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# FABRICATION, CHARACTERIZATION AND OPTIMIZATION OF GASTRO RETENTIVE FLOATING TABLETS OF MOXIFLOXACIN USING NATURAL AND SEMISYNTHETIC POLYMERS

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## ABSTRACT

Gastro retentive drug delivery systems remain in the stomach for a longer period and control release of drug from dosage form. The rationale of present research work is to design, formulate and evaluate gastro retentive formulation for moxifloxacin using various excipients which release the drug in a sustained manner for 12 hrs. Moxifloxacin is a novel synthetic fluoroquinolone, an antibacterial drug. Gastro retentive floating tablets of moxifloxacin were fabricated using variable amounts of hydrophilic and hydrophobic retardants in different combinations for the preparation of tablets. Retardants like HPMC K100M along with effervescent blends were combined to produce tablets by wet granulation procedure.

In the present study 9 formulations were designed, prepared and are assessed for various pharmacopoeial properties like weight uniformity, hardness, friability, floating lag time, gastro retentive floating time, assay, swelling time and In-vitro drug release. Drug release reports of preparations were subjected to pharmacokinetic kinetic statistic modeling. Various Parameters were determined. The outcome of evaluation of all formulations reveals that gastro retentive floating lag time increase with an increase in concentration of polymer combination. According to SUPAC guidelines, formulation trail (F-7) containing 60mg of HPMC K100M and 80mg of tragacanth gum was found to be best-optimized formulation. Formulation F-7 drug release was found to adopt first-order kinetics, Non-Fickian diffusion anomalous transport (n=0.75). The optimized formulation (F-7) exhibited adequate extended drug release and endured buoyant on the surface of the medium for greater than 12 hours.

**KEYWORDS**: Moxifloxacin, Gastro Retentive Drug Delivery System (GRDDS), Floating Tablet, hydroxypropyl methylcellulose K100M, diffusion mechanism.

## 1. INTRODUCTION

In the modern era, excipients full fill multi-functional roles such as changing drug release profiles, enhancement of physical properties and bioavailability of the active pharmaceutical ingredient, improvement of patient acceptability and guarantee the ease of production. Moxifloxacin belongs to fluoroquinolone class of antibiotics that acts against bacteria in the body. It is employed in treatment of different various bacterial infections of the lungs, skin, sinuses and stomach.[1] Fluoroquinolone antibiotics can cause few side effects. Moxifloxacin, a synthetic broad-spectrum antibacterial agent, belongs to the class of fourth-generation fluoroquinolone has a narrow absorption window and absorbed primarily in the proximal portions of the gut, an ideal candidate for a gastro retentive drug-delivery system that will prolong the gastric transit time of formulation, resulting in enhanced bioavailability. Moxifloxacin is also used to avoid and treat plague. In management of acute bacterial sinusitis in adults, moxifloxacin was equal to amoxicillin/clavulanate in terms of treating bacterial infections. It is approved for healing infections caused by susceptible bacteria like Staphylococcus aureus, Streptococcus pneumonia,

Haemophilus influenza, Enterobacter species and Mycobacterium species. Bacterial conjunctivitis (pink eye) can be well treated with moxifloxacin ophthalmic solution.[3]

Moxifloxacin is given in 2 Dosage Forms, injectable solution (400mg/250mL) and as Tablet (400mg). It inhibits DNA gyrase enzyme and helps in inhibition of bacterial DNA replication and transcription. Several Polymers have been successfully investigated and employed in the formulation of antibacterial preparations. GRDDS significantly improve therapeutic efficacy of drugs that act locally in stomach,[4] drugs that have narrow absorption window in stomach or drugs that are unstable in the intestinal or colonic environment. Hydration and swelling ability of polymers are the key performers in gastro retentive drug delivery system

From the literature, very less work reported for combination of HPMC K100M and tragacanth gum although the benefits observed are more from an economy point of view. The risk incidence is also low with use of natural polymers.

**Gastro Retentive Floating Drug Delivery Systems (GRDDS)**

GRDDS are systems which stay in the stomach for an absolute time and control release of drug from the dosage form. Basically floating DDS swells after intake and float over the contents of stomach for several hours, where they release the built-in drug at a specified rate to chosen absorption sites.[5]

GRDDS releases the drugs mainly in upper part of GIT and these are unstable in the pH of distal intestine.[6] They can also be used beneficially in the local therapy of the stomach. Extended gastric retention of the drugs may present several advantages including enhanced bioavailability, therapeutic effectiveness and possible decrease of dosage size.[7]

**Prerequisite for gastro retention:**[8]

- Drugs that are absorbed from the proximal part of the GIT with low solubility profile or that degrade at the alkaline pH conditions.
- Local or sustained drug delivery to the stomach and proximal small intestine.
- In treatment of gastric ulcers caused by H.Pylori infections.

**Gastro retentive floating tablets**

Floating dosage form is helpful for drugs that exhibit action locally in the proximal gastrointestinal tract. These systems are also useful for drugs that are inadequately soluble or unstable in intestinal fluids. The gastro retentive floating properties of these systems assist to hold the drug in the stomach for an extended period. Depending on the mechanism of buoyancy, two assorted procedures have been used in preparation of floating drug delivery systems. These include effervescent method and non- effervescent method. Formulations having a bulk density lower than gastric fluids, float over contents of stomach and increase the gastric emptying rate for a delayed period (fig.1). These are prepared by intimately mixing the gas generating agents and medicament within the matrix tablet. The drug is released gradually at a preferred rate from the gastro retentive floating device and the left over system is emptied from the stomach after the complete release of the drug. This helps to enhance mean gastric residence time (GRT) and controls fluctuations in drug concentration.

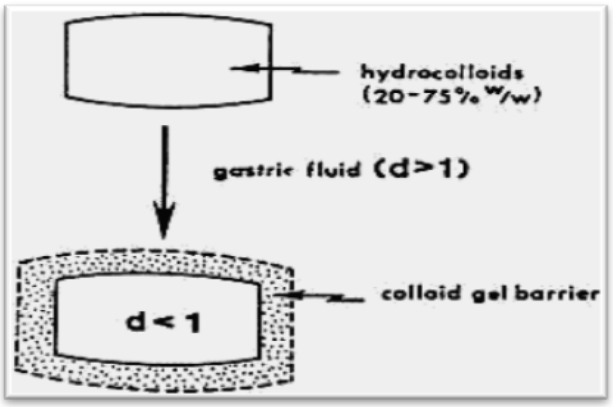


**Figure 1: Intra Gastric Single Layer Gastro Retentive Floating Tablet.**

**Formulation considerations for GRDDS**[9]

GRDDS must be effective for retention in the stomach, convenient for intake, superior drug loading capability, control the drug release, should degrade and evacuate the system once the drug release is completed and should not have an effect on gastric motility including emptying pattern.

**Drugs suitable to prepare gastro retentive devices**[10]

Drugs that act locally in the stomach principally absorbed in the stomach, poorly soluble at an alkaline PH, drugs with a narrow therapeutic window, drugs absorbed rapidly from the GI tract and degrade in the colon are suitable candidates for GRDDS.[11] Drugs that are unbefitting for gastro retentive drug delivery systems have very restricted acid solubility, instability in the gastric area.

**Various Factors affecting gastric retention**[12]

Several factors that influence the bioavailability of dosage form and efficacy of the gastro retentive system are density of DDS, size of dosage form units, fed or unfed state, nature of the meal, colonic content, frequency of feed, gender, age, posture, concomitant drug administration and biological factors.

**2. AIM OF PRESENT STUDY**

Moxifloxacin is L-isomer of ofloxacin with half life of 6hrs and the absorption of moxifloxacin is dose dependant. The main objectives of this investigation were to formulate and evaluate moxifloxacin gastro

retentive floating tablets. In the current study compatibility studies of moxifloxacin with polymers was carried out using IR spectral analysis. The influence of polymers on drug release rate was studied to choose the best drug release retarding polymer.[13]

Comparative releases studies between various formulations were carried out to evaluate the best formulation with better release mechanisms and kinetics. Initially, the compatibility studies of drugs with polymers were studied with help of by IR spectroscopy. Moxifloxacin gastro retentive floating tablets were formulated; mechanism and release kinetics[14] of drugs were checked to select the best formulation with the desired drug release rate.

## 3. EXPERIMENTAL WORK

Moxifloxacin was obtained from Hetero labs, Hyderabad. HPMC was gift samples obtained from Aurobindo pharma Ltd. Lactose, Mannitol, Magnesium stearate, and polyox was acquired from Qualigens fine chemicals, Mumbai. Aerosil and $NaHCO_3$ were purchased from SD fine chemicals, Mumbai. Natural polymers like tragacanth gum were procured from Yucca enterprises, Mumbai. De-ionized water was used for the whole study. In the present study, mannitol and lactose were used as diluents. Synthetic and natural polymers such as HPMC and tragacanth gum were chosen as release rate modifiers. Sodium bicarbonate was employed as $Co_2$ gas generating agent for floating of device on surface of gastric components. Magnesium stearate and aerosil were used as lubricant and glidant respectively.

### Infrared Spectral analysis

IR spectroscopic analysis was used to study determine the various chemical functional groups present in the sample and the interactions between the drug, polymer and other excipients as different functional groups absorb characteristic frequencies of IR radiation.

### Calibration curve

The calibration curve of drug was plotted after dilution of drug with 0.1N Hcl and checking the absorbance. For plotting of standard curve, accurately weighed quantity of drug was mixed with 0.1N Hcl, aliquots were prepared and the absorbance was analyzed using spectrophotometer at 288nm. From the obtained results it was found that there exists a good correlation between concentration and absorbance values.

### Process optimization

To study the influence of process variables such as concentration of release retardant polymers and drug release, floating tablets were prepared by employing effervescent technology. Release retardant polymers were used in different concentrations for process optimization. Moxifloxacin gastro retentive floating tablets were prepared using polymers (Moxifloxacin +HPMC K100M+Natural polymer) in different ratios.[15]

The floating tablets were formulated by employing a wet granulation method using polyox with isopropyl alcohol as granulating fluid.[17] All the formulations contain 400 mg of Moxifloxacin. The details of composition of each formulation are given in Table 1. For each tablet formulation, all ingredients except aerosil and magnesium stearate were sieved through sieve no. 40 and blended carefully before kneading with a solution of polyox in IPA. Damp mass was granulated by passing through sieve no.10 and dried at 60°C for 4 hours. Dried granules were sieved through sieve no.20, mixed and lubricated with talcum and magnesium stearate. The lubricated granules were tested for pre-compression parameters.[16] Granules were then compressed with 15 mm flat surface punch utilizing rotary tablet compression Machine (Cadmach, Ahemadabad) with the hardness of 8 kg/cm$^2$. Formulated tablets were evaluated for post-compression parameters. Compressed tablets were processed for quality control tests as prescribed in pharmacopoeia. Final formulations were transferred to airtight and photo resistant bottle.

**Table 1: Composition of various formulations of moxifloxacin gastro retentive floating tablets prepared with different concentrations of semi synthetic and natural polymers.**

| Ingredients | F1 (mg) | F2 (mg) | F3 (mg) | F4 (mg) | F5 (mg) | F6 (mg) | F7 (mg) | F8 (mg) | F9 (mg) |
|---|---|---|---|---|---|---|---|---|---|
| Moxifloxacin | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 400 | 400 |
| Mannitol | 40 | 50 | 60 | 50 | 60 | 70 | 60 | 70 | 80 |
| HPMC K 100 M | 80 | 80 | 80 | 70 | 70 | 70 | 60 | 60 | 60 |
| Tragacanth Gum | 80 | 70 | 60 | 80 | 70 | 60 | 80 | 70 | 60 |
| POLYOX | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| Lactose | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Sodium Bicarbonate | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| Magnesium stearate | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Aerosil | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |

### Evaluation of Gastro Retentive Floating Tablets of Moxifloxacin

To characterize moxifloxacin powder blend Fourier transform infrared (FT-IR) spectroscopy was used to find probable incompatibility with ingredients of tablet. KBr pellet technique was employed for FTIR analysis and spectra were recorded on FT IR Prestige-21 (Shimadzu, Japan) from wavelength of 4000 to 400 cm$^{-1}$. The drug and excipients must be compatible with one another to produce a product stable, efficacious and safe drug delivery system.

### Evaluation of Powder blends

**Bulk Density (Db):** Bulk density was evaluated using Hamco digital bulk density apparatus is the proportion of total weight of granules to the bulk volume of granules. It was evaluated by pouring the granules (passed through standard sieve # 20) into a measuring cylinder and initial mass will be noted. Bulk density was calculated using

the below-given formula. Bulk Density is expressed in g/ml. All the samplings were performed in the triplicate (n = 3).

**Bulk Density (g/ml) = Mass of the powder/Bulk Volume**

**Tapped Density (Dt):** It is the ratio of total mass of the granules to the tapped volume of the granules. Volume was measured by tapping the powder granules for 750 times and the tapped volume will be noted, TD and BD values were used to calculate Carr's index. Tapped density is expressed in g/ml and is calculated by.

**Tapped density (g/ml) = original mass of the powder/Tapped volume**

**Angle of Repose (ɵ):** The friction forces between granules can be measured by the angle of repose (ɵ). It is indicative of the flow properties of the powder. It is defined as maximum angle possible between the surface of the heap of granules and the horizontal plane. The granules were allowed to flow through the funnel arranged to a stand at a specific height (h). The samplings were performed in the triplicate (n = 3). The angle of repose was calculated by measuring the height and radius of the heap of granules formed.

**$Ø = \tan^{-1}(h/r)$**

Where,

| | | |
|---|---|---|
| Ø | = | angle of repose |
| h | = | height (cms); |
| r | = | radius (cms) |

**Carr's index (or) % compressibility index:** It signifies granule flow properties. It is expressed in percentage and is calculated using following formula

**Carr's Index (%) = (Tapped density – Bulk Density) / Tapped Density × 100**

**Evaluation of Moxifloxacin Floating Tablets**[19]

**Weight variation**

20 tablets were randomly selected, weighed together and the average weight was calculated. Each tablet was individually weighed and variation from average weight of all tablets was calculated. The weight variation test was carried out as per the I.P. guidelines. The samplings were performed in the triplicate (n = 3).

**Thickness**

Thickness formulations were determined by using vernier calipers, by placing tablet between two arms it.

**Hardness**

The crushing strength of the tablets was measured by breakdown of tablet using Monsanto Tablet Hardness Tester. Optimal hardness is desirable for finest mechanical stability.

**Friability**

The friability test of the tablets was done with the help of Roche friabilator. In this method, initial weight ($W_0$) of 20 tablets was noted. Tablets were subjected to 100 revolutions in friability apparatus from a fixed height for at 25 RPM for 4 minutes and weighed (W) again. Percentage friability was calculated by using below given formula. The Percentage friability value should not be greater than 1 %.

**Weight loss (%) = [W0- W / W0] x 100**

**Assay**

Assay was done by triturating tablets equivalent to 100mg of drug. Drug powder was weighed and transferred to a beaker. The powder was mixed with 100 ml of 0.1 N Hcl and sonicated. Aliquots were prepared, shaken for 5 minutes filtered through a 0.45 µ Whatman filter paper and the drug absorbance of the resultant solution was measured spectrophotometrically using Shimadzu 1800 at 288 nm using 0.1 N Hcl as blank.

**Swelling Index**[20]

To check swelling index, initial weight(W1) of tablet was measured and the weight of tablet(W2) after placing in USP dissolution apparatus II with 900 ml 0.1N Hcl at different time intervals viz. 1, 2, 3, 4, 5, 6, 7, 8 hrs was measured. Blotting paper was used to remove surplus fluid. Swelling Index was calculated using following formula.

**Swelling Index (%) = [(W2- W1) / (W2)] x 100**

**Buoyancy Lag Time & Total Floating Time**[21]

The in vitro buoyancy was determined by placing tablet that was placed in a 250 ml beaker containing 0.1N Hcl. The time necessary for the tablet to rise to the surface was taken as the buoyancy lag time and total floating time of all tablets was determined by visual examination. Total floating period for all the formulations was found to be more than 12 hrs, which indicates a stable gel layer formation by all polymers.

**In-vitro drug release study**

The invitro dissolution rate profiles for formulation trials were done using USP type-II dissolution test apparatus. The apparatus containing 900 ml of 0.1N Hcl operated under conditions like temperature 37 ± 0.5°C and rotated at a speed of 50 rpm. At programmed time intervals, 5 ml of the samples were collected, diluted and examined for estimation of drug release by measuring the absorbance at 288 nm using a UV-Visible spectrophotometer [22]. The drug dissolution rate of all the formulations was subjected to kinetic modeling such as zero-order, first-order, Higuchi and Korsmeyer–Peppas models to recognize the drug release mechanisms.

**Kinetic modeling of drug release**[23]

To investigate the method of drug release from the tablets the invitro dissolution profile was fitted to zero order, first order, Higuchi and Korsmeyer-Peppas model.

**Zero order equation**

This equation illustrates the systems where the release rate is independent of the concentration of the dissolved species. A graphical representation of concentration of drug vs time would yield a straight line with a slope equal to $K_0$ and the intercept at the origin of the axes. The zero order plots are derived by plotting the cumulative percent drug dissolved Vs time. The dissolution information is fitted into zero order equation.

$$Q = Q_0 - K_0 t$$

Where

Q = quantity of drug released at time

$Q_0$ = quantity of drug release initially

$K_0$ = rate constant

**First order Equation**

The first order equation illustrates the drug release from system, where dissolution rate is dependent upon the concentration of the dissolving species. A graph of log concentration of drug remaining to be released Vs time yields line. First order release equation is as follows

$$\text{In } Q = \text{In } Q_0 - K_1 t$$

Where

Q = quantity of drug dissolved at any time, t

$Q_0$ = quantity of drug dissolved at t=0

$K_1$ = first order rate constant.

**Higuchi Square Root law of diffusion**

The Higuchi square root law equation explains the mechanism release of drug from system where the solid drug is dispersed in insoluble matrix and the rate of drug release is related to the rate of drug diffusion. Higuchi square root law of diffusion is given by equation below:

$$Q = K_H . t^{1/2}$$

Where

Q = Amount of drug dissolved at time, t

$K_H$ = Higuchi rate constant

**Korsmeyer and Peppas Model**

In this model, a plot of log (Mt/M) vs. log time was plotted and slope was noted to explain release pattern. The release rate was calculated using the following equation

$$M_t/M = K_m . t^n$$

Where

Mt/M = Fraction of drug released

$M_t$ = Amount of drug released at time, t

M = Total amount of drug

n = Diffusion exponent

If n is less than 0.49, the drug release follows non Fickian diffusions. If n = 0.89, the drug release follows Zero order. If n is greater than 0.89, the drug release follows super case II transport. If n value is in between 0.49 to 0.89, drug release follows anomalous non Fickian diffusion.

## 4. EXPERIMENTAL RESULTS

Floating tablets of moxifloxacin were formulated using HPMC K100M, tragacanth gum for identifying the best composition of drug release modifiers along with effervescent mixtures. Formulation design is presented in Table 1.

**Table 2: Construction of Calibration Curve for Moxifloxacin in 0.1N Hcl**

| S.NO | Concentration (µg/ml) | Absorbance ( X ± s.d) |
|---|---|---|
| 1. | 0 | 0 |
| 2. | 2 | 0.196±0.015 |
| 3. | 4 | 0.395±0.038 |
| 4. | 6 | 0.590±0.023 |
| 5. | 8 | 0.782±0.045 |
| 6. | 10 | 0.970±0.076 |

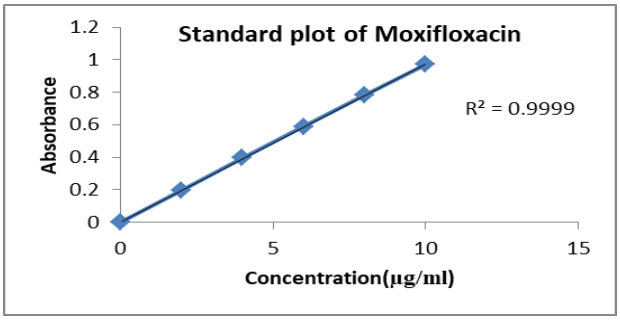


**Fig 2: Standard plot of moxifloxacin.**

Moxifloxacin powder blend was analyzed using Fourier transform infrared (FT-IR) spectroscopy there was no incompatibility between drug and ingredients of tablet.(Fig 3and 4)

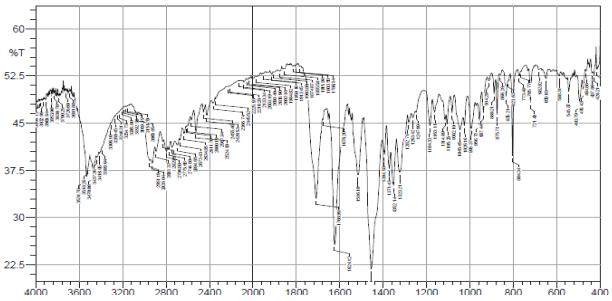


**Figure 3: Moxifloxacin Hcl pure drug.**

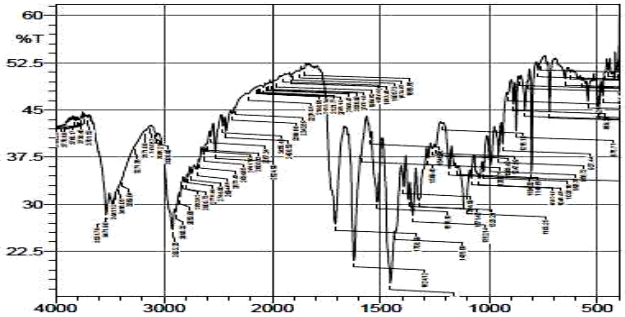


**Figure 4: Physical mixture of Moxifloxacin Hcl with excipients.**

**Table 3: Pre-compression parameters: Angle of repose and compressibility index of moxifloxacin granules.**

| Formulation code | Angle of repose | Compressibility index (%) |
|---|---|---|
| Drug | 35.13±0.92 | 26.21±0.32 |
| F1 | 22.14±0.02 | 12.10±0.024 |
| F2 | 23.44±0.43 | 14.21±0.022 |
| F3 | 21.52±0.76 | 11.89±0.009 |
| F4 | 22.85±0.43 | 11.87±0.017 |
| F5 | 23.01±0.55 | 14.68±0.014 |
| F6 | 24.31±0.87 | 14.32±0.032 |
| F7 | 25.65±0.43 | 11.23±0.023 |
| F8 | 24.53±0.64 | 12.32±0.032 |
| F9 | 24.54±0.96 | 12.43±0.054 |

The evaluated pre-compression parameters like angle of repose and compressibility index of moxifloxacin granules indicate that the granules have good flow properties. (Table-3)

**Table 4: Physical properties of tablets formulated with different polymers.**

| Formulation | Hardness (kg/cm2) | Weight variation (mg) | Thickness (mm) | Friability (%) | Drug content (%) | lag time (min) | Total floating time(hrs) |
|---|---|---|---|---|---|---|---|
| F1 | 5.7±0.32 | 706.32±0.54 | 5.4±0.3 | 0.40±0.010 | 92.55±0.82 | 3.25 | >10 |
| F2 | 5.5±0.42 | 706.65±0.25 | 5.4±0.2 | 0.34±0.018 | 92.96±0.28 | 3.12 | >10 |
| F3 | 6.8±0.03 | 696.83±0.35 | 5.4±0.5 | 0.45±0.024 | 95.66±0.11 | 4.35 | >12 |
| F4 | 4.6±0.63 | 704.12±0.44 | 5.3±0.2 | 0.61±0.036 | 95.29±0.84 | 5.40 | >11 |
| F5 | 5.1±0.54 | 695.76±0.64 | 5.3±0.2 | 0.67±0.048 | 92.29±0.86 | 5.30 | >10 |
| F6 | 6.5±0.02 | 645.45±0.44 | 5.3±0.3 | 0.55±0.43 | 89.29±0.42 | 5.43 | >10 |
| F7 | 8.2±0.04 | 700.35±0.02 | 5.8±0.1 | 0.35±0.32 | 89.29±0.84 | 1.20 | >14 |
| F8 | 7.5±0.04 | 690.43±0.02 | 5.6±0.5 | 0.39±0.55 | 99.92±0.24 | 2.34 | >12 |
| F9 | 7.6±0.32 | 699.43±0.02 | 5.7±0.9 | 0.39±0.35 | 95.29±0.43 | 2.83 | >12 |

**Table 5: Swelling indices of moxifloxacin tablets formulated with different concentrations of polymers.**

| | Swelling Index | | |
|---|---|---|---|
| Formulation code | After 1 hour | After 2 hours | After 8hours |
| F1 | 53.22 | 64.59 | 104.33 |
| F2 | 61.63 | 76.62 | 110.53 |
| F3 | 72.55 | 79.00 | 112.53 |
| F4 | 86.50 | 100.39 | 128.97 |
| F5 | 94.68 | 104.77 | 132.62 |
| F6 | 95.43 | 110.43 | 133.42 |
| F7 | 96.50 | 112.39 | 143.97 |
| F8 | 97.68 | 104.77 | 122.62 |
| F9 | 98.43 | 104.43 | 123.42 |

**Table 6: Invitro drug release data of moxifloxacin gastro retentive floating tablets formulated with different concentrations of polymers.**

| Time | % Moxifloxacin Drug Released (X ± s.d.) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| (hrs) | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 | F9 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 8.68±0.04 | 9.91±0.19 | 13.32±0.41 | 17.32±0.54 | 18.42±0.54 | 21.42±0.54 | 35.32±0.12 | 14.42±0.43 | 19.42±0.32 |
| 2 | 11.33±0.06 | 13.33±0.19 | 15.53±0.64 | 25.32±0.54 | 31.32±0.43 | 35.32±0.21 | 54.33±0.06 | 25.33±0.19 | 25.53±0.64 |
| 4 | 24.42±0.45 | 29.44±0.98 | 35.52±0.41 | 39.32±0.98 | 44.65±0.76 | 45.21±0.23 | 72.32±0.98 | 42.65±0.76 | 49.21±0.23 |
| 8 | 53.25±0.56 | 64.46±0.42 | 65.32±0.32 | 71.91±0.32 | 72.31±0.43 | 64.21±0.22 | 88.91±0.32 | 75.31±0.43 | 79.21±0.22 |
| 12 | 81.42±0.23 | 83.32±0.98 | 84.54±0.53 | 85.54±0.53 | 87.54±0.43 | 89.99±0.44 | 99.21±0.32 | 92.21±0.32 | 90.21±0.32 |

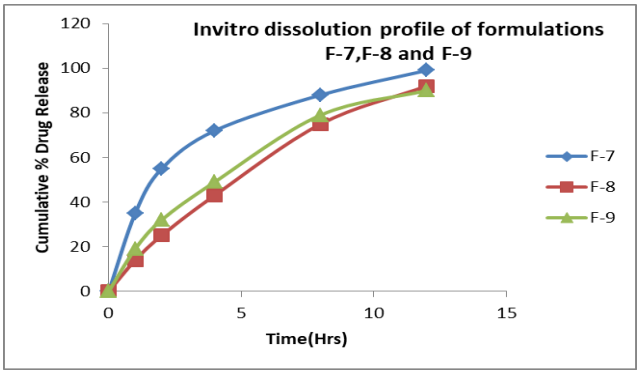


**Fig 5: Dissolution profile of formulations F-7, F-8 and F-9.**

**Mathematical modeling of optimized formula of Moxifloxacin Hcl tablets (F11):**

**Table 7: Release kinetics of optimized formulation (F-7) of Moxifloxacin Hcl floating tablets.**

| Formulation | Correlation Coefficient Value($R^2$) | | | | Exponential Coefficient (n) |
|---|---|---|---|---|---|
| | Zero Order | First Order | Higuchi | Korse-meyer | |
| F-7 | 0.886 | 0.927 | 0.983 | 0.976 | 0.752 |

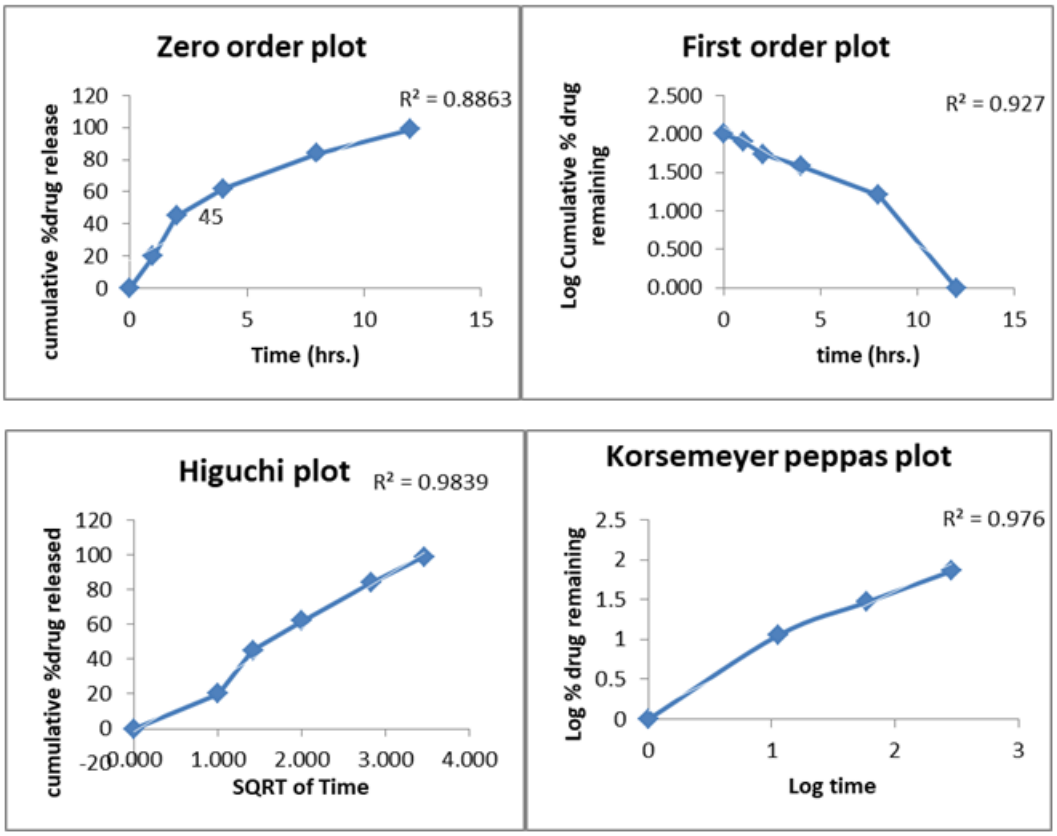


**Fig 5: Plots Representing Release kinetics of formulation (F-7) of Moxifloxacin tablets.**

From above results it is apparent that the regression coefficient value closer to unity in case of first order plot i.e.0.927 indicates that the drug release follows a first order mechanism. This data indicates a lesser amount of linearity when plotted by the zero order equation. Hence it can be concluded that the major mechanism of drug release follows first order kinetics. Further, the mechanism of drug release is known by configuring the data into various mathematical modelings such as Higuchi and Korsmeyer plots. The mass transfer with respect to square root of the time has been plotted, revealed a linear graph with regression value close to one i.e. 0.98, indicating that release from the matrix was through diffusion. Further, n value obtained from the Korsmeyer plots i.e. n=0.75 suggests that drug release was anomalous non-Fickian diffusion.[24]

**Stability studies**

Optimized formulation (F-7) was selected for stability studies based on cumulative % drug release. Stability

studies were conducted for invitro % drug release and floating lag time for 4 months and retained the same properties.[25] From these results, it was concluded that optimized formulation is stable and retained their original properties. The results are depicted in Table 8.

**Table 8: Stability studies of optimized formulation(F-7).**

| Retest time for optimized formulation (F-7) (Days) | In-vitro (%) drug release | Floating lag time (sec) |
|---|---|---|
| 0 | 99.32 | 68 |
| 30 | 98.32 | 65 |
| 60 | 98.11 | 63 |
| 120 | 95.32 | 54 |

## 5. CONCLUSION

Gastro retentive floating tablets of moxifloxacin were formulated with the help of HPMC K100M and tragacanth gum in various compositions for identifying the best composition of drug release modifiers with effervescent mixtures. Floating tablets of moxifloxacin could be used for treatment of gastric ulcers caused by Helicobacter pylori infection by retention of device in the gastric region and its controlled release in the gastric zone which helps in eradicating the bacteria from GI tract. The initial burst release of drug from the formulation was due to the change in viscosity of polymer matrix. As the increase in viscosity of stagnant layer results in a corresponding decrease in the drug release (occurred due to thicker gel layer formation). Dissolution profiles of moxifloxacin floating tablets were subjected to kinetic modeling. Results reveal that all formulation batches best fitted to first-order kinetics, quantification of $R^2$ was founded to be in the range of 0.88 to 0.98. The results were fitted to Higuchi's kinetics, where $R^2$ was found to be in the range of 0.95–0.99. From the Peppas treatment, it reveals that all batches follow that shows non-Fickian diffusion super Case-II path (n values 0.75–0.99).

Gastro retentive floating tablets of moxifloxacin prepared using 90mg of HPMC K100M had shown release for a prolonged period of time by floating on gastric contents. The natural polymers added in all formulations showed drug release retardation nature within an increase in concentration of retardant. The gastro retentive floating tablets (F-7 to F-9) prepared with 60mg HPMC K100 M had shown better drug release than the formulations (F-1 to F-6). Among all formulations, the preparation containing 60 mg HPMC K100 M and 80 mg of tragacanth gum i.e., Formulation F-7 had shown better drug release(Fig.5), Buoyancy time, release retardation, physical properties. Formulation F-7 follows Higuchi's kinetics, Non-Fickian Diffusion, and first-order kinetics (n = 0.75).

Current study concludes that natural and semi synthetic polymers can be used in the preparation of gastro retentive floating tablets of moxifloxacin. Based on current research study, the use of macromolecules (Natural and Semi synthetic polymers) in combination had its advantages of maintaining integrity and buoyancy of tablets. The effervescent based FDDS is a promising formulation to obtain gastro retention using gel-forming polymers such as HPMC K100M, tragacanth gum employing sodium bicarbonate as gas generating agent. Optimized formulation had shown cumulative drug release of 99.24% in 24 hrs and retained their original properties upon storage for 4 months.

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