RESEARCH ARTICLE

Formulation and Evaluation of Floating Tablets Using Natural Polymer

Sahil Kumar, Ritesh Rana*, Priyanka Devi, Puneet Sharma

Himachal Institute of Pharmaceutical Education and Research (HIPER) Nadaun, Himachal Pradesh, India.

Received: 25th March, 2024; Revised: 10th July, 2024; Accepted: 10th August, 2024; Available Online: 31st August, 2024

ABSTRACT

Gastro-retentive effervescent floating tablets containing quetiapine fumarate (QP) are available using different viscosity grades of HPMC (HPMC K4M, HPMC K15M, and HPMC K100M) and TD made by the direct compression technique.The outcomes of the pre-compression parameters indicate that the powder mix of the formulations of both drugs has shown good micromeritic properties. Every tablet formulation that was made had the same amount of drug in it. The low standard deviation results imply that the drugs are distributed uniformly throughout the matrices.Drug compatibility with excipients is demonstrated by DSC and FTIR testing. It was discovered that the floating lag time was influenced by the concentration of citric acid and sodium bicarbonate. All the formulations (QP1 to QP17) floated for more than 24 hours, while the QP formulations remained buoyant for more than 12 hours. Accordingly, the present study's results suggest that the QP floating system has a promising future as a substitute for the corresponding conventional dosage form.

Keywords: Gastroretentive, floating tablets, effervescent, quetiapine fumarate.

International Journal of Pharmaceutical Quality Assurance (2024); DOI: 10.25258/ijpqa.15.3.71

How to cite this article: Kumar S, Rana R, Devi P, Sharma P. Formulation and Evaluation of Floating Tablets Using Natural Polymer. International Journal of Pharmaceutical Quality Assurance. 2024;15(3):1570-1574.

Source of support: Nil.

Conflict of interest: None

INTRODUCTION

Drugs can be continuously injected into the upper gastrointestinal tract with the use of gastroretentive drug delivery systems (GRDDS), which are made to stay for an extended period and release the active ingredients[1–3]. One excellent method of GRDDS to extend stomach residence duration and achieve adequate drug bioavailability is the use of floating drug delivery systems (FDDS) [4–5]. Over an extended period, FDDS float in the stomachdue to their reduced bulk density compared to stomach fluids.While the drug is floating in the stomach, it is progressively expelled from the system [6–8] at the appropriate rate.In addition to limiting systemic exposure to the drug, the drug's regulated, gradual distribution in the stomach maintains long-lasting local therapeutic levels[9]. The wide range of pharmaceutical applications for plant-derived polymers has sparked intense interest in recent years [10]. To create a gel layer on the system's surface that regulates the release of drug[11], natural gums and polymers combine with water. Polysaccharides include tragacanth, karaya, acacia, and khaya, among other natural gums. For years, natural gums have been a popular choice for thixotropic colloids, film-forming agents, emulsifiers, and tablet binders in cosmetics and suspensions.Most gums often absorb water, which makes them swell and discharge around the incision. A few gums have been utilized as a binding agent, an emulsifying agent in oil and resin emulsions, and an insoluble powder for suspending [12]. The tamarind seed is the source of tamarind seed polysaccharide (TSP), a naturally occurring polymer. The primary constituent of tamarind seed is a non-ionic, neutral, branching polysaccharide with a backbone resembling cellulose and substituents made of xylose and galactoxylose. TSP's design provides the product with ideal mucoadhesive characteristics by giving it a "mucin-like" molecular structure[13].

One psychiatric drug used to treat bipolar disorder, schizophrenia, manic episodes, or depression related to bipolar illness is quetiapine fumarate or QP. Due to QP's mean elimination half-life of six hours, administration of the drug must occur twice or three times each day[14]. The solubility of quetiapine fumarate varies with pH. In acidic pH, quetiapine fumarate is extremely soluble, whereas, in basic pH, it is just marginally soluble. To have the most absorption and bioavailability, the drug should be kept in the stomach for an extended amount of time. Therefore, a gastroretentive floating tablet is a preferable method to extend the dose form's residence time in the stomach [15].

MATERIALS AND METHODS

Materials

A gift sample of dried dateskernel powder (TKP) was received from Chhaya Industries in Maharashtra, India. We received a complimentary sample of quetiapine fumarate from Lupin

*Author for Correspondence: riteshpharma1719@gmail.com

Limited in Pune. Danmed Pharmaceuticals, Hyd. was the supplier of Hydroxy Propyl Methyl Cellulose (HPMC) 15 M, 100 M, and K4 M. Anshul Agencies, Mumbai, India, is where the polyvinyl pyrrolidine (PVP-K-30) was acquired. We bought magnesium stearate, microcrystalline cellulose, and dicalcium phosphate from S.D. Fine Chemical Ltd. in Mumbai, India. The supplier of absolute ethanol was Merck Ltd. in India. Every chemical employed was of A.R. grade.

Organoleptic Evaluation of TG

We assessed the gum's color, smell, taste, texture, and fracture during the organoleptic evaluation of TG.

Shape of TG Particles

The Motic microscope was used to observe TG particles at a resolution of 10X.

Identification Tests

The usual protocols were followed to conduct the TG identification tests.

Determination of Solubility

After the TG dispersion of one percent was made, it was mixed for three minutes. After a 15-minute centrifugation, the supernatant was removed from the resulting suspension. 50 ml of the supernatant was moved to a Petri dish and dried at 105 ℃ until its weight remained constant. The solubility percentage in cold water was then determined and noted.

Determination of pH

The pH was measured employing a pH meter after dissolving 1 gram of TG in 100 milliliters of distilled water.

Determination of Swelling

A precisely measured one milligram of powder was used to make measurements of 25 milliliters.We measured the effects of increasing the volume of TG by adjusting the solvent volume of each cylinder and recording our findings. A consistent volume was achieved in each cylinder by taking readings at predefined intervals. The research was conducted three times.

Determination of Viscosity

Distilled water was used to create a 1% TG solution. The viscosity was measured after one hour. The viscosity was measured using a small sample adapter and Spindle No. 21, which was revolved at 100 RPM. The method was carried out three times.

Powder Characteristics of TG

The density of the polymer was measured in both its bulk and tap form.Hausner's proportion and Carr's index were determined by utilizing the bulk and tap densities.

ATR-FTIR Study of TG

The ATR-FTIR spectrophotometer (IR Affinity, Shimadzu, Japan)was used to hold the sample and noted in the range of 600-4000 cm^{-1}.

Thermal Analysis of TG

Our thermogravimetric analyzer (TGA/DSC1, Mettler-Toledo, Switzerland) recorded the TGA and DSC of TG.

Table 1: Ingredients that have been carefully chosen for their intended use

Drug/Excipient	*Function*
Quetiapine Fumarate	Model Drug
Microcrystalline cellulose	Filling agent
Dicalcium phosphate	Filling agent
Magnesium Stearate	Lubricating agent
Talc	Glidant
Bentonite	Adsorbent agent
Tamarind Seed Extract	Binding agent
Starch paste	Binding agent

Table 2: Design of the Experiment (DOE)

Independent Variables			
MCC (X1)	100	150	200
TG (X2)	30	60	90
Sodium bicarbonate (X3)	30	45	60
Dependent variables			
Swelling index (%)	Maximize		
In vitro buoyancy (min)	Maximize		
drug release (%)	Maximize		

X-ray Powder Diffraction

The scanning speed of the X-ray diffractometer was 2°C/min, the scanning angle varied from 0 to 90° (2θ), the voltage was 30 kV, and the target was copper. The X-ray diffractometer (PW1729, Philips, The Netherlands) was used to record the XRD pattern of the sample.

Formulation Design (Table 1 and 2)

Fourier transform infrared spectroscopy (FTIR)

An IR spectrophotometer was used to collect the samples' IR spectra using the KBr disc sample preparation technique, also known as the pressed pellet technique. In a glass mortar, around 100 mg of potassium bromide (spectroscopic grade) and about 1 milligramme of test material were thoroughly mixed. In an environment devoid of moisture, the mixture was compacted into transparent discs, and IR spectra were produced. Between 4000 and 400 cm^{-1} was chosen as the scanning range. Official compendia report and the obtained spectra were compared.

Differential scanning calorimetry (DSC)

Using a DSC refrigeration system (Model Q1000, TA Instruments, UK), thermograms of pure pharmaceuticals and all produced formulations were acquired. Samples (0.8-6.3 mg) were weighed, placed in hermetically sealed aluminum pans for analysis, and heated while argon was continuously purge-filled. Before running the samples, the device was calibrated using indium and sapphire. Samples' thermal behavior was examined between 0˚C and 300˚C at a scanning frequency of 10˚C/min.

General appearance

The general look, size, shape, color, odor, surface texture, physical faultsof each tablet from the various formulations were inspected.

Thickness

A Vernier caliper was used to measure the tablet thickness from each batch.

Hardness test

A device called the "Monsanto Hardness Tester" is used to gauge the hardness of tablets.

Friability test

The tablets were tested using a Roche friabilator, which uses a plastic chamber that rotates at 25 rpm to submit the tablets to the combined effects of shock and abrasion. With each rotation, the tablets are dropped from a height of six inches. After the weighted sample of complete tablets was powdered, it was put in the friability and spun for 100 revolutions. The tablets were weighed and re-dusted after being rotated.

Weight variation test

Each tablet's weight was recorded to verify that it contained the appropriate dosage of the drug. A random selection of twewnty tablets was made from each batch, and the average weight was determined.

Uniformity of drug content

A powder was ground and dissolved in 100 milliliters of pH 1.2 simulated gastric fluid (SGF), with an average weight of about twenty randomly selected tablets. The solution was diluted appropriately and its absorbance was measured spectrophotometrically for each QP separately at 207 and 258 nm after it had been filtered using Whatman filter paper No. 41.

Determination of swelling index

At room temperature, the swelling index was calculated using simulated stomach fluid with a pH of 1.2. Over a day, the tablet's enlarged weight was calculated.

In vitro buoyancy studies

A beaker filled with 100 ml of SGF pH 1.2 was used as the testing medium for this experiment, which was kept at 37 °C. The beaker was filled with randomly selected tablets from each formulation [35]. Assessments are made of the total floating time (TFT) and the floating lag time (FLT).

In-vitro dissolution studies

USP Dissolution Testing Apparatus II (Paddle type) was used to measure the rate of QP release from floating tablets. Nine hundred milliliters of simulated stomach fluid at 37 ± 0.5 ºC and 50 rpm, with a pH of 1.2, were used for the dissolving test. An aliquot of the material was removed from the dissolving apparatus every hour at prearranged intervals for ten hours, and a fresh dissolution media was added. The Whatman filter was used to filter the samples (Paper No. 41). At 234 nm, the absorbance of these solutions was measured.

RESULTS AND DISCUSSION

Extraction of TG

The process of collecting gum from tamarind seeds was tedious and time-consuming, and the yield was also very low (less than 20%). This might be due to the wastage of gum during the extraction process. TKP is available in the market and contains fats, proteins, and carbohydrates. Fats present in TKP were removed with petroleum ether and were further used for the extraction of TG. By precipitating the proteins from the TG, TKP added to a boiling citric acid aqueous solution aid in protein separation. Alcohol precipitation was used to isolate the TG that was in the supernatant solution. The yield of TG was found to be more than 50% (58.46 ± 3.75) when TKP was used for the extraction. The obtained TG was screened through sieve number 80 and stored in a desiccator.

The ATR-FTIR Study Examined TG

The polysaccharide's –OH groups were stretched, as seen by the large peak in the TG ATR-FTIR spectra located at 3500-300 cm-1. The C-O stretching of the alcoholic group is accountable for a peak at 1039 cm-1 and 1143 cm-1. Within an asymmetric stretch of CH, the medium peak t 2920 cm-1 was found. Carbonyl stretching produced the peaks at 1747 cm-1 and 1689 cm-1 (Figure 1). The spectrum peak points of the formulations were similar to those of the pure QP, indicating that there is no drug-polymer interaction(Figure 1 and 2).

X-ray Powder Diffraction

The XRD of TG is shown in Figure 3. TG did not exhibit any peaks, which indicates that the structure is completely amorphous.

Differential Scanning Calorimetry (DSC)

The thermogram displayed a sharp exothermic peak at 173.64°C for quetiapine fumarate. At the same time

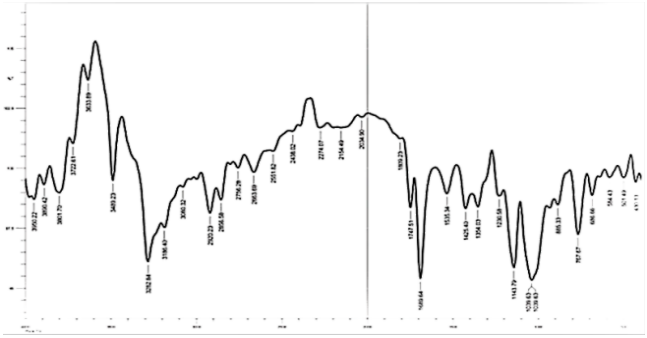

Figure 1: ATR-FTIR spectrum of TG

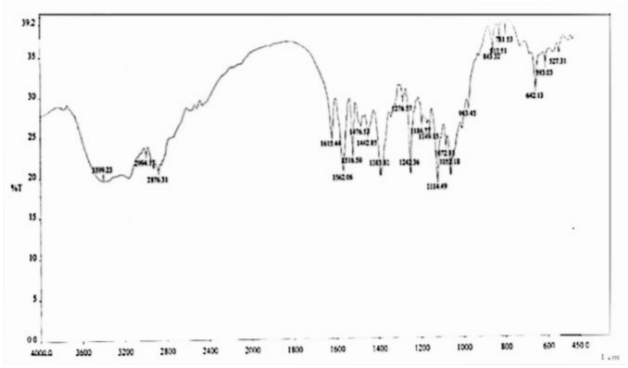

Figure 2: Optimized formulation of tablets

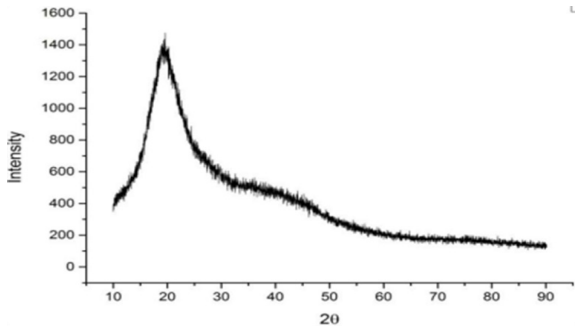

Figure 3: Powdered X-ray diffractogram of TG

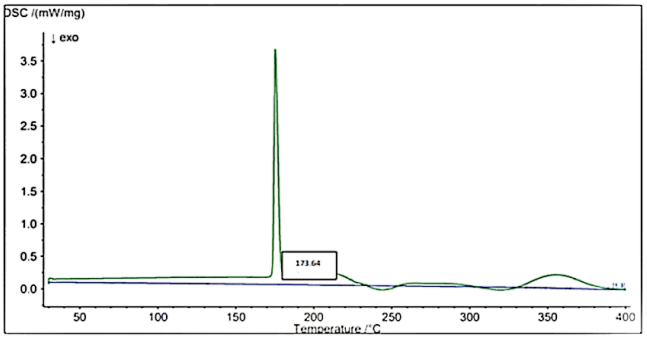

Figure 4: DSC of Quetiapine Fumarate

thermogram for TD the peak was observed at 183.03°C specifying its characteristics. These specified characteristic peaks were absent in the formulation indicating that the drugs were perfectly blended in amorphous form and encapsulated within natural polymer providing a holistic picture of genuine encapsulation (Figure 4)

Evaluation of Pre-Compression Parameters of QP

In response, a tablet powder mixture was pre-formulated. The powder blend demonstrates excellent flow characteristics, as shown by the angle of repose data. The powder appears to have sufficient flow properties, as the bulk densities of all the

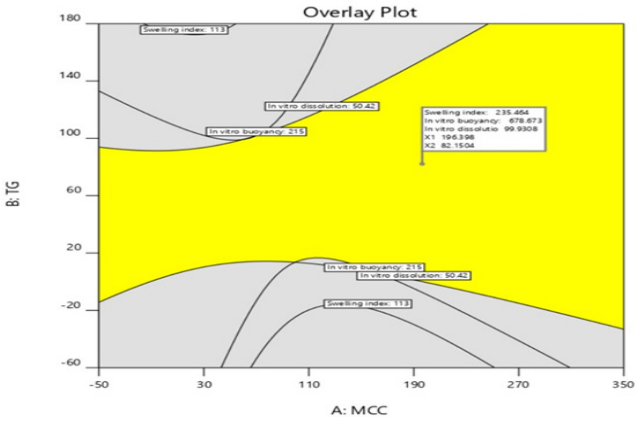

Figure 6: Overlay plot of optimized formulation

formulations varied between 0.52 and 0.72 (g/cm3). The range of tapped densities for all the formulations was 0.65 to 0.89, indicating that the powder exhibited sufficient flow properties. The powder appears to have outstanding flow qualities, as indicated by the compressibility indices that ranged from 10.52 to 21.21 across all formulations. The powder demonstrates excellent flow qualities, as indicated by the Hausner's ratio, which ranges from 1.11 to 1.26. This holds for all formulations.

Response 1: Swelling Index (%)

If a P-value is less than 0.0500, the model terms are considered significant. A, C, AB, BC, and A^2 are important model terms in this case.

Response 2: In vitro buoyancy

If a P-value is less than 0.0500, the model terms are considered significant. A, B, C, AB, AC, BC, A^2, and B^2 are important model terms in this case.

In vitro buoyancy = +314.80 +117.00A +32.88B -80.63C +58.00AB -54.00AC -43.25BC +62.23A2 -19.03B2 -2.02C2

Response 3: In vitro drug release.

Here, the important model terms are A, C, AB, AC, BC, A^2, and B^2.

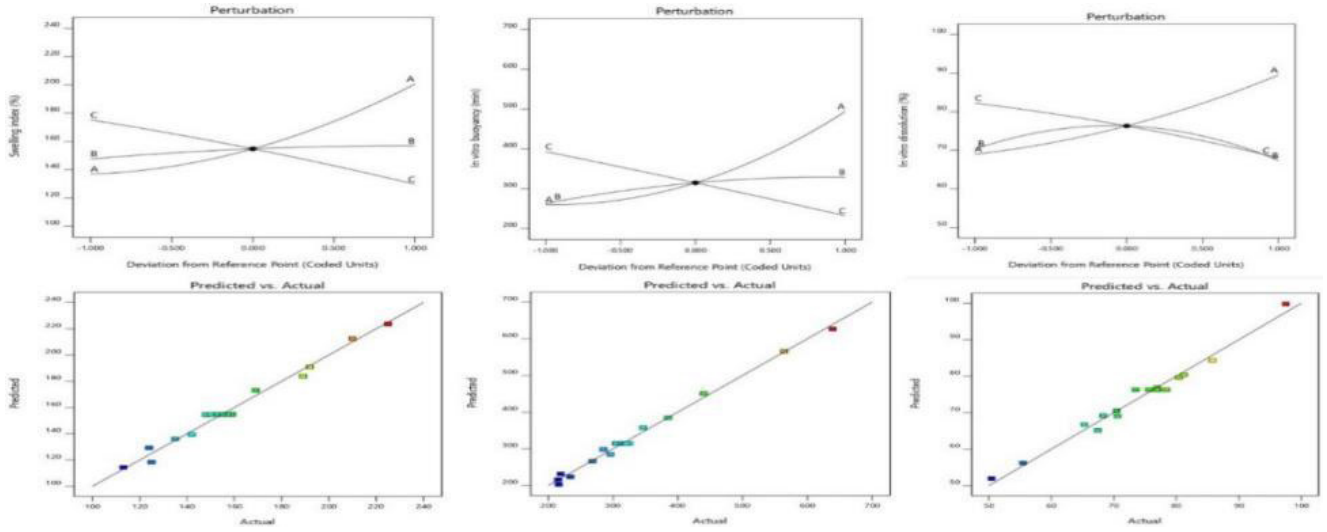

Figure 5: Perturbation plot and actual vs predicted values of dependent variables

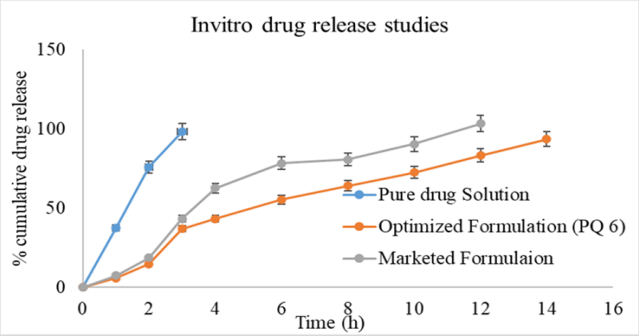

Figure 7: Invitro drug release studies

In Vitro dissolution = +76.31 +10.26A -1.46B -7.08C +3.81AB -4.39AC -7.14BC +2.93 A2 -7.51 B2 -1.16 C2

Assessment of QP Floating Tablets' Post-Compression Properties

It was discovered that every formulation had a cream color, and was flat, round, and odorless.

Floating lag time & Total floating time

As the percentage of sodium bicarbonate rises, the floating lag time in the QP example decreases, indicating that the amount of gas-generating effervescent base has a substantial impact on the system buoyancy lag time.

Swelling index

With a rise in the polymer's concentration, the swelling index rose. TD, and in the case of formulations containing QP; change in sodium bicarbonate concentration had very little effect on the swelling of the tablet.

In-vitro buoyancy studies

All formulations demonstrated good in vitro buoyancy with no floating lag time (zero). The tablets met the requirements for stomach retention by staying buoyant for more than 12 hours.

In-vitro Drug Release

The amount of drug released from formulations of pure drug solution and optimized tablet and marketed formulation in 0.1N HCl after 2hrs were 89.35%, 15.36%, and 24.59% respectively. Optimized sustained-release tablets released 38.94% of the drug in 12 hours, and marketed formulations released 62.59% of the drug in 12 hours respectively (Figure 7). The outcomes showed that as more TG was added to each formulation, the drug release from those formulations decreased. Given that formulation AF4 released 92.35% of the drug after 24 hours, it was deemed to be an optimal formulation based on the drug release profile.

CONCLUSION

Gastroretentive effervescent floating PQ tablets were made by using the direct compression technique. The pre-compression parameter data indicate that the powder mixture of the two drug formulations exhibited good micromeritic qualities. The drug is compatible with the excipients, according to DSC and FTIR testing. It was discovered that the ratio of the drug to the polymer affected the drug release from the formulations. As an alternative to the conforming conventional dosage form, the QP floating system shows great promise, according to the study's findings.

REFERENCES

1. Bharath W Tekade, Vinod M Thakare, Umesh T Jadhaom Sandeep B Khatale, Formulation and evaluation of Metoprololtartrate non-effervescent gastric floating tablets. Hygeia J D Med., 2014; 6, 1, 63-73.
2. Anamika Saxena, Kaplesh Gaur, Virender Singh, Rajneesh Kanth singh and Ashok Dashora. The authors discussed floating microspheres as a drug delivery system. The study was published in AJPPS, 2014; 1, 2, 27-36.
3. Sunil Kumar, M Das, K S Gupta, R Kumar, A Chongdar, L K Ghosh. They designed, developed, optimized and evaluated gastroretentive floating tablets of Atenolol. Der Pharmacia Lettre., 2013; 5, 3, 436-456.
4. Chabria Neetu B, N Narayana, Hygeia. Formulation & in vitro evaluation of oral floating Nicardipine HCl tablets. J.D.Med., 2013; 5, 2, 63-75.
5. DS Goswami, M. Seth. They formulated and evaluated Pioglitazone Floating tablets. The study was published in International journal of research in Pharmaceutical and Biomedical sciences, 2013; 4, 2, 628-632.
6. Prasad K Lende, M S Junajete, Arundhati D Deshmukh. Formulation optimization & in vitro evaluation of floating tablets of Stavudine. Am. J. Pharmatech Res., 2012; 2, 5, 723-739.
7. Basvaraj K Nanjwade, Sagar A, Veerendra K Nanjwade, Kishore R Gaikwad, Sachin A, Thakre and FV Manvi. They developed and evaluated gastroretentive floating tablets of Glipizide based on Effervescent Technology. J. Drug MetabToxicol., 2012; 3, 3, 1-5.
8. Hemanth Salvi, Vivek Jain, Niraj Upamanyu, Subhendu S Mishra, NardeepRaghuvanshi. Formulation and evaluation of effervescent floating tablet of Levofloxacin, Der Pharmacia Lettre, 2011; 3, 6, 272-279.
9. Upender Rao Golla, Bharath Kumar N, RasanagayaT, Praveen Kumar G, Sandeep Kumar V. Formulation and in vitro evaluation of gastroretentive drug delivery system of Ciprofloxacin HCl. The study was published in Der Pharmacia Sinica, 2011; 2, 4, 33-39.
10. Suresh Bandari, Chandra MhanEaga, Ashok Thadishetty and Madhusudan Rao Yamsani: Formulation and evaluation of multiple unit tablets as a biphasic gastroretentive floating drug delivery system for Fenoverine. Acta Pharm. 60 (2010) 89–97.
11. Ramesh Bomma, Rongala Appala Swamy Naidu, Madhusudan Rao Yamsani and Kishan Veerabrahma. Development and evaluated gastroretentive Norfloxacin floating tablets. Acta Pharm., 2009; 59, 211–221.