Formulation of Oral Mucoadhesive Tablets using Mucilage Isolated from *Buchanania lanzan* spreng Seeds

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ABSTRACT

The present study was taken to formulate and evaluate mucilage obtained from *Buchanania lanzan* spreng seeds (BL) belonging to family anacardiacea for oral mucoadhesive drug delivery system containing losartan potassium. Physiochemical characteristics of mucilage, such as swelling index, microbial count, viscosity, hydration capacity, flow property, and pH were studied. The mucilage was evaluated for its mucoadhesive properties in compressed tablet, containing losartan potassium. Granules were prepared by wet granulation process using polyvinylpyrrolidone as binding agent. Mucilage was used in four different concentrations i.e., 21, 42 and 55% w/w. The tablet were prepared and evaluated for its physical property. Further, *in vitro* dissolution and swelling index was determined. The property of bioadhesive strength of isolated mucilage was compared with Guar gum and HPMC E5LV, which was used as standard mucoadhesive agent concentration. Bioadhesive strength of the tablet was measured on the modified physical balance. Result revealed that tablets had good physiochemical properties, and drug release was retarded as concentration of mucilage was increased. The force of adhesion was obtained 0.1238N, 0.2822N, 0.5175N, 0.8679N and 0.3983N respectively for F1, F2, F3, F4 and F5. Formulations were subjected for study the effect of agitation at different rpm. Formulation showed relative effect on release of drug from formulation. All the formulations were subjected to stability studies for three months, all formulations showed stability with respect to release pattern. In conclusions, these results indicate that the seed mucilage of BL can be a suitable excipient for oral mucoadhesive drug delivery systems.

KEYWORDS: *Buchanania lanzan* spreng; Mucoadhesive agent; Force of Adhesion.

Introduction

Delivery of drug via the absorptive mucosa is easily accessible in the body cavities, such as the ocular, nasal, buccal, rectal, and vaginal mucosa. It has the advantage of the dual biophysical and biochemical nature of the mucosal membrane. This readily absorbs drugs with hydrophilic and lipophilic drugs (Chien, 1992). Once the dosage form firmly sticks to the mucosal surface, its gastric residence time is prolonging until it is remove by turnover of mucins or by some other means. This is simple and yet highly innovative concept (Robinson and Park, 1984). Mucus is secret from both non-specialized and specialized “Goblet” epithelial cells. It forms a diffusion barrier between the luminal substances. It may play important roles in immune response. They are either single-layered epithelium (stomach, smaller and large intestine) or multilayered stratified epithelium (esophagus, cornea and vagina) (Warbrick and Boylan, 1994). Mucus glycoprotein chemically consist of large peptide backbone with pendent oligosaccharide side chains whose terminal end is either sialic or sulfonic acid. The presence of sialic acid and sulfate residues and its high charge density play an important role in bioadhesion (Rathbone and Hadgraft, 1991).

Bioadhesion may be defining as the state in which two materials, at least one of which is biological in nature, are held together for extended periods by interfacial forces. In the pharmaceutical sciences, when the adhesive attachment is to mucus or a mucous membrane, the phenomenon is referred to as mucoadhesion (Smart et al., 1984). The most widely investigated group of mucoadhesive is hydrophilic macromolecules containing numerous hydrogen bonds forming groups (Chen and Cyr, 1970; Harding et al., 1999), the so-called first-generation mucoadhesive. The presence of hydroxyl, carboxyl, or amine groups on the molecules favors adhesion. As typical hydrocolloid, glues if the formed adhesive joint is allow drying then they can form very strong adhesive bonds (Lee et al., 2000; Smart et al., 1993). Typical examples are carboxomers, chitosan, sodium alginate, and the cellulose derivatives. These were used initially as they are available “off-the-shelf” with regulatory approval, but in the last few years, new enhanced material have been developed (Ben and Nussinovitch, 1997). In the present study an attempt has been made to investigate the mucoadhesive property of the mucilage isolated from the seeds of *Buchanania lanzan* spreng belonging family anacardiacea. The seeds are non toxic and used variously as food supliments and...
indigenous medicine (Wealth of India, 1992; Kritikar and Basu, 2005; Nadkarni and Nadkarni, 2009).

Materials and Methods

Materials

*Buchanania lanzan* (BL) spreng seeds were procured from the forest of Rajgamar, District-Korba, State Chhattisgarh, India. Losartan Potassium was obtained as gift sample from Alembic Pharmaceutical Pvt. Ltd, Baroda. All other ingredients used are of analytical grade and procured from Loba Chemie, Mumbai.

Methods

Plant collection and authentication

The fruits were collected from the plant and seeds were separated from the fruit. The plant material was identified and authenticated from Dr. H. B. Singh, Professor and Head of Raw Herb and Material Dept., NISCAIR, New Delhi, India.

Isolation of mucilage

The seeds were dried and coarsed powder then extracted with water and methanol by heating under reflux. The extracts were concentrated under reduced pressure to a semisolid mass and it was made free from solvent as per AOAC guideline (AOAC, 1990).

Physicochemical properties of dried mucilage

The physicochemical properties such as appearance, solubility, swelling index, microbial count, melting point, loss on drying, charring, viscosity, hydration capacity, flow property, hausner ratio, bulk density, tapped density, and pH were studied (Martin, 2010).

Drug-excipient interaction studies

Excipient(s) are expected to be the inert substances but they may have considerable impact on the pharmacological availability of a drug substance when added to a formulation. The magnitude of this effect will depend on the physicochemical characteristics of the drug, quantity and properties of the used excipients (Kimberley et al., 2000).

IR spectra of drug, drug and polymers were obtained using Thermo Scientific FTIR (Nicolet Is 10). Further, thermal analysis was performed on the mixture of drug and the selected formulation using a Differential scanning calorimeter (DSC, Mettler Toledo Star System) and Differential thermal analysis (DTA, Linseis Germany, Stapt-1600).

Formulation of losartan oral mucoadhesive tablets

Literature review suggested that studies were conducted on Losartan Potassium as a drug for mucoadhesive delivery system; hence losartan potassium was selected as model drug for the formulation and evaluation of oral mucoadhesive delivery system (Achantaet al., 2012; Chandrasekara et al., 2011).

Oral mucoadhesive tablets containing Losartan Potassium were prepared by wet granulation technique using variable concentration of mucilage obtained from seeds of *Buchanania lanzan* as test mucoadhesive material. Guar Gum and HPMC E5LV were used as standard mucoadhesive agents. In all case, the amount of the active ingredient was kept 50 mg. All the ingredients except Aerosil were blended in a blender uniformly. Granulation was done with sufficient binding solution of PVP in isopropyl alcohol. The lubricated granules were compressed into tablet using 6 mm punch on rotary (Clit Jemkay) machine by keeping average tablet weight of tablet 120 mg. All Losartan Potassium loaded mucoadhesive tablets were kept in airtight container at room temperature for further study. Compositions of various formulations are shown in Table 1.

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>F5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drug</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>MBL</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>GG</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td>HPMC E5LV</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>PVP</td>
<td>q8</td>
<td>q8</td>
<td>q8</td>
<td>q8</td>
<td>q8</td>
</tr>
<tr>
<td>Lactose</td>
<td>42.5</td>
<td>42.5</td>
<td>2.5</td>
<td>42.5</td>
<td>42.5</td>
</tr>
<tr>
<td>Aerosil</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Avg. Wt. (mg)</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
</tbody>
</table>

Evaluation of the mucoadhesive tablet

The formulated mucoadhesive tablets were evaluated for the following official parameters: Hardness, Friability, Weight Variation, Thickness and Drug Content as per official method (USP, 2008).

**In-vitro dissolution study**

The in vitro drug release study of the mucoadhesive tablet was conducted in USP type II dissolution apparatus equilibrated (TDT–08L, USP ETC–11LFC–12 Electro lab) at temperature 37 ± 0.5 °C and 100 rpm speed. The dissolution study was carried out in triplicate for 8 hours in 900 ml of phosphate buffer 6.8 pH. The dissolution samples were collected at specific interval and replaced with an equal volume of gastric fluid to maintain the volume constant. The sample solution was diluted sufficiently and analyzed at 250 nm by a UV spectrophotometer (Shimadzu, Kyoto, Japan). The amount of drug present in the sample was calculated with the help of appropriate calibration curves constructed from reference standard of the respective drug.

**Effect of intensity of agitation on In vitro release rate**

The tablets of all batch was studied to observe the effect of agitation on dissolution which was carried out at 50 and 150 rpm.
Mass degree of swelling

The method reported by Owen was followed to measure the mass degree of swelling. Six tablets from each formulation batch were weighed and placed in petri dish containing the standard set of condition as specified for dissolution. The tablets were removed and change in weight of each tablet was determined after 5 hr using following formula.

\[ \text{Swelling index (S.I)} = \frac{W_t - W_0}{W_0} \times 100 \]

Whereas, SI is swelling index, \( W_t \) is Weight of tablet at time \( t \); \( W_0 \) is Weight of tablet before placing in beaker.

Radial and axial swelling of the tablet

The initial diameter and height of the tablet were measured, and the tablets were kept in distilled water. The increase in diameter and height were measured after 5 h by digital vernier caliper (HI-Mezar) (Owen, 2004). The equilibrium degree of swelling (Q) was calculated from the radial and axial swelling ratio using the following equation.

\[ Q = \left( \frac{V_t}{V_o} \right) = \left( \frac{R_t}{R_o} \right)^2 \times \left( \frac{I_t}{I_o} \right) \]

Were \( V_t \) and \( V_o \) are the tablet volume, \( R_t \) and \( R_o \) is the radius and \( I_t \) and \( I_o \) are the height at the time zero, respectively.

In vitro mucoadhesive strength

Mucoadhesive strength of the tablet was measured on the modified physical balance (Figure 1). The apparatus consist of a modified double beam physical balance in which the right and left pan has been replaced by lighter pan. The left side of the balance was made 5 gm heavier then the right side by placing a 5 gm weight on left side pan. Another Teflon block of 3.8 cm diameter and 2 cm height was fabricated with an upward portion of 2 cm height and 1.5 cm diameter on one side. This was kept in beaker, which was then placed below the left hand set of the balance.

![Fig. 1. In vitro mucoadhesive strength measurement.](image)

(A) Right pan, (B) Left pan, (C) Teflon block, (D) Goat Intestine, (E) Teflon-coated glass slide (F) Beaker containing 6.8 pH buffer, (G) Threads, (H) Pointer and (I) Scale.

The goat intestine mucosa was used as the model membrane and pH 6.8 was used as the moistening fluid. The goat intestine was kept in Tyrode solution at 37 °C for 2 hr. The underlying mucus membrane was separated and washed thoroughly with a pH 6.8 solution. It was then tied to Teflon-coated glass slide and this slide was fixed over the protrusion in Teflon block using a thread. The block was then kept in beaker containing pH 6.8 buffer solution at the level that just touches the membrane. By keeping a 5 gm weight on the right pan, the two sides of the balance were made equal. The beaker with the Teflon block was kept below the left hand set up of the balances. The tablets of each batch were struck to the lower side of the left hand side pan. The 5 gm weight from the right pan was then removed. This lowered the left pan along with the tablet over the membrane with a weight of 5 gm. This was kept undisturbed for 3 minute. Then, the weight on the right hand side was slowly added in an increment of 0.5 gm till the tablet just separated from the membrane surface. The excess weight on right pan i.e., total weight minus 5 gm was taken as a measure of the mucoadhesive strength (Achar and Pepass, 1994). From the mucoadhesive strength, the force of adhesion was calculated using the following formula:

\[ \text{Force of adhesion (N)} = \frac{\text{Mucoadhesive strength}}{1000} \times 9.81 \]

Bold strength (N/m²) = \[ \frac{\text{Force of adhesion (N)}}{\text{Surface area of tablet (m²)}} \]

Surface area of tablet = 2\( \pi \) (r + t); Where r is the radius of the tablet and t is the thickness of the tablet.

Data analysis

To study the mechanism of drug release from the matrix tablets, the in vitro drug release data were fitted to various kinetic models like Zero-order, First order, Higuchi, Peppas, Hixson crowell, and weibull equation and coefficient of correlation (r) values were calculated for linear curves by regression analysis of the above plot. These models used to explain drug release mechanism due to swelling (upon hydration) along with gradual erosion of the matrix (Paulo and Jose, 2001).

Stability studies

The success of an effective formulation can be evaluated only through stability studies. The purpose of stability testing is to obtain a stable product which assures its safety and efficacy up to the end of shelf life at defined storage conditions and peak profile. Losartan Potassium mucoadhesive tablets were placed on plastic tubes containing desiccant and stored at conditions, such as at room temperature, oven temperature (40 ± 2 °C and 75 ± 5%) for a period of 3 month for stability studies. The tablets were evaluated for physical properties and in vitro drug release after 1, 2 and 3 months (ICH, 2005).
Results

Mucoadhesive drug delivery of Losartan Potassium was formulated, using mucilage obtained from seeds of *Buchanania lanzan spreng*.

The mucilage was isolated from the seeds of *Buchanania lanzan spreng* (MBL) following AOAC guide line which yield 16.8% w/w.

**Physicochemical properties of dried mucilage**

The result of physicochemical evaluation of isolated mucilage is presented in Table 2. The result depicted that appearance of mucilage is reddish in color. The isolated natural mucilage from seed was soluble warm water. The swelling index study showed that mucilage swells well in distilled water than in acid and alkaline media. The water absorption (swelling index) capacity of the polymer was inversely proportional to the pH of the medium. The viscosity study of 1.0% w/v solution for isolated mucilage (MBL) showed decrease in viscosity with increase of temperature. The microbial count in MBL was found 81 CFU/g. The result of microbial property obtained was within official limits [Less than 100 colony-forming units (CFU/g)] as per the prescribe range by British Pharmacopoeia, 1993. The pH was found to be neutral. Melting point and charring was obtained as 89.5 °C and 103.1 °C respectively which indicated the mucilage is thermally stable. The true density was obtained as 1.2 g/ml. The result of bulk and tapped density indicated that mucilage is porous in nature. The micromeritics study showed that the flow property was good for MBL as per standard flow range (Subramanyam, 2008).

**TABLE 2**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MBL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Off White</td>
</tr>
<tr>
<td>Solubility</td>
<td>Warm Water</td>
</tr>
<tr>
<td>Swelling index (after 3 hr)</td>
<td></td>
</tr>
<tr>
<td>At, pH-1.2 Distilled water</td>
<td>16.00</td>
</tr>
<tr>
<td>At, pH-7.4</td>
<td>14.11</td>
</tr>
<tr>
<td>Viscosity (1% w/v) (cP)</td>
<td></td>
</tr>
<tr>
<td>At, 37 °C</td>
<td>112.9</td>
</tr>
<tr>
<td>At, 45 °C</td>
<td>51.05</td>
</tr>
<tr>
<td>At, 60 °C</td>
<td>1.210</td>
</tr>
<tr>
<td>Microbial count (CFU/g)</td>
<td>Bacteria: -ve</td>
</tr>
<tr>
<td></td>
<td>Fungi: -ve</td>
</tr>
<tr>
<td>pH</td>
<td>6.5</td>
</tr>
<tr>
<td>Melting point (°C)</td>
<td>89.5</td>
</tr>
<tr>
<td>Charring (°C)</td>
<td>103.1</td>
</tr>
<tr>
<td>Loss on drying (%)</td>
<td>5.00</td>
</tr>
<tr>
<td>True density (g/ml)</td>
<td>1.410</td>
</tr>
<tr>
<td>Bulk density (g/ml)</td>
<td>0.53</td>
</tr>
<tr>
<td>Tapped density (g/ml)</td>
<td>0.72</td>
</tr>
<tr>
<td>Hausner’s Ratio</td>
<td>1.352</td>
</tr>
<tr>
<td>Compressibility index</td>
<td>26.08</td>
</tr>
<tr>
<td>Angle of repose</td>
<td>40.66</td>
</tr>
</tbody>
</table>

**Drug-excipient interaction studies**

The FTIR spectral analysis showed that there was no appearance or disappearance of any characteristic peaks of pure drug Losartan Potassium in the optimized formulation of drug and polymer (Figure 2 and 3), which confirms the absence of chemical interaction between drug and polymers. Further, it was also confirmed by DSC and DTA analysis [Figure 4, 5 and 6].

![Fig. 2. FTIR spectra of losartan potassium.](image-url)
Fig. 3. FTIR spectra of physical mixture of losartan potassium and MBL.

Fig. 4. DSC spectra of losartan potassium.

Fig. 5. DSC spectra of physical mixture of losartan potassium and MBL.
Micromeritics and post compressional evaluation

The result of micromeritics study for granules ready for compression is tabulated in Table 3. Result depicted that granules possess good flow property as compare to muclage. All the formulated batch was evaluated for the physical properties such as hardness which was obtained in the range of 4.5 to 4.6 (kg/cm²). Percentage weight loss in the friability test was obtained less than 1% for all batches. Further, labeled content of all batch were obtained under the official limits. Overall, the prepared tablets were of good quality with regard to hardness, friability and drug content. The result of physical evaluation of all the tablet is tabulated in Table 4.

In-vitro dissolution study

The result of in vitro dissolution study is presented in Figure 7. From the overall dissolution profile, it was concluded that the drug release rate decreased as concentration of the polymer increased, which was also affected by the type of polymer used. This can probably attributed to different diffusion and swelling behavior of the polymer.

Effect of intensity of agitation on in-vitro release rate

The result of effect of intensity of agitation on in-vitro release rate is presented in Figure 8 and 9. The effect of agitation on dissolution showed proportional changes in release profile i.e., on increasing or decreasing the speed of agitation the release profile proportionally changed.

Mass degree of swelling and radial and axial swelling

The result of mass degree of swelling and radial swelling for formulations F1 to F5 is tabulated in Table 5. The result suggested that on increasing the concentration of excipient increases the phenomena of swelling i.e., radial and axial swelling of tablet.

In vitro mucoadhesive strength

The in vitro mucoadhesive strength study was performed on the modified physical balance to measure the force (N) required for detaching the tablet. The result of in vitro mucoadhesive strength analysis is tabulated in Table 5. The mucoadhesion characteristics were affected by the concentration of the mucoadhesive polymer. Further, viscosity of the polymer also affects the mucoadhesive strength of the tablet.

Data analysis

The result of data analysis is tabulated in Table 6. From the result of the dissolution data, the Korsmeyer and Peppas model found to be best fitted in all dissolution profile having a higher correlation coefficient. Thus, it was concluded that the drug release occurred via a diffusion mechanism and due to affinity of hydrophilic polymers towards water.

Stability studies

The stability study showed that there was no change in the appearance and on drug release pattern of the tablet.
TABLE 3
Micromeritics characterization of granules ready for compression.

<table>
<thead>
<tr>
<th>Material</th>
<th>Angle of repose</th>
<th>Bulk density (gm/mL)</th>
<th>Tapped density (gm/mL)</th>
<th>Compressibility Index</th>
<th>Hausner’s ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Losartan</td>
<td>29° 24' ± 0.601</td>
<td>0.465 ± 0.057</td>
<td>0.555 ± 0.010</td>
<td>44.70 ± 0.019</td>
<td>1.19 ± 0.024</td>
</tr>
<tr>
<td>F1</td>
<td>29° 31' ± 0.218</td>
<td>0.512 ± 0.019</td>
<td>0.574 ± 0.025</td>
<td>10.80 ± 0.019</td>
<td>1.12 ± 0.018</td>
</tr>
<tr>
<td>F2</td>
<td>28° 28' ± 0.231</td>
<td>0.544 ± 0.022</td>
<td>0.601 ± 0.022</td>
<td>09.48 ± 0.014</td>
<td>1.10 ± 0.019</td>
</tr>
<tr>
<td>F3</td>
<td>26° 01' ± 0.314</td>
<td>0.539 ± 0.017</td>
<td>0.586 ± 0.021</td>
<td>08.02 ± 0.016</td>
<td>1.09 ± 0.021</td>
</tr>
<tr>
<td>F4</td>
<td>26° 26' ± 0.331</td>
<td>0.557 ± 0.051</td>
<td>0.616 ± 0.015</td>
<td>09.50 ± 0.035</td>
<td>1.10 ± 0.021</td>
</tr>
<tr>
<td>F5</td>
<td>28° 33' ± 0.226</td>
<td>0.498 ± 0.042</td>
<td>0.597 ± 0.039</td>
<td>16.58 ± 0.021</td>
<td>1.19 ± 0.014</td>
</tr>
</tbody>
</table>

Note: values are mean of 6 observation (N = 6) and values in parenthesis are standard deviation (± SD)

TABLE 4
Physical evaluation of uncoated mucoadhesive tablets after compression.

<table>
<thead>
<tr>
<th>Formulations</th>
<th>Weight variation in mg</th>
<th>Thickness in mm</th>
<th>Diameter in mm</th>
<th>Hardness in Kg/cm²</th>
<th>Friability (%)</th>
<th>Drug content</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>120.1 ± 0.32</td>
<td>2.59 ± 0.018</td>
<td>6.70 ± 0.038</td>
<td>4.62 ± 0.18</td>
<td>0.07 ± 0.001</td>
<td>100.91</td>
</tr>
<tr>
<td>F2</td>
<td>121.6 ± 0.22</td>
<td>2.79 ± 0.026</td>
<td>6.60 ± 0.050</td>
<td>4.51 ± 0.26</td>
<td>0.05 ± 0.031</td>
<td>101.34</td>
</tr>
<tr>
<td>F3</td>
<td>122.6 ± 0.42</td>
<td>2.72 ± 0.032</td>
<td>6.60 ± 0.048</td>
<td>4.46 ± 0.24</td>
<td>0.37 ± 0.022</td>
<td>101.52</td>
</tr>
<tr>
<td>F4</td>
<td>120.6 ± 0.16</td>
<td>3.09 ± 0.034</td>
<td>6.61 ± 0.038</td>
<td>4.42 ± 0.19</td>
<td>0.15 ± 0.022</td>
<td>101.29</td>
</tr>
<tr>
<td>F5</td>
<td>118.9 ± 0.11</td>
<td>2.60 ± 0.029</td>
<td>6.56 ± 0.021</td>
<td>4.83 ± 0.22</td>
<td>0.24 ± 0.009</td>
<td>101.18</td>
</tr>
</tbody>
</table>

Note: values are mean of 6 observation (N = 6) and values in parenthesis are standard deviation (± SD)

Fig. 7. *In vitro* dissolution study of formulation F1 to F5 at 100 rpm.

Fig. 8. *In vitro* dissolution study of formulation F1 to F5 at 50 rpm.
Table 5
Physical characterization mucoadhesive tablet.

<table>
<thead>
<tr>
<th>Formulations</th>
<th>Q</th>
<th>SW (%)</th>
<th>Force of adhesion (N)</th>
<th>Bond strength (N/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F₁</td>
<td>1.40 ± 0.033***</td>
<td>26.1 ± 0.032***</td>
<td>0.1238 ± 0.004</td>
<td>0.0009 ± 0.0002</td>
</tr>
<tr>
<td>F₂</td>
<td>1.52 ± 0.005***</td>
<td>33.8 ± 0.026***</td>
<td>0.2822 ± 0.001</td>
<td>0.0021 ± 0.0022</td>
</tr>
<tr>
<td>F₃</td>
<td>1.81 ± 0.026*</td>
<td>47.1 ± 0.008***</td>
<td>0.2895 ± 0.001</td>
<td>0.0029 ± 0.0001</td>
</tr>
<tr>
<td>F₄</td>
<td>5.23 ± 0.001</td>
<td>168.1 ± 0.004</td>
<td>0.8679 ± 0.003</td>
<td>0.0066 ± 0.0012</td>
</tr>
<tr>
<td>F₅</td>
<td>1.04 ± 0.022</td>
<td>1.75 ± 0.012</td>
<td>0.0938 ± 0.002</td>
<td>0.0030 ± 0.0039</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± SEM (n = 6)

Data was analyzed by one way ANOVA followed by Tukey test, (ns)P > 0.05; *P < 0.05; **P < 0.01; ***P < 0.001

TABLE 6
Mechanism of drug release by kinetics study.

<table>
<thead>
<tr>
<th>Code</th>
<th>Zero Order</th>
<th>First order</th>
<th>Higuchi</th>
<th>Pappas</th>
<th>Hixson crowell</th>
<th>Weibull</th>
<th>Other parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>r</td>
<td>K</td>
<td>r</td>
<td>K</td>
<td>n</td>
<td>r</td>
<td>r</td>
</tr>
<tr>
<td>F₁</td>
<td>0.9974</td>
<td>11.618</td>
<td>0.9439</td>
<td>-0.1645</td>
<td>0.9908</td>
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Discussion

Physicochemical properties of dried mucilage

The physicochemical evaluation was performed for to get primary idea on physical property of mucilage. The pH of MBL was neutral indicated that mucilage may not irritate the mucus membrane and will be most suitable for oral mucosal drug delivery systems. The swelling index showed that mucilage swollen slowly in water at neutral pH which can be considered highly beneficial as similar study on Guar gum showed premature swelling cause obstruction of, or damage to, the esophagus and due to such reason appetite suppressants containing guar gum in tablet form have been banned in the UK (Uusitupa, 1990).

Melting point is also one of the physical constant for given material and is depending on structure/physiochemical properties. The weight loss on drying indicates the fine amount of moisture present available in the material.

In similar study mucilage from *Anogeissus latifolia* exhibited good physical properties like swelling index and compressibility which led for better acceptability as an excipient (Jani et al., 2007).

Drug-excipient interaction studies

Compatibility study between drug and polymer was performed in order to check whether there is any interaction available between isolated mucilage and drug. The result of drug-excipient interaction studies showed that there is no change in FTIR spectrum peak. Further, it was supported by the endotherm peaks of DSC and DTA.

Micromeritics and post compressional evaluation

The mucoadhesive tablets of Losartan Potassium were prepared by wet granulation using mucilage (MBL), Guar gum and HPMC E5LV as mucoadhesive agent. The granules for mucoadhesive tablets were prepared according to the formula given in related table and
characterized. Micromeritics study was performed to check the suitability of compression method as well correlation between polymers. The angle of repose was less than 29° for all batch of granules indicated satisfactory flow behavior. Other parameter for granules was also found in acceptable range. The result of micromeritics study showed that some physical modification can improve more efficacies in the property of excipient.

No significant difference was observed in the weight of individual tablets form the average weight. Tablets weight for all batches was found with in official limit. The data of uniformity of content which was performed using UV spectrophotometer indicated that tablets of all batches had drug content within official limit. The hardness of tablet for all batch are in range of 4-5 Kg/cm² which is acceptable for mucoadhesive tablets. Formulation (F1-F5) showed percentage friability less than 1% that indicates ability of tablets to withstand shocks even in transportation. No significant difference was observed in the thickness of individual tablet from the average value.

**In-vitro dissolution and effect of intensity of agitation on in-vitro release rate study**

Addition of either water-soluble or insoluble diluents in large quantities can markedly increase or decrease the release of active principles (Vazquez. et al., 1992). The in vitro release of Losartan Potassium from mucoadhesive tablet of formulation (F1-F5) varied according to the amount and grade of mucoadhesive polymer used. The tablets contain Guar gum as mucoadhesive agent controls the release of medication up to 8 hr and had initial high burst of 33.17% in 1 hr. The total amount was released in 7 hr in the same manner which had used HPMC E5LV and MBL as a polymer. The result suggested that the isolated mucilage have significantly similar result to HPMC E5LV which indicate mucilage have good mucoadhesive property. The effect of agitation on dissolution showed proportional changes on release profile.

**In vitro mucoadhesive strength**

The in vitro mucoadhesive strength study showed that the bioadhesion characteristic of test and standard mucoadhesive polymer was affected by type and concentration of polymer. Viscosity of polymer also affects the bioadhesive strength of tablet as reported earlier by Deshmukh, 2009.

**Mass degree of swelling and radial and axial swelling**

The important physical properties of mucilage depend on the precise structure of the polymer network. Of key importance is mass degree swelling capacity (Hussein et al., 1994). Mass degree of swelling and equilibrium degree of swelling of all the formulation batches showed that the batch which contain hydrophilic polymer Guar gum and MBL have higher degree of both and HPMC E5LV having relatively less degree of swelling in similar manner. During mucoadhesive formulation development, tablet hydration capacity (swelling) is very important to be considered because the water penetration is responsible for drug release. However, since swelling and gel formation can make tablets erodible, it is very important to know if and when the formulation loses its integrity (Perioli et al., 2004). For this reason formulations were investigated by comparing the initial and final tablet weight after immersion in water.

**Data analysis**

The drug release data were explored for the type of release mechanism followed. The in vitro release profile data of Losartan Potassium mucoadhesive tablet were fitted to various kinetic modal such as Zero order, First order, Higuchi, Korsmeyer-Peppa’s, Hixson crowell and Weibull. The interpretation of release exponent values (n) indicated the all the formulation follows zero order of release pattern with anomalous drug transport.

**Stability studies**

The short term stability studies (as per ICH guide line) show the formulation are stable and confirm the suitability of mucilage as mucoadhesive agent. The similar result of stability study was reported for seed mucilage of Blepharis edulis as disintegrant in tablet which indicated that isolated mucilage from seed is stable with different solid dosage form (Shah and Jani, 2009).

**Conclusions**

This study was undertaken with an attempt to formulate and evaluate effect of mucilage isolated from the seed of Buchanania lanzan spreng on release rate of mucoadhesive tablet. Mucoadhesive tablet were formulated using, test and standard polymers in varying concentrations. Tablet were subjected to various evaluation parameters such as hardness, friability, drug content, mucoadhesive strength study and in vitro drug release study. It was revealed that all batches had acceptable physical parameters. Formulation (F3) has good mucoadhesiveness along with in vitro drug release in compression of standard HPMC E5LV but lower than the tablet which was prepared using Guar gum. It was observed that all batch followed the equation of zero order drug release profiles. The release exponent value indicated that drug is releasing from the dosage form following diffusion mechanism. Stability studies revealed that there was no significant change in the hardness, friability, drug content and in vitro dissolution profile of all formulation. Thus all formulations were stable at different condition of temperature. The present study shows that there is sufficient mucoadhesive strength for isolated mucilage from the seeds of Buchanania lanzan spreng.

**References**


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