Design and Evaluation of Floating Microspheres of Pantoprazole Sodium

Behin Sundara Raj1 *, Jigar Pancholi2, Punitha Isaac Samraj3

1School of Pharmacy, Curtin University, Bentley, Perth, Western Australia – 6102
2Department of Pharmaceutics, Shree Devi college of Pharmacy, Airport Road, Kenjar, Mangalore, Karnataka, India – 574 142
3Department of Pharmacognosy, Shree Devi college of Pharmacy, Airport Road, Kenjar, Mangalore, Karnataka, India – 574 142

Abstract

In the present study, an attempt was made to prepare floating microspheres of Pantoprazole sodium by a non-aqueous solvent evaporation method. The half-life of Pantoprazole sodium is 1-1.5 hours and rapidly eliminated from the body. It is in a perfect world suited to be conveyed through floating multiunit measurements structure. Biocompatible polymers, Eudragit S100 and HPMC K 100M were utilized alongside the medication as a part of diverse extents. The prepared six formulations (F1-F6) were characterized for their drug polymer compatibility (IR study), micromeritic properties, particle size, percentage yield, scanning electron microscopy, buoyancy studies, drug encapsulation efficiency and in vitro drug release studies. The formulated microspheres were found to be free flowing. The optical microscopic studies revealed that the particles were of the size range of 193.29-517.16 μm. SEM studies indicated that the microspheres were porous and almost spherical in shape. The prepared floating microspheres were found to produce the percentage yield of 84.43-91.93%, drug encapsulation efficiency was 65.83-90.03% and buoyancy percentage was 61.7-78.46%. In vitro drug release studies showed cumulative percentage drug release between 69.27-79.06%. The information acquired in this study recommends that a micro particulate floating dose type of Pantoprazole sodium can be effectively intended to give delayed arrival of medication and thus enhanced bioavailability.

1 Introduction

Late experimental and patent writing shows expanded enthusiasm for scholastics and mechanical exploration gatherings with respect to the novel measurement shapes that can be held in the stomach for a delayed and unsurprising timeframe. A standout amongst the most attainable methodologies for accomplishing a drawn out and unsurprising medication conveyance profile in the gastro intestinal (GI) tract is to control the gastric residence time (GRT), utilizing gastro retentive drug delivery systems (GRDDS) that will give us new and imperative remedial alternatives.1

GRDDS can remain in the gastric region for several hours and significantly prolong the gastric residence time of drugs. Drawn out gastric maintenance enhances bioavailability, lessens drug wastage, and enhances solvency of medications that are less dissolvable in a high pH environment. It has applications likewise for nearby medication conveyance to the stomach and proximal small insides. Gastro maintenance serves to give better accessibility of new items with new helpful potential outcomes and considerable advantages for patients2.

A number of frameworks have been used to increase the GRT of dosage forms by employing a variety of concepts. These frameworks have been characterized by essential standards of gastric maintenance as floating medication frameworks, bioadhesive frameworks, swelling and growing frameworks and high-thickness frameworks3.

Floating microspheres are gastro retentive drug delivery systems based on the non-effervescent approach. Empty microspheres are in a strict sense, circular vacant particles without a center. These microspheres are distinctively free streaming powders comprising of proteins or engineered polymers, in a perfect world having a size under 200 micrometers. Strong biodegradable microspheres fusing a
medication scattered or broke down all through molecule lattice have the potential for controlled arrival of medications\textsuperscript{4,5}. Floating microspheres can be prepared by solvent diffusion and evaporation, solvent evaporation and spray drying methods. In the present work, we prepared floating microspheres of Pantoprazole sodium by non-aqueous solvent evaporation method. We worked on prolonging its gastric residence time, with the aim of improving the oral bioavailability of the drug.

2 Material and Methods

2.1 Materials

Pantoprazole sodium and HPMC K100M were gift samples and provided by Cadila Pharmaceuticals, Ahmedabad, Gujarat, India. Eudragit S100 was purchased from Yarrow Chemicals, Mumbai, India. Ethanol was procured from Poly Pharma Laboratories, Gujarat. Dichloromethane was purchased from Finar Chemicals, Ahmedabad. All other chemicals and reagents used were of laboratory or analytical grade.

2.2 Methods

2.2.1 Compatibility studies of Pantoprazole sodium and polymers

An FTIR spectrum helps to confirm the identity of the drug and to detect the interaction of the drug with the carriers\textsuperscript{6,7,8}. IR spectroscopy of pure drug and the physical mixture of the drug with polymers were carried out to check the compatibility of drug and polymers. The IR spectra of the drug with polymers was compared with the standard IR spectrum of the pure drug. Infrared spectra of Pantoprazole Sodium, HPMC K100M, Eudragit S-100 and formulations F1, F4 were carried out by using KBr pellet technique and recorded on an FTIR 4100 type A Jasco International co ltd, Japan.

2.2.2 Preparation of floating microspheres of Pantoprazole sodium

The floating microspheres of Pantoprazole sodium were prepared by nonaqueous solvent evaporation method\textsuperscript{6,9-11} using different polymers as follows:

Microspheres containing Pantoprazole sodium as a core material were prepared by Non-aqueous Solvent Evaporation method. Drug and HPMC or Drug and Eudragit S-100 were mixed in Ethanol: Dichloromethane at various ratios. The slurry was slowly introduced into 50 ml of liquid paraffin containing 1% tween 80 as an emulsifying agent while being stirred at 1400 rpm by a mechanical stirrer equipped with a three bladed propeller at room temperature. The solution was stirred for 4h to allow the solvent to evaporate completely, and the microspheres were collected by filtration. The microspheres were repeatedly washed with n-hexane until free from oil. The collected microspheres were dried for 1h at room temperature and subsequently stored in a desiccator.

2.3 Evaluation of Pantoprazole sodium floating microspheres

2.3.1 Micromeritic properties

The microspheres were characterized by their micromeritic properties such as particle size, bulk density, tapped density, compressibility index, Hausner's ratio and angle of repose\textsuperscript{12,13}.

2.3.2 Particle size

The particle size was measured by microscopic technique\textsuperscript{7,8}. The suspension of floating microspheres was prepared using castor oil. A drop of suspension was mounted on a slide and observed under the optical microscope. About 100 particles were measured with the help of the eye piece micrometer. All the microspheres in a field were counted.

\[
\text{Mean particle size} = \frac{\text{Total sum of particle size}}{\text{Total number of particles}}
\]

2.3.3 Bulk density

In this method, floating microspheres were transferred to a measuring cylinder and is tapped manually till a constant volume is obtained\textsuperscript{7,12}. This volume is bulk volume, and it includes the true volume of the powder and the void space between the microspheres.

\[
\text{Bulk density} = \frac{\text{Mass of microspheres}}{\text{Bulk volume}}
\]

2.3.4 Tapped density

In this method, floating microspheres were transferred to a measuring cylinder and tapped for 100 times\textsuperscript{8,12,14,15}. After tapping the volume of microspheres was visually examined. The ratio of the mass of microspheres to the volume of microspheres after tapping gives tapped density of the floating microspheres.

\[
\text{Tapped density} = \frac{\text{Mass of microspheres}}{\text{Volume of microspheres after tapping}}
\]

2.3.5 Carr’s compressibility index

This is an important property of maintaining uniform weight\textsuperscript{16,17}:

\[
\text{Carr’s compressibility index} = \frac{\text{Tapped density} - \text{Bulk density}}{\text{Tapped density}} \times 100
\]
Lower compressibility values indicate better flow.

2.3.6 Hausners ratio

Hausners ratio of microspheres was determined by comparing tapped density to bulk density using the equation.

\[
\text{Hausners ratio} = \frac{\text{Bulk density}}{\text{Tapped density}}
\]

Values less than 1.25 indicates good flow (= 20% Carr), whereas greater than 1.25 indicates poor flow (= 33% Carr).

2.3.7 Angle of repose

The angle of repose (θ) of the microspheres, measures the resistance to particle flow, was determined by a fixed funnel method. The height of the funnel was adjusted in such a way that the tip of the funnel just touches the heap of the blends. Accurately weighed microspheres were allowed to pass through the funnel freely onto the surface. The height and radius of the powder cone were measured, and angle of repose was calculated using the following equation.

\[
\theta = \tan^{-1} \frac{h}{r}
\]

Where,

θ - Angle of repose

h - Height of granules above the flat surface

r - Radius of the circle formed by the granule heap.

2.4 Percentage yield of floating microspheres

The prepared floating microspheres with a size range of 102–420 µm was collected and weighed. The measured weight was divided by the total amount of all non-volatile components which were used for the preparation of microspheres.

\[
\text{% yield} = \frac{\text{Actual weight of product}}{\text{Total weight of excipient and drug}} \times 100
\]

2.5 In-vitro buoyancy

Floating microspheres (equivalent to 150 mg) were dispersed in 900 ml of 0.1 N hydrochloric acid solution (pH 1.2) containing tween 80 (0.01 W/V %) / tween 20 (0.02 W/V %) and was measured by crushing the microspheres and extracting the drug using simulated gastric fluid (SGF) (pH 7.4) (10 ml). The extract was filtered, and from the filtrate 10 ml was taken and further diluted to 100 ml, and the absorbance was measured at 230 nm against SGF (pH 7.4) as blank.

\[
\text{Buoyancy (€)} = \frac{W_f}{W_f + W_s} \times 100
\]

Wf andWs are the weights of the floating and settled microspheres. All the determinations were made in triplicate.

2.6 Estimation of drug loading/encapsulation efficiency

Microspheres weighing 25 mg were taken for evaluation. The amount of drugs entrapped was estimated by crushing the microspheres and extracting the drug using simulated gastric fluid (SGF) (pH 7.4) (10 ml). The extract was filtered, and from the filtrate 10 ml was taken and further diluted to 100 ml, and the absorbance was measured at 230 nm against SGF (pH 7.4) as blank.

\[
\text{% Drug entrapment efficiency} = \frac{\text{amount of drug actually present}}{\text{theoretical drug load expected}} \times 100
\]

\[
\text{% Drug loading} = \frac{\text{weight of drug present in microspheres}}{\text{total weight of microspheres}} \times 100
\]

2.7 Scanning electron microscopy

The morphological study was carried out by Scanning Electron Microscope. SEM studies were carried out by using JEOL JSM-6380 LA scanning electron microscope (Japan). The samples of SEM were prepared by lightly sprinkling the microspheres powder on a double adhesive tape, which was stuck on an aluminium stub. The stubs were then coated with gold to the thickness of about 200 Å using a sputter coater. The photomicrographs were taken with the help of SEM analyzer.

2.8 In-vitro drug release studies

A USP XXIII basket type dissolution apparatus was used to study the in-vitro drug release from microspheres. A weighed amount of floating microspheres equivalent to 40 mg drug was filled into the capsule and placed in the basket. Dissolution medium used was SGF (pH 1.2) 900 ml, containing 0.02% tween 20 maintained at 37±0.1°C and stirred at 100 rpm for 1 h. 10 ml of sample was withdrawn at predetermined time interval, diluted and was analyzed for drug content spectrophotometrically at 289 nm against suitable blank. The volume was replenished with the same amount of phosphate buffer pH 6.8 with tween 80 (0.01 W/V%) / tween 20 (0.02 W/V%) to simulate gastric fluid. 10 ml of sample was analyzed by spectrophotometrically at 289 nm against suitable blank.
withdrawn at different time intervals and replaced with fresh phosphate buffer. The amount of drug released was analyzed at 289 nm using UV-visible spectrophotometer (UV-1800, shimadzu, japan).

2.9 Drug release analysis

To analyze the mechanism for the release and release rate kinetics of the formulated dosage form, the data obtained from conducted studies was fitted into Zero order, First order, Higuchi’s matrix, Peppas and Hixson Crowell model. By comparing the r-values obtained, the best-fit model was selected\textsuperscript{6,21}.

3 Results and Discussions

3.1 Compatibility studies of Pantoprazole sodium and polymers

The FTIR spectra of Pantoprazole and polymers are shown in figure 1A-1C. Our experimental results were assessed on the basis of physical data obtained for drug and polymers as well as formulations. The medication Pantoprazole displayed CH retentions from 2941.3 cm\textsuperscript{-1} demonstrates the vicinity of aromatic and additionally aliphatic CH vibrations. The strong S=O absorption peak was noticed at 1041.37 cm\textsuperscript{-1}. The peak at 1775.5 cm\textsuperscript{-1} shows N-H stretching indicating the presence of amine group. The spectrum also shows a peak at 1590.02 cm\textsuperscript{-1}. The peak in this range is due to C-N stretching. The peak at 1304.61 cm\textsuperscript{-1} is the presence of C-F stretching.

Another polymer Eudragit S 100 showed broad peak at 3500 cm\textsuperscript{-1} corresponding to carboxylic acid moiety present in the polymer. The aliphatic C-H absorption peaks of this molecule were observed around 2953 cm\textsuperscript{-1}. These data are in conformity with the structure of polymer taken for the formulation.

The floating microspheres were obtained with drug Pantoprazole and polymer eudragit S 100 (Formulation F4- F6) as per the procedure described earlier. The strong S=O absorption peak was noticed at 1041.37 cm\textsuperscript{-1}. The peak at 1729.83 cm\textsuperscript{-1} indicates N-H stretching confirming the presence of amine group. The peak at1590.02 cm\textsuperscript{-1} is due to C-N stretching. The spectrum showed the peak at 1304.61 cm\textsuperscript{-1} was due to C-F stretching.

The IR spectra of the medication and physical blend, showed peaks in the same area, which affirmed there was no association in the middle of medication and polymer and there was no incompatibility of medication in the vicinity of the used polymers.

3.2 Preparation of floating microspheres of Pantoprazole sodium

Calibration curve for the estimation of Pantoprazole sodium was constructed in 7.4 pH buffer at 289 nm. The method obeyed Beer’s Lambert law in the range of 10 to 50 mcg/ml. Floating microspheres of Pantoprazole sodium using different grades of HPMC polymer was prepared by emulsion solvent evaporation method as shown in table 1. The emulsion was stabilized by tween-80 and the volatile solvent evaporate leaving a solidified thin film at the interface between the aqueous phase and the organic phase, where Pantoprazole sodium is encapsulated in the core-coat of polymers.
Table 1: Formulation of floating microspheres of Pantoprazole sodium

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Formulation code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F1</td>
</tr>
<tr>
<td>HPMC K100M</td>
<td>0.50</td>
</tr>
<tr>
<td>Eudragit S 100</td>
<td>-</td>
</tr>
<tr>
<td>Lansoprazole</td>
<td>0.50</td>
</tr>
<tr>
<td>Dichloromethane</td>
<td>30</td>
</tr>
<tr>
<td>Ethanol</td>
<td>30</td>
</tr>
</tbody>
</table>

3.3 Evaluation of floating microspheres of Pantoprazole sodium

3.3.1 Micromeritic properties

The mean particle size of the microspheres formulation F1 to F3 containing the different polymer ratio of HPMC K 100 M and Eudragit S-100 were in the range of 193.29±13.8 µm to 517.16±3.25 µm respectively. The mean molecule size of the microspheres arranged by utilizing HPMC K 100 M was observed to be bigger contrasted with the microspheres arranged by utilizing Eudragit S-100. The medium's thickness is expanded at a higher HPMC K 100M fixation bringing about improved interfacial pressure. Shearing proficiency additionally lessened at higher viscosities. This brought about the development of bigger particles.

The bulk density, tapped density, hausners ratio of formulation F1 to F6 containing different polymer concentration of HPMC K 100M and Eudragit S-100 formulation was in the range of 0.3522±0.007 to 0.4220±0.010 gm/cm³ (Table 2).

Table 2: Micromeritic properties of floating microspheres of Pantoprazole sodium

<table>
<thead>
<tr>
<th>Formulation code</th>
<th>Mean particle size (gm/cm³)</th>
<th>Bulk density (gm/cm³)</th>
<th>Tapped density (gm/cm³)</th>
<th>Hausners ratio</th>
<th>Carr’s index (%)</th>
<th>Angle of repose</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>256.32±2.54</td>
<td>0.4220±0.010</td>
<td>0.4964±0.018</td>
<td>0.8501±0.04</td>
<td>17.63±0.11</td>
<td>34.38±1.71</td>
</tr>
<tr>
<td>F2</td>
<td>479.57±2.52</td>
<td>0.3754±0.012</td>
<td>0.4380±0.015</td>
<td>0.8561±0.05</td>
<td>16.80±0.64</td>
<td>33.11±1.89</td>
</tr>
<tr>
<td>F3</td>
<td>517.16±3.25</td>
<td>0.3522±0.007</td>
<td>0.4109±0.014</td>
<td>0.8571±0.03</td>
<td>16.67±0.24</td>
<td>34.82±2.78</td>
</tr>
<tr>
<td>F4</td>
<td>193.29±13.8</td>
<td>0.3532±0.024</td>
<td>0.4204±0.014</td>
<td>0.8401±0.01</td>
<td>19.03±0.33</td>
<td>36.96±1.93</td>
</tr>
<tr>
<td>F5</td>
<td>253.58±2.27</td>
<td>0.3447±0.015</td>
<td>0.3927±0.015</td>
<td>0.8778±0.02</td>
<td>13.92±0.26</td>
<td>28.84±1.80</td>
</tr>
<tr>
<td>F6</td>
<td>309.32±2.25</td>
<td>0.3868±0.012</td>
<td>0.4448±0.021</td>
<td>0.8696±0.01</td>
<td>14.99±0.33</td>
<td>30.74±1.43</td>
</tr>
</tbody>
</table>
Table 3: Percentage yield, in-vitro buoyancy and incorporation efficiency of floating microspheres of Pantoprazole sodium

<table>
<thead>
<tr>
<th>Formulation code</th>
<th>Percentage yield (%)</th>
<th>In vitro buoyancy (h)</th>
<th>Drug loading (%)</th>
<th>Drug entrapment efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>84.43±0.53</td>
<td>61.71±1.52</td>
<td>44.91±1.69</td>
<td>69.80±2.72</td>
</tr>
<tr>
<td>F2</td>
<td>87.63±0.69</td>
<td>64.23±2.07</td>
<td>26.64±1.76</td>
<td>70.02±2.84</td>
</tr>
<tr>
<td>F3</td>
<td>86.36±0.51</td>
<td>62.96±1.04</td>
<td>19.07±1.53</td>
<td>65.83±2.17</td>
</tr>
<tr>
<td>F4</td>
<td>88.30±0.66</td>
<td>71.34±2.02</td>
<td>43.83±1.19</td>
<td>77.41±1.01</td>
</tr>
<tr>
<td>F5</td>
<td>91.93±0.43</td>
<td>78.46±1.07</td>
<td>32.64±1.24</td>
<td>90.03±1.59</td>
</tr>
<tr>
<td>F6</td>
<td>87.05±0.72</td>
<td>74.59±2.06</td>
<td>24.21±1.03</td>
<td>84.31±2.46</td>
</tr>
</tbody>
</table>

3.6 Drug entrapment efficiency

The drug entrapment efficiency of formulations F1 to F6 containing different concentrations of HPMC K100M and Eudragit S-100 formulations was in the range of 65.83±2.17% to 90.03±1.59% (Table 3). Among all the prepared formulations, F5 (90.03±1.59%) results demonstrated that the increase in the concentration of polymer increased the entrapment of the drug. The drug entrapment efficiency was found to be good in all the formulations.

3.7 Scanning electron microscopy (SEM)

Morphology of microspheres was examined by scanning electron microscopy. The view of the microspheres showed a spherical structure with a smooth surface morphology (Figure 2A-2D). Some of the microspheres showed a dented surface structure, but they showed good floating ability on the surface of the medium, indicating intact surface. The outer surface of the microspheres was smooth and dense while the internal surface was porous. The shell of the microspheres also showed some porous structure. It may be caused by the evaporation of solvent entrapped within the shell of microspheres after forming a smooth and dense skin layer.

3.8 In-vitro drug release

In-vitro drug release studies of pantoprazole sodium from floating microspheres were performed at pH 1.2 and pH 7.4 for 10 h in the dissolution test apparatus. Formulations F1- F6 showed the percentage drug release in the range of 69.27±1.10 to 79.06±0.49% at the end of 10 h. Amongst the formulation F3 was found to be the best formulation as it released pantoprazole 79.06±0.49% in a sustained manner with constant fashion over an extended period of time (after 10 h).

It was seen as the grouping of polymers was expanded rate arrival of pantoprazole sodium diminished. The increment in polymer focus prompts the expanded thickness of polymer grid in the microspheres which brought about an expanded diffusional way length. This may diminish the general medication discharge from the polymer grid. Besides, litter microspheres were framed at lower polymer fixation and has bigger surface territory presented to the disintegration medium. The r values of Zero order of the above six formulations were in the range of 0.9665 to 0.9988. Similarly, the r-values of the first order were in between 0.9195 to 0.9761 (Table 4). The results suggest that the drug was released by mixed order kinetics. It suggests that the Higuchi diffusion plots of all the formulations were fairly linear, and we can conclude that the drug was released by Higuchi’s diffusion mechanism. The formulations were also treated to Peppa’s plot by taking log percent versus log time. The plots were fairly linear, and the regression values (n value) of all the formulations ranged from the lowest 0.9374 to highest 1.1730 (Table 4), which is in the range of > 0. 89. This suggested that the drug was released by super case-II transport with swelling.

4 Conclusions

Gliding microspheres of Pantoprazole sodium can be effectively arranged utilizing HPMC and Eudragit S-100 as polymers by emulsion solvent evaporation. The rate yield of all floating microspheres was more than 80% recommending that the system utilized for epitome was viable. In addition, it was seen that on
expanding the measure of polymer in definition it upgrades the rate of gliding microspheres. The entanglement proficiency was more than 80%. This recommended that improved parameters were utilized as a part of the strategy for readiness.

Figure 2: A - Scanning Electron Microscope Photographs of Formulation F1, B - Formulation F3, C - Formulation F5 and D - Formulation F6

The in-vitro buoyancy was more than 65% after 10 h indicates the satisfactory performance of proposed formulations. The percentage buoyancy increased significantly as the amount of polymer was increased in each preparation method. The mean particle size of microspheres was in the range of 193.29-517.16 µm depending upon the type of polymer used. The particle size increased significantly as the amount of polymer increased.

The flow properties of all the prepared microspheres were good as indicated by the low angle of repose (θ<40º) and low carr’s index (I<20). The good flow properties suggested that the microspheres produced were non-aggregated.

The in-vitro release of floating microspheres of Pantoprazole sodium was found to be in following the order F3>F1>F2>F4>F6>F5. In vitro drug release studies showed that the drug release was more in case
of formulations F1-F3 containing HPMC K 100M and formulations F4-F6 containing only Eudragit S-100. In-vitro release data fitted into various kinetic models suggests that the release obeyed mixed order kinetic, Higuchi’s diffusion mechanism, and super case-II transport. Finally, it was concluded that the prepared floating microspheres of Pantoprazole sodium may prove to be a potential candidate for safe and effective sustained drug delivery over an extended period of time which can reduce dosing frequency.

Table 4: Kinetics data obtained from in-vitro release profile for floating microspheres of Pantoprazole sodium

<table>
<thead>
<tr>
<th>Formulation code</th>
<th>Zero-order kinetic data</th>
<th>First-order kinetic data</th>
<th>Higuchi matrix data</th>
<th>Peppas kinetic data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regression Coefficient (r)</td>
<td>Regression Coefficient (r)</td>
<td>Regression Coefficient (r)</td>
<td>Regression Coefficient (r)</td>
</tr>
<tr>
<td>F1</td>
<td>0.9877</td>
<td>0.9249</td>
<td>0.9566</td>
<td>0.9900</td>
</tr>
<tr>
<td>F2</td>
<td>0.9988</td>
<td>0.9761</td>
<td>0.9836</td>
<td>0.9991</td>
</tr>
<tr>
<td>F3</td>
<td>0.9981</td>
<td>0.9457</td>
<td>0.9739</td>
<td>0.9990</td>
</tr>
<tr>
<td>F4</td>
<td>0.9959</td>
<td>0.9507</td>
<td>0.9579</td>
<td>0.9982</td>
</tr>
<tr>
<td>F5</td>
<td>0.9866</td>
<td>0.9411</td>
<td>0.9531</td>
<td>0.9986</td>
</tr>
<tr>
<td>F6</td>
<td>0.9665</td>
<td>0.9195</td>
<td>0.9315</td>
<td>0.9969</td>
</tr>
</tbody>
</table>

5 Acknowledgements
The authors would like to thank Shree Devi Education Trust, Mangalore for providing the necessary facilities to carry out the research work. We also thank Cadila Pharmaceuticals, Ahmedabad, Gujarat for supplying free samples of Pantoprazole sodium and HPMC.

6 Conflicts of interests
The authors declare that they have no competing interests.

7 Authors contributions
BS and PIS carried out literature review and preparation of the manuscript. JP participated in the collection of data. All authors read and approved the final manuscript.

8 References


