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Effectiveness and Acceptability of Aqueous Cinnamon Extract Mouthrinse in Maintaining Salivary and Tongue-coating pH in Comparison with 0.2% Chlorhexidine Mouthwash: A Randomized Controlled Trial

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Abstract

Context: Salivary pH is a fair indicator of health for extracellular fluids and their alkaline mineral reserves. Similarly, tongue pH is indicative of the existing flora and conditions of the tongue. **Objectives:** The purpose of the study was to evaluate effectiveness and acceptability of aqueous cinnamon extract mouthrinse in maintaining salivary and tongue coating pH as compared to 0.2% chlorhexidine mouthwash. **Setting and Design:** A randomized, parallel-group study was conducted among 70 volunteer subjects, who were randomly assigned to two groups of 35 each (20% aqueous cinnamon extract and 0.2% chlorhexidine mouthwash). **Materials and Methods:** Salivary pH was measured by a digital pH meter, while tongue pH was assessed using color changing pH strips. Participants were asked to rinse with the respective mouthwash (10 ml for 1 minute) and expectorate. Salivary and tongue pH were recorded 5 and 30 minutes after rinsing. Participants were instructed to use the mouthwash twice a day in the prescribed manner. The same procedure was repeated on third and seventh day. Responses to a questionnaire related to taste acceptability were collected on the last day. Data were analyzed statistically using repeated measure analysis of variance and Student's *t*-test. **Results:** Mean salivary pH values showed significant increase throughout the duration of the study after rinsing with both cinnamon and chlorhexidine mouthwashes ($p<0.05$). Tongue coating pH showed an increase toward alkalinity in both the groups, but this difference was statistically significant only in the cinnamon extract group 30 minutes after rinsing and on third day. Both agents performed equally well and were equally accepted; there was no statistically significant difference between the two groups. **Conclusion:** Traditional herbal products such as cinnamon can able to regulate the salivary and tongue coating pH as well as standard chlorhexidine mouthwash.

Keywords: Cinnamomum Zeylanicum, Halitosis, Hydrogen Ion Concentration, Mouthwashes, Saliva

Key Messages: Aqueous cinnamon extract at 20% concentration is equivalent to 0.2% chlorhexidine mouthwash when it comes to maintaining salivary and tongue coating pH, as well as taste. Keeping in mind its other proven benefits, this common spice can be used to fight oral diseases among the disadvantaged and rural populations.

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1. Introduction

Dental diseases are almost always initiated at the microbial-host tissue interface. Alterations in the microbial and ecological dynamics can significantly change the ecosystem towards one that may initiate and promote oral diseases[1]. Thus, the varied properties of the environment can determine which organisms occupy a site in the oral cavity, and the metabolic activities of these organisms can in turn transform the properties of the environment.

Many of the organisms associated with oral diseases, both gram-positive and gram-negative, thrive in environments with low pH. For example, a study by Takahashi et al. on the effect of pH on growth of microorganisms showed that P. intermedia grows at a pH of 5.0-7.0[2]. Also, when the oral pH remains in the vicinity of 5.0–5.5, tooth mineral is solubilized, thereby buffering the plaque and maintaining an environment suitable for growth of S. mutans[3]. The normal pH of saliva varies, but usually, the pH of stimulated saliva is 7.0[4]. Saliva contributes to maintenance of pH by two mechanisms - its flow eliminates carbohydrates and removes acids, while its buffering activity also neutralizes acids[3].

There is also an association between tongue microorganisms and those present in saliva. Moreover, past research has found pH to be one of the major regulating factors of halitosis, with the dorsum of the tongue being most commonly implicated in the production of volatile Sulphur compounds[5–7].

Chlorhexidine, a potent chemotherapeutic agent, has been regarded as the gold-standard in mouthwashes because of broad-spectrum antibacterial activity and substantivity of 8-12 hours[8-10]. But, the incidence of side-effects such as tooth discolouration, burning sensation, parotid swelling, taste perturbation, increased supragingival plaque formation, and undesirable taste deter patients from using it effectively[11]. A suitable alternative to chlorhexidine, with equal or superior effectiveness, would be highly advantageous from the point of view of dental practitioners.

Cinnamon (Cinnamomum zeylanicum), a member of the Lauraceae family, is a commonly used spice which has been used extensively for treatment of several conditions[12]. Few researchers have postulated that various extracts of cinnamon have equivalent therapeutic benefits as chlorhexidine mouthwash when it came to controlling S. mutans counts, as well as in controlling gingivitis[13–15].

Studies on the effects of aqueous cinnamon extract on salivary and tongue coating pH are lacking, and the acceptability of the solution is unknown. It is thus important to carry out new studies with these products and identify their influence on salivary and tongue coating pH. This randomized controlled trial was undertaken to compare the effectiveness and acceptability of aqueous cinnamon extract mouthrinse when used for maintaining salivary and tongue coating pH with 0.2% chlorhexidine mouthwash used for the same purpose.

2. Subjects and Methods

The objectives of this study were to

(a) Test the effect of 20% aqueous cinnamon extract mouthrinse on salivary and tongue-coating pH
(b) Compare the effectiveness of 20% aqueous cinnamon extract mouthrinse when used for maintaining salivary and tongue coating pH, with 0.2% chlorhexidine mouthwash used for the same purpose
(c) Compare the acceptability of the two solutions

Before the commencement of the trial, ethical clearance was obtained from the Institutional Review Board. The trial is registered with the Clinical Trials Registry - India (CTRI/2018/01/011587). Informed consent was obtained from all participants prior to recruitment in the study.

This parallel group, randomized, controlled trial was conducted on persons aged over 18 years, free of systemic diseases and willing to provide informed consent. Those who had received any antimicrobial therapy over the past two weeks, or were using any prosthetic or orthodontic appliance were considered to be ineligible.

Sample size was scientifically estimated (using the following values: standard deviation = 1.96, normal deviate at 80% power = 1.28, pooled standard deviation = 4, difference of means between the two groups = 2.2) resulting in a final sample size of 70. Participants were recruited through flyers and advertisements in a University campus, but no additional incentive was provided. A flowchart describing the participants' recruitment and follow-up is shown in (Figure 1).

Preparation of Aqueous cinnamon extract mouthrinse: High quality Cinnamon was purchased from the market, and ground into fine powder in an electrical mixer[13,14]. One hundred gram of finely powdered cinnamon was mixed with one litre of sterile deionized water and kept in

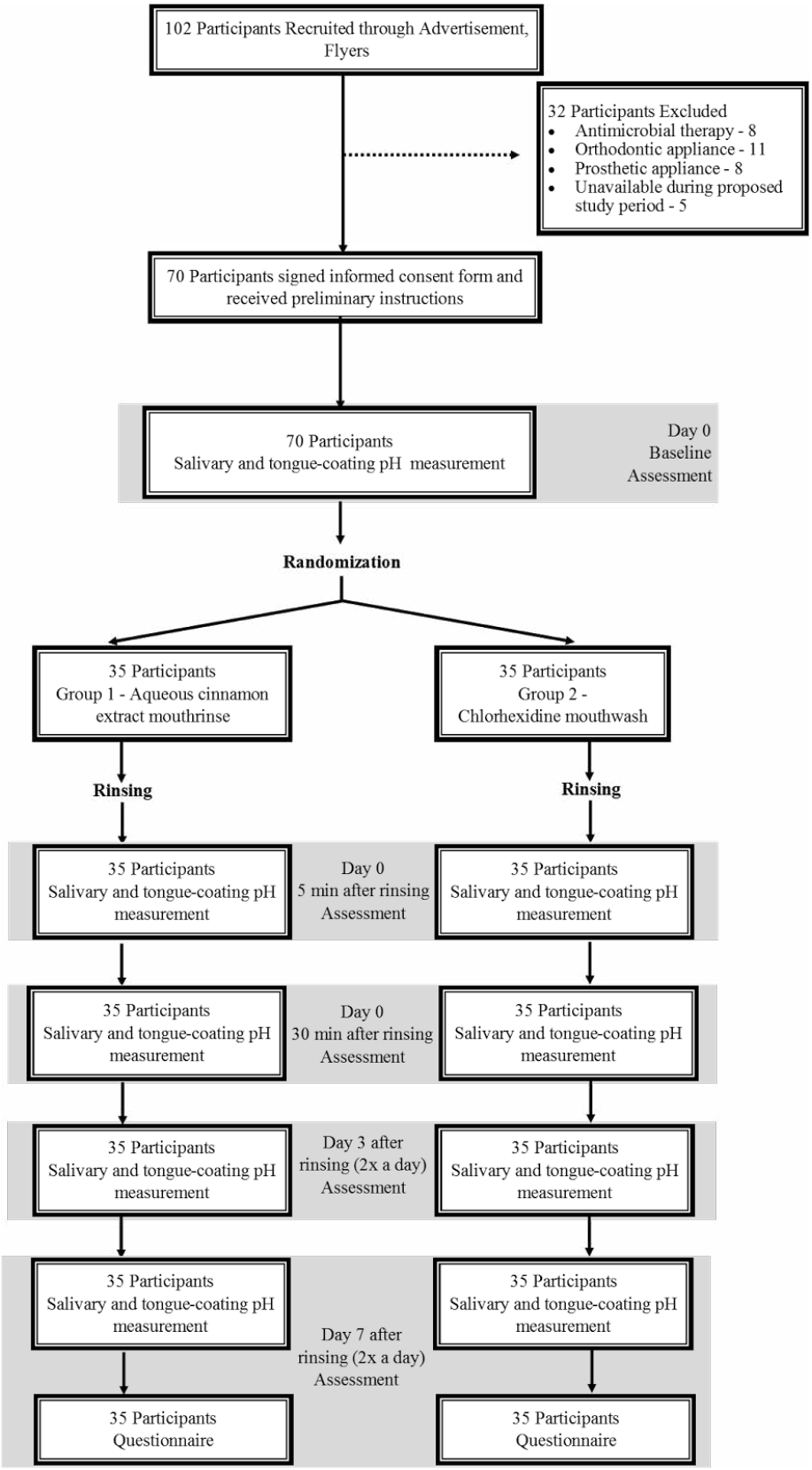

Figure 1. Flowchart depicting flow of participants.

a water bath at 60°C for five hours, then filtered through sterile filter paper. The extract was left to dry at 40°C in hot air oven for evaporation of water. The extract was preserved in a refrigerator until use. Mouthrinse was prepared at a concentration of 20mg/ml by mixing 20g of the prepared powder in 1 litre of water. Mouthwash was dispensed to patients in individual plastic bottles.

Chlorhexidine mouthwash: Standard 0.2% chlorhexidine mouthwash (Rexidin; Indoco Remedies Limited, India) was purchased from the market and dispensed into sterilized plastic bottles. During the course of the study, stimulated saliva was collected from participants at five points - on first day at baseline, after 5 min, after 30 min, on third day, and on seventh day. Salivary pH was measured using a digital pH meter (0 - 14; Horiba India Private Limited, India). Each session of saliva collection was followed up with a recording of the tongue pH using colour-changing strips (0 - 14; Macherey-Nagel, Germany). On the day of baseline assessment, the participants were asked to perform their normal oral hygiene procedure, but refrain from eating or drinking up to one hour prior to saliva collection, and then report to the dental school for saliva collection. During saliva collection, each participant was seated comfortably in a dental chair. Stimulated saliva was collected in the manner recommended by Navazesh and Kumar[16], followed by tongue pH measurement.

The participants were then randomized into two groups using a lottery method - **Group 1:** test group (20% aqueous cinnamon extract mouthrinse) and **Group 2:** Control group (0.2% chlorhexidine gluconate mouthwash), with 35 persons in each group. The allocation procedure was performed using opaque sealed envelopes. The intervention groups were pre-coded, and the mouthrinses packaged in semi-opaque bottles, such that the study subjects, as well as the investigator, were blind to the allocation of the group.

After allocation into the respective groups, each participant was asked to rinse with their allotted mouthwash (10 mL for 1 minute) and then expectorate. Salivary and tongue pH was recorded after five minutes and 30 minutes of rinsing in both the groups.

None of the participants were allowed to eat or drink during the phases. Each participant was given 300 mL of the respective solutions and told to rinse twice a day in the same manner as instructed earlier. This procedure was started from the next day and continued for seven days. The patients reported for salivary and tongue pH measurement on the third and seventh day, and estimation was done in the same manner.

On the seventh day, a pre-validated, close-ended questionnaire relating to the acceptability of the mouthwashes' taste was distributed to the participants[17]. The questionnaire was composed of 3 questions with five options (five-point Likert scale) for each answer.

Salivary pH Measurement: Stimulated saliva was collected in a sterile test tube. The pH-sensitive electrode of the digital pH meter was dipped in the sample. The pH reading was recorded after waiting 10 seconds for the reading to stabilize. In between readings, the electrode was cleaned with distilled water and placed in a standard solution of pH 7.0, as per the manufacturer's instructions.

Tongue pH Measurement: Tongue coating pH was measured using pH indicator strips. One strip was placed on posterior tongue region, with the participant's mouth kept open for 1 min. The color change in the strip was compared with a reference standard, and indicated the tongue coating pH.

Salivary and tongue coating pH were the primary outcome measures, while responses to the questionnaire were the secondary outcome.

Statistical analysis was performed using Statistical Package for Social Sciences (version 22; IBM, Chicago, Illnois) to identify the differences between the two agents used in the study. This included calculation of mean ± standard deviation and use of paired t-test, as well as independent samples t-test to calculate the significance of differences between the groups. Chi-square test, and Fisher's exact test where applicable, was used for analysis of the questionnaire.

3. Results

There were no drop-outs and none of the 70 participants reported any serious adverse event during the course of this study. The distribution of groups according to gender is displayed in (Table 1). All the participants were between 18 – 23 years old.

Table 1. Distribution of participants according to gender

Group	Male n (%)	Female n (%)
Cinnamon extract	10 (28.6)	25 (71.4)
Chlorhexidine	12 (34.3)	23 (65.7)
Total	22 (31.4)	48 (68.6)

3.1 Salivary pH

At baseline, the mean salivary pH (± standard deviation) was 7.40 (± 0.55) in the cinnamon extract group, while it was 7.50 (± 0.43) in the chlorhexidine group. Immediately after rinsing with the respective agents, a significant tendency towards alkalinity was seen in both the groups ($p<0.05$). The mean salivary pH in the cinnamon extract group was 7.58 (± 0.49) as compared to 7.62 (± 0.40) in the chlorhexidine group. There was no statistically significant difference between the groups. The salivary pH showed significant increase in both the groups at the assessment done 30 minutes after baseline rinsing and on the third day. During final assessment, there was still no statistically significant difference between the groups, although the mean salivary pH had further increased in both groups. In the cinnamon extract group, it was 7.85 (± 0.37) and in the chlorhexidine group it was 7.82 (± 0.35) (Table 2).

3.2 Tongue Coating pH

At baseline, the mean tongue pH (± standard deviation) was 7.23 (± 0.43) in the cinnamon extract group, while it was 7.37 (± 0.49) in the chlorhexidine group ($p>0.05$). Immediately after rinsing with the respective agents, the tongue coating pH increased in both the groups, although not significantly so. The mean salivary pH in the cinnamon extract group was 7.31 (± 0.47) as compared to 7.34 (± 0.48) in the chlorhexidine. There was also no statistically significant difference between the groups. However, the cinnamon extract group displayed a significant change after 30 minutes of rinsing and on the third day. During final assessment, there was still no statistically significant difference between the groups ($p = 0.650$), although the mean salivary pH had further increased in both groups. In the cinnamon extract group, it was 7.37 (± 0.49) and in the chlorhexidine group it was 7.43 (± 0.55) (Table 3).

3.3 Acceptability

Participants of both groups demonstrated similar acceptance to the respective agents when it came to the taste of the product, for how long the taste remained in the mouth, or the taste of food and drinks afterwards (Table 4).

4. Discussion

This parallel-group, randomized, controlled trial included 70 participants, with 35 in each group. Aqueous

Table 2. Mean Salivary pH of both the experimental groups

Group	n	Before Mean pH ± Standard deviation	After Mean pH ± Standard deviation	After 30 minutes Mean pH ± Standard deviation	Third day Mean pH ± Standard deviation	Seventh day Mean pH ± Standard deviation
Cinnamon extract mouthrinse	35	7.40 ± 0.55	7.58 ± 0.49*	7.71 ± 0.46*	7.83 ± 0.38*	7.85 ± 0.37*
Chlorhexidine mouthwash	35	7.50 ± 0.43	7.62 ± 0.40†	7.70 ± 0.39†	7.75 ± 0.36†	7.82 ± 0.35†
Independent samples t-test		p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05
*		p < 0.05	Paired t-test, as compared to before rinsing with cinnamon extract mouthrinse			
†		p < 0.05	Paired t-test, as compared to before rinsing with chlorhexidine mouthwash			

Table 3. Mean tongue coating pH in both the experimental groups

Group	n	Before Mean pH ± Standard deviation	After Mean pH ± Standard deviation	After 30 minutes Mean pH ± Standard deviation	Third day Mean pH ± Standard deviation	Seventh day Mean pH ± Standard deviation
Cinnamon extract	35	7.23 ± 0.43	7.31 ± 0.47	7.46 ± 0.56*	7.40 ± 0.55*	7.37 ± 0.49
Chlorhexidine	35	7.37 ± 0.49	7.34 ± 0.48	7.37 ± 0.49	7.37 ± 0.49	7.43 ± 0.56
Independent samples t-test		p > 0.05	p > 0.05	p > 0.05	p > 0.05	p > 0.05
*		p < 0.05	Paired t-test, as compared to before rinsing with cinnamon extract mouthrinse			

Table 4. Acceptance of the agents used in both the experimental groups

How was the taste of the product?						**P - value**
Group	**Very good**	**Good**	**Average**	**Bad**	**Very bad**	
Cinnamon extract mouthrinse	5 (14.3%)	5 (14.3%)	22 (62.9%)	2 (5.7%)	1 (2.8%)	p > 0.05
Chlorhexidine mouthwash	4 (11.4%)	10 (28.6%)	16 (45.7%)	5 (14.3%)	0 (0%)	
How long did the taste remain in the mouth after rinsing?						
Group	**Very long**	**Long**	**Average**	**Short**	**Very short**	
Cinnamon extract mouthrinse	2 (5.7%)	2 (5.7%)	27 (77.1%)	4 (11.4%)		p > 0.05
Chlorhexidine mouthwash	1 (2.8%)	5 (14.3%)	25 (71.4%)	4 (11.4%)		
How was the taste of food and drinks after rinsing?						
Group	**Very positive**	**Slightly positive**	**Not affected**	**Slightly negative**	**Very negative**	
Cinnamon extract mouthrinse		5 (14.3%)	29 (82.9%)	1 (2.8%)		p > 0.05
Chlorhexidine mouthwash		4 (11.4%)	27 (77.2%)	4 (11.4%)		

cinnamon extract was prepared in a standardized manner and adjusted to a concentration of 20mg/ml. A concentration of 20% for the test solution was selected based on previous in vivo studies that found significantly positive effects on Streptococcus mutans count, dental plaque and gingivitis[14,15,18,19]. Chlorhexidine mouthwash of standard concentration of 0.2% was obtained from the market for the purpose of this study.

Salivary pH and tongue coating pH are sometimes used as diagnostic markers to indicate the initiation or presence of oral disease. Although salivary volume and composition are constantly changing, repeated salivary samples collected under strictly standardized conditions seem to be fairly constant in the same individual.[4] In this study, stimulated saliva samples were collected in the manner described in earlier research.[16] For the purpose of tongue coating pH, test strips that change colour according to local environment were used. These have shown good feasibility and reliability in the past[20].

The results of this study show that the salivary pH significantly increased towards alkalinity in both the experimental groups after rinsing with the respective mouthwashes. Moreover, there was no statistically significant difference between the groups. These results are similar to previous research by Al-Joubori et al.[20] It was also noted in the present study that the salivary pH continued to increase steadily for up to 30 minutes, similar to the results reported previously[20]. But, in the study by Tolentino et al.[21], the salivary pH showed an increase after rinsing with any solution, even distilled water, even though the increase was not of statistical significance. Based on the current results, it can be said that both cinnamon and chlorhexidine were equally effective in increasing salivary pH over a seven-day period.

In the present study, the cinnamon extract mouthrinse group showed a discernible increase in the tongue coating pH after 30 minutes of rinsing and on the third day, when compared to baseline. Yet, no significant differences were observed when comparing immediately after rinsing and seventh day values with the results obtained at baseline. Additionally, there was no significant difference in the chlorhexidine group before and at any point after rinsing. The results of these two agents on tongue coating pH could not be compared with other studies, as no studies have reported the same. Based on the results of the present study, it cannot be concluded whether aqueous cinnamon extract mouthrinse or chlorhexidine mouthwash have any major effect on the tongue coating pH.

The majority of participants in the cinnamon extract (62.8%) and chlorhexidine groups (45.7%) rated the taste of the mouthwash as average. Most participants from both groups (cinnamon extract – 77.2%, chlorhexidine – 71.4%) found that the taste remained in the mouth for an average period of time. Also, almost all participants said that the taste of food and drinks was unaffected after using the respective mouthwashes. The lack of adverse events reported in this study is encouraging, and future research can test the implications of long-term usage of a cinnamon mouthwash. Additionally, considering the easy availability of cinnamon, and the various methods available for its extraction, future studies should test the effectiveness of simpler extracts such as infusion and decoction. This will help us identify the effectiveness of aqueous cinnamon extract in a low-resource or home-based situations.

This study is subject to certain limitations that should be kept in mind when interpreting the results. Firstly, the short duration of this study prevented testing of the long-term effectiveness of the product. Also, the small sample size may limit the generalization of the findings.

5. Conclusion

The present study revealed that 20% aqueous cinnamon extract is a viable option to increase the salivary pH of a patient, and is comparable to 0.2% chlorhexidine mouthwash used for the same purpose. There was no discernible effect of chlorhexidine on tongue pH, but the cinnamon mouthwash was able to increase tongue pH 30 minutes after rinsing and on third day, when compared to baseline. Yet, no significant differences were observed between the two experimental groups. The acceptability of the two mouthwashes were similar.

The potent action of cinnamon in this study, and previously, suggests that this common product can be used to fight oral diseases among the disadvantaged and rural populations who often lack access and affordability. Being an herbal product with a pleasant taste, it is likely to be accepted with ease.

6. References

1. Marsh PD. Are dental diseases examples of ecological catastrophes? *Microbiology*. 2003; 149:279–294. https://doi.org/10.1099/mic.0.26082-0. PMid:12624191
2. Takahashi N, Schachtele CF. Effect on pH on the growth and proteolytic activity of Porphyromonas gingivalis and Bacteroides intermedius. *J Dent Res.* 1990; 69(6):1266–1269. https://doi.org/10.1177/00220345900690060801. PMid:2191980
3. Hicks J, Garcia-Godoy F, Flaitz C. Biological factors in dental caries: role of saliva and dental plaque in the dynamic process of demineralization and remineralization (part 1). *J Clin Pediatr Dent.* 2004; 28(1):47–52. https://doi.org/10.17796/jcpd.28.1.yg6m443046k50u20
4. Humphrey SP, Williamson RT. A review of saliva: Normal composition, flow and function. *J Prosthet Dent.* 2001; 85(2):162–169. https://doi.org/10.1067/mpr.2001.113778. PMid:11208206
5. Rosenberg M, McCulloch CA. Measurement of oral malodor: Current methods and future prospects. *J Periodontol.* 1992; 63(9):776–782. https://doi.org/10.1902/jop.1992.63.9.776. PMid:1474479
6. Rosenberg M. Clinical assessment of bad breath: current concepts. *J Am Dent Assoc.* 1996; 127(11):475–482. https://doi.org/10.14219/jada.archive.1996.0239. PMid:8655868
7. Casemiro LA, Martins CH, Carvalho TC, Panzeri H, Lavrador MA, Pires-de-Souza FC. Effectiveness of a new toothbrush design versus a conventional tongue scraper in improving breath odor and reducing tongue microbiota. *J Appl Oral Sci.* 2008; 16(4):271–274. https://doi.org/10.1590/S1678-77572008000400008. PMid:19089259. PMCid:PMC4327536
8. Balagopal S, Arjunkumar R. Chlorhexidine: The gold standard antiplaque agent. *J Pharm Sci.* 2013; 5(12): 270–274.
9. Mandel ID. Chemotherapeutic agents for controlling plaque and gingivitis. *J Clin Periodontol.* 1988; 15(8):488–498. https://doi.org/10.1111/j.1600-051X.1988.tb01020.x. PMid:3053790
10. Tomas I, Cousido Mc, Garcia-Caballero L, Rubido S, Limeres J, Diz P. Substantivity of a single chlorhexidine mouthwash on salivary flora: influence of intrinsic and extrinsic factors. *J Dent (Shiraz).* 2010; 38(7):541–546. https://doi.org/10.1016/j.jdent.2010.03.012.PMid:20380865
11. Hepso HU, Bjornland T, Skoglund LA. Side-effects and patient acceptance of 0.2% versus 0.1% chlorhexidine used as a postoperative prophylactic mouthwash. *Int J Oral Maxillofac Surg.* 1988; 17(1):17–20. https://doi.org/10.1016/S0901-5027(88)80222-4
12. Nabavi SF, Di Lorenzo A, Izadi M, Sobarzo-Sanchez E, Daglia M, Nabavi SM. Antibacterial effects of Cinnamon: From farm to food, cosmetic and pharmaceutical industries. *Nutrients*. 2015; 7(9):7729–7748. https://doi.org/10.3390/nu7095359. PMid:26378575. PMCid:PMC4586554
13. Rashad JM. Effect of water cinnamon extract on mutans streptococci, in comparison to chlorhexidine gluconate and Zac (in vitro and in vivo study). *Mustansiria Dental Journal.* 2008; 5:250–260.
14. Al-Duboni G, Osman MT, Al-Naggar R. Antimicrobial activity of aqueous extracts of cinnamon and ginger on two oral pathogens causing dental caries. *Research Journal of Pharmaceutical, Biological and Chemical Sciences.* 2013; 4(3):957–965.
15. Gupta D, Jain A. Effect of cinnamon extract and chlorhexidine gluconate (0.2%) on the clinical level of dental plaque and gingival health: A 4-week, triple blind, randomized controlled trial. *International Academy of Periodontology*. 2015; 17(3):91–98.
16. Navazesh M, Kumar SKS. Measuring salivary flow: challenges and opportunities. *J Am Dent Assoc.* 2008; 139:355-405. https://doi.org/10.14219/jada.archive.2008.0353
17. Balappanavar AY, Sardana V, Singh M. Comparison of the effectiveness of 0.5% tea, 2% neem and 0.2% chlorhexidine mouthwashes on oral health: a randomized control

trial. *Indian J Dent Res.* 2013; 24(1):26–34. https://doi.org/10.4103/0970-9290.114933.PMid:23852229

18. Gupta C, Kumari A, Garg AP, Catanzaro R, Marotta F. Comparative study of cinnamon oil and clove oil on some oral microbiota. *Acta Biomed.* 2011; 82:197–199.
19. Al-Joubori SK, Al-Obeidi WA. Effect of cinnamon extract of streptococci and mutans streptococci, in comparison to chlorhexidine gluconate. *Journal of Baghdad College of Dentistry.* 2011; 23(1):141–145.
20. McDowell JD, Kassebaum DK. Diagnosing and treating halitosis. *J Am Dent Assoc.* 1993; 124:55–64. https://doi.org/10.14219/jada.archive.1993.0263
21. Tolentino ES, Chinellato LEM, Tarzia O. Saliva and tongue coating pH before and after use of mouthwashes and relationship with parameters of halitosis. *J Appl Oral Sci.* 2011; 19(2):90–4. https://doi.org/10.1590/S1678-77572011000200002. PMCid:PMC4243744