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RESEARCH ARTICLE ON FORMULATION AND EVALUATION OF COLON TARGETED MUCOADHESIVE MICROSPHERE OF ACECLOFENAC

Sandhya Sharma*[1], Amarjeet Singh[2] and Neelam Singh[3]

[1]Assistant Professor, Innovative College of Pharmacy, Greater Noida.
[2]Professor&H.O.D. Innovative College of Pharmacy, Greater Noida.
[3]Assistant Professor, I.T.S College of Pharmacy,Murad Nagar, Ghaziabad.

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***Corresponding Author**
Sandhya Sharma
Assistant Professor, Innovative College of Pharmacy, Greater Noida.

ABSTRACT

The colon may be one of the finest sites for drug delivery because of the long residence time and the low digestive enzymatic activity; this may be useful for prolonged drug delivery. Also it is a prospective site for systemic delivery of therapeutic drugs. Mucoadhesive microspheres are comprehensively proved as a targeted drug delivery system for pharmaceutical appliances. To formulate and evaluate the colon targeted mucoadhesive microsphere of Aceclofenac. Formulation containing sodium alginate as a release retarding polymer and pectin as a mucoadhesive polymer prepared by ionotropic gelation method using calcium chloride as cross-linking agent. Mucoadhesive microsphere was enclosed in to hard gelatin capsule and capsule shell was coated with pH sensitive polymer to prevent the adherence of mucoadhesive microsphere in upper GIT. The microspheres were evaluated for physical characteristics such as surface morphology by scanning electron microscopy, drug entrapment efficiency, in vitro drug release and in vitro mucoadhesion. The optimized formulation was found on the basis of evaluation of mucoadhesive microspheres. Formulation (A30) showed the best result as drug entrapment efficiency 82.5%, in vitro drug release 98.7% and in vitro mucoadhesion 84%. Capsule was subjected to evaluate for in vitro drug release, disintegration time and drug release kinetic model was found as 96.43%, 2.41±1.16904 hr and first order model with R^2 is0.951 respectively. The microspheres are found to have a good mucoadhesive property. Due to the mucoadhesive property of microsphere it was adhering to colonic mucosa for extended period of time and exerts local action in colonic mucosa. The outer enteric coating provided a satisfactory acid resistibility due to negligible release of drug in upper GIT. This proves the ability of the formulated capsule to sense the arrival of the dosage form to the colon where it gave the highest release. Thus it is signifying a promising sustained release drug delivery system.

KEYWORDS: Aceclofenac, Calcium Chloride, Colonic Mucosa, Hard Gelatin Capsule Sodium Alginate.

INTRODUCTION

Colon is a part of digestive system and is responsible for absorbing water from stool before it exit the body. Colon is also known as the large intestine, where the solidifying and processing of solid wastes take place with the aid of bacterial flora. Colon drug delivery system refers to targeted delivery of drug in to the lower parts of GI tract, mainly large intestine.

Colon drug delivery has gained increased importance not just for the delivery of drug for the treatment of local disease associated with the colon, such as chrone's disease, ulcerative colitis, colorectal cancer, also it is a potential site for systemic delivery of therapeutic drugs (Brahmankaret. al, 1995). Drug targeting to colon is useful when a delay in drug absorption is desired from the therapeutic point of views, an oral colonic delivery system should retard drug release in the stomach but allow complete release in the colon. Treatment might be more effective, if the drug substance were targeted directly on the site of action in the colon(Kramer et al., 2003; Krogars et al., 2000; Sarasija et al.,2000).

There are several approaches, which is utilized in achieving colon targeting include use of pH, enzyme, transit time and microbial flora. (Sarasijaet al., 2000; Chourasia et al., 2003). The site specific delivery of drug to the target receptor site has the potential to reduce side effects and to increase pharmacological response. Frequent administration of drug is necessary when those have shorter half life and all these leads to decrease in patient's compliance (Rajkumar et al., 2012).In order to overcome the above problems, various types of

controlled release dosage forms are formulated and altered, so that patient compliance increase through prolonged effect by maintaining relatively constant drug level in the plasma by releasing the drug at a predetermined rate for an extended period of time. One such delivery system is Microspheres as carriers of drug which are defined as "Monolithic sphere or therapeutic agent distributed throughout the matrix either as a molecular dispersion of particles" (or) can be defined as structure made up of continuous phase of one or more miscible polymers in which drug particles are dispersed at the molecular or macroscopic level and has a particle size of (1-1000nm) (Mathew et al., 2010; Karmakar et al.,2009).

Microencapsulation for oral use has been employed to sustain the drug release, and to reduce or eliminate gastrointestinal tract irritation. In addition, multiparticulate delivery systems spread out more uniformly in the gastrointestinal tract which results in more reproducible drug absorption and reduces local irritation when compared to single-unit dosage forms such as no disintegrating, polymeric matrix tablets and unwanted intestinal retention of the polymeric material, which may occur with matrix tablets on chronic dosing, can also be avoided(Mathew et al.,2008) Due to its small particle size, are widely distributed throughout the gastrointestinal tract which improves drug absorption and reduces side effects due to localized build-up of irritating drugs against the gastrointestinal mucosa(Li, et al.,1998).

Mucoadhesion is defined as the interaction between a mucin surface and a synthetic or natural polymer. Mucoadhesive drug delivery has been a theme of enthusiasm for the plan of drug delivery system to stretch the time period of the dosage form at the place of use or retention and to encourage insinuates interaction of the definition through the basic ingestion surface, to enhance and upgrade the bioavailability of medication. Mucoadhesive controlled drug delivery system are advantageous, since they give a controlled drug release over some retention of time and can likewise be used for confining the drug to a particular site in the body(Khairnar GA et al,.2010; Das R et al., 2011).Mucoadhesive system is utilized to localise a delivery device inside the lumen to improve the drug absorption in a site-specific manner(Gavin P.A et al ., 2009).

Aceclofenac is one of the most commonly used non-steroidal anti-inflammatory drug for treating various diseases like osteoarthritis, rheumatoid arthritis and ankylosing spondylitis. Aceclofenac having less GIT complication, the short biological half-life 4 h, and dosing frequency more than are time make it an ideal candidate for modified release multiple unit preparation. Suppressed action of inflammatory cytokines decreases the production of reactive oxygen species. Aceclofenac is shown to decreased production of nitrous oxide in human articular chondrocytes (Brogden RN et al; 1996). It has a good patient compliance and less toxicity. Due to all these reasons Aceclofenac is suitable for making sustained release dosage form.

In the present study mucoadhesive microspheres has been prepared by ionotropic gelation method because of better extent of drug release, good entrapment efficiency and good flowing property. It also shows good mucoadhesive property.

The objective of the study is to prepare colon targeted mucoadhesive microsphere and enclosed in hard gelatin capsule. The present study will increase the need for maximal intestinal tissue drug exposure and will decrease the systemic delivery to avoid unwanted side effects.

MATERIALS AND METHODS

Formulation code	PECTIN (mg)	SODIUM ALGINATE (mg)
A3	100	100
A6	100	300
A14	200	200
A16	200	100
A19	300	300
A30	100	200
A31	200	300

Materials

Aceclofenac was kind gift from Amoli organics Pvt. Ltd. (Mumbai) Aceclofenac was kind gift from Amoli organics Pvt. Ltd. (Mumbai). Pectin, sodium alginate, calcium chloride, polyethylene glycol and acetone was obtained from CDH chemical New Delhi.

Formulation design

The miscellaneous factorial design with independent 2 factors and 3 levels (design expert -11 software, Statease, U.S. A) was apply to design and optimized the delivery system. Total 32 runs with formulation code A1-A32 were obtained and from the 32 runs only seven formulation (i.e A3,A6,A14,A16,A19,A30,A31) proceeded for the further study because microsphere was formed only by these batches rather than left batches due

to less concentration of polymer and calcium chloride. There was two independent factor (Pectin and sodium alginate) and two dependent factor (% cumulative drug release and entrapment efficiency).

Methods

Mucoadhesive microspheres were prepared by ionotropic gelation technique. Sodium alginate and pectin were mixed in purified water. At that point drug was added and homogenized the solution to form a viscous dispersion. Resulted dispersion was added manually drop wise into calcium chloride solution through a syringe with a needle of diameter of 0.45mm. The added droplets were retained in the calcium chloride solution for 20min. to complete the curing reaction and to produce spherical rigid microspheres. The microspheres collected by filtration and dried at (45°C) for 12 hours **(**Chowdary K.P.R.,2003;Lim F et al.,1981).

Preparation of Capsule filling and coating

capsules (Capsugel Division of Pfizer Inc) made from hydroxypropyl methylcellulose without coloring agent, 6 capsule of optimized batch(A30)was filled by hand with 400mg microsphere equivalent to 100mg drug. The filled capsule was coated with the coating dispersal which is set up by using 5g Eudragit S-100 to arecently arranged blend of 1.4% w/v plasticizer(polyethylene glycol 400), in 90% (acetone : ethanol 2:1)) and dynamically agitated, exchange to a homogenizer, homogenize for 5 minutes and channel before use. The filled capsule was dipped in the coating solution (2-3 time) with the help of tongs. As the mechanical properties of hydrophilic polymers are influenced by the residual moisture, any drying by pre-heating or high process temperatures must be avoided. Due to the low minimum film forming temperatures of the coating dispersions, the temperature of the capsules could be kept between 25 and 27 °C during spraying. By using such mild process conditions any drying of the capsule shells or spray drying of the atomized mist can be avoided. After the coating process the capsules were dried on trays for 2 h at 30 °C

Evaluation of mucoadhesive microsphere

IR spectroscopic studies(FT/IR-4100)

The IR spectra of the free drug and the microspheres are recorded. The identical peaks corresponding to the functional groups features confirm that neither the polymer nor the method of preparation has affected the drug stability (Pavia L.D et al.,2007).

Entrapment efficiency

Microspheres was crushed and then dissolved in distilled water with the help of ultrasonic stirrer for 3 hours and was filtered then assayed by ultra violet spectroscopy(UV spectrophotometer-1800). Entrapment efficiency is equal to ratio of actual drug content to theoretical drug content (Soni L.M. et al.,2010).

In vitro drug release studies

In-vitro release studies can be performed according to USP XXII type 2 dissolution apparatus at suitable conditions. The temperature should be maintained at 37±0.5°C and the rotation speed of100 rpm. Then 5 ml of sample should be withdrawn at various time intervals and replenished with anequal volume of fresh dissolution media. The drug content in the sample can be analyzed spectrophotometrically at specific wavelength (nm) (Parmar H et al., 2010).

Scanning electron microscopy (SEM)

Surface morphology was determined by the method SEM. In this microcapsule were mounted directly on the SEM sample slub with the help ofdouble sided sticking tape and coated with gold film under reduced pressure (Chowdary K.P.R et al.,2003).

Ex-vivo Mucoadhesion Study

The mucoadhesive properties of the microspheres were evaluated by Ex-vivo wash-off test as reported by Lehr et al. A 1-cm by 1-cm piece of rat mucosa was tied onto a glass slide (3inch by 1-inch) using thread. Microspheres were spread (∽50) onto the wet, rinsed, tissue specimen, and the prepared slide was hung onto one of the groves of a USP tablet disintegrating test apparatus. The disintegrating test apparatus was operated such that the tissue specimen was given regular up and down movements in a beaker containing the simulated gastric fluid (pH 1.2). At hourly intervals up to 10 hours, the number of microspheres still adhering onto the tissue was counted. Percent mucoadhesion was given by the following formula (Lehr CM et al., 1992; Leher C.M et al.,1990).

Percentage of mucoadhesion = (no.of microspheres remains / no. of applied microspheres) ×100

Stability studies

Stability studies were carried out on according to International Conference on Harmonization(ICH) guidelines. The formulation was kept in vials at 4^{o}C, 25 ± 2^{o}C/60%±5% RH and 40 ± 2^{o}C/75%± 5% RH in a humidity chamber. Samples were withdrawn at 0,30,60 and 90days and evaluated for entrapment efficiency, drug release, physical appearance (guidance on stability testing annex2;2009).

Evaluation of capsule

Disintegration of capsules

For the disintegration of capsule, one capsule in each cylinder has been utilized. The machine has been worked for 2 hrs without the plates in 0.1 M hydrochloric acid. No capsule shows the sign of deterioration or of crack allowing the discharge of the substance. The medium in the vessel has been blended with phosphate buffer pH 6.8.Adisc has been to each cylinder and the device has been worked for further an hour. The mechanical assembly has been expelled from the medium and the capsule has been inspected. The test has been finished if

no deposit remains on the screen or on the underside of the plates, or, if a deposit remains, it comprises of pieces of shell or of a delicate mass with no palpable core which are not moistened (Indian pharmacopoeia; 1996).

Dissolution of capsules

In vitro dissolution studies were carried out using USP type 2(paddle method) apparatus(PDA-6S). In order to simulate the pH changes along with the GIT, dissolution media with 0.1N HCL and phosphate buffer(pH 6.8)were sequentially used. When performing the experiment, 0.1N HCL medium was added for 2 hours(since the average gastric emptying time is 2 h). Then removed and fresh phosphate buffer (ph 6.8)was added for subsequent hours. 900 ml of the dissolution medium was used at each time and stirred at 50 rpm at 37±0.5 ºC. 5ml of dissolution media was withdraw at predetermined time interval and fresh dissolution media was replaced. The withdrawn samples were analyzed by UV spectrophotometer (Prasanth V.V;2012).

Drug release kinetics (Shoaib M.H et al., 2006).

To analysis the mechanism of drug release and release rate kinetics of the formulated dosage form, the data obtained from conducted studies was fitted in to zero order, first order, Higuchi matrix and peppas model. In this study the drug release kinetics can be determined by comparing r- value obtained, the best fit model was selected.

Observation

Evaluation of mucoadhesive microspheres

Infrared spectroscopy The FTIR spectrum of aceclofenac drug fig.1 which is similar to the standard spectrum of aceclofenac drug.

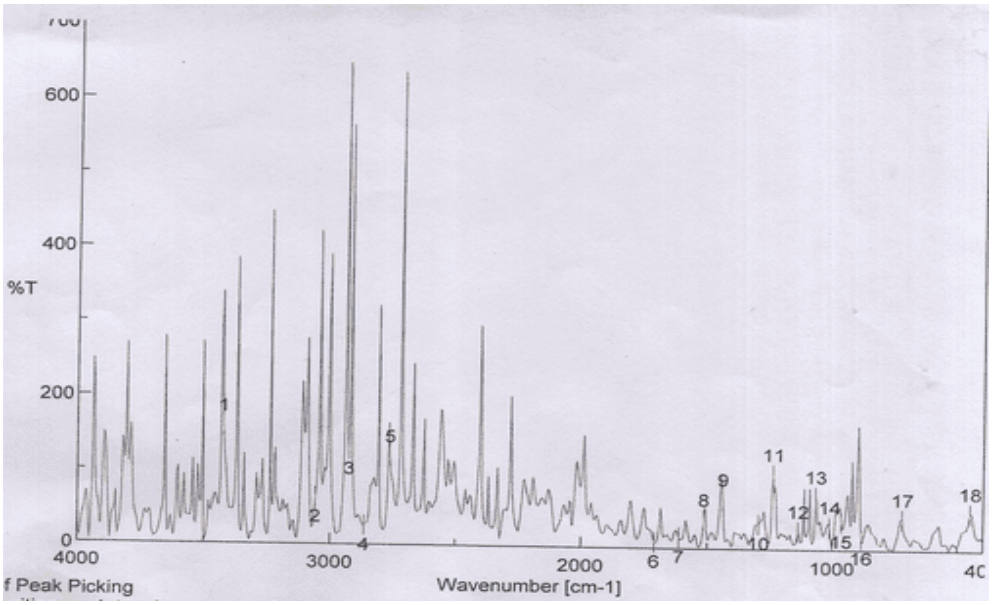


Fig. 1: IR spectrum of aceclofenac.

The spectrum of aceclofenac showed the following functional groups at their frequency mentioned in table 1.

Table 1: IR spectrum of Aceclofenac.

Stretching frequency (cm^{-1})	Bond	Intensity
3150-3050	C-H Aromatic(stretch)	Strong
3000-2850	C-H Alkane(stretch)	Strong
1725-1705	C=O Ketone	Strong
1350-1000	C-N Amines	Medium-strong

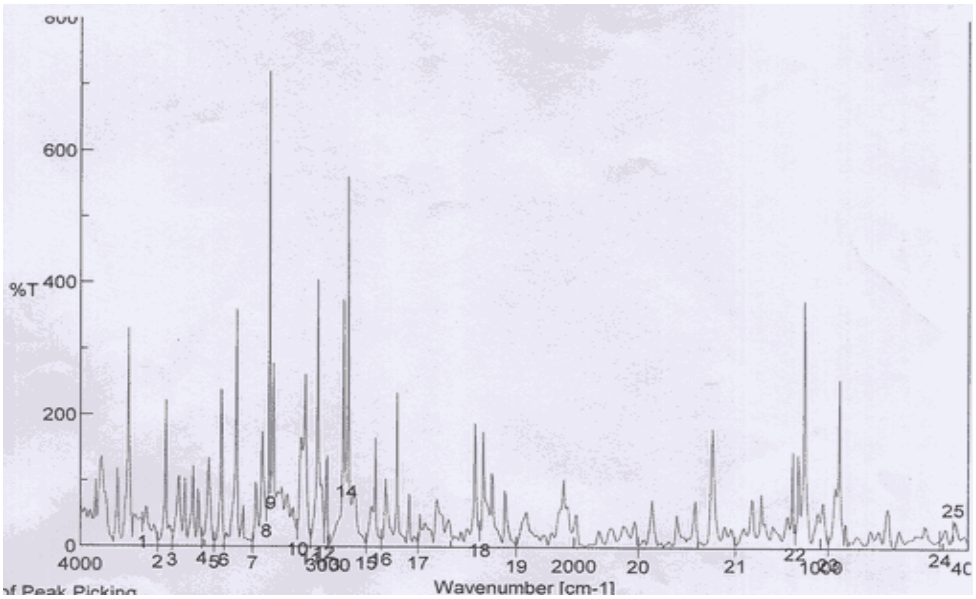


Fig. 2: IR spectrum of combination(drug+sodiumalginate+pectin).

Table 2: IR spectrum of combination(drug+sodiumalginate+pectin).

Stretching frequency (cm^{-1})	Bond	Intensity
3650-3600	O-H Free	Medium
3500-3100	N-H Stretch	Medium
3400-2400	O-H carboxylic acid	Medium
3000-2850	C-H Alkanes(stretch)	Strong
2270-1940	X=C=Y Allenes, ketones, isocyanates, isothiocyanates	Medium to Strong
1375-1300	S=O Sulfones, Sulfonyl chloride, Sulfates, Sulfonamide	Strong

Scanning electron Microscopy

Shape and surface morphology of prepared mucoadhesive microsphere were evaluated by SEM, the study revealed that most of the microsphere were fairly spherical rounded in shape and the surface of the particle showed characteristic smoothness.

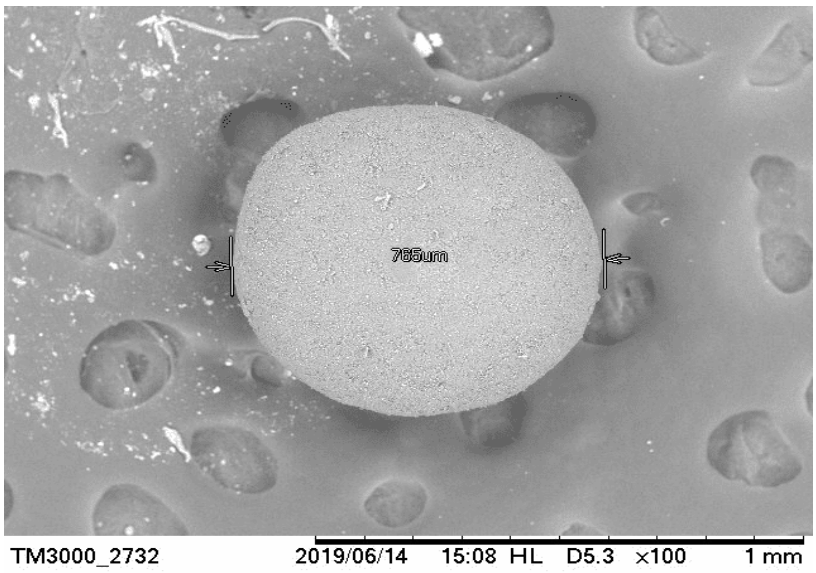


Fig. 3: SEM of mucoadhesive microspheres of optimized formulation A30.

Drug entrapment efficiency

The drug entrapment efficiency was found in between 51.2% and82.5%. The minimum and maximum entrapment efficiency was A6 and A30 respectively.

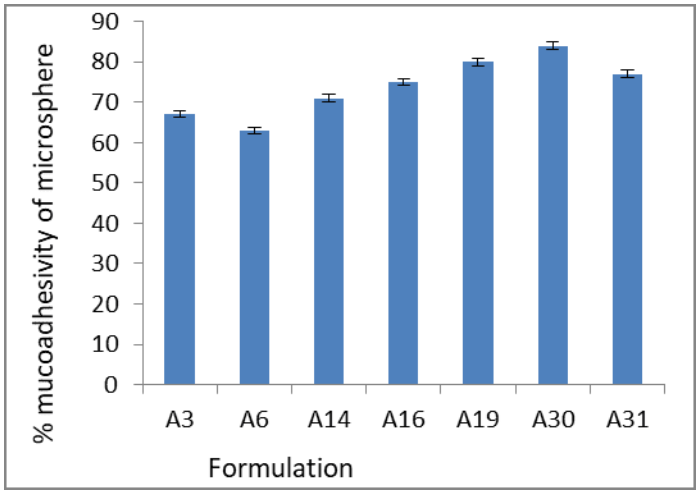


Fig. 4: Bar chart of drug entrapment efficiency(%) of different formulation batches.

In-vitro drug release profile

The in vitro drug release profile of different batches of microsphere was found in between 91.5% and 98.74%. The minimum and maximum release profile were A19 and A30 respectively.

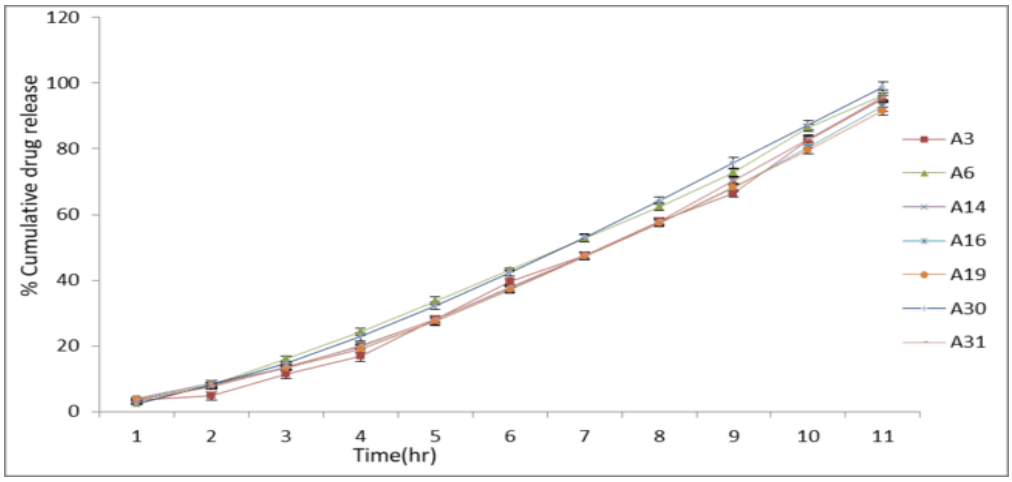


Fig. 5: In vitro drug release profile of different batches of microsphere.

Mucoadhesivity of Microspheres

The value of percent mucoadhesivity of microspheres shown in table 3. The percent mucoadhesivity of microspheres was found in between 63% and 84 %. The minimum and maximum mucoadhesivity of microsphere were A6 and A30 respectively.

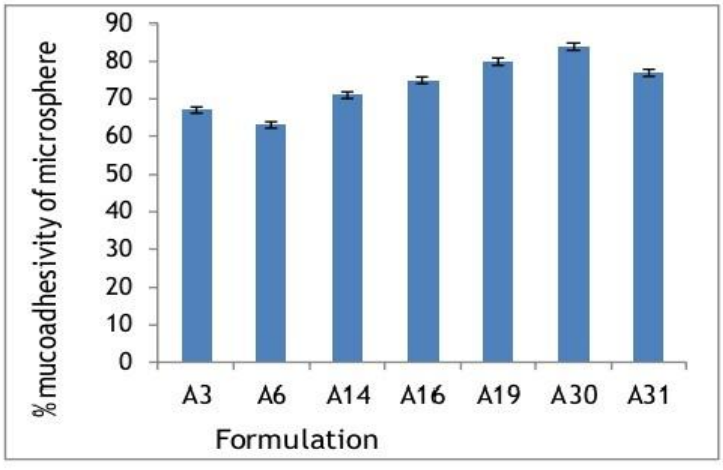


Fig. 6: Bar chart of Mucoadhesivity(%) of different formulation batches.

Stability study

The optimized formulation were subjected to stability studies at different temperature for 3 month. The optimized formulations were evaluated for their in-vitro release study, entrapment efficiency and physical appearance. Negligible changes was seen in different parameters at25±2°C/60%±5% RH(table 3), 40±2°C/75%± 5% RH(table 4).

Table 3: Stability studies of optimized formulation at 25±2°C/60%±5% RH.

Evaluation parameters	Results			
	0 day	After 30 days	After 60 days	After 90 days
Entrapment efficiency	82.5%	81.1%	80.3%	79.6%
Drug release	98.7 %	97.2%	96.9%	95.8%
Physical appearance	No change	No change	No change	No change

Table 4: Stability studies of optimized formulation at 40±2°C/75%± 5% RH.

Evaluation parameters	Results			
	0 day	30 days	60 days	90 days
E.E	82.5%	81.1%	80.3%	79.6%
Drug release	98.7 %	97.2%	96.9%	95.8%
Physical appearance	No change	No change	No change	No change

Table 5: Optimization Of formulation using miscellaneous three level factorial design Observed responses for 7 runs of mucoadhesive microsphere by ionotropic gelation method prepared by pectin and sodium alginate according to Miscellaneous response design.

Formulation Code	Pectin (mg)	Sodium alginate (mg)	Cumulative Drug release (%)			Entrapment Efficiency (%)		
			Actual value	Predicted value	Residual value	Actual value	Predicted value	Residual value
A3	100	100	95.20	95.18	0.0233	74.3	74.4	-0.1383
A6	100	300	96.3	96.28	0.0233	51.20	51.34	-0.1383
A14	200	200	95.89	95.84	0.0467	76.30	76.58	-0.2767
A16	200	100	93.10	93.12	-0.0233	64.20	64.06	-0.1383
A19	300	300	91.50	91.50	0.0000	73.2	73.06	0.1383
A30	100	200	98.70	98.72	-0.0233	82.50	82.50	0.0000
A31	200	300	95.5	95.65	-0.0467	71.2	70.92	0.2767

Table 6: Design summary for formulation of cumulative drug release.

Source	Sequential p-value	Adjusted R^2	Predicted R^2	Suggested
Mean	**<0.0001**			
Linear	0.3320	0.1358	-1.2425	Aliased
2F1	0.7848	-0.1191	-3.8632	Aliased

Table 7: ANOVA for Quadratic model (Aliased).

Source	Sum of square	Df	Mean square	F-value	P-value	
Model	32.9	5	6.44	985.34	0.0242	Significant
A-Pectin	21.97	1	21.97	3363.04	0.0110	
B-Sodium alginate	15.68	1	15.68	2400.00	0.0130	
C-$CaCl_2$	0.0000	0				
AB	5.06	1	5.06	774.87	0.0229	
AC	0.0000	0				
BC	0.0000	0				
A^2	17.81	1	17.81	2726.21	0.0122	
B^2	0.0085	1	0.0085	1.31	0.4576	
C^2	0.0000	0				
Residual	0.0065	1	0.0065			
Cor total	32.19	6				

Factor coding is coded.
Sum of squares is Type III – Partial
The Model F-value of 985.34 implies the model is significant. There is only a 2.42% chance that an F-value this large could occur due to noise.

P-values less than 0.0500 indicate model terms are significant. In this case A, B, AB, A^2 are significant model terms. Values greater than 0.1000 indicate the model terms are not significant. If there are many insignificant model terms (not counting those required to support hierarchy), model reduction may improve your model.

The coefficient estimate represents the expected change in response per unit change in factor value when all remaining factors are held constant. The intercept in an orthogonal design is the overall average response of all the runs. The coefficients are adjustments around that average based on the factor settings. When the factors are orthogonal the VIFs are 1; VIFs greater than 1 indicate multi-co linearity, the higher the VIF the more severe the correlation of factors. As a rough rule, VIFs less than 10 are tolerable.

Final equation in terms of coded factor
CDR = $+95.84-4.64A+2.80B+C+2.25AB+AC+BC-4.84A^2+0.08B^2+C^2$

The equation in terms of coded factors can be used to make predictions about the response for given levels of each factor. By default, the high levels of the factors are coded as +1 and the low levels are coded as -1. The coded equation is useful for identifying the relative impact of the factors by comparing the factor coefficients.

Table 8: Design summary for formulation of entrapment efficiency.

Source	Sequential p-value	Adjusted R^2	Predicted R^2	Suggested
Mean	**<0.0001**			
Linear	0.3707	0.0867	-1.6702	Aliased
2F1	0.0977	0.5780	-0.9532	Aliased

Table 9: ANOVA for Quadratic model (Aliased).

Source	Sum of square	Df	Mean square	F-value	P-value	
Model	612.07	5	122.41	985.34	0.0242	Significant
A-Pectin	0.2444	1	0.2444	3363.04	0.0110	
B-Sodium alginate	40.50	1	40.50	2400.00	0.0130	
C-$CaCl_2$	0.0000	0				
AB	258.24	1	258.24	1124.60	0.0190	
AC	0.0000	0				
BC	0.0000	0				
A^2	28.75	1	28.75	125.19	0.0567	
B^2	85.65	1	85.65	373.00	0.0329	
C^2	0.0000	0				
Residual	0.2296	1	0.2296			
Cor total	612.30	6				

Factor coding is coded.
Sum of squares is Type III – Partial
The Model F-value of 533.09 implies the model is significant. There is only a 3.29% chance that an F-value this large could occur due to noise.

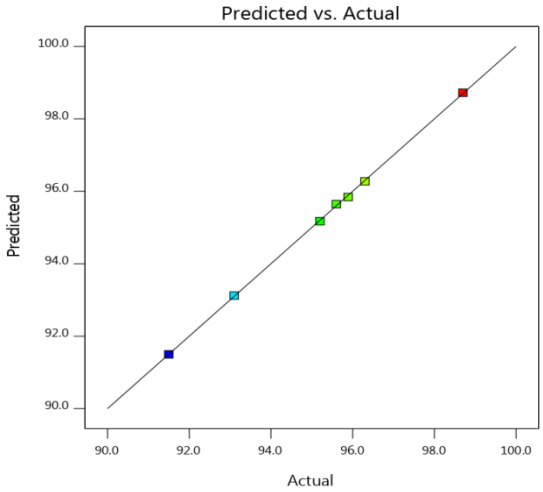
P-values less than 0.0500 indicate model terms are significant. In this case B, AB, B^2 are significant model terms. Values greater than 0.1000 indicate the model terms are not significant. If there are many insignificant model terms (not counting those required to support hierarchy), model reduction may improve your model.

The coefficient estimate represents the expected change in response per unit change in factor value when all remaining factors are held constant. The intercept in an orthogonal design is the overall average response of all the runs. The coefficients are adjustments around that average based on the factor settings. When the factors are orthogonal the VIFs are 1; VIFs greater than 1 indicate multi-co linearity, the higher the VIF the more severe the correlation of factors. As a rough rule, VIFs less than 10 are tolerable.

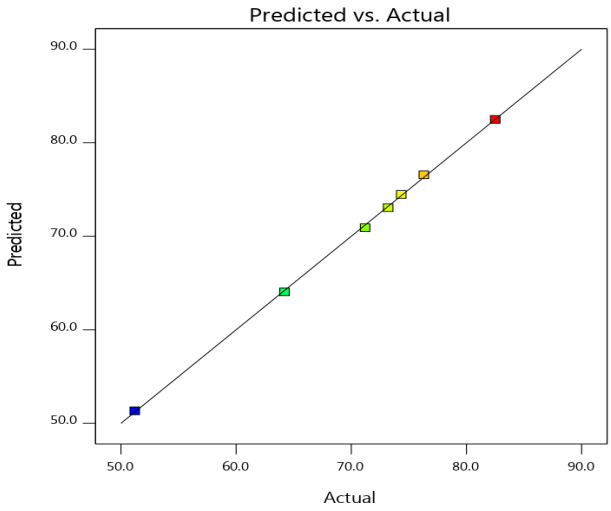
Final equation in terms of coded factor

$E.E = 76.58-0.4892A+4.50B+C+16.07AB+AC+BC-6.14A^2-8.01B^2+C^2$

The equation in terms of coded factors can be used to make predictions about the response for given levels of each factor. By default, the high levels of the factors are coded as +1 and the low levels are coded as -1. The coded equation is useful for identifying the relative impact of the factors by comparing the factor coefficients.

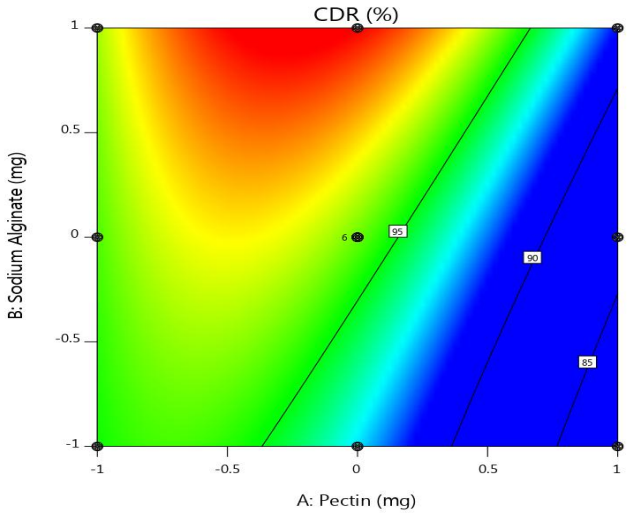


(a)



(b)

Fig. 7: Graph of actual value vs. predicted value of formulation prepared by polymers (Sodium alginate and pectin) for (a) Percent Cumulative drug release of formulation (b) percent drug entrapment efficiency of formulation.



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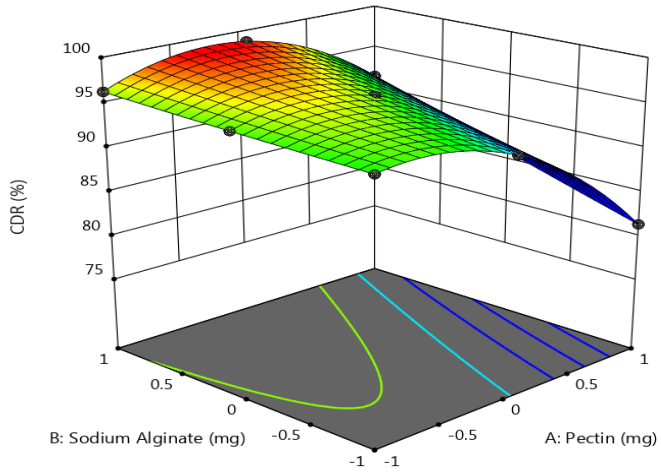
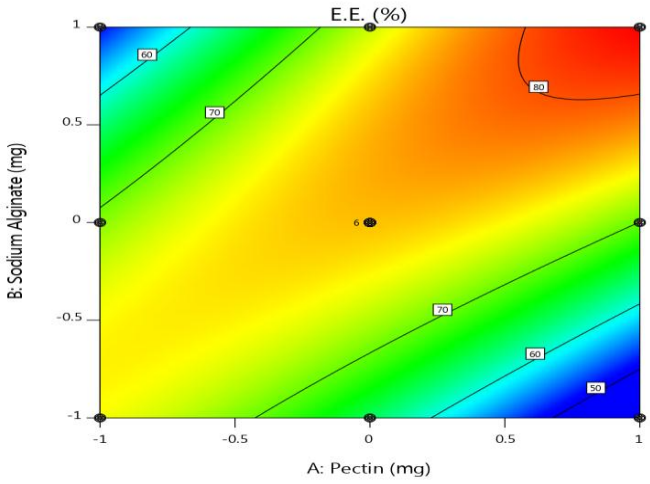
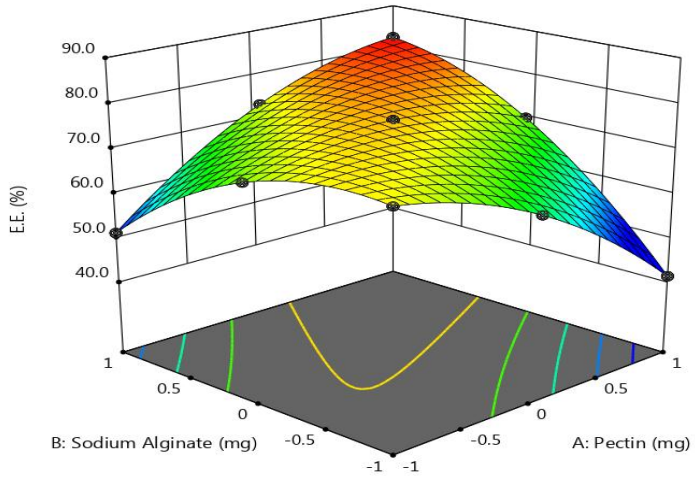


(b)

Fig. 8: (a) contour plot and (b) 3-D surface response of sodium alginate and Pectin on % Cumulative drug release.



(a)



(b)

Fig. 9: (a) contour plot and(b)3-D surface response of sodium alginate and Pectin on % Entrapment efficiency.

Evaluation of capsules

Disintegration

Disintegration time of optimized formulation A30 was found to be 2.14hr

In vitro drug release

Fig.10.%Cumulative drug release vs time of optimized formulation(Capsule A30)

No release was shown in 2 hr (pH 1.2), The drug was slowly released after 2 hour in pH 6.8 and show maximum released up to 24 hour.

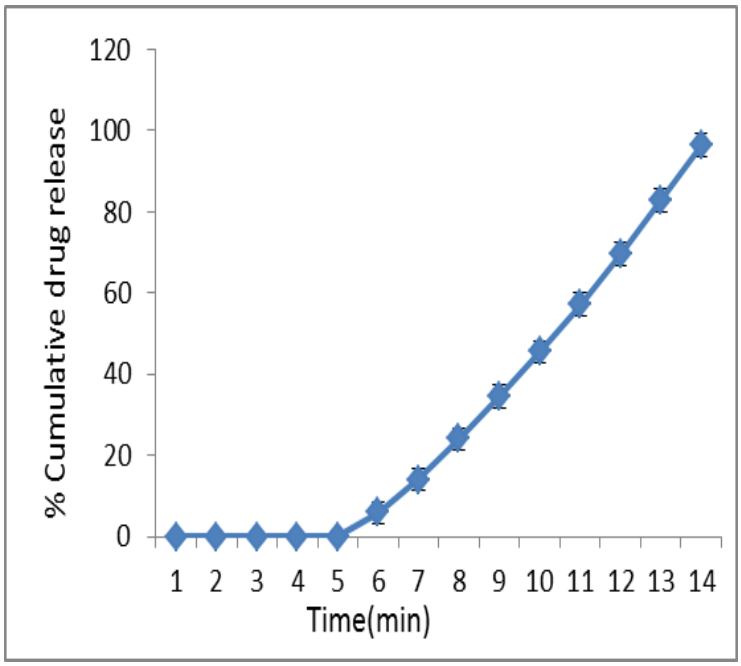


Fig. 10: %Cumulative drug release vs time of optimized formulation(Capsule A30) Drug release kinetics.

Formulation capsule A30 follow first order model with R^2 is0.951, it is concentration-dependent process i.e., the higher the concentration, the faster the clearance.

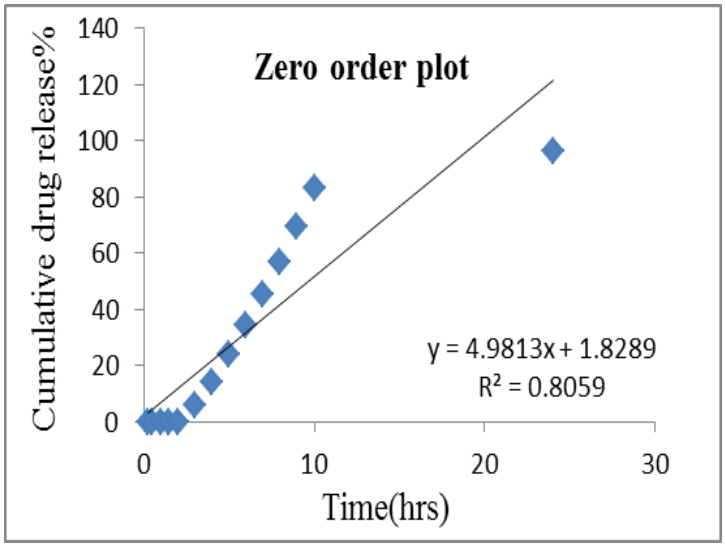


Fig. 11: Cumulative drug release % vs time.

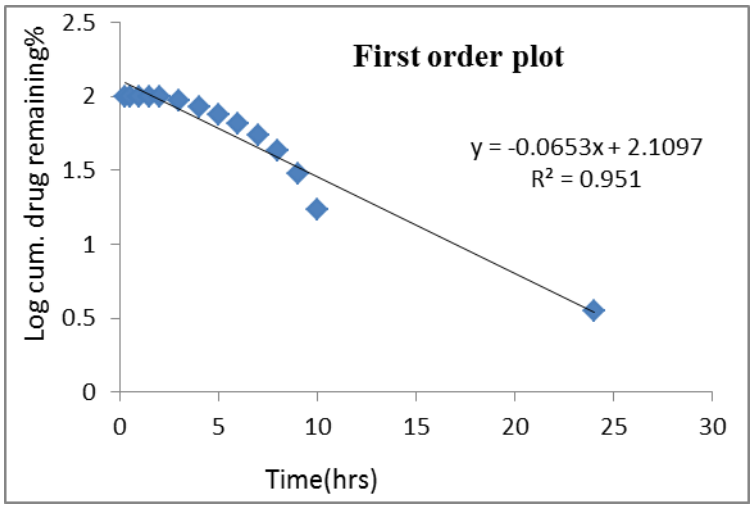


Fig. 12: Log cum. Drug remaining % vs time.

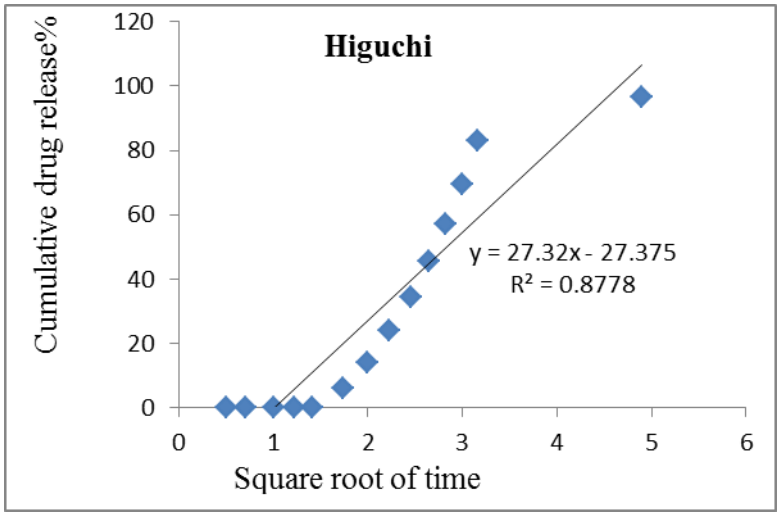


Fig. 13: Cumulative drug release% vs square root of time.

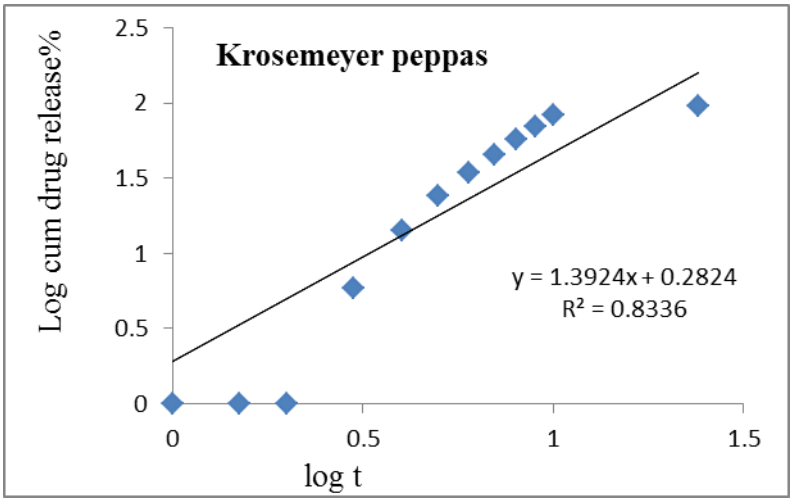


Fig. 14: Log cumulative drug release % vs log t.

CONCLUSION

Sustained release of mucoadhesive microspheres of Aceclofenac was prepared by ionotropic gelation method using mucoadhesive polymers and calcium chloride as a cross linking agent. Further, mucoadhesive microsphere was enclosed in to hard gelatin capsule and capsule shell was coated with pH sensitive polymer to prevent adherence of mucoadhesive microsphere in upper GIT.Sustained release mucoadhesive microspheres was subjected to evaluation of entrapment efficiency, drug release and % Mucoadhesivity and optimized as 82.5 %, 98.7% and 84 % respectively. Subsequently, proceeded for filling of mucoadhesive microsphere in hard gelatin capsule and enteric coating of capsule shell was subjected to evaluate of drug release profile, disintegration time, drug release kinetic model and found as 96.43% 2.14±1.16904hr and first order model with R^2 0.951 respectively.When capsule coating dissolve in pH 6.8, microsphere come in contact of colonic mucosa and adhere there, and slowly release the drug up to long time.

This proves the ability of the formulated capsule to reach, intact in to the colon where capsule shell get dissolved and give sustained action of the drug. Prepared capsule may be used for the treatment of colonic inflammation in a better way.

Future scope

The design of colon delivery system has significantly advanced the future for inflammatory bowel disease therapy by improving the selective targeting of active agents to site of inflammation. Contrary to most therapeutic regimens utilizing oral administration, systemic absorption is an undesirable delivery feature for these drugs. Disease localization dictates the need for maximal intestinal tissue drug exposure while systemic delivery should be minimized to avoid unwanted side effects.

This drug delivery approach has been shown to increase therapeutic efficacy, lower the therapeutically effective dose, reduce systemic side effect, and has allowed the use of novel compounds with poor physicochemical properties for oral delivery. This has been achieved through specific bio distribution and accumulation in the inflamed intestinal regions.

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