Design, Formulation, and Evaluation of Senna Effervescent Tablets

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Abstract— Cassia leaves and pods extracts has been used in traditional or herbal medicine since ancient times. The pods and leaves contain anthraquinone glycosides that have a significant laxative effect. In this study anthraquinone was extracted from Senna (Cassia acutifolia Delile) pods and the active constituents were checked to confirm the presence of the both Anthraquinone compounds (sennosoides A and B). Effervescent tablets were formulated using the senna extract as the active ingredient in addition to other tabletting constituents. The formulated tablets were then subjected to the known official monographs requirements like: resistance to crushing (hardness test), weight variation, disintegration time/ effervescent time, friability test, content uniformity test and pH. The results obtained were: 7.4 kg / cm², 10%, 59.01 s, 0.74 %), 97.30 %) and 5.4 for resistance to crushing, weight variation, disintegration time, friability test, content uniformity test and pH respectively. The values obtained indicate the effervescent comply with the pharmaceutical standards set by British Pharmacopoeia (BP) and United States Pharmacopoeia (USP). These tablets can be used as an alternative source of laxative medicine in Sudan due to the abundance of Cassia acutifolia as a wild plant.

Index Terms— Senna, (Cassia acutifolia) Extract, Anthraquinones, Effervescent Tablets.

I. INTRODUCTION

According to the World Health Organization [1] traditional medicine or herbal medicine is the accumulation of the knowledge, skills, and practices based on the theories, beliefs, and indigenized by different cultures, to maintain health. Herbal medicines include herbs, herbal materials, herbal preparations and finished herbal products, which contain as an active ingredients parts of plants, or other plant materials, or combinations.

Herbal treatments are the most popular form of traditional medicine, and are highly lucrative in the international marketplace. Annual revenues of traditional medicine were US$ 1.47 billion in Japan, US$ 4.7 billion in China, and US$ 7.4 million in Korea for 2008, 2009 and 2010, respectively [2]. Cassia acutifolia Delile., also known as Alexandrian senna, the senna is a large genus of around 250 species of flowering plants in the family Fabaceae, subfamily Caesalpinioideae. Senna fruits contain about 2.5 to 4.5 %of sennosides A and B (not less than 2.2%) in Alexandrian senna [3] and from 1.2 to 2.5% in the Tinnevelly. The pods are superior to leaves, as they contain more percentage of glycoside present pericarp of pods [4] while the seeds contain very little quantity of sennoside. The active constituents of senna are sennosides A, B, C, D, and free anthraquinones (aloe-emodin, chrysophanol, rhein) with sennosides A and B present in the greatest concentration [5].

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Sule et al. [6] reported the presence of anthraquinones in the park of Senna alata Linn. crude stem bark extract. Ayo [7] reported the presence of sennosides in Cassia nigricans which is used by Nigerian herbal healer for treatment of gastro-intestinal disorders.

Senna leaves and pods have been shown to have laxative activity, anti-fungal activity [6]. It is useful in habitual constipation. Pharmacological investigations show that sennoside A and B account for the entire activity of the senna leave and pods. Sennosides A and B were used as laxative formulation [8] replacing the previously used carcinogenic phenolphthalein [9]. The glycosides are pro-drugs that are neither absorbed nor cleaved in upper gastrointestinal tract. They are degraded in the colon by bacterial enzymes to rheinanthrone, the laxative metabolite of which 90% is bound to the feces in the colon and excreted as a polymer. It has been reported that the anthraquinone glycosides are capable to exert their laxative effect by small dose as they not likely to enter the systemic circulation [10, 11]. Sultana et al. [12] reported the use of Cassia angustifolia as laxative drug against constipation in Indo-Pak subcontinent. In Thai medicine ripe cassia pods were used as laxative drug by boiling it with water and filtration through muslin cloth. The filtrate was made in small pills after evaporation [13]. Effervescent tablets liberate carbon dioxide when added to water thus facilitates tablets disintegration and dissolutions [14]. In Sudan cassia leaves and pods decoction is used for the treatment of many problems of stomach disorder, but the quantity to be taken is unspecified due to the lack of the knowledge of the effective ingredients. The aims of the present study were to obtain the extract of the pods of Cassia acutifolia Delile and verify the presence of sennosides A and B and formulate an effective, non-folicular monographs of BP and USP requirements. Resistance to crushing was determined by taking 10 tablets from the formulation using a Pfizer hardness tester (Electrolab Pvt. Ltd., India). The average weight was determined by randomly picking 20 tablets and recording the weight of each tablet using a sensitive balance. Friability of the tablet determined using Roche friabilator. In this experiments the tablets are subjected the combined effect of abrasion and shock in a plastic chamber revolving at 25 rpm and dropping a tablet at 6 inches height in each revolution. The pre-weighed sample of tablets were placed in the friabilator and subjected to the 100 revolutions. Tablets were then dusted using a soft muslin cloth and re-weighed. The friability (F) is given by the formula:

\[ F = \left( \frac{W_i - W_f}{W_i} \right) \times 100 \]

where \( W_i \) and \( W_f \) stand for initial and final weights respectively.

The effervescent tablet of 600 mg was prepared as follows: The senna pods extract (active ingredient) 7.50 mg, polyvinyl pyrrolidone (PVP) binder 24.00 mg, Talc powder 7.50 mg, magnesium esterase 3.75 mg, saccharin 73.50 mg, polyethylene glycols (PEG) 12.00 mg, citric acid 79.33 mg, tartaric acid 158.66 mg and sodium bicarbonate 269.71 mg. The extract was dried in oven at 60 °C to constant weight and triturated in a mortar and pestle to make powder then mixed with calculated amount of the other components. The binder was added and formed into a paste and granulated using mesh 10. The granules were oven dried at 50 °C for one hour and resized using mesh 14. The granules were transferred to the hopper of a single punch tabletting machine (Erweka – Germany). The physical tests that included resistance to crushing (hardness test), weight variation, disintegration time/effervescent time, friability test, content uniformity test and pH were carried out to confirm their conformity with monographs of BP and USP requirements. Resistance to crushing was determined by taking 10 tablets from the formulation using a Pfizer hardness tester (Electrolab Pvt. Ltd., India). The average weight was determined by randomly picking 20 tablets and recording the weight of each tablet using a sensitive balance. Friability of the tablet determined using Roche friabilator. In this experiments the tablets are subjected the combined effect of abrasion and shock in a plastic chamber revolving at 25 rpm and dropping a tablet at 6 inches height in each revolution. The pre-weighed sample of tablets were placed in the friabilator and subjected to the 100 revolutions. Tablets were then dusted using a soft muslin cloth and re-weighed. The friability (F) is given by the formula:

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and dissolve in water. Then the mixture was diluted to 100ml with ether from which 10 ml were taken into a petri dish and evaporated to dryness. The dried residue was dissolved in 10 ml of 1.0 M KOH and the absorbance was immediately measured at 530 nm using 1.0 M KOH as a blank. A calibration curve using standard sennoside in 1.0 M KOH was constructed. The amount of sennoside in the tablet was determined and percent content was calculated


![Picture (2): Effervescent Tablets](image)

### III. RESULTS AND DISCUSSION

Due to the high solubility of anthaquinone glycosides in water, decoction was employed as a reliable method for extraction [17]. The extract of senna pods decoction was found to contain anthaquinone derivatives that has been identified phytochemically using the modified Borntrager’s test and ultraviolet spectroscopy [15]. It has been reported that cassia species are rich in anthaquinone derivatives [18]. Due to its laxative effect [19] the extract was the active ingredient in the prepared tablets. The anthaquinones exert their laxative effects either by altering colonic motility leading to an accelerated large intestinal transit [20] or alteration in absorption or secretion of the colon causing diarrhea due to fluid accumulation [21]. The quantity of anthaquinone derivatives sennoside A and B was small i.e. only 7.50 mg. It has been reported that sennoside A and B are not likely to enter the systemic circulation, hence they function at a low dose [10,11]. The effervescent tablets are formed by adding an acid to a base to liberate carbon dioxide thus make the tablet content highly soluble. The reaction of sodium bicarbonate with tartaric acid is an example.

\[
3\text{NaHCO}_3 + \text{C}_6\text{H}_5\text{O}_7 \cdot \text{H}_2\text{O} \rightarrow \text{Na}_3\text{C}_6\text{H}_5\text{O}_7 + 4\text{H}_2\text{O} + 3\text{CO}_2
\]

In this study the effervescent tablets were formulated using than granulation method which is superior to direct compression method as granulation reduces capping and protect the acid and base from environmental moisture [22]. The official monographs requirements were carried out to check the compliance of these tablets with the standards set by BP and USP.

<table>
<thead>
<tr>
<th>Tablet No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force / kg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The resistance to crushing or hardness test is the measure of the ability of a tablet to withstand mechanical effect during storage and handling. It is an indication for its dissolution or disintegration rate i.e. the harder the tablet the longer is its dissolution time. The hardness can be varied by changing the binder ratio. According to BP the mean reading should fall in a range equivalent to 4 – 8 kg/ cm² [23]. The 7.54 kg / cm² value obtained by this study (table (1)) is within this range.

According to BP and USP [22, 23] no tablet has a deviation of 10 % of the average and there should be no more than two tablets deviation by 5 % (30 mg). From table (2) it is clear that none of the weight loss that no deviation of 10 % (600 ± 60) and none has 5 % (±30 mg) deviation.
Table (2)
The weight variation test for the tablets

<table>
<thead>
<tr>
<th>Tab.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wt.</td>
<td>600</td>
<td>610</td>
<td>560</td>
<td>590</td>
<td>600</td>
<td>590</td>
<td>600</td>
<td>560</td>
<td>580</td>
<td>600</td>
<td>620</td>
<td>600</td>
<td>580</td>
<td>590</td>
<td>610</td>
<td>590</td>
<td>600</td>
<td>590</td>
<td>620</td>
<td>580</td>
</tr>
</tbody>
</table>

The average weight is 590 mg

Table (3)
Friability test for the tablets

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wt. of 20 tablets before the test</td>
<td>12.03 g</td>
</tr>
<tr>
<td>Wt. of 20 tablets after the test</td>
<td>11.94 g</td>
</tr>
<tr>
<td>Wt. loss for tablets</td>
<td>0.09 g</td>
</tr>
<tr>
<td>% Wt. loss for 20 tablets of the test</td>
<td>0.74 %</td>
</tr>
</tbody>
</table>

The total weight loss should not exceed 1 % and no tablet should exhibit any type of break or crack [24,25]. The weight loss indicated is 0.74 % which is less than 1.0 % indicating the compliance of the sample with test.

Table (4)
Disintegration time and pH test for the tablets

<table>
<thead>
<tr>
<th>Tab. No.</th>
<th>Dis. Time (s)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>59.30</td>
<td>5.3</td>
</tr>
<tr>
<td>2</td>
<td>58.31</td>
<td>5.5</td>
</tr>
<tr>
<td>3</td>
<td>59.43</td>
<td>5.4</td>
</tr>
<tr>
<td>Mean</td>
<td>59.01</td>
<td>5.4</td>
</tr>
</tbody>
</table>

The disintegration time for the tablets is 59.01 s making the formulation appropriate for use. A value of 62 s was reported by Srinath et al.[22] for effervescent paracetamol tablets compare to 55 s for marketed tablets in India.

Table (5)
Content uniformity test for the tablets

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wt. equivalent for 600 mg</td>
<td>7.50 mg</td>
</tr>
<tr>
<td>Experimentally obtained Wt.</td>
<td>7.30 mg</td>
</tr>
<tr>
<td>Content percent</td>
<td>97.30 %</td>
</tr>
</tbody>
</table>

The content uniformity test is a measure of the homogeneity of the tablet. Faure et al.[26] reported that wet granulation of tabletting provides better uniformity of content especially at low drug concentration. In this study the value was found to be 97.30 %. This value lies within the range of 95 – 105 % set by [27] and similar results for the effervescent senna tablet was obtained by HPLC [28].
IV. CONCLUSIONS

1. The extract of cassia was found to contain sennosides A and B which are the active ingredients of a laxative drug. Effervescent tablets were formulated from the senna extract and optimized using different tablet additives for a convenient oral administration tablets.

2. The formulated tablets were subjected to the known official monographs requirements and were found to comply with the standards of the BP and USP. These tablets which were prepared from local plant that grows wild in Sudan can be used as a laxative drug with low price and short disintegration time.

3. The use of local binders like gum [29] which are also available, may even lower the cost, hence different types of local binders can be used and analyzed to see their suitability.

REFERENCES


2. WHO 2011-2010. Regional progress in traditional medicine.


