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DEVELOPMENT AND IN-VITRO EVALUATION OF CURCUMIN LOADED FLOATING MICROSPONGE FOR THE ENHANCED GASTRORETENTIVE PROPERTIES AGAINST GASTRIC ULCER.

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Abstract

This research work was carried out to measure the gastro retentive efficacy leading towards the antiulcer potential of curcumin loaded floating micro sponges for improved site specific absorption for gastric ulcer in clinical platform. The microsponge were prepared by the modified quasi emulsion solvent diffusion method entrapping pure curcumin. The process and formulation parameters were well optimized leading to the ideal % entrapment efficiency, % buoyancy and % cumulative drug release. The in vitro release and the release studies were carried out at different pH for investigation of gastroretentive properties resulting in best fitted zero order models. The developed curcumin loaded floating microsponge formulation were well characterized for TEM, Zeta sizer, zeta potential showing well architecture of microsponge with ideal size micrometre size range (175 µm) along with (% entrapment efficiency (76), % buoyancy (82) and % cumulative drug release (90). DSC investigations confirmed molecular dispersion of the drug in the microsponge' polymeric matrix. Overall the current approach validated the stable and dispersed formulation showing ideal floating and gastroretentive ability of microsponge for treatment of gastric ulcer in clinical platform.

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1. Introduction

Liver is the most important organ of human body and it plays an important role detoxification and also the first victim to toxins leading to hepatotoxicity. Most of the liver damages are induced by lipid peroxidation and other oxidative damages caused by toxins. Exogenous factors like smoke, alcohol, stress, fatty food will trigger free radical generation which further leads to mucosal ischemia, excess secretion of hydrochloric acid, pepsin ultimately resulting in ulcers [1]. In India, more than 93 medicinal palnts are used in different combination in the preparations of 40 patented herbal formulations. From the herbal source various plants with antioxidant capability as major mechanism along with other mechanisms are used for the hepato and gastric protection [2].

The ulcer preventive and the H2 receptor blocking activity of curcumin have been demonstrated in numerous antiulcer pre-clinical trials. Curcumin produce gastro protective effect which is related to its antisecretory activity and its ability to activate a sensory neuron-dependent mechanism of defence. It has been reported to increased action on the gastric mucosal defensive capacity and enhancement of mucosal blood flow via capsaicin-sensitive sensory neurons there by providing gastro protective effects even against necrotizing agents such as nonsteriodal anti-inflammatory drugs [3]. The gastro protective action of curcumin includes increase in mucin biosynthesis via stimulation of nitric oxide production, increasing the thickness of the surface mucus gel layer, and maintaining gastric mucosal blood flow and bicarbonate response. Curcumin has been found to be effective in subjects with Helicobacter Pylori infections and it induces an increase in intragastric pH. The efficacy of curcumin has been proven clinically that it balances both the aggressive and the defensive factor in the management of acid peptic disorders [4].

Curcumin, a natural polyphenol, found in the rhizomes of curcuma longa (turmeric), a member of the ginger family Zingiberaceae. Chemically curcumin is a α, β-unsaturated β-diketone with IUPAC name 1,7-bis (4-hydroxy-3-methoxyphenyl)- 1,6-heptadiene-3,5-dione and commonly called as diferuloylmethane, which exhibits keto-enoltautomerism having a predominant keto form in acidic and natural solutions and stable enol form in alkaline medium. It is a hydrophobic molecule and it is practically insoluble in aqueous solutions [5]. Curcumin is known to possess multiple therapeutic effects with remarkable effect on peptic ulcer. This drug has a poor bioavailability by virtue of its hydrophobicity and research is being conducted in order to find a carrier that can increase its bioavailability. Curcumin has very low water solubility, which makes it difficult to achieve the optimum plasma concentration at the target site. Another issue with this drug is that the soluble portion is rapidly degraded at physiological pH making it very unstable in the human body and less active [6]. Various methods have been tried to improve its water solubility as well as stability by complexation and similar techniques. Thus to increase its efficiency researchers over the world have come out with newer and better ways to carry the drug into the body and make sure the required concentration is obtained at the effect site.

It is determined that curcumin degrades in neutral, alkaline and photolytic condition but remains stable in acidic condition. Taking in to consideration the reasons attributable to poor bioavailability of curcumin, it would be advantageous to design a formulation which prolongs gastric residence time in stomach. Various strategies have been undertaken to deliver curcumin in gastric cavity by oro-dispersible tablets [7]. These systems have potential for targeting drug molecule to its targeted site but have low drug loading capacity. Microsponges offer an efficient drug delivery system for stomach specific delivery with high drug loading capacity. Microsponges have the ability to entrap wide range of active material due to its numerous interconnected pores and can adsorb high quantity of active pharmaceutical ingredients on its surface and load into the bulk of particles [8]. This system provides maximum efficiency, extended product stability, reduced side effect and modifies drug release favourably [8]. In oral application, the microsponges system has been shown to increase the rate of solubilization of poorly water soluble drugs by entrapping drugs in pores of microsponges.as these pores are very small, the drug in effect reduced to microscopic particles and the significant increase in the surface area thus greatly increase the rate of solubilization [9]. This paper is the first report on development highly efficient curcumin floating microsponges system with high drug loading capacity using biocompatible, safe and inexpensive polymers ethyl cellulose and eudragit S 100 to target gastric ulcer as a site specific targeted drug delivery system [9].

2. Materials & Methodology

Ethyl cellulose (polymer) medium molecular weight and Eudragit S100, ethanol, Poly vinyl alcohol (PVA) and Sodium chloride ultra-pure was acquired from Hi-media chemical Ltd Mumbai, India. The Span 80 and DCM were procured from Sigma Aldrich, Bengaluru, India. The bulk drug curcumin was obtained as a benevolent gift from Taj Pharmaceutical Pvt. Ltd, Hyderabad, India. Deionized water was produced from Milli-Q Synthesis (18 MΩ, Millipore). All other reagents and chemical were of analytical grade and used as received. The chemicals used were of laboratory reagent grade and were used as they were procured. The distilled water was used in all experiments.

2.1 Synthesis method of floating microsponge

Floating Microsponges were prepared by quasi-emulsion solvent diffusion technique using sodium chloride solution as porogen.Solution of ethyl cellulose, Eudragit S100 and curcumin was prepared in ethanol and dichloromethane (1:1 organic phase). 1.5% (w/v) aqueous solution of the porogen was prepared and sufficient amount of span 80 was added to it with agitation to obtain 1.5% (v/v) dispersion. The porogen solution was uniformly emulsified in polymeric solution, to form a w/o emulsion. An aqueous polyvinyl alcohol solution (aqueous phase) was prepared separately and previously prepared w/o emulsion was emulsified in it [10]. This w/o/w emulsion was stirred on magnetic stirrer for 8 h. The dispersed droplets were solidified in the aqueous phase by evaporation of the solvent. The microsponges were filtered, dried at 60ºC in the hot air oven and stored in desiccator till use [11].

3. Characterization

3.1 Melting Point

The melting point of obtained drug sample (Curcumin) was determined by melting point apparatus. The small quantity of drug was taken in a capillary tube sealed at one end and was placed in digital melting point apparatus and temperature range at which the drug melts is noted [12].

3.2 UV spectroscopy

Most drugs absorb light UV wavelength (200-400nm), since they contain aromatic double bonds. The solution containing 10µg/ml of sample drug curcumin was prepared and scanned over the range of 200-400 nm against 0.1 N HCL as blank using shimadzu double beam UV spectrophotometer. The maximum wave length obtained 424 nm in the graph was considered as λmax for the pure drug [13].

3.3 Solubility analysis

The investigation of solubility analysis criteria of drug (curcumin) is important to check whether it is soluble or not in different solvent system.The solubility was checked in different solution such as acetic acid, ethanol, 0.1N HCL and methanol 10 ml each in separate beaker and add 100mg of drug in each beaker and check the solubility by stirring it [14].

3.4 Particle size & Zeta potential

The Malvern Zetasizer 3000 was used to measure the particle size of the synthesized curcumin loaded floating microsponge, surface charge, and PDI (Malvern Instruments, Bedfordshire, UK). By using the electrophoretic mobility concept of particles under an applied electrical field, the Zeta potential was examined. For prospective evaluation, the concentration of the curcumin loaded floating microsponge was adjusted to 0.01% w/v using distilled water in 0.01 M sodium chloride solution [15]. The Dynamic light scattering analysis was performed for a clearer and more conclusive assessment of the curcumin loaded floating microsponge at a wavelength of 424 nm and a temperature of 25°C. The formulation, analysis, and reporting of the data were done in triplicate, and the average of the results was published with SD [16].

3.5 Percentage yield analysis

The practical percentage yield was calculated from the weight of floating micro sponges recovered from each batch in relation to the sum of the initial weight of starting materials. The practical percentage yield was calculated from the weight of floating micro sponges recovered from each batch in relation to the sum of the initial weight of starting materials [17]. The percentage yield was calculated using the following formula:

$$\% \text{ yield} = \frac{\text{Practical Mass (flot. microsponges)}}{\text{Theoretical Mass (Polymer + Drug)}} \times 1$$

3.6 Drug content

The prepared floating microsponges of drugs were assayed spectrophotometrically for the drug content at the maximum wavelength with proper dilution of formulations taking suitable solvent as blank. Taking accurately weighted 50 mg of prepared micro sponges and crushed it and mixed in a beaker containing 100 ml 0.1 NHCL and stirred it at 75 rpm for 2 hrs. Filtered it and taken supernatant filtrate and observed at 424 nm using

UV spectroscopy and calculated drug content using following formula [18].

$$\% \text{ Drug Content} = \frac{\text{Practical Drug Content}}{\text{Theoretical Drug Content}} \times 100$$

3.7 Buoyancy

The percentage buoyancy was carried out using 0.1 N HCl containing 1% span 20 as a dispersing medium. Micro sponges were spread over the surface of 900 ml of dispersing medium at 37± 0.5ºC. A paddle rotating at 100 rpm agitated the medium for 8 hrs. Each fraction of micro sponges floating on the surface and those settled down were collected at a predetermined time point [19]. The collected samples were weighed after drying. The % buoyancy was determined by following equation.

% Buoyancy = weight of micro sponges floating on the surface/ initial total weight of micro sponges× 100

3.8 Drug loading Efficiency

The drug loaded floating micro sponge (50 mg) was digested with 100 ml of 0.1N HCL at room temperature for 12 h. After filtration and suitable dilution, curcumin present in the solution was determined at 424 nm using a UV visible spectrophotometer [20]. Drug loading in the micro sponge was estimated by using following formula.

% E = Actual drug content/Total amount of drug × 100
Where, %E = % Drug entrapment Efficiency of floting. Microsponges.

3.9 In vitro drug release study

To determine the drug release pattern from developed curcumin loaded floating microsponge, in vitro drug-release research was conducted. An in-vitro drug release investigation was carried out (Molecular wt. 12k-14k Da) [21]. About 10 ml of pH 5 & 7 PBS buffer solution, free drug curcumin suspension and curcumin loaded floating microsponge were added at the stirring speed of 100 rpm at room temperature. About 5 ml of sample was periodically taken and same amount of PBS solution was simultaneously added. At predetermined interval UV VIS spectrometry analysis at the wavelength 424 nm was used to calculate the amount of curcumin emitted [22].

3.10 DSC Analysis

DSC was performed in order to assess the thermotropic properties and thermal behaviour of the drug curcumin and the complex compacts prepared microsponges. About 5 mg of the sample were sealed in the aluminium pans and heated at the rate of 10º C/min, covering a temperature range of 40ºC to 300ºC under nitrogen atmosphere of flow rate 30 ml/min [23].

3.11 TEM Analysis

The shape and morphology of the developed floating microsponge was determined by TEM (Hitachi H-7500 TEM analyzer). The microsponge formulation was coated with 2.5% w/v of phospho-tungstic acid (PTA) solution and placed in a copper disc grid. The grid was then dried in 60 watt LED lamp (Philips, India Ltd) and was finally placed into the disc holder and scanned by using TEM [24].

3.12 Stability Studies

The microsponge equivalent to 50mg of curcumin were filled in hard gelatin capsules size 0. The filled capsules were manually packed in blister and the samples were maintained in a stability chamber under accelerated storage conditions, 40 ± 2ºC and 75 ± 5% relative humidity for three months with humidity and temperature control. The samples were analysed for Physical changes, buoyancy, % drug content and %CDR at 0, 30, 60, and 90 days and results were noted [25].

3.13 Statistical Analysis

All data analyses were performed using SPSS 23.0 software (IBM, USA). Data are presented as the mean ± standard deviations (SD) of at least three independent experiments. Statistical analysis was performed using one-way ANOVA with Tukey's post hoc test. $P < 0.05$ was considered significant: $^*P < 0.05$; $^{**}P < 0.01$ [26].

4. Result & Discussion

4.1 Melting point analysis

The melting point describes the purity of compound and recommended as the primary method for the investigation of impurities in compounds. The melting point of standard curcumin in literature is 183-185ºC after estimation by capillary method, it was found to be 180ºC **(Table 1)**which indicates purity of drug sample curcumin.

4.2 UV spectroscopy analysis

The UV spectroscopy analysis was carried out to investigate the qualitative evaluation of and identification of any compound, drug or substances. The methods allows the measurement of sharp efficiency and validation to carry out the experimental procedure in the laboratories. The

λ_{max} of curcumin was determined in 0.1N HCL which was scanned between 200-400 nm in the UV spectrophotometer. It was found to be 420 nm which is sharply close fitted to the standard UV scan of curcumin in practical platform **(Table 1 & Figure 1)**.

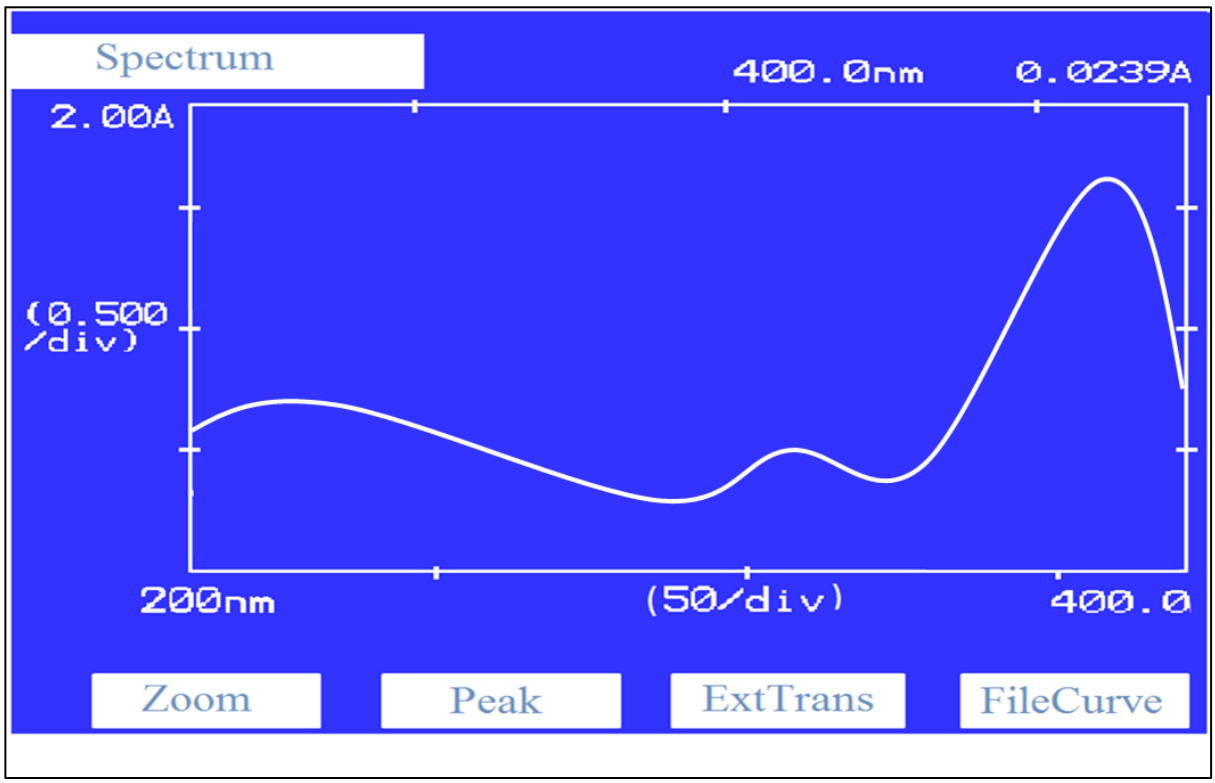

Figure 1: Diagrammatic elaboration of $\lambda_{max}$by UV spectrophotometric analysis at 420nm Mean ± SD (n= 3).

4.3 Particle size Analysis

The particle size of the micro sponges ranged between from 104.3 µm to 190.4 µm **(Table 1 & Figure 2)**. when both ethyl cellulose and PVA were at high levels the formulation exhibited maximum particle size of 190 µm and when both ethyl cellulose and PVA were at low levels the formulation exhibited minimum particle size of above 100 µm. Considering the design, for a given level of PVA, as the level of ethyl cellulose to be incorporated increased, particle size increased. The particle size increase is attributable to viscous organic phase produced at higher strengths of ethyl cellulose that formed larger sized emulsion droplets and consequently larger micro sponges. As the level of PVA increased, the emulsion droplets could not be easily divided into smaller droplets particles that resulted in larger micro sponges. Overall the average particle size of optimized floating microsponge was found to be 175.23 ± 3.657 which is found significant for clinical delivery against peptic ulcer conditions.

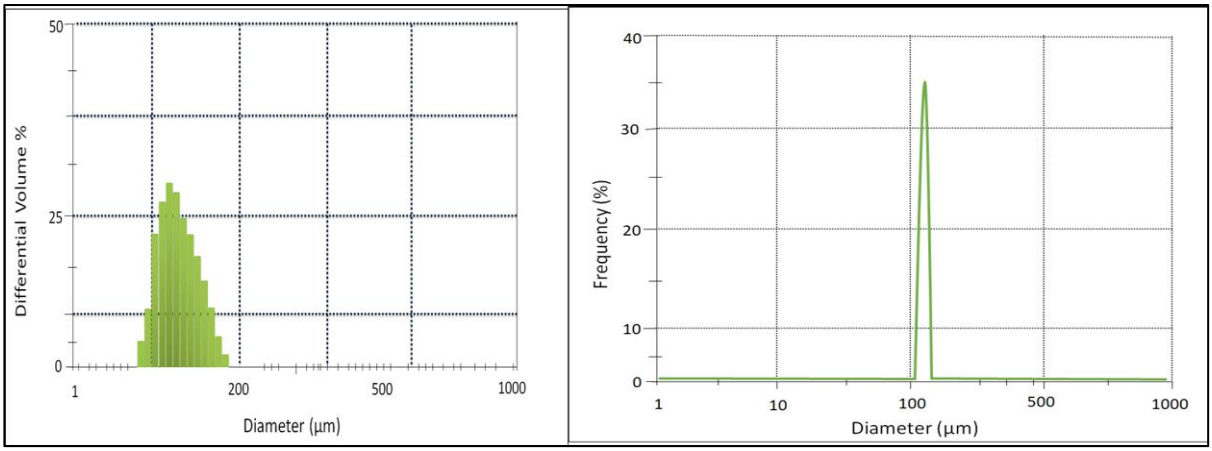

Figure 2: Demonstration of zeta sizer evaluation of particle size analysis and distribution pattern of developed floating microsponge at micrometre scale bar. Mean ± SD (n= 3).

Table 1: Elaboration of Melting point analysis, UV spectrometric analysis & particle size analysis parameters of developed floating microsponge, Mean ± SD (n= 3).

S. No.	Study parameter	Inference
1	**Melting Point**	183-185ºC
2	**UV spectrometric analysis**	420 nm
3	**Particle size analysis**	175.23 ± 3.657 µm

4.4Solubility Analysis

The solubility criteria of drug are important to check whether it is soluble or not. The solubility measurement of any compounds decides the nature of substances whether it is hydrophilic or lipophilic in nature. This investigation plays important part in the designing and development of any micro-carrier system or nanocarrier system which directky influenced the stability of drug delivery system and therapeutic efficiency. For the efficient solubility analysis different solvent system such as acetic acid, Ethanol, 0.1N HCL and methanol 10 ml were taken each in separate beaker and add 100mg of drug in each beaker and check the solubility by stirring it the results where It was freely soluble in acetic acid, soluble in methanol, sparingly soluble in ethanol and practically insoluble in water**(Table 2)**.

Table 2: Elaboration of solubility profile of developed floating microsponge, in different solvent system, Mean ± SD (n= 3).

S. No.	Solubility analysis (solvents)	Inference
1	Acetic acid	Freely soluble
2	Ethanol	Sparingly soluble
3	0.1N HCL	Insoluble
4	methanol	Soluble

4.5 Percentage yield

The microsponge formulation was highest yielding product (80%) containing high level of ethyl cellulose and low level of PVA and low yielding product containing low level of ethyl cellulose and high level of PVA(60%)**(Table 3)**. The average percentage yield of optimized batch of floating microspheres was found to be 79.65 ± 2.956% which was found significant and elaborated stable and physiochemical dispersed microsponge formation devoid of any leakage and unwanted drug outflow. Furthermore, for a given same level of PVA, on increasing the level of ethyl cellulose the product yield increased. As described in literatures high level of ethyl cellulose retards the diffusion of organic phase to aqueous phase that delays polymer precipitation and provides more time for droplet formation thus increasing yields. On the other hand less, viscous organic phase (low level of ethyl cellulose) causes rapid mixing and faster removal of solvent that reduces the coalescence time and solidification of drug and polymer before droplet formation decreasing the yield provides more time for droplet formation thus increasing yields. On the other hand less, viscous organic phase (low level of ethyl cellulose) causes rapid mixing and faster removal of solvent that reduces the coalescence time and solidification of drug and polymer before droplet formation decreasing the yield.

4.6 Drug Content Uniformity

The drug content uniformity in the developed microsponge formulation was evaluated on the basis of swelling and de-swelling phenomenon which play vital role in drug entrapment and release. The percentage of drug content for formulated floating micro sponge was found to be 81.23 ± 2.9 to 90.08 ± 4.1 % of curcumin**(Table 3)**. The average drug content uniformity of optimized batch of floating microsponge was found to be 86.50 ± 4.821 % which was found significant and showed ideal holding capacity of drug inside the polymer matrix of microsponge. The highest drug content was found in formulation containing high level of ethyl cellulose. The drug content uniformity was decent and microsponge formulation found physiochemical stable due to varied polymer range and ratio, which influence greatly in the molecular weight and thickness.The floating microsponge showed good swelling ability which results in decent drug content. The microsponge consist varied polymer range of which have the tendency to engulf large amount of water and have propensity to swell. This swelling aid in better entrapment of curcumin in the microsponge which play vital role in efficient therapeutic potential.

4.7 Bulk Density

Bulk density of all floating micro sponges was determined. It ranges from 0.114 g/cc to 0.299 g/cc. The microsponge formulation shows more

bulk density. The density of floating micro sponges was cons increasing ethyl cellulose concentration which play vital role in buoyant character. The optimized floating microsponge formulation showed the average bulk density of 0.217 ± 0.09 g/cc which was found significant and physiochemical stable for floating formulation in vivo for future evaluations. The results were shown in following **table 3.**

4.8 Drug entrapment Efficiency

The Entrapment efficiency of optimized microsponge formulation was found to be 76.19 ± 1.535%. At constant level of PVA and variations in ethyl cellulose level, entrapment efficiency showed bell shaped pattern, it was peaking at mid-level. The developed microsponges made same level of ethyl cellulose and 0.5%, 1.0%, 1.5% PVA exhibited close entrapment efficiencies of 66.36%, 63.10%, 59.27% respectively affirming adsorption as dominant mode of drug incorporation. The results were shown in following **table 3.** The drug entrapment potential was above 60 % in all batches which is decent and stable along with it is suggestively reliant on on drug concentration and time of incubation. Along with the concentration of drug and incubation time, stirring speed, time and sonication period also play vital role in the EE, elevated rate of stirring and amplitude may results in early burst of microsponge results in the leaking of curcumin due to swelling in the high in the aqueous environment.

4.9 Percentage buoyancy of floating microsponges

The in vitro buoyancy test was carried out to investigate buoyancy of prepared optimized floating micro sponges. The developed floating microsponge's formulation showed good floating ability range from 75% to 85%. In vitro buoyancy of microsponges can be correlated to low density (0.3 g/cc) of ethyl cellulose and that of the formulations. The microsponges formed with high level of ethyl cellulose were more buoyant than those with low level of ethyl cellulose. The microsponges made with high level of PVA were less dense than those made with low level of PVA. Overall the optimized floating microsponge formulation showed the average buoyancy of 82.35 ± 2.894 % which is found significant and stable compared to other batches. The results were shown in following **table 3.**

Table 3: Elaboration of Percentage yield, Drug content uniformity, Bulk density, Drug entrapment efficiency and Buoyancy analysis of optimized floating microspheres,Mean ± SD (n= 3).

S. No.	Study parameter	Inference
1	**Percentage yield**	79.65 ± 2.956%
2	**Drug content**	86.50 ± 4.821 %
3	**Bulk Density**	0.217 ± 0.09 g/cc
4	**Drug entrapment**	76.19 ± 1.535%.
5	**Buoyancy**	82.35 ± 2.894 %

4.10 TEM

The Transmission electron microscopy (TEM) showed very different particles exhibiting spherical shape and size range of 100-120micrometer **(Figure 3)**. The microsponge of curcumin were spherical and their surface was smooth and devoid of cracks giving them good appearance. The slight cluster of particles was assessed TEM profile exhibiting the agglutinating characteristics prepared microsponge under influence of polymer and drug system makes amiable to absorb other particles and get agglomerate. The drug crystals were not visible on the surface indicating its molecular dispersion in the polymeric matrix. The results from TEM studies showed that the developed floating microsponge were proved as suitable candidates for the effective antiulcer delivery and reveals better therapeutic potential at desired site.

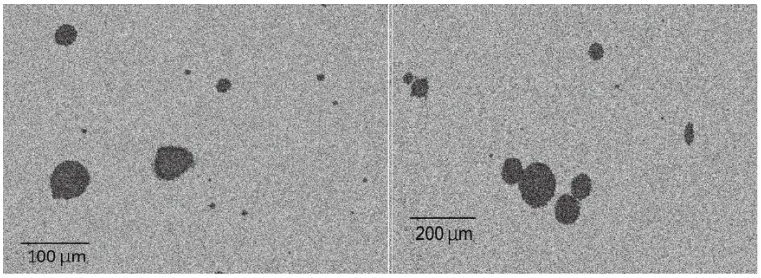

Figure 3: Illustration of TEM analysis of developed floating microsponge at micrometre scale bar. Mean ± SD (n= 3).

4.11 DSC

The results of DSC analysis showed that the melting temperature for pure drug curcumin and Eudragit S100 183.1˚C and 215.28˚C but pure ethyl cellulose doesn't shows any DSC peak establishing its complete amorphous nature. The formation of microsponge and integration with Eudragit S 100, the ethyl cellulose marginal peak at 180.22 ˚C. The integrity of drug was unaffected when developed in to microsponges, this is confirmed by DSC of formulation where the composite melting peaks of pure drug, Eudragit S 100 and ethyl cellulose were found to be at 1886˚C, 220˚C and 190.21ºC respectively indicating stable compatibility between drug polymer and processing conditions. Whereas developed floating microsponge showed the sharp peak at 229.17 ˚C showing complete stable formation of formulation avoiding unwanted leakage of drug from polymer matrix**(Figure 4 a)**. Appearance of no new peak and absence of any potential shift suggested compatibility of curcumin with polymers and was confirmed by diffuse reflectance infrared Fourier transform spectroscopy.

4.12 FTIR spectroscopy

FTIR spectroscopy is a powerful technique, which is used for identification of drug substances. After comparing FTIR peaks of curcumin with standard, it is confirmed that the obtained sample is curcumin. All the characteristic peaks of curcumin were present in spectra at within the respective wavelengths**(Table 4 b)**. Thus, indicating compatibility between drug and polymers. It shows that there was no significant change in the chemical integrity of the drug is a powerful technique, which is used for identification of drug substances. After comparing FTIR peaks of curcumin with standard, it is confirmed that the obtained sample is

curcumin**(Figure 4)**. All the characteristic peaks of curcumin were present in spectra at within the respective wavelengths. Thus, indicating compatibility between drug and polymers. It shows that there was no significant change in the chemical integrity of the drug.

Table 4: Illustration of important absorption band of curcumin by FTIR spectrophotometric evaluations, Mean ± SD (n= 3).

S. No.	Absorption (cm^{-1})	Inference
1	2954	C-H stretching
2	1430	C-H stretching
3	1376	C-H stretching
4	1627	enol carbonyl stretching vibration
5	964	plane bending of aromatic C-H bond
6	1155	C-O stretching
7	1605	stretching vibrations of benzene ring
8	1435	olefinic C-H bending vibrations

4.13 In vitro drug release

The in-vitro drug release study of floating microsponge of curcumin shows 90.14% and 19.36% drug release within 24hrs at different pH 4 & 7 respectively**(Figure 4 c)**. From these results it is evident that as the amount of hydrophobic polymer (EC) increases, drug release decreases. The fabricated microsponges with low level of ethyl cellulose formed small size microsponges that can be associated with higher surface area and shorter path length leading to higher release rate. From the results it seen that the drug release mechanism from the formulations was found to be follows Zero order kinetics, in which the rate of drug release is independent of concentration of drug. This further strength the suitability of developed Floating Microsponge of curcumin.

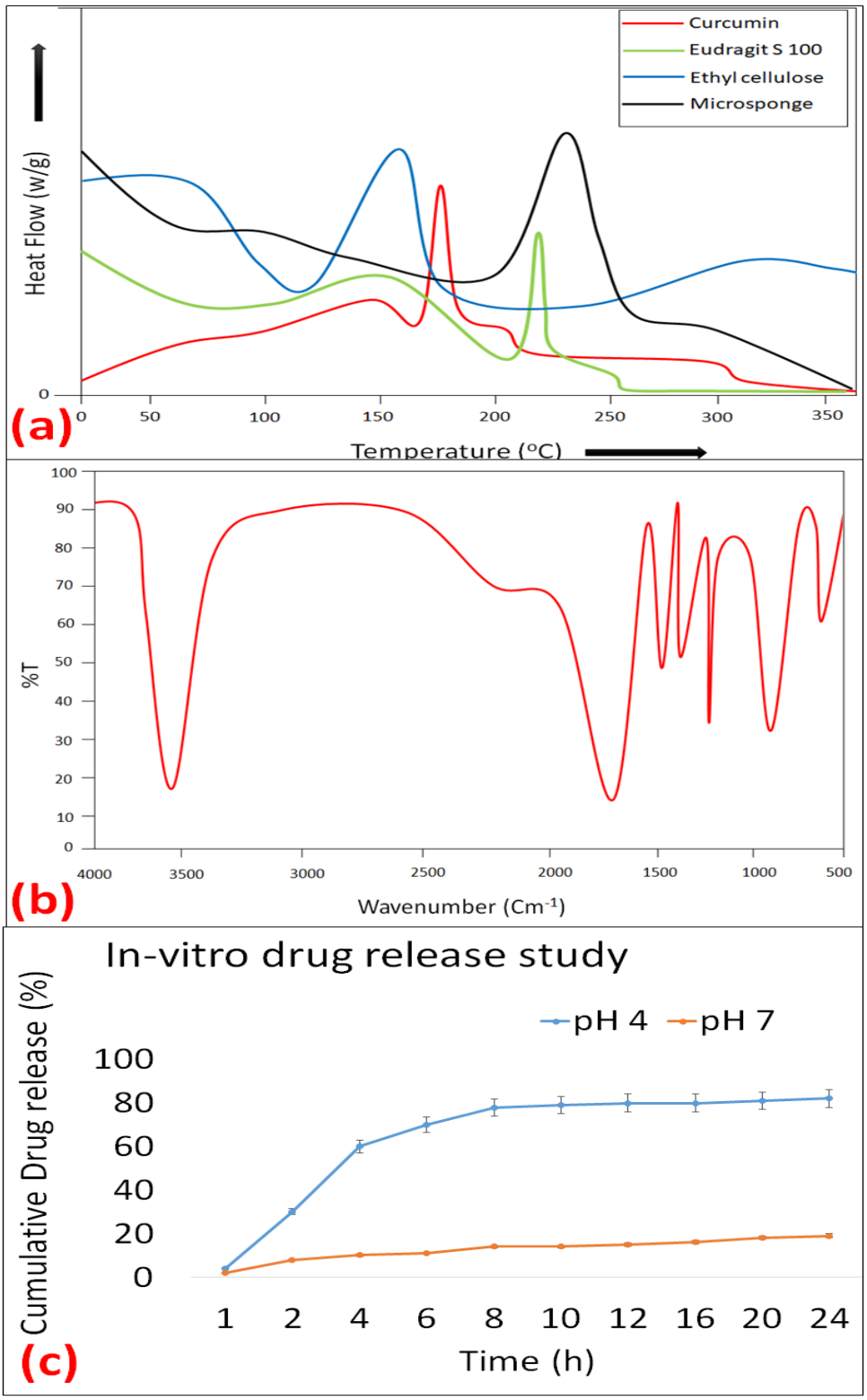

Figure 4: Illustration of (a) DSC analysis of individual components with developed floating microsponge, (b) FTIR analysis of obtained curcumin drug, (c) in-vitro drug release profile of developed floating microsponge at different pH (4 & 7) respectively, Mean ± SD (n= 3).

4.14 Stability Assay

The stability study carried out for 0 to 90 days. On physical observation of the stored samples there was found that no change in colour and shape of microsponges. The drug content and percentage buoyancy did not change significantly ($p > 0.05$) on storage. The stored formulations were also subjected to In vitro drug release study and compared. For comparison of In vitro release profiles. Similarity factor is emphasized by USFDA that was calculated by Pheq bootstrap V1.1software (30–688, Krakow, Poland) with

5000 bootstrap at 90% confidence interval. Similarity factor was found to be more than 60 indicating similarity between release profiles of microsponges at different storage periods. The studies suggest physical and chemical stability of floating microsponges of curcumin for a period of three months under test conditions. Results were shown in **Table 5**

Table 5: Demonstration of stability studies of curcumin loaded floating microsponge in 90 days of time line, Mean ± SD (n= 3).

S. No.	Time (Days)	% Buoyancy	Physical change	%CDR	% Drug Content
1	0	81.34 ± 1.67	--	88,52 ± 3.12	93.45 ± 2.64
2	30	79.14 ± 4.91	No change	83.57 ± 4.62	90.28 ± 4.28
3	60	75.96 ± 3.79	No change	78.19 ± 5.91	87.59 ± 3.76
4	90	70.76 ± 2.47	No change	72.49 ± 1.99	85.60 ± 4.87

Conclusion

The expediency of microsponges as floating gastro retentive system was affirmed by successfully development of curcumin loaded gastro retentive microsponges to provide sustained release of drug at the site of action. The high drug loading capacity of microsponges offered a convenient approach for fabricating in to a conventional capsular system to heal gastric ulcer. For scientific as well as economic reasons, such delivery system have potential advantages which include enhanced therapeutic response, predictable rate of release, extent of absorption and improve patient acceptance. This study presents a new approach based on floating ability of microsponges for gastroretentive applications and treatment of gastric ulcer in clinical platform.

CONFLICT OF INTEREST

The author declares no conflict of interest

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