Comparative Evaluation of Salivary pH with Honey and Vinegar Mouth Rinse in Diabetic and Healthy Adults

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Authors’ contributions

This work was carried out in collaboration among all authors. The concept of study, drafting and finalizing of the results were done by author LF. Data analysis was performed by author AA. The article was critically reviewed and finally drafted by authors AA and LF. Finally reviewed and approved by author SNA. Laboratory/instrument based work was performed under the supervision of author AA and assisted by authors SM and AM. All authors read and approved the final manuscript.

ABSTRACT

Background: Salivary fluid creates a particular environment of oral cavity that helps in mastication, lubrication of food and mucosa and in speech. Intake of food and different liquids (drinks, juices, milk) causes modulation in pH of saliva that lead to change in the environment of oral cavity. The pH of saliva decreases to acidic side when bacteria breakdown the carbohydrates and start releasing acids, these acids damage the structure of tooth and leads to cavity formation i.e. dental caries.

Objective: The current study is aimed to evaluate the salivary pH of diabetic and healthy individual before and after using honey and vinegar mouth rinses.

Methods: It was a pre-clinical experimental study conducted in dental OPD of Baqai medical college Karachi from 1st January to 15th February. The calculated sample size N=80 was divided in 4 groups, Group A, n=20 healthy participants who rinsed with honey mouth rinse, Group B n=20...
1. INTRODUCTION

Salivary fluid creates a particular environment of oral cavity that helps in mastication, lubrication of food and mucosa and in speech [1,2]. Major and minor glands generally secret 0.5 to 1.5 litre saliva in a day, and 6.2 – 7.2 pH is considered as normal pH of saliva [3]. Intake of food and different liquids (drinks, juices, milk) causes modulation in pH of saliva that lead to change in the environment of oral cavity. The pH of saliva decreases to acidic side when bacteria breakdown the carbohydrates and start releasing acids, these acids damage the structure of tooth and leads to cavity formation i.e. dental caries [4]. Alkaline environment of saliva appears when pH of saliva increases which causes development of plaque and calculus. The health of oral cavity and periodontal condition in neutral pH has less chances of decay and periodontal problems [5].

Diabetes mellitus is a health challenge faced by the medical professionals worldwide, according to a survey, 19.2% population of Pakistan has Type II diabetes mellitus [6]. Being a part of metabolic syndrome diabetes mellitus affects all body systems including oral cavity. It contributes to various oral ailments such as halitosis, caries, gingivitis, periodontitis and ultimately loosening of teeth by altering the salivary pH. This alteration in salivary pH is also contributed by decreased salivary rate as it is observed that in diabetes mellitus due to systemic dehydration and increase in salivary glucose patient may complain of dry mouth which is also considered as a risk factor for above mentioned problems related to oral cavity [7]. Patients with uncontrolled diabetic profile have low salivary efficacy to neutralize the acidic environment of oral cavity hence are more susceptible to develop dental problems particularly dental carries. Systemic hyperglycemia and increase in amount of glucose in saliva facilitates the growth of acidogenic bacteria i.e. Streptococcus mutans, which ultimately leads to tooth decay [8].

Many natural products such as medicinal herbs, extract of seeds, flower, leaf and stem of different plants as well as honey is also considered as a good choice to prevent the dental problems [9]. Honey is a natural sweet product processed by the honey bees, it is reported that honey is less likely to participate in carries progression when compared with glucose or fructose along with that it is also highlighted that it has anti-bacterial, anti-inflammatory, anti-ulcer and antioxidant properties [10]. Due to its wide range properties it has been found to use it as treatment of gingivitis, bleeding and receding gums. Its antimicrobial properties are attributed to enzyme glucose oxidase which produces hydrogen per oxide on mixing the honey with water [11]. Vinegar is made from fermentable sugar source like dates, apple, grapes etc [12]. Studies have reported its bactericidal effects and biofilm removal properties that are beneficial for dental health. Various studies has shown that after washing toothbrushes with vinegar decreases the number of streptococcus pyogens [13,14]. The current study is aimed to evaluate the salivary pH of diabetic and healthy individual before and after using honey and vinegar mouth rinses.

2. MATERIALS AND METHODS

It was a pre-clinical experimental study conducted in dental OPD of Baqai medical college Karachi from 1st January to 15th February 2021. The sample size was calculated by sealed...
envelope software i.e. N=80. The participants were divided into 4 groups by simple random sampling technique. Patients with type II diabetes (without other comorbidities) and healthy individuals who visited the dental OPD for regular visit were included as study participants. Individuals with other oral and systemic comorbidities were excluded. Grouping was performed as; Group A, n=20 healthy participants who rinsed with honey mouth rinse, Group B n=20 patients with diabetes who rinsed with honey mouth rinse. Similarly, Group C, n=20 healthy participants who rinsed with vinegar mouth rinse and Group D, n=20 patients with diabetes who rinsed with vinegar mouth rinse. We enrolled participants who agreed and were according to inclusion criteria and asked educated them to maintain the oral hygiene for 15 days. They were instructed to refrain from eating for 1 h before collection of saliva. For the patients with diabetes Random Blood Sugar levels were taken before the mouth rinse. 2 ml of saliva was collected by asking the participants to collect it in the floor of the mouth and swallowing for one minute was prohibited and after that they were asked to expectorate it into the sterile container. Then they were given the mouth rinse according to group distribution and after rinsing they were asked to wait for half an hour after that saliva was again collected from same participant to identify the rinse induced change in pH of oral cavity. pH strips were immersed in the sterile container and reading were noted. It was reassured by the examiner that the pH strips were uncontaminated and were kept in place for 30 seconds and used as per manufacturer’s guidelines. The colour change was noted and readings were compared with the indicator chart given in the pH strip packing.

### 2.1 Preparation of Mouth Rinse

Ten ml of commercial honey was added to 100 ml of distilled water, and mixed for 10 minutes until it was homogenized. Same protocol was followed for the vinegar mouth rinse and was kept at room temperature in sterile bottle until use. Both the solutions were reduced to 10 ml to obtain 100% (W/V) concentration [15]. Prior to experiment A pilot study was conducted on 6 participants to determine the acceptability and safety of the mouthwashes and no adverse events were reported.

The data collected was analyzed using SPSS version 21 for descriptive and analytical statistics. The interpretations of the pH readings are based on the colour coding chart. pH between the range of 4.0–5.5 shows it to be in the acidic range which can be improved by the change in the dietary pattern to benefit the pH of one’s body. The pH reading in between 6.5 and 7.5 is the optimal range to maintain the alkalizing lifestyle. Above 8 is uncommon showing salivary pH to be too alkaline which is not normal. Paired T test was applied to record the pre and post rinsed oral pH followed by ANOVA for inter group comparison of post rinsed pH values with p-value less than 0.05 considered as significant.

### 3. RESULTS

The mean age of patients with diabetes (group B and D) was 53.4 ± 8.2 years and mean age of healthy individuals (Group A and C) was 45.9 ± 9.6 years. There were 56 female and 24 male participants in our study. The random blood sugar levels in patients with diabetes were 203.5 ± 23.4 mg/dl. In group A, there was no significant change in pH of saliva before and after rinsing with honey mouth rinse, however, when Group B i.e., diabetic individuals were checked significant increase in saliva was observed after 30 of rinsing as shown in Table 1.

**Table 1. The observed pH of group A and B before and after honey mouth rinse**

<table>
<thead>
<tr>
<th></th>
<th>pH before honey rinse</th>
<th>pH after honey rinse</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>5.95 ± 1.8</td>
<td>6.1 ± 1.02</td>
<td>0.133</td>
</tr>
<tr>
<td>Group B</td>
<td>5.01 ± 1.49</td>
<td>6.75 ± 0.58</td>
<td>0.033</td>
</tr>
</tbody>
</table>

**Table 2. The observed pH of group C and D before and after vinegar mouth rinse**

<table>
<thead>
<tr>
<th></th>
<th>pH before vinegar rinse</th>
<th>pH after vinegar rinse</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group C</td>
<td>5.56 ± 1.02</td>
<td>5.90 ± 1.49</td>
<td>0.142</td>
</tr>
<tr>
<td>Group D</td>
<td>5.42 ± 1.83</td>
<td>6.1 ± 1.0</td>
<td>0.043</td>
</tr>
</tbody>
</table>

**Table 3. ANOVA analysis after rinsing**

<table>
<thead>
<tr>
<th>Groups</th>
<th>pH after rinsing</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>6.1 ± 1.02</td>
<td></td>
</tr>
<tr>
<td>Group B</td>
<td>6.75 ± 0.58</td>
<td>0.024</td>
</tr>
<tr>
<td>Group C</td>
<td>5.90 ± 1.49</td>
<td></td>
</tr>
<tr>
<td>Group D</td>
<td>6.1 ± 1.0</td>
<td></td>
</tr>
</tbody>
</table>
The analysis of Group C showed no significant difference before and after rinsing with vinegar mouth rinse while analysis of Group D showed significant increase in pH of saliva of diabetic individuals results are highlighted in in Table 2.

The intra group comparison of mouth rinses showed that honey mouth rinse was significantly more effective than vinegar mouth rinse in increasing the salivary pH of oral cavity in diabetic individuals.

4. DISCUSSION

Diabetes mellitus is a chronic iceberg disease and public health problem which effects the individuals of any age. Patients suffering from diabetes compromise the salivary gland function and results in decrease alteration of salivary flow [16,17]. Saliva contains a variety of host defence factors. Decrease in salivary flow may manifest to oral complications such as xerostomia which manifest as dental caries, gingivitis, periodontitis, and certain fungal infections [18]. According to WHO statistics about 80% of the population is using natural products due to their potent activates and less disadvantages. Natural products now becoming popular approach, especially in developing countries. The antibacterial activity of honey was known because it contain methylglyoxal and presence saturated groups in honey [19]. Without dilution original form of honey was used in various in vitro and in vivo studies against dental plaque and caries [20], but the current study was Planned to explore the effectiveness of diluted form of honey as mouth rinse in diabetic and non-diabetic patients. Honey contains many enzymes such as hydrogen peroxidase when diluted it become potent antibacterial rinse. In our study when healthy individuals were assessed for honey and vinegar mouth rinse there was no any significant change observed before and after the rinse, it is observed in multiple studies that diabetes mellitus is one of the reasons that causes decrease in salivary pH which results in dental problems and increase the susceptibility of affected individuals towards oral infections [21, 22]. While when it comes to healthy individuals there is no significant change in pH of saliva which is showing the parallel findings with above studies as well as highlighting the protective effects of saliva in healthy individual. It was observed in diabetic individuals that their salivary pH before the rinse was slightly acidic when compared to healthy individuals which provides a good media for growth of acidogenic bacteria such as Strep. mutans that leads to more pronounced dental and periodontal changes in diabetic individuals [22]. After 30 minutes of honey mouth rinse there was significant increase in salivary pH of diabetic participants the same results were observed atwa et., al who proved that honey was effective in preventing plaque and gingivitis [23]. When the findings were observed for vinegar mouth rinse the results identified were parallel to multiple studies in which its antibacterial, antifungal activities are compared and are attributed to its ability of change in salivary pH, the role of vinegar is also highlighted as a potent irrigant for canal while Root canal treatment [24,25]. When honey mouth rinse was compared with vinegar rinse we found better results with honey which may be due to its neutralizing properties, however, as vinegar itself lies in category of week acids it did not show equality in maintaining the salivary pH of diabetic individuals.

5. CONCLUSION

Honey and vinegar mouth rinses proved to be effective natural products in maintaining the pH of saliva of diabetic individuals.

6. LIMITATIONS

After rinse pH was evaluated after 30 minutes which is minimum time to strengthen the study. We recommend recording the pH maximum after two hours of rinsing.

CONSENT

Each participant was briefed regarding the study protocol and after that written informed consent was taken.

ETHICAL APPROVAL

Study was ethically approved by ERC of Baqai Medical University Karachi.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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