Formulation and Evaluation of Shikakai Paste as Denture Cleanser

Santoshi Naik, Thriveni M, Mohammed Gulzar Ahmed*

Email: mohammedgulzar1@gmail.com

Abstract

The objective of the current study was to prepare Shikakai paste and evaluate their effect on Staphylococcus aureus and Escherichia coli biofilm formed on dentures. Shikakai (Acacia concinna) has a marked antibacterial activity against bacterial strains of gram positive and gram negative. Denture cleansers remove not only the biofilm, but also stains and other forms of food debris from dentures. The Shikakai paste was formulated by trituration method using varying concentrations of Shikakai powder. The formulated paste was then evaluated for different parameters such as pH, physical examination, foamability, moisture content, spreadability, abrasiveness, extrudability, cleaning ability, anti-microbial activity, and stability studies. From the results of the cleaning ability, it was found that the colour was removed completely without excessive brushing. The developed Shikakai Denture cleanser exhibited fairly well in the anti S. Aureus and E.Coli activity as compared to the standard Cefixime medication. The results of the present research highlighted that Shikakai has the potential to act as a Denture cleanser.

Key words: Denture Cleanser, Escherichia Coli, Shikakai, Staphylococcus aureus

Introduction

Dentures are prosthetic devices constructed to replace missing teeth and are supported by the surrounding soft and hard tissues of the oral cavity (Fig 1). Prosthesis is often neglected in maintenance due to the nature of design, age, and lack of awareness, leading to microbial contamination. Microorganisms like Staphylococcus aureus and Escherichia coli grow on dentures in the mouth. Over time, the bio film that develops on dentures may harden and become difficult to remove. Denture cleanliness is vital to avoid malodour, bad aesthetics and plaque/calculus accumulation with its deleterious impact on the oral mucosa. There is a large number of solutions, pastes and powders available for cleaning dentures with a variety of claims for their relative efficiency. Mechanical and chemical methods are used to clean the dentures, and the most frequent method is water and a toothbrush. However, toothbrushes are ineffective against microbial activity on denture bio films and they can only remove large debris. Consequently, this issue has stimulated the introduction of Denture cleansers, which remove not only the bio film, but also stains and other forms of food debris from dentures. Over the last few years, commercially available Denture cleansers have been the only mode of cleaning or disinfecting them. These usually contain many chemical substances that could be harmful to patients. Many Denture cleansers have sodium hypochlorite as their primary cleaning agent. The content may also be allergic to few patients. As reported by World Health Organization, there is an increasing demand and use of herbal medicines around the world, most prominently within the Chinese and Indian communities. It has been reported that herbal medicines are better tolerated and are associated with reduced side effects when compared to the conventional drugs. Therefore, naturally available substances and traditionally used cleansers can be checked for the cleaning ability.
Acacia concinna (Fabaceae) is a climbing shrub and a well-known medicinal plant widely used in Southeast Asia. It has a significant antibacterial activity against gram positive and gram negative bacterial strains. The fruits of this plant are rich in Saponins that act as foaming agents to create lather when used as shampoo for hair. Traditionally, it was used as a herbal shampoo and in the treatment of jaundice, constipation and skin problems as well.6-9 Dubey et al., (2004) prepared and evaluated Herbal shampoo powder using bahera, amla, tulsi, Shikakai and brahmi, and then evaluated them for organoleptic, powder characteristics, foam test and physical evaluation.10 However, there has been no study carried out to check the efficiency of Shikakai on denture bio film. In the present study, an attempt was made to prepare the Shikakai paste and evaluate their effect on Staphylococcus aureus and Escherichia coli bio film formed on dentures. Thus, the objective of the present research work was to formulate and evaluate Shikakai paste as Denture cleanser.

Materials and Methods
Shikakai powder was purchased from Yucca Enterprises, Mumbai. HPMC E50, Sodium bicarbonate, Sodium lauryl sulphate, Glycerine, Methyl paraben, Propyl paraben, and Peppermint oil was purchased from Hi Media, Mumbai. All the chemicals used were of analytical grade.

Formulation of Shikakai paste
The required quantity of Shikakai powder was weighed and taken in mortar. Sodium bicarbonate, HPMC, methyl paraben and propyl paraben was added to the mortar and triturated to obtain a fine mixture. Glycerine and peppermint oil was added to this mixture drop-wise and triturated. Finally, purified water was added until paste consistency was obtained (Table 1).11

<table>
<thead>
<tr>
<th>Table 1 Formulation of Shikakai paste</th>
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<tbody>
<tr>
<td>Ingredients</td>
</tr>
<tr>
<td>Shikakai powder</td>
</tr>
<tr>
<td>HPMC E50</td>
</tr>
<tr>
<td>Sodium bicarbonate</td>
</tr>
<tr>
<td>Glycerine</td>
</tr>
<tr>
<td>Methyl paraben</td>
</tr>
<tr>
<td>Propyl paraben</td>
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<tr>
<td>Peppermint oil</td>
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<tr>
<td>Purified water (QS)</td>
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</tbody>
</table>

Evaluation of formulated Shikakai paste:
Physical Examination
The formulated paste was evaluated for its colour, odour was found by smelling the product; and the taste was checked manually by tasting the formulation. The smoothness was tested by rubbing the paste formulation between the fingers for any grittiness.12

Determination of pH
To determine the pH of the formulated paste, 5 gm was placed in a 150 ml beaker containing 10 ml of boiled and then cooled water. Then, it was stirred vigorously to make a suspension, and the pH of each solution was measured using a pH metre (Labman Digital pH Metre, Model No: LMPH-10).12

Foamability
The formulation with water was placed in the measuring cylinder and covered with an aluminium foil. The initial volume was noted and thereafter shaken 10 times. The final volume was noted with foam.12

Determination of moisture content
5 gm of each formulation was placed in a porcelain dish. The sample was dried in an oven at 105°C. The final weight of the dried paste was noted.13

% of moisture content = $\frac{MI - M}{M} \times 100$

MI = Loss of mass (gm) on drying
M = Mass (gm) of the material taken for the test.

Spreadability
Taking two glass slides of equal length, the spreadability of the paste formulation was determined. A paste of 1 gm was applied on one glass slide. Weights (100 gm) were added to the other slide and the time taken to slide off the first glass slide from the second glass slide was determined. Better spreadability was indicated by a shorter interval. Using the following formula, spreadability was calculated.13

\[ S = \frac{M \times L}{T} \]

Where, \( S \) = spreadability, \( M \) = Weight on upper slide, \( L \) = Length of glass slides,
\( T \) = Time taken to separate the slides completely from each other.

Abrasiveness
A pea-sized quantity of the paste was placed on a smooth microscope plastic slide and 1-2 drops of water was added. The paste was then rubbed back and forth 25 times with brief 1 cm strokes using a smooth cotton swab. The microscope slide was rinsed carefully and dried with a soft tissue or paper towel. The slide was then examined under a microscope and the number of scratches was determined. The scratches were rated from 0 (no scratches) to 5 (high degree of scratches).13

Determination of hard and sharp edged abrasive particles
The paste was squeezed on a piece of waxed paper and pressed with a finger along its length to check for tough and sharp abrasive edged particles. The test was repeated for all the paste samples.14

Extrudability
The extrudability test is based on determining the weight needed to extrude 0.5 cm paste formulation in 10 seconds from the lacquered aluminium collapsible tubes. Using the following formula, the extrudability was then calculated.7,13

\[ \text{Extrudability} = \frac{\text{Weight applied to extrude paste from tube (g)}}{\text{Area (cm}^2\text{)}} \]

Cleaning ability
A line was drawn along the length of an eggshell using a permanent marker dividing it into 2 halves. The toothbrush was moistened with water and the excess water was removed. The damp toothbrush was then brushed with 5 to 10 strokes on one side of an egg and inspected to see if any colour had been removed.14 Similarly, the egg shells were stained using picric acid stain and checked for the cleaning ability of Shikakai paste.

Anti-microbial activity
In vitro antimicrobial study of the formulated paste was performed by using Muller-Hinton agar (MHA) medium against pathogenic bacterial strains of Staphylococcus aureus and Escherichia coli. 20 ml of MHA medium was poured into a sterilized petridish, and after complete solidification, it was inoculated with...

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with the organism and allowed to solidify. Then, wells were made aseptically with a cork bore and the formulated Shikakai paste was placed over the bacterial plates and incubated at 37°C for 24 hours, with Cefixime as the positive control. The inhibition area (Zone of Inhibition) diameter was measured in millimetres (mm).11,15

Table 2: Physical examination of Shikakai paste

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Parametres</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Colour</td>
<td>Brownish Black</td>
</tr>
<tr>
<td>2</td>
<td>Odour</td>
<td>Characteristic odour</td>
</tr>
<tr>
<td>3</td>
<td>Taste</td>
<td>Bitter</td>
</tr>
<tr>
<td>4</td>
<td>Smoothness</td>
<td>Smooth paste</td>
</tr>
</tbody>
</table>

Stability study:
The formulated paste was filled in a collapsible tube and stored at different temperatures and humidity conditions at 40 ± 2°C/75 ± 5% RH, 25°C ± 2°C/60% ± 5% RH, and 30°C ± 2°C/65% ±5% RH for three months and studied for appearance, cleaning, and antimicrobial activity.15

Results and Discussion
The formulated Denture cleanser containing Shikakai was evaluated for various evaluation parametres and all the formulations complied with the Bureau of Indian Standards norms (Fig 2). The physical examination of the formulated paste was found to be within the Indian Pharmacopoeial specifications (Table 2). The results of the present research also highlighted the fact that Shikakai, being a natural substance used for cleansing activity, has the potential to act as a Denture cleanser since it exhibited antimicrobial activity against the selected microbial species. The components added to the Shikakai paste were properly ground and found that trituration is an excellent method of preparation. According to Katz 2012, the excipients were selected and used in varied concentrations in the formulation of Shikakai paste.16 The maximum pH value of toothpaste is 10.5 in accordance with BIS norms.12 The pH of the prepared formulations ranged from 8.5 - 8.6 and complied with the standard range, indicating that all the formulations were considered safe for use. According to BIS standards, the minimum foam formation is 50 ml.12 The foamability of the formulated Denture cleanser was found to be fairly good for all the formulations (Table 3). The results showed that the evaluated Denture cleanser’s foam formation is adequate for its cleaning action. The percentage of moisture content of all the formulations is given in the Table 3. These results explain that all the formulations have good moisture content. Spreadability test was performed for all the formulations and was found that the spreadability of the formulated Denture cleanser reduced with an increase in the inorganic thickener concentration (Table 3). No scratches were found after observing them under the microscope indicating the fineness of the formulation without any gritty particles. For the presence of hard and sharp edged particles, all three formulations were evaluated and found to be free from hard and sharp edged abrasive particles. There was no difficulty with toothpaste filling and paste extrusion from the tubes. Extrudability test results are tabulated in Table 3. The cleaning ability of Shikakai paste has been tested on egg shells previously coloured with permanent markers and picric acid stain. The colour was removed completely with 5-10 strokes of the toothbrush indicating the cleaning ability of Shikakai without excessive brushing as shown in Fig 3 and 4. The formulated
Shikakai Denture cleanser exhibited a fairly well anti S. aureus and Escherichia coli activity as compared to the standard drug Cefixime. The formulation exhibited an impressive zone of inhibition against S. aureus of 18 mm, 17 mm and 17 mm and against E. coli of 20 mm, 18 mm and 18 mm for F1, F2 and F3 formulation, respectively. The highest inhibition zone was observed in F1 against S. aureus (18 mm) and against E. coli (20 mm), whereas Cefixime exhibited a zone of inhibition of 31 mm. Therefore, it may be concluded that formulated toothpaste have a potential to exhibit an anti-microbial activity (Fig 5 and 6). There was no change in appearance, colour, cleaning, and antimicrobial activity observed during the stability studies.

Conclusion
The Shikakai paste as Denture cleanser was formulated and evaluated successfully. From the study we concluded that Shikakai has the potential to show cleaning and antimicrobial activities when formulated in different concentrations as a paste to clean the dentures. The prepared Shikakai Denture cleanser is safer with minimum side effects when compared with the commercial preparations.

Acknowledgement
The authors would like to thank Yenepoya Pharmacy College & Research Centre, Yenepoya (Deemed to be University), Mangalore, for the assistance and facilities provided to carry out the research.

Conflict of Interest
No conflict of interest declared by authors.

References

Table 3: Evaluation of Shikakai Denture cleanser

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Parameters</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td>8.6±0.15</td>
<td>8.6±0.05</td>
<td>8.5±0.1</td>
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<tr>
<td>2</td>
<td>Extrudability</td>
<td>90.3%±0.17</td>
<td>90.8%±0.16</td>
<td>91.2%±0.15</td>
</tr>
<tr>
<td>3</td>
<td>Spreadability</td>
<td>21.2 g cm/sec±0.1</td>
<td>20.08 g cm/sec±0.095</td>
<td>19.04 g cm/sec±0.08</td>
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<tr>
<td>4</td>
<td>Homogeneity</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>5</td>
<td>Foamability</td>
<td>30 ml±0.7</td>
<td>10 ml±0.5</td>
<td>30 ml±0.57</td>
</tr>
<tr>
<td>6</td>
<td>Moisture content</td>
<td>14.6 %±0.27</td>
<td>15.77 %±0.16</td>
<td>16.57 %±0.34</td>
</tr>
<tr>
<td>7</td>
<td>Zone of inhibition</td>
<td>18 mm±0.76</td>
<td>17 mm±0.58</td>
<td>17 mm±0.62</td>
</tr>
</tbody>
</table>