INTRODUCTION

Oral drug delivery is the most desirable and preferred method of administering therapeutic agents for their systemic effects. The high level of patient compliance in taking oral dosage forms is due to the ease of administration, patient compliance, flexibility in formulation and handling of these forms. However the oral route of administration suffers with certain drawbacks mainly short residence time of the dosage form in the GI tract, unpredictable gastric emptying and degradation of the drug due to highly reactive nature of GI contents. Gastric emptying is a complex process and makes in vivo performance of the drug delivery system uncertain. Formulation of floating drug delivery systems is an useful approach to avoid this variability with increased gastric retention time of the drug delivery system. Floating systems or hydrodynamically controlled systems are low-density systems that have sufficient buoyancy to float over the gastric contents and remain buoyant in the stomach without affecting the gastric emptying rate for a prolonged period of time. While the system is floating on the gastric contents, the drug is released slowly at the desired rate from the system. After release of drug, the residual system is emptied from the stomach. This results in an increased gastric residence time and a better control of the fluctuation in plasma drug concentration.

Advantages of FDDS

1. Improved drug absorption, because of increased gastric residence time and more time spent by the dosage form at its absorption site
2. Controlled delivery of drugs.
3. Delivery of drugs for local action in the stomach.
4. Minimizing the mucosal irritation due to drugs, by drug releasing slowly at controlled rate.
5. Treatment of gastrointestinal disorders such as gastro-esophageal reflux.
6. Simple and conventional equipment for manufacture.
7. Ease of administration and better patient compliance.
8. Site-specific drug delivery.

Disadvantages of FDDS

1. Floating systems are not feasible for those drugs that have solubility or stability problems in gastric fluids.
2. Drugs such as Nifedipine, which is well absorbed along the entire GI tract and which undergo significant first-pass metabolism, may not be suitable candidates for FDDS since the slow gastric emptying may lead to reduced systemic bioavailability. Also there are limitations to the applicability of FDDS for drugs that are irritant to gastric mucosa.

3. Gastric retention is influenced by many factors such as gastric motility, pH and presence of food. These factors are never constant and hence the buoyancy cannot be predicted.

4. Drugs that cause irritation and lesion to gastric mucosa are not suitable to be formulated as floating drug delivery systems.

Suitable Drug Candidates for FDDS
Various drugs have their greatest therapeutic effect when released in the stomach, particularly when the release is prolonged in a continuous, controlled manner. In general, appropriate candidates for FDDS are molecules that have poor colonic absorption but are characterized by better absorption properties at the upper parts of the GIT.

I. Non-effervescent Systems (balanced systems)
These are single-unit dosage forms, containing one or more gel-forming hydrophilic polymers. Hydroxypropylmethylcellulose (HPMC) is the most commonly used excipient, although ethylcellulose (HEC), hydroxypropylcellulose (HPC), sodium carboxymethyl agar, carrageen or alginic acid are also used. The polymer is mixed with drug and usually administered in a gelatine capsule. The capsule rapidly dissolves in the gastric fluid, and hydration and swelling of the surface polymers produces floating mass. Drug release is controlled by the formation of a hydrated boundary at the surface. Continuous erosion of the surface allows water penetration to the inner layers, maintaining surface hydration and buoyancy.

II. Gas-generating systems
Floatability can also be achieved by generation of gas bubbles. Carbon dioxide (CO₂) can be generated in situ by incorporation of carbonates or bicarbonates, which react with acid, either the natural gastric acid or co-formulated as citric or tartaric acid. The optimal stoichiometric ratio of citric acid and sodium bicarbonate for gas generation is reported to be 0.76:1. Gastric floating drug delivery system (GFDDS) offers numerous advantages over other gastric retention systems. These systems have a bulk density lower than gastric fluids and thus remain buoyant in the stomach without affecting the gastric emptying rate for a prolonged period of time. While the system is floating on the gastric contents, the drug is released slowly at desired rate from the stomach.

B. Multi –Unit Dosage Forms:
The purpose for designing multiple-unit dosage form is to develop a formulation which has all the advantages of a single-unit form and also devoid the above mentioned disadvantages of single-unit formulations. In pursuit of this endeavor many multiple-unit floatable dosage forms have been designed. Microspheres with high loading capacity can be formulated using various polymers such as albumin, gelatine,
starch, polymethacrylate, polyacrylamine, and polyalkylcyanoacrylate. Spherical polymeric microsponges, are referred as “microballoons,” have been prepared. Microspheres have a characteristic internal hollow structure and show an excellent in vitro float ability. In Carbon dioxide–generating multiple-unit oral formulations several devices with features that extend, unfold, or are inflated by carbon dioxide generated in the devices after administration have been described in the recent patent literature. These dosage forms are excluded from the passage of the pyloric sphincter if a diameter of ~12 to 18 mm in their expanded state is exceeded.

C. Raft Forming Systems:
Raft forming systems have received much attention for the delivery of antacids and drug delivery for gastrointestinal infections and disorders. The mechanism involved in the raft formation includes the formation of viscous cohesive gel in contact with gastric fluids, wherein each portion of the liquid swells forming a continuous layer called a raft. This raft floats on gastric fluids because of low bulk density created by the formation of CO$_2$. Usually, the system contains a gel forming agent and alkaline bicarbonates or carbonates responsible for the formation of CO2 to make the system less dense and float on the gastric fluids an antacid raft forming floating system. The system contains a gel forming agent (e.g. alginic bicarbonate, calcium arbonate, mannitol and a sweetener. These ingredients were granulated, and citric acid was added to the granules. The formulation produces effervescence and aerates the raft formed, making it float acid), sodium bicarbonate and acid neutralizer, which forms a foaming sodium alginate gel (raft) when in contact with gastric fluids. The raft thus formed floats on the gastric fluids and prevents the reflux of the gastric contents (i.e. gastric acid) into the esophagus by acting as a barrier between the stomach and esophagus. A patent assigned to Reckitt and Colman Products Ltd., describes a raft forming formulation for the treatment of helicobacter pylori (H. Pylori) infections in the GIT.

Formulation excipients used in FDDS


2. Inert fatty materials (5%-75%): Edible, inert fatty material having a specific gravity of less than one can be used to decrease the hydrophilic property of formulation and hence increase buoyancy. E.g. Beeswax, fatty acids, long chain fatty alcohols, Gelucires 39/01 and 43/01.

3. Effervescent agents: Sodium bicarbonate, citric acid, tartaric acid, Di-SGC (Di-Sodium Glycine Carbonate, CG (Citroglycine).

4. Release rate accelerants (5%-60%): eg. lactose, mannitol.

5. Release rate retardants (5%-60%): eg. Dicalciumphosphate, talc, magnesium stearate.


7. Low density material: Polypropylene foam powder (AccurelMP 1000).

Factors Affecting the Floating and Floating Time

1. Density: - Floating is a function of dosage form buoyancy that is dependent on the density.

2. Shape of dosage form: - Tetrahedron and ring shaped devices with flexural modules of 48 and 22.5 kilo pounds per square inch (KSI) are reported to have better floating, 90% to 100% retention at 24 hours compared with other shapes.

3. Concomitant drug administration: - Anticholinergics like atropine and propantheline, opiates like codeine and prokinetic agents like metoclopramide and cisapride; can affect floating time.

4. Fed or unfed state: - Under fasting conditions, the GI motility is characterized by periods of strong motor activity or the migrating myoelectric complex (MMC) that occurs every 1.5 to 2 hours.

5. Nature of meal: - Feeding of indigestible polymers or fatty acid salts can change the motility pattern of the stomach to a fed state, thus decreasing the gastric emptying rate and prolonging drug release.
6. **Caloric content and feeding frequency:** Floating can be increased by up to 10 hours with a meal that is high in proteins and fats. The floating can increase by over 400 minutes when successive meals are given compared with a single meal due to the low frequency of MMC.

7. **Age:** Elderly people, especially those over 70, have a significantly longer floating time. Disease conditions such as diabetes and Crohn’s disease also affect drug delivery.

8. **Posture:** Floating can vary between supine and upright ambulatory states of the patient.

**Evaluation of Floating Drug Delivery Systems**

Various parameters that need to be evaluated in gastro retentive formulations include floating duration, dissolution profiles, specific gravity, content uniformity, hardness, and friability in case of solid dosage forms. In the case of multiparticulate drug delivery systems, differential scanning calorimetry (DSC), particle size analysis, flow properties, surface morphology, and mechanical properties are also performed. In vivo evaluation is performed by X-ray, Gamma-scintigraphy, gastroscopy, and ultra sonography.

**Applications of Floating Drug Delivery Systems**

1. **Enhanced Bioavailability:**
   The bioavailability of riboflavin CR-GRDF is significantly enhanced in comparison to the administration of non-GRDF CR polymeric formulations. There are several different processes, related to absorption and transit of the drug in the gastrointestinal tract, that act concomitantly to influence the magnitude of drug absorption.

2. **Sustained drug delivery:**
   Oral CR formulations are encountered with problems such as gastric residence time in the GIT. These problems can be overcome with the HBS systems which can remain in the stomach for long periods and have a bulk density <1 as a result of which they can float on the gastric contents. These systems are relatively larger in size and passing from the pyloric opening is prohibited.

3. **Site specific drug delivery systems:**
   These systems are particularly advantageous for drugs that are specifically absorbed from the stomach or the proximal part of the small intestine. The controlled, slow delivery of drug to the stomach provides sufficient local therapeutic levels and limits the systemic exposure to the drug. This reduces side effects that are caused by the drug in the blood circulation. In addition, the prolonged gastric availability from a site directed delivery system may also reduce the dosing frequency. Eg: Furosemide and Riboflavin.

4. **Absorption enhancement:**
   Drugs which are having poor bioavailability because of site specific absorption from the upper part of the GIT are potential candidates to be formulated as floating drug delivery systems, thereby maximizing their absorption.

5. **Minimized adverse activity at the colon:**
   Retention of the drug in the HBS systems at the stomach minimizes the amount of drug that reaches the colon. Thus, undesirable activities of the drug in colon may be prevented. This Pharmacodynamic aspect provides the rationale for GRDF formulation for beta-lactam antibiotics that are absorbed only from the small intestine, and whose presence in the colon leads to the development of microorganism’s resistance.

6. **Reduced fluctuations of drug concentration:**
   Continuous input of the drug following crgrdf administration produces blood drug concentrations within a narrower range compared to the immediate release dosage forms. Thus, fluctuations in drug effects are minimized and concentration dependent adverse effects that are associated with peak concentrations can be prevented. This feature is of special importance for drugs with a narrow therapeutic index.

**Drugs Investigated in Floating Drug Delivery Systems**

Several drugs belong to various pharmacological categories were investigated in different types of Floating Drug Delivery Systems as shown in Table 1.
### Table 1: Drugs Investigated In Floating Drug Delivery Systems

<table>
<thead>
<tr>
<th>S. No</th>
<th>Types Of Dosage Forms</th>
<th>Drugs Explored In Floating Dosage Forms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Microspheres</td>
<td>Aspirin, Griseofulvine, P-Nitro Aniline, Ibuprofen, Ketoprofen, Terfenadine, Tranilast, Verapamil.</td>
</tr>
<tr>
<td>2</td>
<td>Granules</td>
<td>Diclofenac Sodium, Indomethacin, Prednisolone.</td>
</tr>
<tr>
<td>3</td>
<td>Films</td>
<td>Cinnarizine, Drug Delivery Device.</td>
</tr>
<tr>
<td>4</td>
<td>Capsules</td>
<td>Chloridiazepoxide Hcl, Diazepam, Furosemide, L-Dopa And Benserazide, Misoprostol, Nicardipine, Propranolol Hcl, Ursodeoxycholic Acid</td>
</tr>
<tr>
<td>5</td>
<td>Tablets/Pills</td>
<td>Acetaminophen, Aspirin, Amoxycillin Trihydrate, Ampicillin, Atenolol, Captoril, Ciprofloxacin, Chlormpheniramine Maleate, Cinnarizine, Furosemide, 5-Fluorouracil, Isosorbide Mononitrate, Diltiazem, Isosorbide Dinitrate, Nimodipine, Para Amino Benzoicacid, Piretanide, Prednisolone, Quinidine, Varapamil Hcl, Riboflavin, Sotalol, Theophylline.</td>
</tr>
</tbody>
</table>

**Recent Research on Floating Drug Delivery Systems:**

A summary of recent research on floating drug delivery systems is given in Table 2

**CONCLUSION**

Formulation of floating drug delivery systems is an efficient and potential approach for gastric retention of dosage forms to improve bioavailability and also to achieve controlled release. Though several approaches and techniques are developed for FDDS, research in this area is needed until an ideal system with applicability and industrial feasibility is developed.

### Table 2: Summary of Recent Research on Floating Drug Delivery Systems

<table>
<thead>
<tr>
<th>S. No</th>
<th>Drugs (Category)</th>
<th>Type of Dosage Form</th>
<th>Excipients / Polymers Used</th>
<th>Method</th>
<th>Reason / Results</th>
<th>Ref no</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Captopril (Anti Hypertensive-ACE inhibitor)</td>
<td>Core mini tablets</td>
<td>HPMCK100, Ethylcellulose 7cps, MCC.</td>
<td>Direct compression</td>
<td>Prolonged gastric residence time and Increased bioavailability.</td>
<td>47</td>
</tr>
<tr>
<td>2</td>
<td>Acyclovir (antiviral drug)</td>
<td>Tablet</td>
<td>Psyllium husk, HPMC K4M, sodium bicarbonate.</td>
<td>Wet granulation</td>
<td>Increased gastric residence time and bioavailability</td>
<td>48</td>
</tr>
<tr>
<td>3</td>
<td>Ciprofloxacin (First generation fluoroquinolone)</td>
<td>Tablet</td>
<td>HPMC 4M, K15M, K100M, Citric acid, anhydrous, sodium bicarbonate.</td>
<td>Direct compression</td>
<td>Improved GI absorption and controlled release of drug.</td>
<td>49</td>
</tr>
<tr>
<td>4</td>
<td>Clarithromycin (Macrolide antibiotic)</td>
<td>Tablet</td>
<td>HPMC K4M, sodium bicarbonate.</td>
<td>Wet granulation</td>
<td>Improved bioavailability.</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>Famotidine (Histmine H2receptor antagonist)</td>
<td>Gel beads</td>
<td>Sodium alginate, HPMC K15m.</td>
<td>Gelation method</td>
<td>Prolonged the gastric residence time upto 8hr and improved bioavailability.</td>
<td>51</td>
</tr>
<tr>
<td>6</td>
<td>Metformin (Antidiabetic)</td>
<td>Micro Capsule</td>
<td>Cellulose acetate butyrate, Eudragit</td>
<td>Solvent evaporation method</td>
<td>Enhanced absorption and improved bioavailability.</td>
<td>52</td>
</tr>
<tr>
<td>7</td>
<td>Propranolol HCL (Anti hypertensive)</td>
<td>Tablet</td>
<td>HPMC, HPC, Xanthan gum sodium alginate</td>
<td>Direct compression</td>
<td>Increase bioavailability and Gastric residence time.</td>
<td>53</td>
</tr>
<tr>
<td>8</td>
<td>Rantidine (Histmine H2receptor antagonist)</td>
<td>Tablet</td>
<td>HPMC K4M Guar gum, Xanthan gum</td>
<td>Direct compression</td>
<td>Increased Gastric residence time and better sustained effect.</td>
<td>54</td>
</tr>
<tr>
<td>No.</td>
<td>Drug Name</td>
<td>Formulation</td>
<td>Excipients</td>
<td>Preparation Method</td>
<td>Pharmacological Action</td>
<td></td>
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</tr>
<tr>
<td>9</td>
<td>Rifabutin (Anti-mycobacterial agent)</td>
<td>Beads</td>
<td>Deacetylated gellan gum</td>
<td>Ionotropic gelation in acidic medium</td>
<td>Sustained pharmacological action and improved bioavailability.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Silymarin (Anti-Oxident)</td>
<td>Tablet</td>
<td>Psyllium husk, HPMC K4M, K15M, sodium bicarbonate, crospovidone, MCC.</td>
<td>Direct compression</td>
<td>Prolonged drug release and improved bioavailability and patient compliance.</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Tizanidine HCL (central acting muscle relaxant)</td>
<td>Matrix tablet</td>
<td>HPMC, MCC PH 102, Dicalcium phosphate, Lactose</td>
<td>Wet granulation</td>
<td>Sustained release over 24hr.</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Zidovudine (antiviral drug)</td>
<td>Tablet</td>
<td>HPMC K4M, Xanthan gum, carboxapol 934P.</td>
<td>Direct compression</td>
<td>Improved bioavailability and control release.</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Itopride (peptic ulcer)</td>
<td>Matrix tablet</td>
<td>HPMC K100M, K4M, K15M, NaHCO3</td>
<td>Direct compression</td>
<td>Improved bioavailability.</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Hydro Chlor Thiazide (thiazide diuretic)</td>
<td>Microsphere</td>
<td>EC, cellulose seacate, cross linked PVP, polyacrylamide,PEG HPMC</td>
<td>Ionotropic gelation in acidic medium</td>
<td>Sustained and pH independent and reproducible drug release.</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Verapamil HCL (Anti hypertensive-calcium channel blocker)</td>
<td>Tablet</td>
<td>MCC 102, HPMC K4M, HPMC 15M.</td>
<td>Direct compression</td>
<td>PH dependent and controlled release was obtained.</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Atenolol (Beta adrenergic blocker)</td>
<td>Tablet</td>
<td>HPMC K4m, K100m, Directly compressible lactose, xanthan gum.</td>
<td>Direct compression</td>
<td>Prolonged gastric residence time.</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Foscarnet sodium (antiviral drug)</td>
<td>Alginate beads</td>
<td>HPMCK15m,Guar gum, Tamarind gum.</td>
<td>Ionic gelation method</td>
<td>Prolonged gastric residence time and increased bioavailability.</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Gabapentin (Anti-convulsant)</td>
<td>Tablet</td>
<td>HPMC K100M, K15M, PVPK30, MCC.</td>
<td>Direct compression</td>
<td>Increased bioavailability and Prolonged drug release.</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Metoprolol tartrate (cardio selective β blocker)</td>
<td>Core mini tablets</td>
<td>HPMC K15M, PVPK30, HCL, MCC.</td>
<td>Wet granulation</td>
<td>Increased gastric residence time.</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Retabutin (Anti-microbial)</td>
<td>Microspheres</td>
<td>Gellan gum</td>
<td>Ionic gelation</td>
<td>Remained buoyant up to 18h and provided controlled release.</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Verapamil HCL (Anti hypertensive)</td>
<td>Gel beads</td>
<td>Sodium alginate, calcium chloride.</td>
<td>Emulsion gelation technique</td>
<td>Prolonged drug release.</td>
<td></td>
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<tr>
<td>22</td>
<td>Rosiglitazone maleate (Antidiabetic)</td>
<td>Microsphere</td>
<td>Eudragit RS100, tributyletrate,heavy liquid paraffin, petroleum ether.</td>
<td>Emulsification-solvent evaporation method</td>
<td>Control release and improved bioavailability.</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Cefpodoxime Proxetil (cephalosporin prodrug)</td>
<td>Matrix tablet</td>
<td>HPMC K4M, sodium CMC, carboxapol 934P.</td>
<td>Direct compression</td>
<td>Prolonged gastric residence time and increased drug absorption and bioavailability.</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Cefuroxime HCI (Cephalosporin)</td>
<td>Matrix tablet</td>
<td>HPMC K4M, sodium bicarbonate.</td>
<td>Direct compression</td>
<td>Buoyancy over 8-24hr.</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Cinnarizine (Histmine H2receptor antagonist)</td>
<td>Gelling suspension</td>
<td>Sod alginate , calcium carbonate.</td>
<td>Ionic gelation</td>
<td>98.90% release in 12 hours over instant floating.</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Atorvastatin calcium (HMG-CoA reductase inhibitor)</td>
<td>Tablets</td>
<td>HPMC K4M, Ethyl cellulose Bees wax</td>
<td>Melt granulation</td>
<td>Drug release in a controlled manner for extended period of time.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drug Name</td>
<td>Formulation</td>
<td>Excipients</td>
<td>Method of Manufacture</td>
<td>Description</td>
<td>Page</td>
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</tr>
<tr>
<td>27</td>
<td>carbamazepine (Anti-convulsant)</td>
<td>Matrix tablet</td>
<td>HPMC, sodium bicarbonate, and EC</td>
<td>Melt granulation</td>
<td>Improved drug absorption and bioavailability.</td>
<td>73</td>
</tr>
<tr>
<td>28</td>
<td>Labetalol Hydrochloride (non-selective α,β-adreno receptor antagonist)</td>
<td>Matrix tablets</td>
<td>HPMCK4M, Carbopol 934P, Sod CMC, citric acid sodium bicarbonate.</td>
<td>Simplex Centroid Design</td>
<td>Improved bioavailability and controlled over 12hr.</td>
<td>74</td>
</tr>
<tr>
<td>29</td>
<td>Levofloxacin (antibiotic)</td>
<td>Tablet</td>
<td>Citric Acid and Sodium Bicarbonate. HPMC, EC.</td>
<td>Direct compression</td>
<td>Drug release with prolonged Period.</td>
<td>75</td>
</tr>
<tr>
<td>30</td>
<td>Lornoxicam (NSAID)</td>
<td>Matrix tablets</td>
<td>HPMC K15M, calcium carbonate (13%).</td>
<td>Direct compression</td>
<td>Prolonged gastric residence time and improved bioavailability.</td>
<td>76</td>
</tr>
<tr>
<td>31</td>
<td>Metoclopramide HCL (Anti-emetic)</td>
<td>Capsule</td>
<td>HPMK4M, Carbopol 934P, Sod CMC, mannitol, Sod alginate.</td>
<td>Capsule</td>
<td>Controlled drug release upto 6-8hr.</td>
<td>77</td>
</tr>
<tr>
<td>32</td>
<td>Montelukast (selective leukotriene receptor antagonist.)</td>
<td>Matrix tablets</td>
<td>HPM(K4M, K15M), xanthan gum sodium bicarbonate</td>
<td>Direct compression</td>
<td>Prolonged drug release over 24hr.</td>
<td>78</td>
</tr>
<tr>
<td>33</td>
<td>Nifedipine (calcium channel blocking agent)</td>
<td>Floating tablet</td>
<td>HPMC K100M</td>
<td>Fabrication</td>
<td>Prolonged gastric residence time, and controlled release over 24hr and improved bioavailability.</td>
<td>79</td>
</tr>
<tr>
<td>34</td>
<td>Nizatidine (an antiulcer)</td>
<td>Tablet</td>
<td>HPMC (K100, K4M, K15M &amp; K100M), sodium bicarbonate</td>
<td>Direct compression</td>
<td>Controlled rehalese and enhanced bioavailability.</td>
<td>80</td>
</tr>
<tr>
<td>35</td>
<td>Norfloxacin (antibiotic)</td>
<td>Tablet</td>
<td>HPMC K4M, HPMC K100M, and xanthan gum, citric acid</td>
<td>Direct compression</td>
<td>Increased bioavailability.</td>
<td>81</td>
</tr>
<tr>
<td>36</td>
<td>Ofloxacin (antibacterial)</td>
<td>Tablet</td>
<td>guar gum, locust bean gum, HPMC K100M, sodium bicarbonate</td>
<td>Wet granulation</td>
<td>Prolonged gastric residence time and controlled and uniform release.</td>
<td>82</td>
</tr>
<tr>
<td>37</td>
<td>Ondansetron HCL (OND) (selective serotonin 5HT3 receptor antagonist)</td>
<td>Coated pellets</td>
<td>HPMC-E6; Eudragit RL-100 (ERL) RS-100 (ERS), cetyl alcohol, NaHCO3, PEG6000</td>
<td>Direct compression</td>
<td>Prolonged gastric residence time and increased bioavailability.</td>
<td>83</td>
</tr>
<tr>
<td>38</td>
<td>Cephalexin (β-lactum antibiotic)</td>
<td>Tablet</td>
<td>Citric Acid, Sodium Bicarbonate. HPMC K100M.</td>
<td>Wet granulation</td>
<td>Drug release over 12hr</td>
<td>84</td>
</tr>
<tr>
<td>39</td>
<td>Piroxicam (NSAID)</td>
<td>Microspheres</td>
<td>Eudragit S 100; Polyvinyl alcohol (0.1-0.5 g)</td>
<td>Emulsification solvent-evaporation</td>
<td>Sustained drug delivery.</td>
<td>85</td>
</tr>
<tr>
<td>40</td>
<td>Pregabalin (Anti convulsent)</td>
<td>Matrix tablet</td>
<td>HPMC K4M ethyl cellulose, crosovidone</td>
<td>Wet granulation</td>
<td>Improved bioavailability.</td>
<td>86</td>
</tr>
<tr>
<td>41</td>
<td>Rabeprazole sodium (Anti-ulcer)</td>
<td>Microspheres</td>
<td>HPMC, Ethyl cellulose and Chitosan</td>
<td>Solvent evaporation</td>
<td>Polongation of gastric retention time and enhanced drug absorption and bioavailability</td>
<td>87</td>
</tr>
<tr>
<td>42</td>
<td>Tinidazole (Antibacterial and anti protozoal)</td>
<td>Tablet</td>
<td>HPMC, Sodium bicarbonate, citric acid.</td>
<td>Direct compression</td>
<td>Good Controlled release improved bioavailability.</td>
<td>88</td>
</tr>
<tr>
<td>43</td>
<td>Tramadol (Opioid analgesic)</td>
<td>Matrix tablet</td>
<td>15M, HPMC 100 LV, Sodium bicarbonate, gum tragacanth,</td>
<td>Direct compression</td>
<td>Prolonged gastric residence time and enhanced bioavailability.</td>
<td>89</td>
</tr>
<tr>
<td>No.</td>
<td>Drug</td>
<td>Formulation Details</td>
<td>Delivery System Characteristics</td>
<td></td>
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<td>44</td>
<td>Amoxicillin trihydrate</td>
<td>Matrix tablet HPMC K4M, xanthan gum, ethocel,</td>
<td>Sustained release over 12hr.</td>
<td></td>
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<tr>
<td>45</td>
<td>Glipizide.</td>
<td>Matrix tablets HPMC K100M, sodium alginate, Carbopol 940, and PVP K30</td>
<td>Prolonged gastric retention and improved bioavailability</td>
<td></td>
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<tr>
<td>46</td>
<td>Perindopril erbumine</td>
<td>Microspheres Ethyl cellulose, HPMC K4M, Eudragit S100, PVP K30 &amp; PVP K90</td>
<td>Double emulsion solvent diffusion method</td>
<td></td>
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<tr>
<td>47</td>
<td>Trimitazidin Dihydro chloride</td>
<td>Microspheres Chitosan</td>
<td>Capillary extrusion technique</td>
<td></td>
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<tr>
<td>48</td>
<td>Acetazolamide</td>
<td>Microspheres HPMC K15M, Ethyl cellulose 25 cps</td>
<td>Non aqueous solvent evaporation method</td>
<td></td>
<td></td>
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<tr>
<td>49</td>
<td>Ketorolac trometamol (NSAID)</td>
<td>Microspheres Ethyl cellulose, HPMC K4M, Eudragit S100, Eudragit 100</td>
<td>Improved absorption and bioavailability.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>50</td>
<td>Boswellic acid</td>
<td>Microspheres Ethyl cellulose, HPMC</td>
<td>Remained buoyant for more than 12h.</td>
<td></td>
<td></td>
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</table>

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