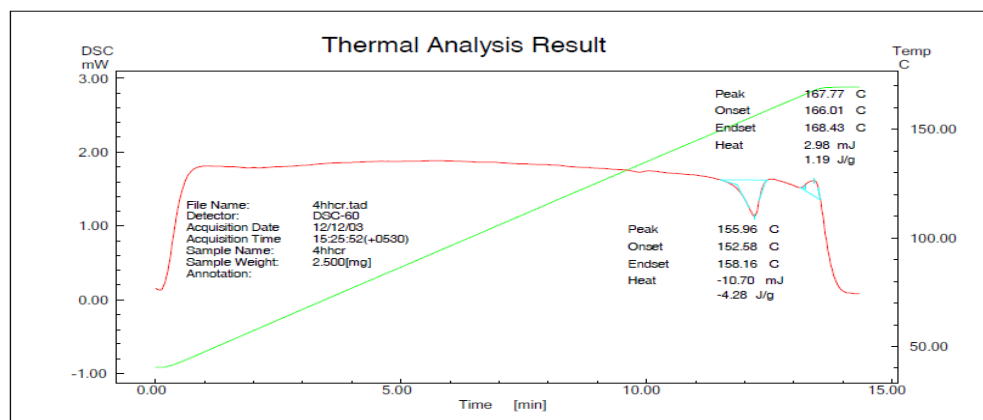
S. No.	Formulation code	Compressibility index (%)	Hausner ratio	Swelling Index after 6 th hours (%)	Mucoadhesion after 6 th hours (%)
1.	F1	13.97	1.16	69%	50
2.	F2	14.53	1.17	85%	54
3.	F3	15.67	1.18	89%	58
4.	F4	16.14	1.19	94%	62
5.	F5	11.49	1.12	73%	74
6.	F6	15.12	1.17	87%	74
7.	F7	17.30	1.20	91%	77
8.	F8	17.74	1.21	97%	79

2.2.11 Differential scanning calorimetry (DSC):

The physical state of drug, Drug polymer mixture, and formulation was analyzed by DSC. The thermograms of Rabeprazole sodium, Rabeprazole sodium microspheres with different polymers were obtained at a scanning rate of 10°C/min conducted over a temperature range of 25–350°C, respectively.



Graph No.-4 DSC of pure drug rabeprazole sodium



Graph No.-6 DSC of formulation F5

2.2.12 In-vitro drug release study:

The microspheres equivalent to 20 mg of drug Rabeprazole sodium were filled in hard gelatin capsules (no. 4) and coated with 1% w/v solution of cellulose acetate phthalate (CAP) by dip-coating method. The coating was accomplished by dipping the filled capsules thrice in CAP solution and air drying after each coating step successively. *In-vitro* drug release on the capsules size 4 was undertaken using USP Apparatus 2 at 50 rpm, in 900 ml of medium at $37^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$ with a wire sinker. For the enteric capsules 2 h of exposure in 0.1 N hydrochloric acid (pH 1.2) followed by testing in phosphate buffer of pH 7.4 for 10 h. A suitable volume of sample were withdrawn after suitable time interval and equal volume of fresh medium was replaced to maintain a constant total volume. Samples were filtered using $0.45\mu\text{m}$ filter. Rabeprazole sodium concentrations were determined by UV spectrophotometry (Jasco- V-530) at a wavelength of 284 nm.

3. Result and Discussion

3.1 Percentage yield:

Percentage yield of different formulation was determined by weighing the microspheres after drying. It was observed that as the polymer ratio in the formulation increases, the product yield slightly decreases. The probable reason behind this may be the high viscosity of the solution, adhesion of polymer solution to the wall of beaker and magnetic bead which ultimately decreased the production yields of microspheres. The percentage yield was found to be in the range of 80.33 to 92.83%. The percentage yield of different formulation is shown in Table-2.

Maximum practical yield of around 92.83 % was obtained with batches F5. From other batches like F1, F2, F3, F4, F6, F7 and F8 very less practical yield was obtained.

3.2 Particle size analysis:

Particle size was determined by Optical microscopy method. It plays important role in mucoadhesive ability and release of drug from microspheres. The mean size increased with increasing polymer concentration which is due to a significant increase in the viscosity, thus leading to an increased droplet size and finally a large microspheres size.

Uniform average particle size was obtained for the formulation F5. Microspheres obtained with batch F5 showed uniform average particle size of 253.26 μ m. The average particle size of mucoadhesive microsphere was in range 253.26 – 518.56 μ m as shown in Table -1.

3.3 Shape and surface morphology:

Morphology of microspheres was investigated by using optical Leica microscopy. The photographs of the optimized formulations taken by Leica microscope are shown in the figure-6 and figure-7. The results of Leica microscope revealed that the microspheres of Rabeprazole sodium using HPMC1500cps combination with carbopol934p as a polymer (F5) were spherical and their surface was smooth and devoid of cracks giving them a good appearance.

3.4 Drug Entrapment efficiency (DEE %):

Drug entrapment efficacy slightly decrease with increase Carbopol content and decreased HPMC ratio in microspheres. This is due to the permeation characteristics of Carbopol that could facilitate the diffusion of part of entrapped drug to surrounding medium during preparation of microspheres. The % drug entrapment efficacies of different formulations were found to be in the range of 58.14 -80.07% w/w.

3.5 Bulk Density:

The bulk density of each formulation was determined by dividing the weight of sample in grams by the final volume in cm³ of the sample contained in the 10 ml graduated cylinder. The bulk density value of mucoadhesive microsphere range from 0.277 to 0.357 gm/cm³ as shown in Table No.- 3. Usually, bulk density is of great importance when one considers the size of high-dose capsule product or the homogeneity of a low-dose formulation in which there are large differences in drug and excipient densities. Knowing the anticipated dose and tapped formulation density, one may use to determine the appropriate size for a capsule formulation. In a free flowing microspheres such interaction are generally less significant, and the bulk and tapped densities will be closer in value. For poor flowing materials, there are greater interparticle interactions and a greater bulk and tapped densities will be observed. These differences are reflected in compressibility index and hausner ratio .

3.6 Tapped density:

Tapped density was determined by tapping method. The tapped density value of different mucoadhesive microspheres range from 0.322 to 0.434 gm/cm³.

3.7 Percentage Compressibility index and hausner ratio

The compressibility index and hausner ratio are measures of the porosity of a microspheres to be compressed as such they are measures of the relative interparticulate interaction. In a free flowing microspheres such interaction are generally less significant, and the bulk and tapped densities will be closer in value. For poor flowing materials, there are greater interparticle interactions and a greater bulk and tapped densities will be observed. These differences are reflected incompressibility index and hausner ratio.

The compressibility index and the closely related hausner ratio have become the simple, fast and popular methods of predicting powder flow characteristics. The compressibility index has been proposed as an indirect methods of bulk density. Size shape, surface area, moisture content, and cohesiveness of materials because all of these can influence the observed compressibility index. It is determined by using the value of tapped density and bulk density. The percentage compressibility index was found to be range of 11.49 to 17.74% as shown in table 4. The percentage compressibility value less than 20 for all formulation. The hausner ratio was found to be range of 1.12 to 1.21

3.8 Swelling index:

Degree of swelling is expressed as the percentage of water in the hydrogel at any instant during swelling. Swellability is an important characteristic as it affects mucoadhesion as well as drug release profiles of polymeric drug delivery systems.

The *in-vitro* swelling property of microspheres was studied in Phosphate buffer pH 7.4. It can be concluded from the data that with an increase in polymer concentration, the degree of swelling also increases. Thus we can say that amount of polymer directly affects the degree of swelling. As the polymer to drug ratio increased, the degree of swelling increased from 69% to 97% for microspheres of Rabeprazole sodium using HPMC and coabopol as copolymer. Swelling index of different formulation of rabeprazole sodium mucoadhesive microspheres was determined in pH 7.4 phosphate buffer and its range is 69% to 97% as shown in table 4.

3.9 Mucoadhesion test:

The mucoadhesive property of microspheres was determined by an *in-vitro* adhesion testing method known as wash-off method. When the Concentration of polymer increases, Mucoadhesion will be increases. High viscosity grade of HPMC15000cps with combination of carbopol934p, formulation (F5 to F8) showed highest mucoadhesivity, compare to formulation (F1 to F4) showed less mucoadhesivity. The percentage of mucoadhesion of different formulation was in range of 50-79% as shown in Table-4.

3.10 Differential scanning calorimetry (DSC) :

The DSC thermograms of pure drug, physical mixture of drug-polymer and formulation F5 were individually generated and investigated for presence of additional peaks or absence of peaks indicating possible polymer interactions or phase transformations by instrument DSC-60 (Shimadzu). The thermal peaks give the melting points of the samples which can be used as a test for purity analysis and also for sample characterization by comparing with the standard melting points reported for corresponding samples.

DSC of pure drug Rabeprazole sodium peak was observed at 1430C, which corresponds to the melting point of drug. Physical mixture of drug and polymer shows endothermic peak at 155.960C, and formulation F5 thermal peaks was observed.

3.11 *In-vitro* Drug release study:

In-vitro drug release test were to assure that the microspheres of Rabeprazole sodium are delivered to the target area, and to elucidate the release kinetic for the developed formulation. Rabeprazole sodium is unstable at gastric pH and therefore the microspheres of the drug were capsulated in hard gelatin capsules, coated with 1% w/v CAP and studied for *in-vitro* release of drug using USP dissolution apparatus 2 in pH 1.2 for 2 h followed by release in pH 7.4. In the initial 2 h, Rabeprazole sodium was not released more than 10% in the gastric fluid, thereafter the release was initiated when the pH was changed to intestinal fluid (phosphate buffer, pH 7.4) for the next 10 h. The drug release pattern from microspheres of Rabeprazole sodium was in a sustained manner, in contrast to the Dissolution of pure drug.

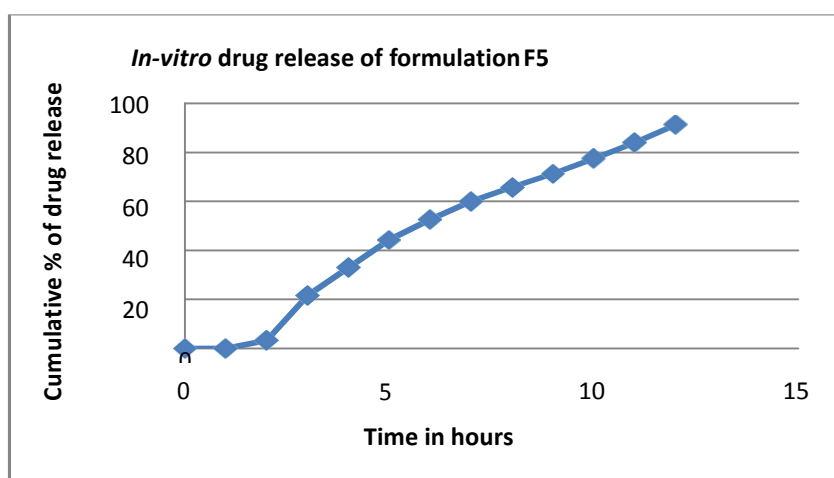


Figure no.-1 *In-vitro* drug release for formulation F5.

However, the release of Rabeprazole sodium from the microspheres made with HPMC15000cps and carbopol934p (Formulation F5) percent cumulative drug release (% CDR) was found to be 91.188%. Release data for F5 formulation has been shown in Table No.-28.

Table 5: Release Kinetic Treatment for Formulation F5

S.No.	Release Kinetic model	Correlation coefficient
1.	Zero order model	$R^2=0.976$
2.	First order model	$R^2= 0.954$
3.	Higuchi model	$R^2 = 0.990$
4.	Korsmeyer peppas model	$R^2 = 0.844$

4. Conclusion

Drug absorption in the GIT is a highly variable process, prolonging gastric retention of the dosage forms and extends the time of drug absorption. Mucoadhesive microspheres are prepared with HPMC and Carbopol successfully by the solvent evaporation technique.

Mucoadhesive microspheres of Rabepazole sodium showed excellent mucoadhesivity, and prolonged drug release up to 12 hours. Microspheres of different size and drug content could be obtained by varying the formulation variables. Thus the prepared mucoadhesive microspheres may prove to be potential candidates for oral delivery devices. Formulation Batch F5 showed best appropriate balance between mucoadhesivity and drug release rate, which can be considered as a best fit for mucoadhesive microspheres. The polymer ratio (HPMC15000cps and Carbopol934p) of 1:1 were selected as best formulation, The formulated system showed sustained release up to 12 h and the system is potentially useful to overcome poor bioavailability problems associated with Rabepazole sodium.

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