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DEVELOPMENT AND EVALUATION OF GASTRO-RETENTIVE FLOATING BEADS OF DICYCLOVERINE HYDROCHLORIDE

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ABSTRACT

Floating Drug delivery systems are designed to prolong the gastric residence time after oral administration. Dicycloverine is used for irritable bowel syndrome, abdominal pain, motion sickness and other conditions. Dicycloverine works by relieving smooth muscle spasms of the gastrointestinal tract. It is more soluble in water, alcohol and chloroform and slightly soluble in ether. Precipitation of the drug occurs in the intestine, which adversely affects the absorption in the lower sections of the intestine. So there is a need for systems that reside in the stomach over a relatively long period and release the active compound in a sustained manner. The aim of the present study was to develop a delivery system wherein the retention of Dicycloverine could be achieved for increasing local action in the gastric region against irritable bowel disease (IBD) and GIT spasms with the development of sodium alginate floating beads containing Dicycloverine. Various formulations (FB1- FB7) of floating beads of Dicycloverine were developed using different concentrations of polymers like Ethyl cellulose, PVP, HPMC etc. The beads were prepared by Ionotropic gelation method using calcium chloride as a cross-linking agent. Floating beads were characterized by polymer compatibility by using FT-IR, DSC & Calibration. The prepared beads were evaluated for particle size, surface morphology, buoyancy, actual drug content, and entrapment efficiency in *vitro* drug release and stability studies. Finally batch FB1 is concluded as optimum formulation.

Keywords: Dicycloverine, colon, IBD, gastric residence time, polymer mixture, ionotropic gelation.

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1. INTRODUCTION

Floating drug delivery system (FDDS) promises to be a potential approach for gastric retention. The controlled gastric retention of solid dosage forms may be achieved by the mechanisms of mucoadhesion, flotation, sedimentation, expansion, modified shape systems, or by the simultaneous administration of pharmacological agents that delay gastric emptying. Several approaches are currently used to prolong gastric retention time[1]. These include floating drug delivery systems, also known as hydro dynamically balanced systems, swelling and expanding systems, polymeric bio adhesive systems, modified-shape systems, high-density systems, and other delayed gastric emptying devices. Various gastro retentive techniques were used, like floating, swelling, high density, and bio-adhesive system. Out of these floating system have been explored to increase the gastro-retention of dosage forms[2, 3].

Calcium alginate gel beads have been developed in recent years as a unique vehicle for drug delivery system. Various categories of drug have been encapsulated such as non-steroidal anti-inflammatory drugs, enzymes, peptides/proteins, and acid labile drugs[4].

Dicycloverine was selected as a model drug for incorporation in calcium alginate beads. Dicycloverine is used for irritable bowel syndrome, abdominal pain, motion sickness and other conditions. Dicycloverine works by relieving smooth muscle spasms of the gastrointestinal tract. It is more soluble in water, alcohol and chloroform and slightly soluble in ether. The beads were evaluated with respect to micromeretic properties,

floating property, drug content, entrapment and encapsulation efficiency, *in vitro* drug release.

In the present investigation, a controlled release formulation of Dicycloverine capable of providing detectable blood levels over 10-12 hrs[5] was formulated. The polymer used was sodium alginate which is an inexpensive and nontoxic. Sodium alginate has been used as thickening and gelling agent. Hydroxy propyl methylcellulose (K100M), ethyl cellulose and PVP were also used to achieve a controlled drug release[6, 7, 8].

2. MATERIAL AND METHODOLOGY

Table 1: Chemicals used in research work

S.NO	Chemicals	Source
	Dicycloverine	Agron Remedies Pvt. Ltd Kashipur, India.
	Ethyl cellulose	Agron Remedies Pvt. Ltd Kashipur, India.
	Polyvinyl Pyrolidine	LOBA Chemie Pvt. Ltd. Mumbai
	Hydroxy propyl methyl cellulose	Agron Remedies Pvt. Ltd Kashipur, India.
	Sodium Alginate	Classic Business Organisation Kashipur, India.
	Calcium chloride	Pallav Chemicals & Solvents Pvt. Ltd. Boisar
	Calcium Carbonate	Pallav Chemicals & Solvents Pvt. Ltd. Boisar
	Sodium Alginate	Babu Genu Road, Mumbai

Table 2: Equipments used in research work

S.NO	Equipment	Company
1.	Single pan Electronic Balance	Sigma-200/A Deluxe, Sen Shine Balance Works, Varanasi, India
2.	Magnetic stirrer	Biocraft, Gwalior, M.P.India
3.	pH – Meter	VSI-1B,VSI electronic Chandigarh, India
4.	Hot – air oven	Biocraft, Gwalior, M.P., India
5.	UV/ Vis Spectrophotometer	Lasani
6.	Mechanical Shaker	Jyoti Industries, Gwalior, M.P., India
7.	FTIR Spectrophotometer	Perkin Elmer, BX, UK
8.	Dissolution Apparatus(USP XXIV, type I)	Electrolab, Mumbai, India
9.	Dessicator	Biocraft, Gwalior, M.P., India
10.	Scanning Electron Microscope	JEOL, Japan
11.	DSC instrument	NETZSCH, DSC-204 F1 PHOENIX

2.1. Preformulation studies[9]:

Preformulation testing is the first step in the rational development of dosage forms of a drug. It can be defined as an investigation of physical and chemical properties of drug substance, alone and when combined with excipients in order to develop stable, safe and effective dosage form. The overall objective of preformulation testing is to generate information useful to the formulator in developing stable and bioavailable dosage forms, which can be mass produced. A thorough understanding of physicochemical properties may ultimately provide a rationale for formulation design or support the need for molecular modification or merely confirm that there are no significant barriers to the compounds development[10]. The goals of the program therefore are:

1. To establish the necessary physicochemical characteristics of a new drug substance.

2. To determine its kinetic release rate profile.

3. To establish its compatibility with different excipients.

Hence, preformulation studies of the obtained sample of drug include color, tests, solubility analysis, melting point determination and compatibility studies.

2.1.1. Physical Appearance:

The drug was observed visually for the color and appearance, whether amorphous or crystalline.

2.1.2. Angle of Repose:

Angle of repose helps to evaluate powder flowability by assessing inter-particulate friction. In general, the higher is the angle of repose poor is the flowability of powde[11]. The angle of repose of each powder blend was determined by glass funnel method, using following equation,

$$\tan \theta = h/r$$

Here, θ= Angle of Repose

h= Height of the pile

r = Radius of the cone made by powder blend

Table 3: Relation between angle of repose and flowability

Angle of Repose	Flowability
<20	Excellent
20-30	Good
30-34	Passable
>40	Very poor

2.1.3. Bulk Density:

It is ratio of mass to bulk volume. Bulk density may influence dissolution and other properties and depends on the particle size, shape and tendency of particles to adhere together. Bulk density of formulated beads was determined by taking a known mass of beads in a 5 ml graduated measuring cylinder. The cylinder was dropped three times from a height of one inch at an interval of two seconds. The bulk density was calculated by following equation,

$$\rho_{b} = M/Vb$$

Where, ρ_{b} = Bulk density
M = Weight of the Powder
Vb = Bulk Volume

2.1.4. Tapped density:

Tapped density helps to determine packing geometry and flowability. Tapped density is the volume of powder determined by tapping using measuring cylinder containing weighed amount of sample. Tapped density of beads was calculated by following equation,

$$\rho_{t} = M/V_{t}$$

Where, ρ_{t}=Tapped density
M = Weight of the powder
V_{t} = Tapped powder

2.1.5. Carr's compressibility index: This is an important property in maintaining uniform weight. It is calculated using following Equation,

$$\text{Carr's Index} = \frac{(\text{Tapped density} - \text{Bulk density})}{\text{Tapped density}} \times 100$$

Table 4: Carr's compressibility index

% Compressibility	Flow Description
5-15	Excellent(free flowing granules)
12-16	Good (free flowing powdered granules)
18-21	Fair (powdered granules)
23-28	Poor (very fluid powder)
28-35	Poor (fluid cohesive powder)
35-38	Very poor (fluid cohesive powder)
>40	Extremely poor (cohesive powder)

2.1.6. Hausner's ratio:

Hausner's ratio less than 1.25 indicates good flow and greater than 1.5 indicates poor flow whereas between 1.25 and 1.5 indicates glidant normally improves flow. Hausner's ratio can be calculated by formula,

$$\text{Hausner's Ratio} = \frac{\text{Tapped density}}{\text{Bulk density}}$$

2.1.7. Solubility analysis

Solubility of Dicycloverine in water was determined at 37^{0}C.10gm of Dicycloverine was transferred in a series of different solvents having volume 10 ml in different test tubes[12]. These test tubes were shaken by a mechanical shaker for 2 hours under constant temperature. Solution was filtered by Whatman filter paper and the clear filtrate was assayed spectro-photometrically at 210 nm against blank solution[13]. Available literature shows that adsorption to Filter II (Whatman Filter) was much lower and in most cases negligible.

2.1.8. Melting point determination

Melting point determination of the obtained sample was done because it is a good first indicationof purity of the sample sincethe presence of relatively small amount of impurity can be detected by a lowering as well as widening in the melting point range[14]. Melting point of Dicycloverine was determined by using Melting Point Apparatus, the drug filled (sample amount) in a capillary tube whose one end is sealed with the flame was placed in the pockets of apparatus accompanied with thermometer. The heating was started and the point at which drug start melting was noted and the melting point of drug were found to be 160- 163^{0}C.

2.1.9. Partition coefficient

The partition coefficient is defined as the ratio of unionized drug distributed between the organic and aqueous phase at equilibrium. For a drug delivery system, lipophilic/hydrophilic balance has been shown to be a contributing factor for rate and extent of drug absorption. Partition coefficient provides a means of characterizing lipophilic/hydrophilic nature of drug. The measurement of drug lipophilicity is indication of its ability to cross the lipoidal cell membrane[15].

Procedure: The partition coefficient study was performed using n-octanol as oil phase and phosphate buffer pH 7.4 and water as aqueous phase[16] The two phases were mixed in an equal quantity and were saturated with each other on a mechanical shaker for 24 hrs. The saturated phases were separated by separating funnel. Equal volume (10 ml each) of the two phases were taken in conical flasks and to each, 100 mg of drug was added. The flasks were stirred at 320C for 6 hours to achieve a complete mixing at 100 rpm. The two phases were separated by separating funnel then the phases were analyzed for respective drug amount by the means of UV spectrophotometer at 210 nm.

The partition coefficient value "p" was calculated by the following equation-

$$Po/w = \frac{\text{Concentration in octanol}}{\text{Concentration in phosphate buffer pH 7.4}}$$

2.1.10. Differential scanning Calorimetry (DSC):

Differential scanning Calorimetry, experiments were performed with differential Scanning Calorimeter chamber[16]. Instrument is comprised of a calorimeter a flow controller a thermal analyzer and an operating software. Sample of pure Dicycloverine, was weighed in an aluminium pan and sealed with an aluminium lid. The pan was placed in the DSC and heated from 20-350°C at a heating rate of 50°C/min in nitrogen atmosphere. The scan was recorded and plotted showing heat flow (w/g) on the Y-axis and temperature on the X-axis.

2.1.11. Excipients compatibility studies: Fourier Transform Infra-Red (FTIR) Spectroscopy[17]

Interaction of drug with excipients was confirmed by carrying out IR interactions studies. Drug and excipients used in study were placed in air tight screw cap amber colored vials, then vials were kept at room temperature as well as in hot air oven at 400C for one week to get them moisture free and FT-IR analysis was carried out with saturated potassium bromide using pellet making method. Standard and KBr were taken in the ratio of 1:300 to make a solid disc or pellet with the help of Hydraulic Pellet Machine.

2.1.12. Preparation of Calibration Curve:

Calibration curve of Dicycloverine: - 10 mg of drug was weighed and dissolved in 10 ml of phosphate buffer 6.8, to give a solution of 1000 µg/ml concentration[18]. From this solution 1 ml was taken and diluted to 10ml using Phosphate buffer 6.8to produce a stock solution of 100 µg/ml. From this stock solution different concentrations were prepared. The absorbance of these solutions was measured at 210 nm by UV spectrophotometer. Calibration curve of Dicycloverine also prepared in water by preparing stock solution of different concentration ranging from 2-16 µg/ml as above. The absorbance was measured at 210 nm by UV spectrophotometer.

2.2. Development of floating beads of Dicycloverine Hydrochloride by Ionotropic Gelation Method[19]

The beads of Dicycloverine were prepared by ionotropic gelation technique according to the formula given in Table 5.

Accurately weighed drug was added to 100ml of Distilled Water and stirred on magnetic stirrer. Polymer, $CaCO_3$ and sodium alginate were then added to the solution and stir continuously till uniform polyelectrolyte solution was formed also known as pre-alginate solution. Calcium chloride was separately dissolved in 100 ml water and stirred on magnetic stirrer. Pre- alginate solution of drug and polymer was added drop by drop to the $CaCl_2$ solution with the help of 21 G needle. The formed alginate beads were cured at different time interval. The alginate beads were there after dried overnight at room temperature.

Table 5: Formulation design of floating beads of Dicycloverine Hydrochloride

Formulation code	Drug (mg)	Sodium Alginate (%)	HPMC (K100) mg	Ethyl Cellulose (mg)	PVP (mg)	CaCl2 Solution (%)	CaCo3 (gm)
FB1	200	3%	200	_	_	3	1.5
FB2	200	4%	_	200	_	3	1.5
FB3	200	4%	_	_	200	3	1.5
FB4	200	3%	100	100	_	3	1.5
FB5	200	5%	_	100	100	3	1.5
FB6	200	2%	100	_	100	3	1.5
FB7	200	2%	_	_	_	3	1.5

2.2.1. Evaluation Tests for Floating Beads[20, 21]

2.2.2. Particle size analysis:

The beads should be studied for shape and size for uniform distribution. It can be obtained by various techniques given below.

2.2.3. SEM of floating beads

Morphological characterization of the floating beads is done by taking scanning electron micrograph (Model Jeol JSM-5200)[22]. Cross-sectional views are obtained by cutting the bead with a razor blade. The samples were coated to 200 Aº thickness with gold- palladium prior to microscopy. A working distance of 20 nm, a tilt of 0º and accelerating voltage of 15 KV were the operating parameters. Photographs were taken within the range of 50- 500 magnifications.

2.2.4. Determination of Percentage yield

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

$$\text{Percentage Yield} = \frac{\text{Actual weight of products}}{\text{Weight of drug and excipients}} \text{x } 100$$

2.2.5. Drug Entrapment Efficiency

Beads equivalent to 100 mg of the drug were taken for evaluation. The amount of drug entrapped was estimated by rushing the beads and extracting with aliquots of 0.1N HCl repeatedly. The extract was transferred to a 100 ml volumetric flask and the volume was made up using 0.1N

HCl. The solution was filtered and the absorbance was measured at suitable wavelength against appropriate blank. The amount of drug entrapped in the beads was calculated by the following formula,

$$Drug\ Entrapment\ Efficiency = \frac{Amount\ of\ drug\ actually\ present}{Theoretical\ drug\ loaded\ expected}\ x\ 100$$

2.2.6. In *vitro* buoyancy study

Beads (300mg) were spread over the surface of a USP XXIV dissolution apparatus type II filled with 900 ml of 0.1 N HCl containing 0.02% Tween 80. The medium was agitated with a paddle rotating at 100 rpm for 12 hr. The floating and the settled portions of beads were

recovered separately. The beads were dried and weighed. Buoyancy percentage was calculated as the ratio of the mass of the beads that remained floating and the total mass of the beads.

$$\% \text{ Buoyancy} = \frac{Qfx}{(Qf + Qs)} x\ 100$$

Where,

Qf = Weight of the floating Beads

Qs = Weight of settled Beads

2.2.7. In-*vitro* drug release study

The drug release study from beads is performed using USP dissolution apparatus Type I in 900 ml of 0.1 N HCl dissolution media (pH- 1.2) at 100 rpm and 37°C. 2 ml sample was withdrawn at 1 hr. time interval for 12 hr. and same volume of fresh medium was replaced to maintained sink condition. Withdrawn samples were assayed spectrophotometrically at suitable wavelength. The drug release was analyzed by UV spectro-photometer.

2.2.8. Determination of Moisture Content

The formulations were subjected to moisture content study by using an IR moisture balance by placing the beads at 60 °C for 10 min.

2.2.9. Stability study

Stability studies of floating beads of Dicycloverine HCL[23]

Stability studies carried out by storing the prepared floating beads of Dicycloverine HCL at various temperature conditions like refrigeration on (2-80C) room temperature (25±0.50C) and elevated temperature (45±0.50C) for a period of 12 weeks. Drug content was periodically monitored. ICH (International Conference on Harmonization) guidelines suggests stability studies for floating beads powder meant for reconstitution should be studied for accelerated stability at 75% relative humidity as per international climatic zones and climatic conditions[23].

3. RESULTS AND DISCUSSION

3.1. Preformulation Studies

Preformulation studies were carried out to find out the powder properties such as angle of repose, bulk density, tapped density and Carr's index, hausner's ratio as per the methods described in methodology. The results are reported in Table 6.

Table 6: Powder properties of Dicycloverine hydrochloride

S.NO	Powder Properties	Results
	Angle of repose (θ)	17.43±0.081
	Bulk density (gm/mL)	1.09±0.008
	Tapped Density (gm/mL)	1.38±0.028
	Carr's Index (%)	20.69±0.35
	Hausner's Ratio	1.26±0.003

The angle of repose of Dicycloverine HCl was found to be in the range of 25^0 to30^0 indicates good flow property and acceptable characteristics. The % compressibility index was determined from the bulk and tapped densities. The percentage compressibility index of Dicycloverine HCl were found to be in the range of 11 % to 23%, were also within the acceptable limit. The Hausner's ratio of Dicyclomine HCl was found to be near 1.26 indicates good flow properties.

3.1.1. Physical Appearance: Dicycloverine Hydrochloride was found to be white or almost white, crystalline powder.

3.1.2. Solubility: Freely soluble in water, alcohol and chloroform but very slightly soluble in ether.

3.1.3. Melting Point: The melting point of Dicycloverine Hydrochloride was found to be 160-163ºC by capillary tube method.

3.1.4. Partition Coefficient: Log P value was found to be 5.5

3.1.5. Preparation of Calibration Curve: The calibration curve for Dicycloverine HCL was plotted in phosphate buffer, pH 6.8 and water .The graphs was plotted between concentration (X axis) and absorbance (Y-axis). The results of calibration curve of Dicycloverine HCL were shown in Figure 1 and 2 shows the absorbance of Dicycloverine hydrochloride standard solution containing 1-6 µg/ml of drug in phosphate buffer pH 6.8 and water at the maximum wavelength of 210nm.

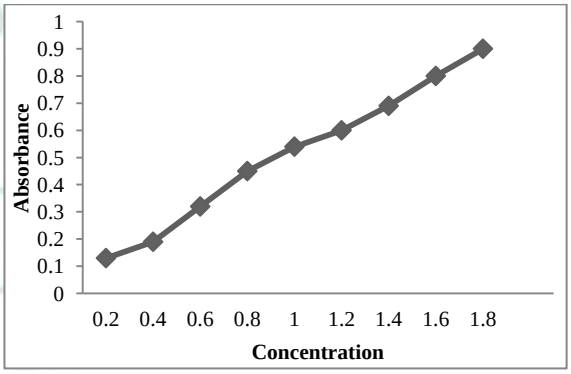

Figure 1: Standard Curve for Dicycloverine HCL in phosphate buffer 6.8

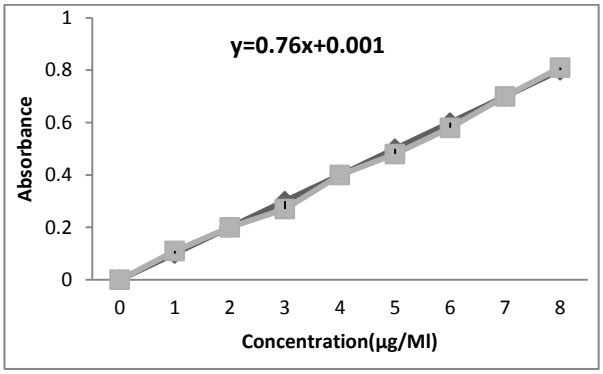

Figure 2: Standard Curve for Dicycloverine HCL in Water.

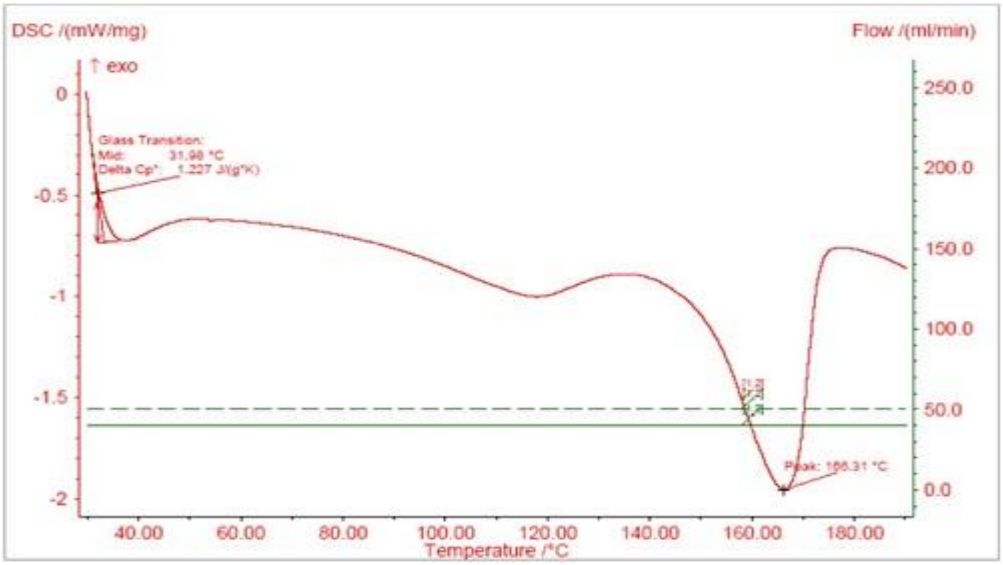

Figure 3: DSC of Dicycloverine HCL

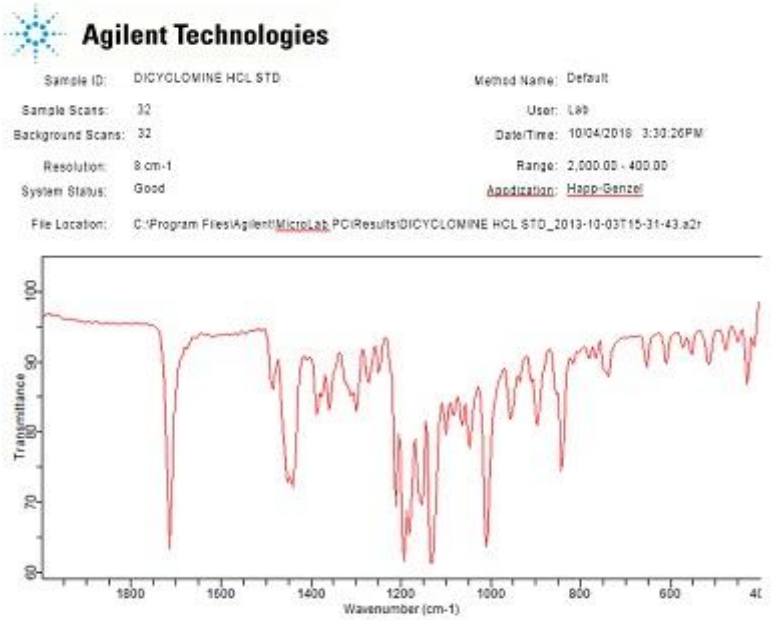

Figure 4: FTIR spectrum of Dicycloverine HCL

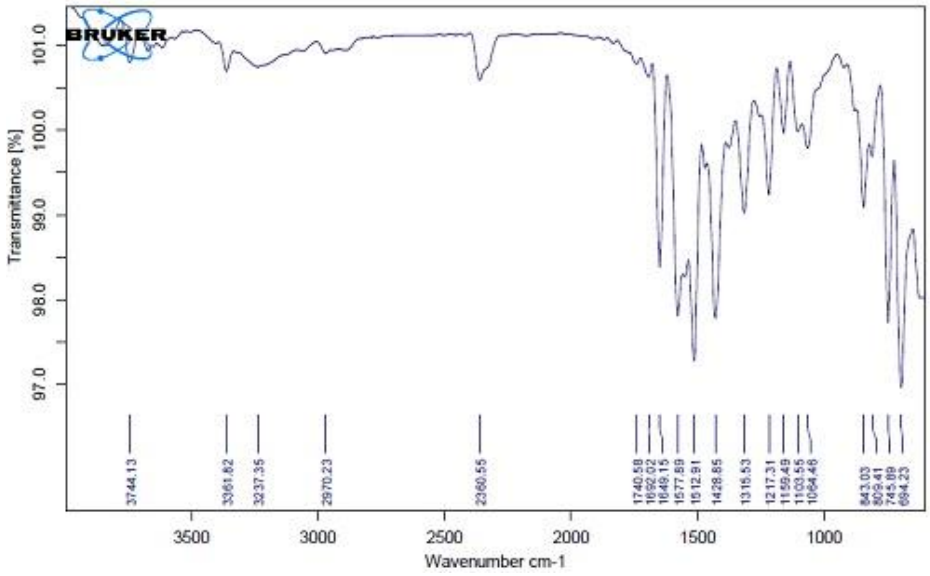

Figure 5: FTIR spectrum of Dicycloverine HCL and HPMCK100

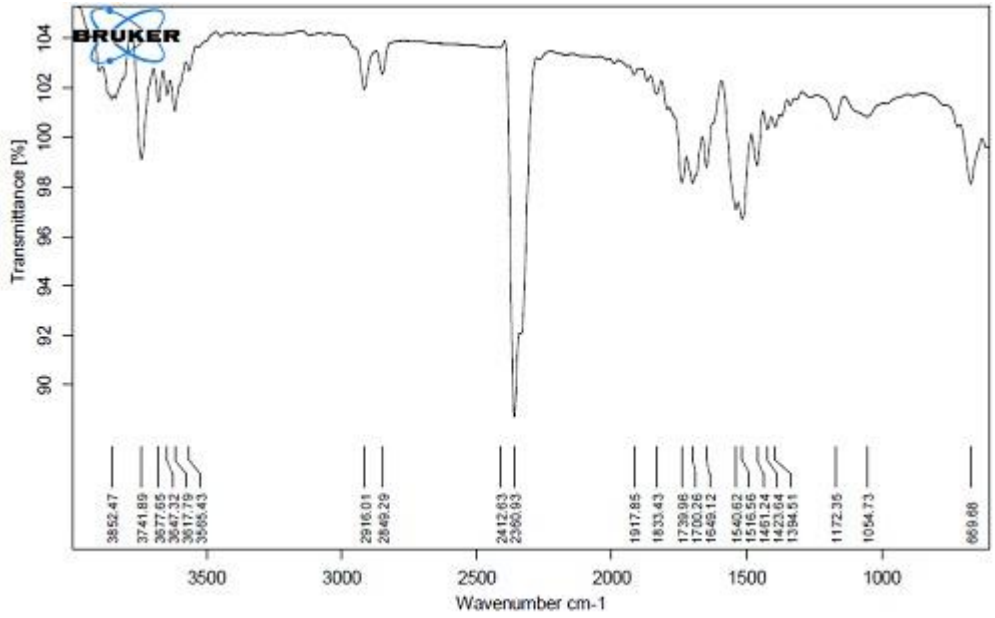

Figure 6: FTIR spectrum of Dicycloverine HCL and PVP

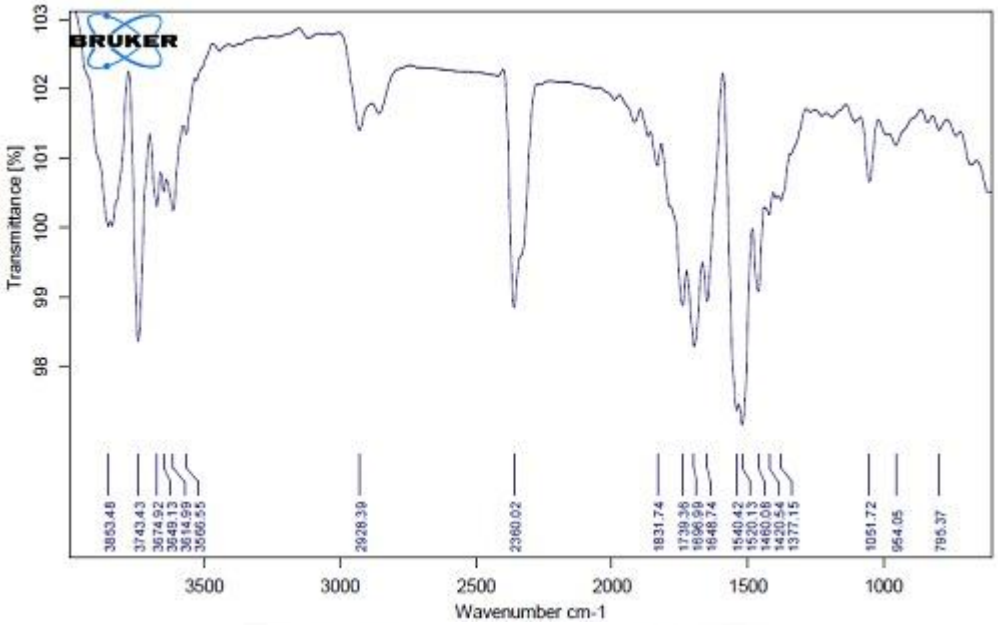

Figure 7: FTIR spectrum of Dicycloverine HCL and EC

Figure 8: Floating beads formulations of batch FB1

Figure 9: Floating beads formulations of batch FB2

Figure 10: Floating beads formulations of batch FB3

Figure 11: Floating beads formulations of batch FB4

Figure 12: Floating beads formulations of batch FB5

Figure 13: Floating beads formulations of batch FB6

Figure 14: Floating beads formulations of batch FB7

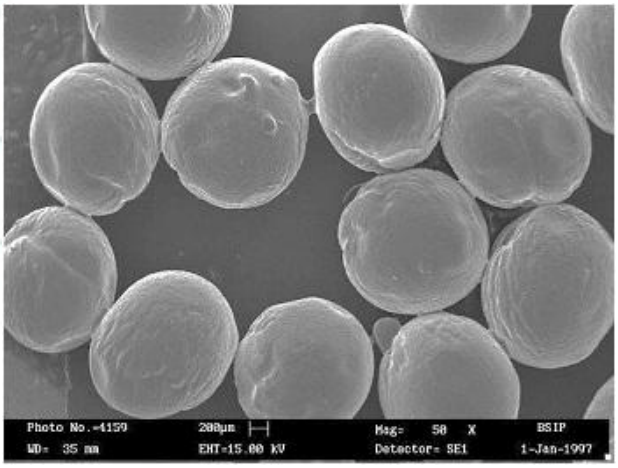

Figure 15: Scanning Electron Microscopy of floating beads of Dicycloverine HCL

Table 7: Characterization of floating beads of Dicycloverine HCL

Batch Code	Yield (%)	Entrapment Efficiency (%)	% Buoyancy
FB1	60.34±0.061	90%±0.014	68.23±0.081
FB2	66.41±0.085	85%±0.021	71.46±0.032
FB3	65.46±0.102	92.5%±0.07	70.84±0.125
FB4	90.23±0.043	80.15%±0.20	96.21±0.063
FB5	74.27±0.042	86.4%±0.34	79.38±0.081
FB6	78.29±0.120	76.4%±0.036	92.12±0.078
FB7	80.45±0.091	81%±0.047	78.38±0.032

(Mean±S.D, N=3)

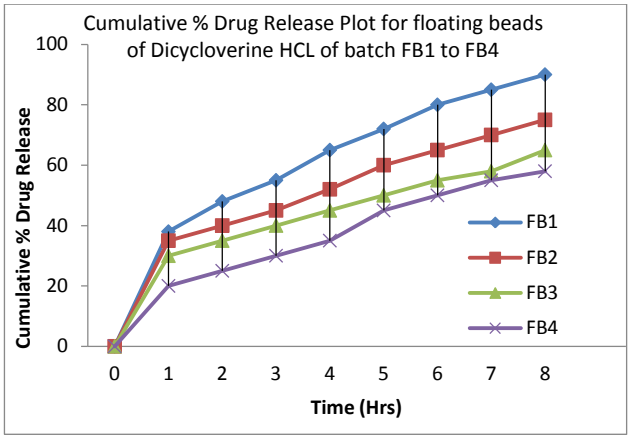

Figure 16: Percentage of drug released from floating beads of Dicycloverine HCL of batch FB1 to FB4

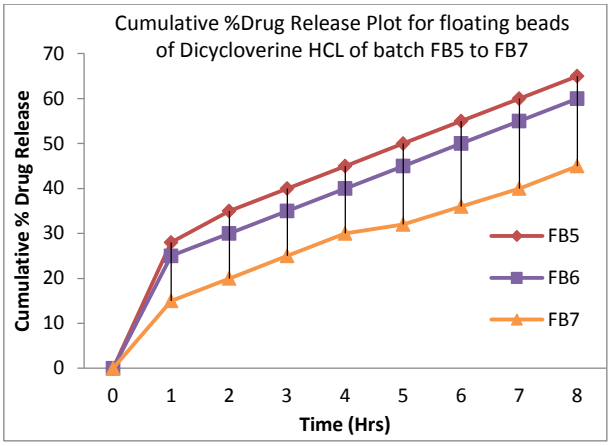

Figure 17: Percentage of drug released from floating beads of Dicycloverine HCL of batch FB5 to FB7

Table 8: Stability Study of floating beads of Dicycloverine HCL Batch FB1 and FB2

Weeks	Batch FB1			Batch FB2		
	Refrigeration (4 ±2^{O}C)	Room (30±2^{O}C)	Oven (40±2^{O}C)	Refrigeration (4 ±2^{O}C)	Room (30±2^{O}C)	Oven (40±2^{O}C)
0	100	100	100	100	100	100
1	96.10±0.01	95.89±0.01	95.83±0.15	96.5±0.04	96.23±0.03	96.19±0.13
3	95.62±0.01	94.43±0.03	95.40±0.26	95.53±0.03	94.83±0.01	95.28±0.20
6	94.10±0.23	94.02±0.15	95.01±0.14	94.92±0.14	94.42±0.07	94.69±0.17
9	95.00±0.11	94.90±0.8	95.00±0.28	94.26±0.26	93.82±0.06	94.16±0.22
12	94.64±0.31	94.56±0.08	94.50±0.25	93.88±0.30	93.25±0.09	93.87±0.33

(Mean±S.D, N=3)

Table 9: Stability Study of floating beads of Dicycloverine HCL Batch FB3 and FB4

Weeks	Batch FB3			Batch FB4		
	Refrigeration (4 ±2^{O}C)	Room (30±2^{O}C)	Oven (40±2^{O}C)	Refrigeration (4 ±2^{O}C)	Room (30±2^{O}C)	Oven (40±2^{O}C)
0	100	100	100	100	100	100
1	96.89±0.01	95.72±0.01	95.95±0.15	95.66±0.04	95.46±0.03	95.57±0.13
3	95.32±0.01	94.84±0.03	95.41 ±0.26	95.03±0.03	94.56±0.01	95.31±0.20
6	94.43±0.23	94.02±0.15	94.79 ±0.14	94.95±0.14	93.88±0.07	94.94±0.17
9	93.79±0.11	93.58±0.8	94.09 ±0.28	94.78±0.26	93.69±0.06	94.80±0.22
12	93.68±0.31	93.23±0.08	93.64 ±0.25	94.56±0.30	93.51±0.09	94.54±0.33

(Mean±S.D, N=3)

Table 10: Stability Study of floating beads of Dicycloverine HCL Batch FB5 and FB6

Weeks	Batch FB5			Batch FB6		
	Refrigeration (4 ±2^{O}C)	Room (30±2^{O}C)	Oven (40±2^{O}C)	Refrigeration (4 ±2^{O}C)	Room (30±2^{O}C)	Oven (40±2^{O}C)
0	100	100	100	100	100	100
1	96.63±0.01	96.72±0.06	96.63±0.04	95.86±0.04	95.56±0.03	95.77±0.13
3	95.83±0.03	95.91±0.06	95.71 ±0.09	95.23±0.03	94.38±0.01	95.31±0.20
6	95.033±0.06	94.45±0.06	94.53±0.13	94.85±0.14	93.95±0.07	94.84±0.17
9	94.49±0.04	93.68±0.8	93.79 ±0.28	94.78±0.26	93.69±0.06	94.79±0.22
12	94.38±0.03	93.13±0.03	93.54 ±0.29	94.56±0.30	93.41±0.09	93.54±0.33

(Mean±S.D, N=3)

Table 11: Stability Study of floating beads of Dicycloverine HCL Batch FB7

Weeks	Batch FB7		
	Refrigeration ($4 \pm 2^{O}C$)	Room ($30 \pm 2^{O}C$)	Oven ($40 \pm 2^{O}C$)
0	100	100	100
1	94.66±0.01	94.26±0.06	94.17±0.04
3	93.03±0.03	93.56±0.06	93.01 ±0.09
6	92.45±0.06	92.38±0.06	92.14±0.13
9	91.78±0.04	91.79±0.8	91.68 ±0.28
12	90.16±0.03	90.51±0.03	90.04 ±0.29

(Mean±S.D, N=3)

CONCLUSION

The present study has been a satisfactory attempt to formulate floating beads with a view of improving oral bioavailability and giving a prolonged release of drug. The floating beads prepared with HPMC, ethyl cellulose, and polyvinyl pyrrolidine were successfully formulated into floating beads for oral administration. The polymers studied were found to be the efficient carriers for Dicycloverine beads showing controlled release. The floating systems have been found to have good potential for prolonged drug release and therefore can be beneficial for use in the treatment of various GIT disorders. Additional benefits such as dose reduction, reduced frequency of administration and avoiding related systemic side effects can be produced.

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