ABSTRACT

Objectives: Objective of present study involves preparation and evaluation of floating microballoons of Stavudine. It is a potent antiviral agent, used for treatment of human immunodeficiency virus (HIV) infection. In present study Stavudine is used as a model drug, to increase its residence time in the stomach without contact with the mucosa.

Methods: Eight floating microballoons formulations of Stavudine were prepared by using different polymers i.e. Eudragit S100, EC and PVP K30, in different ratio by emulsion solvent diffusion method. The microballoons were prepared by the emulsion solvent diffusion technique using different ratio of polymers (Eudragit S100, Ethyl cellulose and PVP K 30) as carriers.

Results: The mean particle diameter of the microballoons was between 230.23-238.33μm. The yield of microballoons was up to 68.32-80.22%. The cumulative percent drug release after 24 hrs of the Stavudine microballoons was in the range of 53.62 to 87.45%. The mean percentage buoyancy of the microballoons was between 69.23-82.53%. The cumulative percent drug release after 24 hrs of the Stavudine microballoons was 53.62 to 87.45%.

Conclusion: Stavudine floating microballoons formulations of batch MB4 was concluded as the optimum formulations among the all 8 formulations based on different parameters. Study concludes that stavudine can be delivered through floating microballoons dosage form in an effective way.

Keywords: Emulsion solvent diffusion method, floating drug delivery system, floating microballoons, Stavudine.
MATERIALS AND METHODS
Stavudine was received as gift sample from ASPEN Pharmcare NIG. LTD, Eudragit S 100 from BOLAR Pharmaceuticals Ltd, and EC from Drugfield Pharmaceuticals Ltd, Nigeria. All other chemicals were of analytical grade.

Development of floating microballoons
Stavudine floating microballoons were prepared by emulsion solvent diffusion method. 200 mg Stavudine and polymers in different ratio were mixed in ethanol by using blending solvent dichloromethane and heavy liquid paraffin. The slurry was introduced into 250ml beaker containing 0.2% Tween 80. The stirring was done for 2hrs at 1000-1200 rpm by mechanical stirrer equipped with four bladed propellers, to evaporate the volatile solvent. After evaporation of solvent, microballoons were collected by filtration, washed with water and dried at room temperature in a desiccator for 24 h. The composition of different formulations are shown in Table 1.

Table 1: Composition of floating microballoons formulations of Stavudine

<table>
<thead>
<tr>
<th>Batch code</th>
<th>Eudragit S100 (mg)</th>
<th>EC (mg)</th>
<th>PVP (mg)</th>
<th>Tween 80 (mg)</th>
<th>Di-chloromethane: Ethanol ::1:1</th>
<th>Liquid Paraffin (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB1</td>
<td>200</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>MB2</td>
<td>-</td>
<td>200</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>MB3</td>
<td>100</td>
<td>200</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>MB4</td>
<td>200</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>MB5</td>
<td>-</td>
<td>200</td>
<td>100</td>
<td>5</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>MB6</td>
<td>-</td>
<td>100</td>
<td>200</td>
<td>5</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>MB7</td>
<td>100</td>
<td>-</td>
<td>200</td>
<td>10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MB8</td>
<td>200</td>
<td>-</td>
<td>100</td>
<td>10</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

EVALUATION PARAMETERS
1. % Yield of microballoons: Percentage yield of microballoons was calculated using the following formula:

\[ \text{% Yield} = \left( \frac{\text{Actual weight of product}}{\text{Total weight of Product}} \right) \times 100 \]

2. Microballoons size: The size was measured using an optical microscope and the mean microballoons diameter was calculated by measuring 100 particles with the help of a calibrated ocular micrometer.

3. Sphericity of the microballoons
Sphericity, of prepared microballoons were taken on a black paper using camera lucida. Circulatory factor (S) was calculated using,

\[ S = \frac{P^2}{12.56 \times A} \]

Where A is area (cm²) and, P is the perimeter of the circular tracing.

4. Drug entrapment efficiency
Accurately weighed 10 mg of crushed microballoons were dissolved in 0.1N HCl, and then transferred to 100 ml volumetric flask. The volume was made up to 100 ml with 0.1N HCl. The solution was filtered using Whatman filter paper no. 41. The samples were assayed for drug content using UV spectrophotometry at 265nm.

The amount of drug entrapped in the microballoons was calculated by the following formulae:

\[ \text{Entrapment efficiency} = \left( \frac{\text{Amount of drug actually present}}{\text{Theoretical drug load expected}} \right) \times 100 \]

5. Assessment of in-vitro buoyancy
The floating microballoons about 100 mg were spread over the surface of the dissolution medium of 900 ml simulated gastric fluid (SGF, pH 2.0), which is placed in USP dissolution apparatus II. The medium temperature was maintained at 37°C and was agitated by paddle at 100 rpm. After agitation the microballoons that floated over the surface of the medium and those that settled down at bottom of the flask were recovered separately and dried. The percentage of floating microballoons was determined by the following equation:

\[ \text{Buoyancy (%) = } \left( \frac{WF}{WF + WS} \right) \times 100 \]

Where WF and WS are the weight of floating and settled microballoons respectively.

6. In-vitro drug release studies
The in-vitro dissolution studies were carried out by using USP II paddle type dissolution apparatus. Accurately 100 mg of microballoons was introduced into 900 ml of 0.1 N HCl (pH 2), used as a dissolution medium, maintained at a temperature of 37°C, and a rotational speed of 100 rpm. Samples were withdrawn at predetermined time intervals of every one hour for twelve hours. The samples were analyzed UV spectrophotometrically at 265 nm to determine the percentage of drug release.

RESULTS AND DISCUSSION
Eight floating microballoons formulations of Stavudine were prepared by using different polymers i.e. Eudragit S100, EC and PVP K30, in different ratio by emulsion solvent diffusion method. The mean particle diameter of the microballoons was between 230.23-238.33µm. In general as the polymer concentration increases, the particle size also increases. This is because the viscosity of the polymer solution increases with increasing polymer concentration, which in turn decreases the stirring efficiency. The sphericity factor obtained for the microballoons lies in the range of 1.04-1.14. The sphericity value nearer to 1 indicates that the prepared formulations were spherical in nature. High incorporation efficiencies are seen with lower concentrations of polymer with the drug. The percentage entrapment efficiency of the microballoons was between 74.64-85.37%. The percentage yield of the microballoons was between 68.32-85.37%. The purpose of preparing floating microballoons was to extend the gastric residence time of a drug.
The floating ability test was carried out to investigate the floatability of the prepared microballoons. The mean percentage buoyancy of the microballoons was between 69.23-82.53%. In-vitro buoyancy studies reveal that in spite of stirring the dissolution medium for more than 12 hrs formulations were still continued to float without any apparent gelation, thus indicating that microballoons exhibit excellent buoyancies which can be attributed to the pores and cavities present in them.

In general with increase in the amount of polymers there is an increase in the buoyancy percentage. The increase in the buoyancy percentage may be attributed to air which caused swelling because of increased amount of the polymers present. The good buoyancy behavior of the microballoons may be attributed to the hollow nature of the microballoons.

The cumulative percent drug release after 24 hrs of the Stavudine microballoons was 53.62 to 87.45%. Maximum percent release was shown by formulation containing Eudragit S 100 and Ethylcellulose of batch MB4. It was also observed that the drug release generally decreased as the polymer ratio increased. The release of the drug was retarded due to the hydrophobic and insoluble nature of the polymers used. The increased density of the polymer matrix at higher concentrations results in an increased diffusion path length. This may decrease the overall drug release from the polymer matrix. Furthermore, smaller microballoons are formed at a lower polymer concentration and have a larger surface area exposed to dissolution medium, giving rise to faster drug release.

### Table 2: Characterization of floating microballoons formulations of Stavudine

<table>
<thead>
<tr>
<th>Batch Code</th>
<th>Particle Size (µm)</th>
<th>Sphericity</th>
<th>Yield (%)</th>
<th>Entrapment Efficiency (%)</th>
<th>% Buoyancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB1</td>
<td>230.23±0.35</td>
<td>1.08±0.04</td>
<td>70.34±0.05</td>
<td>80.52±0.23</td>
<td>69.23±0.21</td>
</tr>
<tr>
<td>MB2</td>
<td>235.53±0.24</td>
<td>1.11±0.13</td>
<td>68.32±0.08</td>
<td>79.64±0.41</td>
<td>74.46±0.12</td>
</tr>
<tr>
<td>MB3</td>
<td>228.12±0.31</td>
<td>1.09±0.09</td>
<td>66.46±0.41</td>
<td>83.37±0.52</td>
<td>75.84±0.21</td>
</tr>
<tr>
<td>MB4</td>
<td>230.21±0.18</td>
<td>1.07±0.06</td>
<td>80.22±0.63</td>
<td>85.37±0.13</td>
<td>82.53±0.12</td>
</tr>
<tr>
<td>MB5</td>
<td>234.12±0.27</td>
<td>1.04±0.21</td>
<td>79.44±0.53</td>
<td>79.64±0.29</td>
<td>73.46±0.21</td>
</tr>
<tr>
<td>MB6</td>
<td>235.16±0.22</td>
<td>1.08±0.11</td>
<td>75.46±0.22</td>
<td>75.64±0.31</td>
<td>76.46±0.17</td>
</tr>
<tr>
<td>MB7</td>
<td>236.21±0.13</td>
<td>1.14±0.41</td>
<td>78.46±0.51</td>
<td>74.64±0.42</td>
<td>77.46±0.32</td>
</tr>
<tr>
<td>MB8</td>
<td>239.33±0.33</td>
<td>1.11±0.32</td>
<td>75.46±0.32</td>
<td>78.64±0.53</td>
<td>78.46±0.33</td>
</tr>
</tbody>
</table>

CONFLICT OF INTEREST
No conflict of interest was associated with this work.

REFERENCES


