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Review Article

# Formulation and Evaluation of Valacyclovir Hydrochloride Effervescent Floating Tablets

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ABSTRACT

The purpose of this research was to develop gastro-retentive drug delivery system of Valacyclovir hydrochloride to prolong gastric residence time with desired in vitro release profile. Valacyclovir hydrochloride is an Anti-viral drug with high solubility in gastric pH. In the present study, Valacyclovir hydrochloride floating tablets were prepared by effervescence method using sodium bicarbonate and citric acid as a gas generating agent. The tablets were formulated using direct compression method using polymers like HPMC K15M, HPMC K100M, Xanthan gum and Sodium alginate. Pre-compression parameters such as for angle of repose, bulk density, tapped density and hausner's ratio whereas the prepared tablets were evaluated for weight variation, thickness, hardness, friability, drug content, floating lag time, total floating time, in vitro dissolution study and in vivo radiographic studies. FT-IR and DSC studies elucidated the compatibility of the drug with the polymers and other excipients used in the study. In Vitro release studies of the prepared tablets depicted to follow Zero order kinetics with R2 value of 0.941 and Fickian diffusion where n value is < 0.5 and found to be the main mechanism of drug release. The manufacturing procedure was found to be reproducible and formulations were stable after one month of accelerated stability studies.

## 1. Introduction

Oral route is considered as the most common route of administration for drug delivery [1]. Effective oral drug delivery may depend upon the factors such as gastric emptying process, gastrointestinal transit time of dosage form, drug release from the dosage form and site of absorption of drugs [2]. Most of the oral dosage forms suffer from several physiological limitations such as variable gastrointestinal transit, variable gastric emptying time, non-uniform absorption profiles, incomplete drug release and shorter residence time of dosage form in stomach [3].

As a result, drugs with absorption window in the upper part of the small intestine undergo incomplete absorption [4]. Hence a beneficial delivery system would be one which possesses the ability to control and prolong the gastric emptying time and can deliver drugs in higher concentrations to the absorption site i.e. upper part of the small intestine [5]. Gastric retention of drugs is one of the approaches used in the prolongation of gastric retention time with suitable therapeutic activity [6].

Valacyclovir Hydrochloride is an anti- viral drug used commonly in the treatment of infections caused by Herpes virus [7]. Valacyclovir HCl converts to acyclovir with L-valine by first-pass metabolism [8]. Plasma concentrations of unconverted valacyclovir are low with transient, generally becoming non-quantifiable by 3 hours after administration. Peak plasma valacyclovir centrations are generally less than 0.5 mcg/mL at all doses [9].

Valacyclovir hydroconchloride is suitable for floating drug delivery system as it undergoes hepatic metabolism which hinders with the oral bioavailability of the drug. It also has multiple dosage activity for a day that maintains stable drug plasma concentration [10].

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## 2. Materials and Methods

Valacyclovir HCl was received as a gift sample from NATCO Pharma Pvt., Ltd, Hyderabad. Hydroxy propyl methyl cellulose (HPMC K4M, HPMCK15M and HPMC K100M), Ethyl **cellulose**, sodium bicarbonate, xanthan gum, guar gum, Dicalcium Phosphate, Mannitol, Lactose, Starch, Avicel, and Magnesium stearate were purchased from SD Fine Chemicals., Hyderabad. All the ingredients used in this work were of analytical grade.

***Solubility studies***

Excess amount of Valacyclovir HCl was placed in 0.1N HCl, ethanol, methanol, water respectively in order to determine its solubility. The samples were shaken for 48 hr at 37 ℃ in a horizontal shaker [11]. The supernatant was filtered and the filterate was diluted with the appropriate dissolution medium and assayed by UV-spectrophotometer at 255 nm.

***Drug-excipient compatibility studies***

Compatibility studies were carried out to know the possible interactions between Valacyclovir HCl and the excipients used in the formulation. Physical mixtures of drug and excipients were prepared to study the compatibility using the InfraRed spectrophotometer. The investigations were carried out to denote the changes in chemical composition of the drug after combining with the excipients [12]. The pure drug mixture was placed under Bruker FTIR. The spectra was analyzed and interpreted.

***Construction of calibration curve of Valacyclovir Hydrochloride***

100 mg of Valacyclovir HCl was dissolved in 100 mL of 0.1N HCl. Series of dilutions containing 5,10,15,20 and 25 µg/mL of drug per mL of solution were prepared. The absorbance of the above dilutions was measured at 255 nm by using UV-spectrophotometer. Graph was plotted by taking concentration on X-axis and absorbance on Y-axis which gives a straight-line linearity of standard curve was assessed from the square of correlation coefficient ($R^2$) which determined by least-square linear regression analysis [13].

***Pre-compression parameters***

The powder blends of all formulations were evaluated for Bulk density, Tapped density, Hausner's ratio, Angle of repose [14]. Thermo-gram of pure drug was obtained using Differential Scanning Calorimetry to observe any noticeable physical changes in the prepared formulation [15].

***Formulation of Valacyclovir Hydrochloride effervescent Floating Tablets***

Effervescent floating tablets of Valacyclovir HCl were prepared by using direct compression method. In this method, the drug along with all the excipients were geometrically mixed manually in a polythene bag for about 30 min to obtain a homogenous mixture [16]. After attaining sufficient uniformity magnesium stearate was added as lubricant and was mixed for 2-3 min. The composition of all the formulations of Valacyclovir HCl floating tablets are shown in **Table-1.** The tablets were compressed with rotary tablet machine. The mixture equivalent to 700mg was compressed with 14mm round concave punches at a hardness of 4-7 kg/cm$^2$.

***Evaluation of Post Compression Parameters***

*Differential scanning calorimetry:* Thermo-grams of formulated preparations were obtained using DSC instrument equipped with an intercooler. Indium/Zinc standards were used to calibrate the DSC temperature and enthalpy scale. The sample preparations were hermetically sealed in an aluminum pan and heated at a constant rate of 20°C/min; over a temperature range of 100 °C- 200 $^0$C. Inert atmosphere was maintained by purging nitrogen gas at the flow rate of 50ml/min [17].

*In vitro buoyancy studies: In vitro* buoyancy of the prepared tablets was determined by noting down the floating lag time. The tablets were placed in 100 ml beaker containing 0.1N HCl. The time required for the tablet to rise onto the surface and float was determined floating lag time. The duration of time it has taken to remain on the surface of medium was determined as the total floating time [18].

*Weight variation test:* Twenty tablets were taken and their weight was determined individually and collectively on a digital weighing balance. The average weight of one tablet was determined from the collective weight. The test was performed according to official method. The average weight was noted and standard deviation was calculated [19].

*Thickness:* Thickness and diameter of the tablets were measured using a calibrated Vernier calipers. Three tablets of each formulation were picked randomly and dimensions were determined in mm [20].

*Hardness test:* Hardness of a tablet is defined as the force applied across the diameter of the tablet in order to break the tablet. The resistance of the tablet to chipping, abrasion or breakage under condition of storage depends upon hardness. Hardness of tablets was determined using Monsanto hardness tester and the average was calculated with deviation [21].

*Friability test:* It is used to measure mechanical strength of tablets. Roche friabilator was used to determine friability. Pre-weighed tablets were placed in the friabilator and rotated at 25rpm for 4minutes (100rotations). The tablets were reweighed again and expressed in percentage [22]

*Drug content:* Ten tablets were finely powdered and one tablet equivalent weight of valacyclovir hydrochloride was accurately weighed, transferred to a 100 ml volumetric flask containing 50ml water and was allowed to stand to ensure complete solubility of drug. The mixture was made till final volume with water. The solution was diluted and absorbance was checked under UV Visible spectrophotometer at $\lambda_{max}$ of 255 nm. The drug concentration was calculated [23].

*In vitro drug release studies:* 900ml 0f 0.1N HCl was placed in vessel and the USP apparatus –II (Paddle Method) was assembled. The medium was allowed to equilibrate to temp of 37° $\pm$ 0.5° C. Tablet was placed in the

**Table 1. Composition of Valacyclovir HCl floating tablets (in mg)**

| Formulation code | Valacyclovir HCl | HPMC K15M | HPMC K100M | Xanthum gum | Sodium alginate | Sodium bicarbonate | Citric acid | Magnesium stearate | Talc | Total Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| **F1** | 500 | 166.6 | - | - | - | 27 | 3.4 | 1.5 | 1.5 | 700 |
| **F2** | 500 | 125 | - | - | - | 60 | 7.6 | 3.7 | 3.7 | 700 |
| **F3** | 500 | 100 | - | - | - | 80 | 10 | 5 | 5 | 700 |
| **F4** | 500 | - | 166.6 | - | - | 27 | 3.4 | 1,5 | 1.5 | 700 |
| **F5** | 500 | - | 125 | - | - | 60 | 7.6 | 3.7 | 3.7 | 700 |
| **F6** | 500 | - | 100 | - | - | 80 | 10 | 5 | 5 | 700 |
| **F7** | 500 | - | - | 166.6 | - | 27 | 3.4 | 1.5 | 1.5 | 700 |
| **F8** | 500 | - | - | 125 | - | 60 | 7.6 | 3.7 | 3.7 | 700 |
| **F9** | 500 | - | - | 100 | - | 80 | 10 | 5 | 5 | 700 |
| **F10** | 500 | - | - | - | 166.6 | 27 | 3.4 | 1.5 | 1.5 | 700 |
| **F11** | 500 | - | - | - | 125 | 60 | 7.6 | 3.7 | 3.7 | 700 |
| **F12** | 500 | - | - | - | 100 | 80 | 10 | 5 | 5 | 700 |

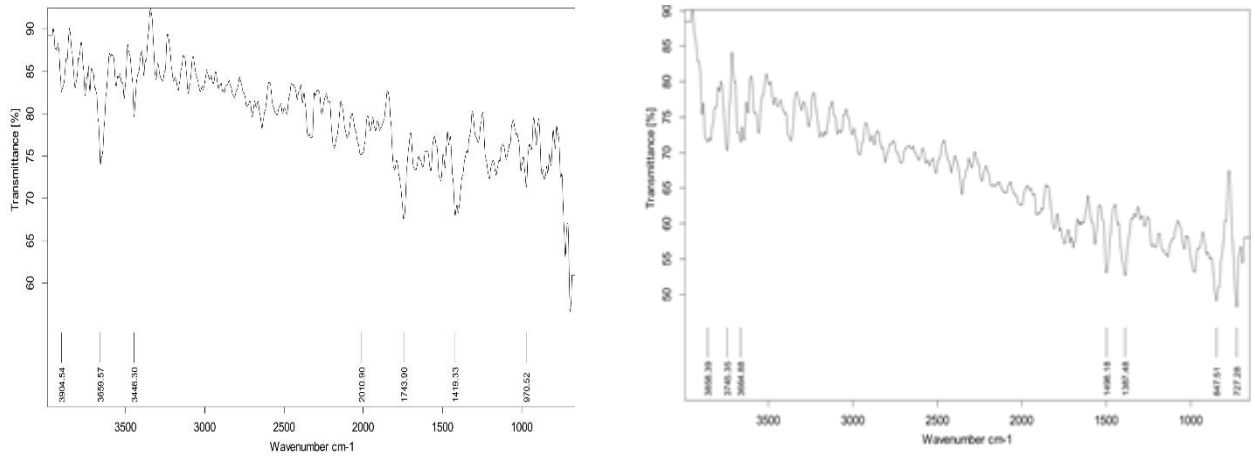


**Figure 1.** FTIR Spectra of pure Valacyclovir hydrochloride and optimized formulation (F6)

vessel and the vessel was covered the apparatus was operated for 12 hr and then the medium 0.1N HCl was taken and process was continued from 0 to 12 hr at 50 rpm. At definite time intervals of 5 ml of the receptors fluid was withdrawn, filtered and again 5ml receptor fluid was replaced. Suitable dilutions were done with receptor fluid and analyzed by spectrophotometrically at 255 nm using UV-spectrophotometer [24].

*In vivo radiographic studies:* X-ray radiography was used to determine the gastric residence time of the tablets. The optimized tablet formulation F6 was used for this purpose. The tablet should be opaque for X-ray detection. 150mg of the drug was replaced with barium sulfate (all other ingredients were kept constant). The amount of barium sulfate in tablet should be sufficient to provide visibility by X-ray. For *in vivo* evaluation of gastric residence time, three healthy volunteers (25±5 yrs age, male, 55±5kgs weight) swallowed the tablet with a glass of water. With food and the radiographic image of the tablet was recorded at intervals of 1hr till 12$^{th}$ hr of post ingestion of tablet [7]. The studies were performed after the approval of Institutional Human Ethical Committee.

## 3. Results and Discussion

***Solubility studies***

Valacyclovir Hcl was found to be soluble in 0.1N HCl, water, ethanol and methanol. It was found to be insoluble in chloform.

***Drug-excipient compatibility studies by FTIR studies***

FT-IR spectroscopic studies were conducted to determine possible drug polymer interactions. Pure drug Valacyclovir HCl along with polymers, HPMCK100M, HPMCK15M, Xanthan gum and Sodium alginate were present in the physical mixture. The following peaks were observed at following wave number for pure drug as shown in Fig.1. N-H peak at 3659.5, C=O peak at 1743.9, $CH_3$ peak at 1419, and for that of optimized formula was observed as N-H peak at 3446.3, C=O peak at 1692.4, $CH_3$ peak at 1498.

**Table 2. Comparision of FTIR Spectra of Pure drug with optimized formulation (F6)**

| Particulars | Peak functional group wavenumber $cm^{-1}$ | | |
|---|---|---|---|
| | N-H | C=O | $CH_3$ |
| Valacyclovir hydrochloride | 3659.5 | 1743.9 | 1419 |
| Optimized formulation | 3446.3 | 1692.4 | 1498 |

**Calibration curve of Valacyclovir Hydrochloride**

Different concentrations of Valacyclovir HCl versus absorbance plot were shown in **Fig. 2**. The solutions obeyed Beer-Lambert's law over a concentration range of 4-28 µg/mL with a regression coefficient, $R^2$ of atleast 0.990 was achieved. The regression equations for Valacyclovir hydrochloride were y=0.032 in 0.1N HCl. This was utilized in estimation of valacyclovir hydrochloride in preliminary floating tablets in *in vitro* samples.

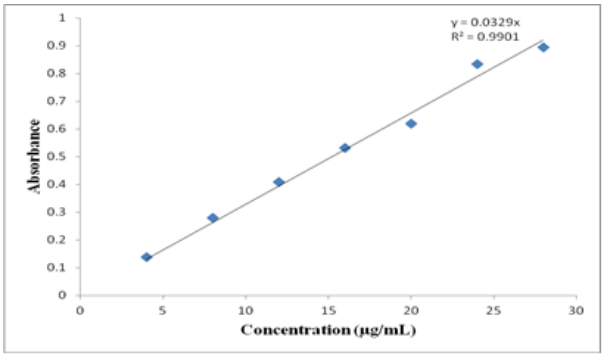


**Figure 2.** Calibration curve of Valacyclovir HCl in 0.1 N HCl.

**Pre compression parameters**

The results of bulk density, tapped density, Hausner's ratio and angle of repose of all the formulations depicted good flow of property which were within the limits as per official pharmacopeia (**Table-3**).

**Table 3.** Physical properties of powder blends of tablet formulations.

| Code | Angle of repose | Bulk Density (gm/cc) | Tapped Density (gm/cc) | Hausner's Ratio |
|---|---|---|---|---|
| **F1** | 27.52±0.235 | 0.561±0.032 | 0.634±0.043 | 1.130 |
| **F2** | 24.51±0.290 | 0.567±0.045 | 0.660±0.057 | 1.164 |
| **F3** | 27.21±0.352 | 0.574±0.058 | 0.652±0.083 | 1.135 |
| **F4** | 27.05±0.252 | 0.582±0.026 | 0.674±0.048 | 1.158 |
| **F5** | 24.62±0.374 | 0.575±0.048 | 0.680±0.061 | 1.182 |
| **F6** | 28.56±0.380 | 0.624±0.043 | 0.691±0.053 | 1.107 |
| **F7** | 24.84±0.972 | 0.607±0.057 | 0.667±0.063 | 1.098 |
| **F8** | 29.65±0.78 | 0.605±0.086 | 0.682±0.049 | 1.127 |
| **F9** | 28.46±0.850 | 0.611±0.048 | 0.679±0.057 | 1.111 |
| **F10** | 25.32±0.332 | 0.577±0.035 | 0.650±0.048 | 1.12 |
| **F11** | 24.65±0.243 | 0.612±0.028 | 0.684±0.047 | 1.117 |
| **F12** | 27.34±0.348 | 0.584±0.042 | 0.676±0.053 | 1.157 |

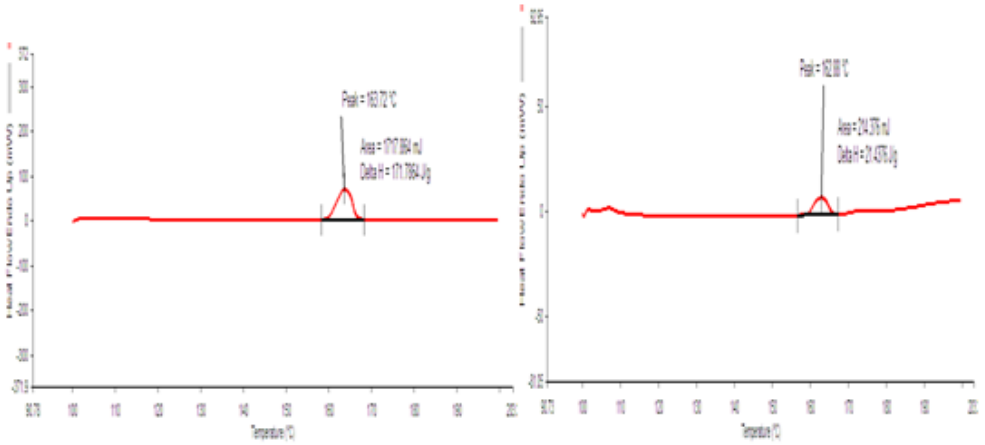

**Figure 3.** DSC of pure drug and optimized formulation (F6).

**Differential Scannig Calorimetry**

From the DSC analysis it was clear that there was no interaction between drug and polymers. Exothermic peak of pure drug was found at 163.7 ºC in thermograms of DSC and it was found that there was no significantly deviation in melting exothermic of the physical mixture of drug with polymer. The results indicated that the selected drug was physically compatible with the selected polymers. The DSC thermograms are shown in **Figure.3.**

**Evaluation of Floating Tablets of Valacyclovir Hydrochloride**

**a) Weight variation**

The physical evaluation parameters were also tested (**Table-4**). The total weight of each formulation was attained constant. The weight variation of the tablets was within the limits. The weight of the tablets ranged from 694±1.4 to 704±1.7 mg. The values were within the acceptance limits.

**b) Thickness**

The weight of the tablets and their thickness were linearly related. The thickness of floating tablet ranged from 4.92±0.07 to 5.11±0.05 which linearly correlated with the weight of tablets.

**(c) Hardness**

Hardness of the tablet was within the pharmacopeial limits for all the tablets containing different polymers.

**(d) Friability**

Friability test of all the formulations was found satisfactory showing enough resistance to the mechanical shock and abrasion. The range varied from 0.45 to 0.68, confirm with normal range.

**(e) Drug content:** The drug content was found to be in range of 97.55% to 98.89% which was in acceptable limits.

**(f) *In vitro* buoyancy studies:** The prepared floating tablets remained buoyant for 12 hrs with a floating lag time of less than 75 seconds. The optimized concentrations of the effervescent mixture (sodium bicarbonate and citric acid) contributed to the buoyancy of the tablets. Buoyancy results of floating tablets were shown below (**Table-4**).

***In vitro* release of Valacyclovir HCl from HPMC K15M containing formulations**

Drug release was inversely proportional to the polymer concentration and also dependent on the agitation intensity and hardness of tablet. The drug release from floating tablets was controlled for a prolonged period of time due to the viscous nature of the HPMC through which drug diffused. HPMC aided to extend the drug release upto 12hr and maintained the integrity and buoyancy of the tablets formed.

The *in vitro* drug release studies revealed that formulation F2 showed release of 97.2±0.3% in 12hrs and F6 with release of 98.6±0.5%. All the 12 formulation floated for >12hr. The results are shown in **Table-5**.

**Release Kinetics of Optimized formulation**

Highest percentage of drug release (98.6%) was observed with HPMC K100M polymer and followed diffusion with erosion mechanism (Non-Fickian transport). This formulation can be further be used to extend and develop novel floating drug delivery systems with enhanced therapeutic effect eliminating the sidefeffects caused in the gastric system.

***In Vivo* Buyoyancy studies**

X- ray images confirmed buoyancy of Valacyclovir tablets in stomach upto 8 hrs as shown below in **Fig 6.**

**Table 4. Evaluation of post compression parameters and floating properties of Valacyclovir HCl floating tablets.**

| Formulation Code | Post compression parameters | | | | | Floating properties | |
|---|---|---|---|---|---|---|---|
| | Weight variation (mg) | Hardness (kg/cm$^2$) | Thickness (mm) | Friability (%) | Drug content (%) | Floating lag time (sec) | Total floating time (hrs) |
| **F1** | 696±1.2 | 4.9±0.5 | 5.00±0.06 | 0.68±0.03 | 97.98±1.2 | 53 | ≥12 |
| **F2** | 702±1.1 | 5.4±0.3 | 5.11±0.03 | 0.57±0.04 | 98.05±1.6 | 29 | ≥12 |
| **F3** | 695±1.2 | 4.4±0.5 | 5.00±0.04 | 0.65±0.02 | 97.55±1.5 | 41 | ≥12 |
| **F4** | 698±1.3 | 4.3±0.2 | 5.00±0.06 | 0.55±0.04 | 98.12±1.1 | 55 | ≥12 |
| **F5** | 704±1.7 | 5.5±0.5 | 5.11±0.05 | 0.64±0.03 | 99.89±1.4 | 48 | ≥12 |
| **F6** | 699±1.1 | 5.6±0.3 | 5.10±0.25 | 0.58±0.02 | 98.20±1.3 | 16 | ≥12 |
| **F7** | 702±1.2 | 5.5±0.2 | 5.00±0.04 | 0.51±0.06 | 97.48±1.6 | 68 | ≥12 |
| **F8** | 699±1.4 | 5.4±0.5 | 4.95±0.07 | 0.55±0.04 | 97.69±1.4 | 60 | ≥12 |
| **F9** | 697±1.4 | 4.5±0.3 | 5.00±0.04 | 0.51±0.02 | 97.99±1.2 | 75 | ≥12 |
| **F10** | 694±1.4 | 4.6±0.3 | 4.94±0.06 | 0.45±0.02 | 98.05±1.2 | 58 | ≥12 |
| **F11** | 702±1.3 | 5.5±0.1 | 4.92±0.07 | 0.62±0.03 | 98.21±1.6 | 30 | ≥12 |
| **F12** | 695±1.2 | 4.3±0.2 | 5.11±0.03 | 0.51±0.06 | 97.48±1.3 | 63 | ≥12 |

**Table 5.** *In vitro* drug release profile of Valacyclovir HCl floating tablets containing HPMC K15 M (F1-F3) and HMC K100M (F4-F6).

| Time (hrs) | Cumulative % drug release | | | | | |
|---|---|---|---|---|---|---|
| | F1 | F2 | F3 | F4 | F5 | F6 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 27.2±0.72 | 30±0.4 | 29±0.35 | 20.2±0.72 | 23.2±0.64 | 26±0.52 |
| 2 | 30.1±0.32 | 34±0.6 | 31.9±0.5 | 27.4±0.79 | 29.1±0.81 | 37±0.81 |
| 3 | 35.1±0.45 | 38.2±0.58 | 36±0.45 | 35.1±0.77 | 36±0.83 | 44±0.2 |
| 4 | 39.9±0.3 | 44±0.45 | 40.9±0.3 | 38.7±0.3 | 40±0.62 | 55.2±0.3 |
| 5 | 46±0.5 | 52.1±0.41 | 48±0.45 | 47.1±0.79 | 48.9±0.5 | 61±0.2 |
| 6 | 51±0.3 | 58±0.5 | 53±0.5 | 55±0.86 | 56.1±0.75 | 68±0.41 |
| 7 | 59±0.5 | 66±0.3 | 63.2±0.72 | 62±0.83 | 63.1±0.76 | 76.6±0.25 |
| 8 | 68.1±0.36 | 74±0.25 | 70.3±0.81 | 66.9±0.98 | 68.9±0.6 | 88±0.2 |
| 9 | 74±0.65 | 77.9±0.55 | 76.2±0.64 | 70.9±0.92 | 73.9±0.62 | 90±0.37 |
| 10 | 80.2±0.58 | 85±0.6 | 83±0.45 | 82±0.91 | 83±0.51 | 94±0.6 |
| 11 | 88.9±0.5 | 93.4±0.4 | 93±0.45 | 88.7±0.73 | 90.9±0.51 | 96±0.26 |
| 12 | 93.4±0.41 | 97.2±0.3 | 95.4±0.35 | 93.3±0.25 | 95.3±0.4 | 98.6±0.5 |

**Table 6.** *In vitro* drug release profile of Valacyclovir HCl floating tablets containing Xanthan gum (F7-F9) and Sodium Alginate (F10-F12).

| Time (hrs) | Cumulative % drug release | | | | | |
|---|---|---|---|---|---|---|
| | F7 | F8 | F9 | F10 | F11 | F12 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 18±0.3 | 19.8±0.62 | 16.1±0.56 | 24.6±0.52 | 26.1±0.76 | 20.8±0.72 |
| 2 | 25.8±0.7 | 28.9±0.65 | 24.2±0.49 | 28.9±0.79 | 29.4±0.78 | 24.5±0.5 |
| 3 | 31±0.6 | 33.1±0.66 | 28.9±0.45 | 38.5±0.55 | 39.9±0.65 | 28.8±0.8 |
| 4 | 39±0.61 | 40±0.7 | 35.9±0.5 | 47.2±0.31 | 49.1±0.51 | 39.1±0.98 |
| 5 | 46±0.66 | 48.9±0.36 | 42.1±0.41 | 50.8±0.83 | 53.2±0.85 | 47.9±0.9 |
| 6 | 50.1±0.85 | 54.1±0.51 | 48±0.8 | 58.5±0.41 | 59±0.53 | 50.9±0.95 |
| 7 | 58.2±0.92 | 62±0.6 | 56±0.7 | 62.5±0.52 | 63±0.71 | 54.5±0.51 |
| 8 | 60.1±0.56 | 67.8±0.72 | 59±0.3 | 69.6±0.52 | 70±0.95 | 60.8±0.72 |
| 9 | 65.9±0.85 | 72.1±0.32 | 63.9±0.65 | 78.8±0.91 | 81.1±0.45 | 74.5±0.51 |
| 10 | 70.1±0.95 | 80.8±0.41 | 68±0.8 | 86±0.96 | 87.9±0.55 | 82.9±0.85 |
| 11 | 78.1±0.7 | 90±0.45 | 79.9±0.5 | 90.5±0.66 | 92.2±0.72 | 89.9±0.9 |
| 12 | 85.9±0.8 | 92.1±0.55 | 84±0.5 | | | |

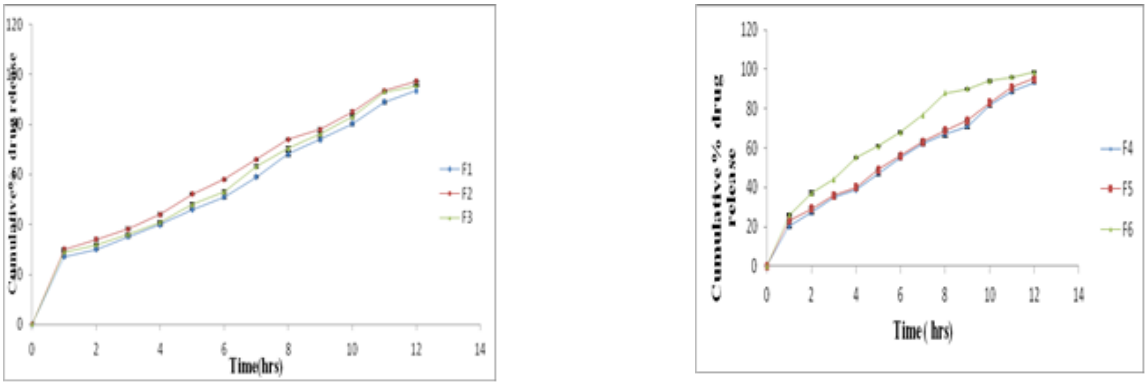


**Figure 4.** Dissolution Profile of Valacyclovir HCl floating tablets containing HPMC K15 M (F1, F2, F3) and HPMC K100 M (F4, F5, F6).

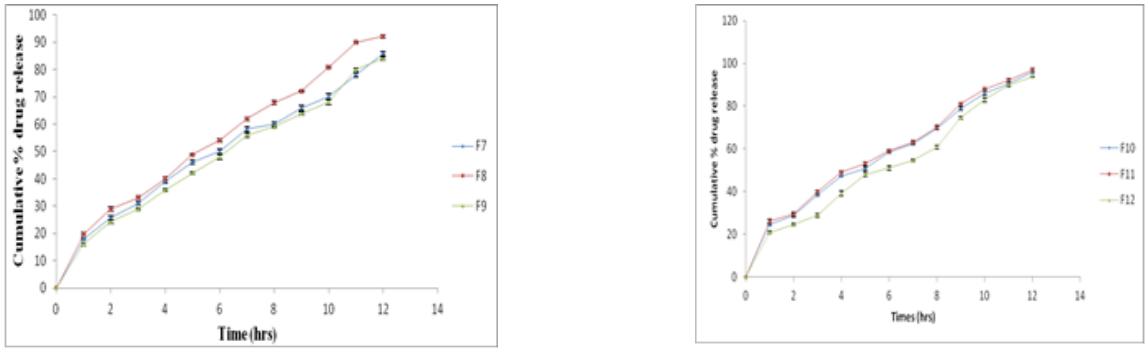


**Figure 5.** Dissolution Profile of Valacyclovir HCl floating tablets containing Xanthan gum (F7, F8, F9) and Sodium alginate (F10, F11, F12).

| Table 7. Kinetics of drug release and mechanism of drug release from dosage form. | | | | | | |
|---|---|---|---|---|---|---|
| Formulation | Zero Order $R^2$ Value | First Order $R^2$ Value | Higuchi $R^2$ value | Korsmeyer- Peppas | | Mechanism of drug release |
| | | | | $R^2$ Value | n Values | |
| F6 | 0.985 | 0.941 | 0.967 | 0.965 | 0.674 | Non-Fickian Diffusion |

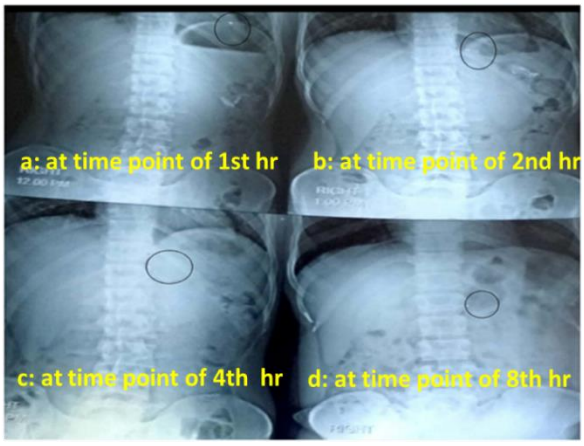


**Figure 6.** In-Vivo Radiographic images of optimized formulation

## 4. Conclusion

Floating tablets of Valacyclovir hydrochloride were formulated as an approach to increase gastric residence time.Optimized formulation F6 which contains HPMC K100M has successfully showed the drug release for 12 hr.This dosage form can be considered suitable for further studies which can be extrapolated for this delivery system. IR spectrum for pure drug and physical mixture of drug- polymers were obtained and analyzed for principal peaks. The spectra depicted that there was no incompatibility between drug and polymers.

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## Conflict of Interest

The author(s) confirm that this article content has no conflict of interest.

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