INTRODUCTION

Oral delivery of drugs is the most preferable route of drug delivery. Oral route is considered most natural, uncomplicated, convenient and safe due to its ease of administration, patient compliance and flexibility in formulation and cost effective manufacturing process [1]. Many of the drug delivery systems, available in the market are oral drug delivery type systems. Pharmaceutical products designed for oral delivery are mainly immediate release type or conventional drug delivery systems, which are designed for immediate release of drug for rapid absorption. These immediate release dosage forms have some limitations such as:
1. Drugs with short half-life require frequent administration, which increases chances of missing dose of drug leading to poor patient compliance.
2. A typical peak-valley plasma concentration-time profile is obtained which makes attainment of steady state condition difficult.
3. The unavoidable fluctuations in the drug concentration may lead to under medication or overmedication as the C_{ss} values fall or rise beyond the therapeutic range.
4. The fluctuating drug levels may lead to precipitation of adverse effects especially of a drug with small therapeutic index, whenever overmedication occurs [2].

In order to overcome the drawbacks of conventional drug delivery systems, several technical advancements have led to the development of controlled drug delivery system that could revolutionize method of medication and provide a number of therapeutic benefits [3].

Controlled Drug Delivery Systems

Controlled drug delivery systems have been developed which are capable of controlling the rate of drug delivery, sustaining the duration of therapeutic activity and/or targeting the delivery of drug to a tissue [4]. Controlled drug delivery or modified drug delivery systems are divided into four categories.

1. Delayed release
2. Sustained release
3. Site-specific targeting
4. Receptor targeting

More precisely, controlled delivery can be defined as:-

1. Sustained drug action at a predetermined rate by maintaining a relatively constant, effective drug level in the body with concomitant minimization of undesirable side effects.
2. Localized drug action by spatial placement of a controlled release system adjacent to or in the diseased tissue.
3. Targeted drug action by using carriers or chemical derivatives to deliver drug to a particular target cell type.
4. Provide physiologically/therapeutically based drug release system. In other words, the amount and the rate of drug release are determined by the physiological/therapeutic needs of the body.

A controlled drug delivery system is usually designed to deliver the drug at particular rate. Safe and effective blood levels are maintained for a period as long as the system continues to deliver the drug (Figure 1) [6]. Controlled drug deliveries usually results in substantially constant blood levels of the active ingredient as compared to the uncontrolled fluctuations observed when multiple doses of quick releasing conventional dosage forms are administered to a patient.

**Fig 1. Drug level verses time profile showing differences between zero order, controlled releases, slow first order sustained release and release from conventional tablet**

Oral drug delivery systems have progressed from immediate release to site-specific delivery over a period of time. Every patient would always like to have a ideal drug delivery system possessing the two main properties that are single dose or less frequent dosing for the whole duration of treatment and the dosage form must release active drug directly at the site of action [7]. Thus the objective of the pharmacist is to develop systems that can be as ideal system as possible. Attempts to develop a single- dose therapy for the whole duration of treatment have focused attention on controlled or sustained release drug delivery systems. Attention has been focused particularly on orally administered sustained drug delivery systems because of the ease of the administration via the oral route as well as the ease and economy of manufacture of oral dosage forms. Sustained release describes the delivery of drug from the dosage forms over an extended period of time. It also implies delayed therapeutic action and sustained duration of therapeutic effect. Sustained release means not only prolonged duration of drug delivery and prolonged release, but also implies predictability and reproducibility of drug release kinetics. A number of different oral sustained drug delivery systems are based on different modes of operation and have been variously named, for example, as dissolution controlled systems, diffusion controlled systems, ion-exchange resins, osmotically controlled systems, erodible matrix systems, pH-independent formulations, swelling controlled systems, and the like.

An orally administered controlled drug delivery system encounters a wide range of highly variable conditions, such as pH, agitation intensity, and composition of the gastrointestinal fluids as it passes down the G.I tract. Considerable efforts have been made to design oral controlled drug delivery systems that produce more predictable and increased bioavailability of drugs. However, the development process is precluded by several physiological difficulties, like inability to retain and localize the drug delivery system within desired regions of the G.I tract and highly variable nature of the gastric emptying process. An important factor, which may adversely affect the performance of an oral controlled drug delivery system, is the G.I transit time. The time for absorption in the G.I transit in humans, estimated to be 8-10 hr from
mouth to colon, is relatively brief with considerable fluctuation. G.I transit times vary widely between individuals, and depend up on the physical properties of the object ingested and the physiological conditions of the gut. This variability may lead to predictable bioavailability and times to achieve peak plasma levels. One of the important determinants of G.I transit is the residence time in the stomach.

Majority of the drugs are well absorbed from all the regions of the G.I tract while some are absorbed only from specific areas, principally due to their low permeability or solubility in the intestinal tract, their chemical instability, the binding of the drug to the gut contents, as well as to the degradation of the drug by the microorganisms present in the colon. Therefore, in instances where the drug is not absorbed uniformly over the G.I tract, the rate of drug absorption may not be constant in spite of the drug delivery system delivering the drugs at a constant rate into the G.I fluids. More particularly, in instances where a drug has a clear cut absorption window, i.e., the drug is absorbed only from specific regions of the stomach or upper parts of the small intestine; it may not be completely absorbed when administered in the form of a typical oral controlled drug delivery system. It is due to the relatively brief gastric emptying in humans, which normally averages 2-3 hrs through the major absorption zone. It may cause incomplete drug release from the dosage form at absorption sites leading to diminished efficacy of the administered dose. It is apparent that for a drug having such an absorption window, an effective oral controlled drug delivery system should be designed not only to deliver the drug at a controlled rate, but also to retain the drug in the stomach for a long period of time. For this drug, increased or more predictable availability would result if controlled release systems could be retained in the stomach for extended periods of time (Table 1).

<table>
<thead>
<tr>
<th>Dosage form</th>
<th>Transit time (h)</th>
<th>Gastric</th>
<th>Small intestine</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tablets</td>
<td>2.7±1.5</td>
<td>3.1±0.4</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td>Pellets</td>
<td>1.2±1.3</td>
<td>3.4±1.0</td>
<td>4.6</td>
<td></td>
</tr>
<tr>
<td>Capsules</td>
<td>0.8±1.2</td>
<td>3.2±0.8</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>Oral solution</td>
<td>0.3±0.07</td>
<td>4.1±0.5</td>
<td>4.4</td>
<td></td>
</tr>
</tbody>
</table>

It is well recognized that the stomach may be used as a depot for controlled release dosage forms. The stomach is J-shaped organ located in the upper left hand portion of the abdomen, just below the diaphragm. The stomach is composed of the following parts [9-10].

**Fig 2. Anatomy of stomach**

The proximal stomach made up of the fundus and body regions, Serves as a reservoir for ingested materials while the distal region (antrum) is the major site of mixing motions, acting as a pump to
accomplish gastric emptying. The pylorus is an anatomical sphincter situated between the most terminal antrum and the duodenum.

**Gastric emptying**
The process of gastric emptying occurs in two states:
- Fasting as well as
- Fed states.

The pattern of motility is distinct in both states [11-14].

**Fig 3. Gastrointestinal motility pattern**

In fasting state
An interdigestive series of electrical events occurs in a cyclic manner both through stomach and small intestine every 2 to 3 hours [15]. This activity is called the interdigestive myoelectric cycle or migrating myoelectric cycle (MMC), which is further divided into following 4 consecutive phases as [16] Fig 3.

In fed state
The motor activity in the fed state is induced 5-10 min after ingestion of a meal and persists as long as food remains in the stomach. This is also known as digestive motility pattern and comprises continuous contractions as in phase II of fasted state. These contractions are not as severe as those in the third phase of the fasted motility pattern. These contractions result in reducing the size of food particles (to less than 1 mm), which are propelled toward the pylorus in a suspension form. During the fed state onset of MMC is delayed resulting in slowdown of gastric emptying rate [17].

**Factors Affecting Gastric Retention**

**Density**
GRT is a function of dosage form buoyancy that is dependent on the density of a dosage form which affects the gastric emptying rate. A buoyant dosage form should have a density of less than that of the gastric fluids floats. Since it is away from the pyloric sphincter, the dosage unit is retained in the stomach for a prolonged period [18-19].

**Size**
Dosage form units having a diameter of more than 7.5 mm are reported to have an increased gastric residence time compared with those having a diameter of 9.9 mm. Gastric retention time of an dosage form in the fed state can also be influenced by its size. Small tablets are emptied from the stomach during the digestive phase while large size units are expelled during the house keeping waves Table 2 [20].

**Posture**
GRT can vary between supine and upright ambulatory states of the patient. When subjects were kept in the supine position it was observed that the floating forms could only prolong their stay.
because of their size; otherwise the buoyancy remained no longer an advantage for gastric retention [21-22].

**Biological factors**
Diabetes and Crohn’s disease, Etc.

**Concomitant Drug administration & interaction**
Anticholinergics like atropine and propantheline, opiates like codeine and prokinetic agents like metoclopramide and cisapride.

$pH$: Decrease in pH i.e., increase in acidity slows gastric emptying time.

**Stress:** Increases whereas, **Depression:** slows gastric emptying rate [23].

**Absorption window**
The G.I tract offers a varied environment capable of affecting the absorption of poorly administered drugs. Anatomical features, physiological phenomenon, and nature of gastrointestinal milieu contribute these changes. This can lead to the variations in the intestinal permeability of drug molecules, resulting in the phenomenon of Absorption window, where in, the drug is preferentially absorbed only from a particular region of the G.I. tract [24].

**Absorption window could result from the following factors**

1. **Physicochemical factors**
   **PH- dependent solubility and stability**
   A drug experiences a pH range of 1–8 across the G.I tract and needs to be in solubilised form to successfully cross the biological membrane. Most of the drugs are passively absorbed, in their un-ionized form.

2. **Physiological factors**
   (a) **Mechanism of absorption**
   Perorally administered drugs are absorbed both by passive diffusion as well as by non passive means of absorption. Drugs absorbed by active and facilitated transport mechanisms show higher regional specificity due to the prevalence of these mechanisms only in a particular region of G.I. tract.

**Aim of the Work**
The aim of the study is to formulate and evaluate Gastric floating tablets of Lisinopril using natural and synthetic polymers [24-25].

**Objective of the Study**
Lisinopril is a drug of the angiotensin-converting enzyme (ACE) inhibitor class used primarily in treatment of hypertension, congestive heart failure, and heart attacks, and in preventing renal and retinal complications of diabetes. Its indications, contraindications, and side effects are as those for all ACE inhibitors.

In the present work, floating tablets of lisinopril were prepared by effervescent approach using various polymers. The main objective of the study is to evaluate the effect of the polymers on drug release and the effect of sodium bicarbonate on buoyancy.

**DRUG PROFILE**
Lisinopril is a potent, competitive inhibitor of angiotensin-converting enzyme (ACE), the enzyme responsible for the conversion of angiotensin I (ATI) to angiotensin II (ATII). ATII regulates blood pressure and is a key component of the renin-angiotensin-aldosterone system (RAAS). Lisinopril may be used to treat hypertension and symptomatic congestive heart failure, to improve survival in certain individuals following myocardial infarction, and to prevent progression of renal disease in hypertensive patients with diabetes mellitus and microalbuminuria or overt nephropathy.

**Structure**

**RESULTS AND DISCUSSION**
The present study was aimed to developing gastro retentive floating tablets of Lisinopril using various polymers. All the formulations were evaluated for physicochemical properties and in vitro drug release studies.
Analytical Method

Graph of Lisinopril was taken in Simulated Gastric fluid (pH 1.2).

Table 3. Observations for graph of Lisinopril in 0.1N HCl

<table>
<thead>
<tr>
<th>Concentration[µg/ml]</th>
<th>Absorbance (Å)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0.158</td>
</tr>
<tr>
<td>4</td>
<td>0.315</td>
</tr>
<tr>
<td>6</td>
<td>0.503</td>
</tr>
<tr>
<td>8</td>
<td>0.653</td>
</tr>
<tr>
<td>10</td>
<td>0.812</td>
</tr>
</tbody>
</table>

Fig 4. Standard graph of Lisinopril in 0.1N HCl

\[ y = 0.081x - 0.002 \]
\[ R^2 = 0.999 \]

Drug – Excipient compatibility studies

Fig 5. FT-IR Spectrum of Lisinopril pure drug

Fig 6. FT-IR Spectrum of Optimised Formulation
From the FTIR data it was evident that the drug and excipients doses not have any interactions. Hence they were compatible.

Preformulation parameters of powder blend

Table 4. Pre-formulation parameters of blend

<table>
<thead>
<tr>
<th>Formulation Code</th>
<th>Angle of Repose (°)</th>
<th>Bulk density (gm/ml)</th>
<th>Tapped density (gm/ml)</th>
<th>Carr’s index (%)</th>
<th>Hausner’s Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>27.11 ± 0.56</td>
<td>0.56 ± 0.06</td>
<td>0.63 ± 0.12</td>
<td>11.11 ± 0.13</td>
<td>1.12 ± 0.01</td>
</tr>
<tr>
<td>F2</td>
<td>25.67 ± 0.24</td>
<td>0.49 ± 0.15</td>
<td>0.58 ± 0.14</td>
<td>15.51 ± 0.13</td>
<td>1.18 ± 0.02</td>
</tr>
<tr>
<td>F3</td>
<td>28.54 ± 0.65</td>
<td>0.57 ± 0.13</td>
<td>0.66 ± 0.13</td>
<td>13.63 ± 0.11</td>
<td>1.15 ± 0.03</td>
</tr>
<tr>
<td>F4</td>
<td>26.43 ± 0.47</td>
<td>0.50 ± 0.22</td>
<td>0.59 ± 0.11</td>
<td>15.25 ± 0.12</td>
<td>1.18 ± 0.04</td>
</tr>
<tr>
<td>F5</td>
<td>27.34 ± 0.71</td>
<td>0.47 ± 0.11</td>
<td>0.53 ± 0.07</td>
<td>11.32 ± 0.04</td>
<td>1.12 ± 0.02</td>
</tr>
<tr>
<td>F6</td>
<td>28.22 ± 0.58</td>
<td>0.45 ± 0.15</td>
<td>0.56 ± 0.12</td>
<td>16.07 ± 0.13</td>
<td>1.24 ± 0.01</td>
</tr>
<tr>
<td>F7</td>
<td>27.18 ± 0.63</td>
<td>0.52 ± 0.23</td>
<td>0.60 ± 0.16</td>
<td>13.33 ± 0.11</td>
<td>1.15 ± 0.02</td>
</tr>
<tr>
<td>F8</td>
<td>26.22 ± 0.42</td>
<td>0.55 ± 0.21</td>
<td>0.62 ± 0.08</td>
<td>11.29 ± 0.15</td>
<td>1.12 ± 0.03</td>
</tr>
<tr>
<td>F9</td>
<td>27.05 ± 0.81</td>
<td>0.47 ± 0.40</td>
<td>0.56 ± 0.17</td>
<td>12.50 ± 0.14</td>
<td>1.19 ± 0.01</td>
</tr>
</tbody>
</table>

Tablet powder blend was subjected to various preformulation parameters. The angle of repose values indicates that the powder blend has good flow properties. The bulk density of all the formulations was found to be in the range of 0.45 ± 0.15 to 0.57 ± 0.13 (gm/cm3) showing that the powder has good flow properties. The tapped density of all the formulations was found to be in the range of 0.53 ± 0.07 to 0.66 ± 0.13 showing the powder has good flow properties. The compressibility index of all the formulations was found to be ranging from 11.11 ± 0.13 to 16.07 ± 0.13 which show that the powder has good flow properties. All the formulations have shown the hausner’s ratio ranging from 0 to 1.25 indicating the powder has good flow properties.

Optimization of sodium bicarbonate concentration

Three formulations were prepared with varying concentrations of sodium bicarbonate. The formulation containing sodium bicarbonate in 20 mg concentration showed less floating lag time of 20 seconds and the tablet was in floating condition for more than 12 hours.

Post compression Parameters For tablets

Table quality control tests such as weight variation, hardness, and friability, thickness, and drug release studies in different media were performed on the tablets. All the parameters such as weight variation, friability, hardness, thickness and drug content were found to be within limits.
Formulation and in vitro evaluation of floating tablets of lisinopril using natural and synthetic polymers

<table>
<thead>
<tr>
<th>Formulation code</th>
<th>Weight variation (mg)</th>
<th>Hardness (kg/cm²)</th>
<th>Friability (%loss)</th>
<th>Thickness (mm)</th>
<th>Drug content (%)</th>
<th>Floating lag time (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>202.5 ± 0.95</td>
<td>4.8 ± 0.01</td>
<td>0.51 ± 0.05</td>
<td>3.5 ± 0.02</td>
<td>98.67 ± 0.15</td>
<td>26 ± 0.02</td>
</tr>
<tr>
<td>F2</td>
<td>200.4 ± 0.85</td>
<td>4.7 ± 0.02</td>
<td>0.69 ± 0.08</td>
<td>3.5 ± 0.01</td>
<td>99.54 ± 0.13</td>
<td>24 ± 0.11</td>
</tr>
<tr>
<td>F3</td>
<td>199.6 ± 0.78</td>
<td>4.6 ± 0.03</td>
<td>0.64 ± 0.12</td>
<td>3.4 ± 0.03</td>
<td>98.43 ± 0.98</td>
<td>20 ± 0.05</td>
</tr>
<tr>
<td>F4</td>
<td>202.6 ± 0.66</td>
<td>4.8 ± 0.02</td>
<td>0.58 ± 0.09</td>
<td>3.5 ± 0.02</td>
<td>99.78 ± 0.56</td>
<td>28 ± 0.14</td>
</tr>
<tr>
<td>F5</td>
<td>197.4 ± 1.58</td>
<td>4.6 ± 0.01</td>
<td>0.53 ± 0.10</td>
<td>3.4 ± 0.02</td>
<td>98.41 ± 1.02</td>
<td>25 ± 0.06</td>
</tr>
<tr>
<td>F6</td>
<td>200.7 ± 0.82</td>
<td>4.8 ± 0.02</td>
<td>0.68 ± 0.15</td>
<td>3.5 ± 0.01</td>
<td>99.65 ± 0.38</td>
<td>23 ± 0.07</td>
</tr>
<tr>
<td>F7</td>
<td>197.3 ± 1.23</td>
<td>4.8 ± 0.03</td>
<td>0.63 ± 0.09</td>
<td>3.4 ± 0.01</td>
<td>99.24 ± 0.26</td>
<td>26 ± 0.06</td>
</tr>
<tr>
<td>F8</td>
<td>196.2 ± 1.77</td>
<td>4.6 ± 0.01</td>
<td>0.64 ± 0.12</td>
<td>3.4 ± 0.02</td>
<td>98.56 ± 0.57</td>
<td>23 ± 0.10</td>
</tr>
<tr>
<td>F9</td>
<td>201.3 ± 0.94</td>
<td>4.7 ± 0.02</td>
<td>0.58 ± 0.13</td>
<td>3.5 ± 0.01</td>
<td>99.21 ± 0.63</td>
<td>21 ± 0.07</td>
</tr>
</tbody>
</table>

**Weight variation and thickness**
All the formulations were evaluated for uniformity of weight using electronic weighing balance and the results are shown in table 7.3. The average tablet weight of all the formulations was found to be between 196.2 ± 1.77 to 202.6 ± 0.66. The maximum allowed percentage weight variation for tablets weighing <250 mg is 7.5% and no formulations are not exceeding this limit. Thus all the formulations were found to comply with the standards given in I.P. And thickness of all the formulations was also complying with the standards that were found to be between 2.4 ± 0.01 to 2.5 ± 0.02.

**Hardness and friability**
All the formulations were evaluated for their hardness, using monsanto hardness tester and the results are shown in table 7.3. The average hardness for all the formulations was found to be from 4.6 ± 0.01 to 4.8 ± 0.03 Kg/cm² which were found to be acceptable. Friability was determined to estimate the ability of the tablets to withstand the abrasion during packing, handling and transporting. All the formulations were evaluated for their percentage friability using roche friabilator and the results were shown in table 7.3. The average percentage friability for all the formulations was between 0.53 ± 0.10 and 0.69 ± 0.08, which was found to be within the limit.

**Drug content**
All the formulations were evaluated for drug content according to the procedure described in methodology section and the results were shown in table 7.3. The drug content Values for all the formulations were found to be in the range of (98.41 ± 1.02 to 99.78 ± 0.56). According to IP standards the tablets must contain not less than 95% and not more than 105% of the stated amount of the drug. Thus, all the formulations comply with the standards given in IP.

**Floating lag time**
All formulations were examined for buoyancy studies, in that to determine the floating lag time and duration of floating time. The floating lag time of most of the formulations were showed within 30 seconds.

---

**In-Vitro Drug Release Studies**

**Table 7. Dissolution Data of Lisinopril Tablets Prepared with Sodium alginate**

<table>
<thead>
<tr>
<th>TIME (hr)</th>
<th>CUMULATIVE PERCENT DRUG RELEASED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.5</td>
<td>12.68</td>
</tr>
<tr>
<td>1</td>
<td>21.57</td>
</tr>
<tr>
<td>2</td>
<td>42.16</td>
</tr>
</tbody>
</table>
Sumayya Jabeen et al., Formulation and in vitro evaluation of floating tablets of lisinopril using natural and synthetic polymers

<table>
<thead>
<tr>
<th>TIME (hr)</th>
<th>CUMULATIVE PERCENT DRUG RELEASED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F4</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.5</td>
<td>9.14</td>
</tr>
<tr>
<td>1</td>
<td>12.25</td>
</tr>
<tr>
<td>2</td>
<td>26.31</td>
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<td>3</td>
<td>38.14</td>
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<td>4</td>
<td>50.17</td>
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<td>5</td>
<td>63.74</td>
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<tr>
<td>11</td>
<td>94.21</td>
</tr>
<tr>
<td>12</td>
<td>94.21</td>
</tr>
</tbody>
</table>

Fig 7. Dissolution profile of Lisinopril floating tablets (F1, F2, F3 formulations)

Table 8: Dissolution Data of Lisinopril Tablets Prepared With Guar gum

Fig 8. Dissolution profile of Lisinopril floating tablets (F4, F5, F6 formulations)
Table 9. Dissolution Data of Lisinopril tablets prepared with Carbopol 934

<table>
<thead>
<tr>
<th>Time (hr)</th>
<th>Cumulative Percent Drug Released</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F7</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.5</td>
<td>4.6</td>
</tr>
<tr>
<td>1</td>
<td>8.16</td>
</tr>
<tr>
<td>2</td>
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<td>3</td>
<td>27.84</td>
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<td>83.37</td>
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<tr>
<td>11</td>
<td>90.05</td>
</tr>
<tr>
<td>12</td>
<td>97.92</td>
</tr>
</tbody>
</table>

Fig 8. Dissolution profile of Lisinopril floating tablets (F7, F8, F9 formulations)

From the dissolution data it was evident that the formulations prepared with Sodium alginate was
unable to retard the drug release up to desired time period. The formulations prepared with Guar gum also unable to retard the drug release at lower concentration of polymer whenever increase the concentration of Guar gum in the formulation (F6) it was showed maximum drug release at 12 hours (i.e . 96.32).

The drug release of formulations prepared with Carbopol 934 at low concentration showed maximum drug release up to 12 hours and it was showed good floating lag time and duration of floating time. When increase the concentration of polymer it retards more than 12 hours. So, that formulation was not considered. Among F6 and F7 formulations, F7 formulation was considered as optimized formulation due to less concentration of polymer.

**Application of Release Rate Kinetics to Dissolution Data**

Various models were tested for explaining the kinetics of drug release. To analyze the mechanism of the drug release rate kinetics of the dosage form, the obtained data were fitted into zero-order, first order, Higuchi, and Korsmeyer-Peppas release model.

<table>
<thead>
<tr>
<th>Table 10. Release kinetics data for optimised formulation</th>
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<tbody>
<tr>
<td>Cumulative (%) release Q</td>
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<tr>
<td>--------------------------</td>
</tr>
<tr>
<td>0</td>
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<tr>
<td>4.6</td>
</tr>
<tr>
<td>8.16</td>
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<tr>
<td>16.36</td>
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<td>27.84</td>
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<tr>
<td>42.94</td>
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<td>50.41</td>
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<td>59.66</td>
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<td>68.07</td>
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<td>75.14</td>
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<tr>
<td>83.37</td>
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<tr>
<td>90.05</td>
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<td>97.92</td>
</tr>
</tbody>
</table>

**Fig 9. Zero order release kinetics graph**

**Fig 10. Higuchi release kinetics graph**
From the above graphs it was evident that the formulation F7 was followed Zero order release kinetics.

**CONCLUSION**
Development of Gastro retentive floating drug delivery of Lisinopril tablets is to provide the drug action up to 12 hours. Gastro retentive floating tablets were prepared by direct compression method using polymers Sodium alginate, Guar gum and Carbopol 934. The formulated gastro retentive floating tablets were evaluated for different parameters such as drug excipient compatibility studies, weight variation, thickness, hardness, content uniformity, Floating lag time, in vitro drug release. In vitro drug release studies performed in 0.1N HCl for 12hrs and the data was subjected to zero order, first order, Higuchi release kinetics and kars mayer peppas graph. The following conclusions could be drawn from the results of various experiments.

FTIR studies concluded that there was no interaction between drug and excipients. The physico-chemical properties of all the formulations were shown to be within limits. Quality control parameters for tablets such as weight variation, hardness, friability, thickness, drug content and floating lag time were found to be within limits. In-vitro drug release studies were carried out for all prepared formulation and from that concluded F7 formulation has shown good results. Finally Applied release kinetics to optimized formulation (F7) has followed Zero order release kinetics.

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CONFLICT OF INTEREST
No Conflict of Interest.

REFERENCES


