



Contents lists available at ScienceDirect

Journal of Traditional and Complementary Medicine

journal homepage: <http://www.elsevier.com/locate/jtcme>

Effectiveness of novel herbal dentifrice in control of plaque, gingivitis, and halitosis – Randomized controlled trial

Kalyana-Chakravarthy Pentapati ^{a,*}, Meena Anand Kukkamalla ^b, Hanan Siddiq ^a, Neeraja Sabnis ^c

^a Department of Public Health Dentistry, Manipal College of Dental Sciences, Manipal, Manipal Academy of Higher Education, Manipal, India

^b Department of Periodontology, Manipal College of Dental Sciences, Manipal, Manipal Academy of Higher Education, Manipal, India

^c Manager (R and D for Cosmetics), Sriveda Sattva Pvt. Ltd, Bangalore, India

ARTICLE INFO

Article history:

Received 12 February 2019

Received in revised form

29 May 2019

Accepted 25 June 2019

Available online 25 June 2019

Keywords:

Dental
Malodour
Gum bleeding
Oral
Randomized
Toothpaste

ABSTRACT

Background and aim: Plaque is a common etiological factor for common oral conditions like gingivitis, periodontitis, dental caries and halitosis. We aimed to evaluate the efficacy of a novel herbal dentifrice in control of plaque, gingivitis, and halitosis in comparison to control dentifrice.

Experimental procedure: We conducted a randomized controlled, single center, double-blinded parallel arm clinical trial. Participants were randomly distributed with commercially available herbal dentifrice or control dentifrice. Assessments of plaque, gingivitis, halitosis, unstimulated saliva pH were done at baseline and at one month by a trained and calibrated periodontist. All the participants were given new toothbrushes one week before the start of the study. They were asked to brush with the designated dentifrices for 2–4 min, twice daily for one month.

Results and conclusion: A total of 79 participants were recruited for this study, out of which 75 participants completed the follow-up. Inter-group comparisons of all the variables at baseline showed no significant differences in the mean plaque index, gingival index, halitosis and pH between test and control groups respectively. Intra-group comparisons showed a significant decrease in mean plaque, gingival and halitosis at follow-up than at baseline in both test and control groups. No significant differences between test and control groups were seen in the mean plaque index ($P = 0.792$), gingival index ($P = 0.292$), halitosis ($P = 0.266$), pH ($P = 0.742$) at follow-up after adjusting the respective baseline scores. The novel herbal dentifrice could be a suitable alternative for the control of plaque, gingivitis, and halitosis.

© 2019 Center for Food and Biomolecules, National Taiwan University. Production and hosting by Elsevier Taiwan LLC. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

Dental plaque is a microbial biofilm, which is a complex accumulation of 3-dimensional arrangement of bacteria. In the oral cavity, bacterial biofilms are found on both hard and soft tissues.¹ Plaque is a common etiological factor for common oral diseases like gingivitis, periodontitis, and dental caries.^{2,3} Microbial

degradation of organic substrates in the oral cavity can also cause halitosis. Over 80–90% of the cases, halitosis is caused by oral conditions such as dental plaque, impacted food or debris, tongue coating, periodontal disease, peri-implant disease, and many others.⁴

Optimal plaque control plays a pivotal role in the prevention and control of gingivitis and periodontal diseases. Many mechanical plaque control aids are currently available to remove or control plaque.⁵ Brushing of teeth twice a day and daily flossing is shown to be highly effective in plaque reduction. However, over 50% of adults still shown to have gingivitis on an average of 3–4 teeth.⁶ Hence, various chemical formulations were tried in dentifrices to prevent plaque and gingivitis.

As some of these chemical substances may have undesirable side effects, such as staining of teeth, alteration of taste, abrasion of

* Corresponding author. Department of Public Health Dentistry, Manipal College of Dental Sciences, Manipal, Manipal Academy of Higher Education, Manipal, Karnataka, 576104, India.

E-mail addresses: kalyan.cp@manipal.edu, drkalyan81@gmail.com (K.-C. Pentapati).

Peer review under responsibility of The Center for Food and Biomolecules, National Taiwan University.

teeth, ulceration of oral mucosa, etc.,⁷ interest in natural-based dentifrices has increased lately. Moreover, herbal dentifrices can help in the control of common oral diseases without the need for chemical agents. Thus, amidst growing evidence of connecting oral health and whole body health, ‘naturally occurring’ active ingredients of herbal medicines, in the least harmful way, offers milder and long-lasting methods for restoration of health. Many clinical trials have been published on the reduction of supragingival plaque and gingivitis and the positive effect of toothbrushing with herbal dentifrices.^{8–15}

Numerous herbal dental dentifrices are now commercially available out of which Sudanta dentifrice (Sri Sri Tattva Sudanta) has received attention as it has an all-natural, fluoride-free composition. It is a polyherbal composition of Cloves (*Syzygium aromaticum*), Cinnamon (*Cinnamomum zeylanica*), Black pepper (*Piper nigrum*), Bakul (*Mimusops elengi*), Mayaphal (*Quercus infectoria*) and Camphor (*Cinnamomum camphora*). Hence, we aimed to evaluate the efficacy of novel herbal dentifrice in control of plaque, gingivitis, and halitosis in comparison to control dentifrice. This study would help to understand the benefits of Ayurveda based herbal dentifrice over a control dentifrice in controlling plaque, gingivitis, and halitosis.

2. Materials and methods

We conducted a randomized controlled, single center, double-blinded parallel arm clinical trial to evaluate the efficacy of herbal novel dentifrice on control of plaque and gingivitis. Permission to conduct was sought from the institutional ethics committee, (IEC: 222/2018) and the trial was registered with the Clinical Trial Registry of India (CTRI/2018/05/014049). The scope of the study with possible benefits and harms were explained to all the participants, and informed consent was sought. The study was conducted among the adolescent students of government polytechnic college, Udupi. We included participants willing to participate, aged 18 and above with plaque and gingivitis score of more than 2. Subjects with a history of use of antibiotics or anti-inflammatory drugs in the last one week, allergy to any herbal products or rampant caries or subjects with more than 30% of the teeth missing or crowns or large restorations were excluded. Participants were screened for inclusion and exclusion criteria, and eligible consented participants were randomized by block randomization (block size = 4) into either the test or control group. Serial opaque cardboard boxes with pre-assigned numbers corresponding to block randomization code were used to allocate the participants into their respective groups ensuring the blinding of the outcome assessor or the examiner (Fig. 1).

Sample size calculation was done using PS program version 3.1.6 (power and sample size calculations)¹⁶ based on the findings of the previous study.¹² It was estimated that 36 subjects were needed in each group with a mean difference of 0.2 and standard deviation of 0.3 to reject the null hypothesis that the population means of the test and control groups are equal with a power of 80% and confidence interval of 95%.

2.1. Interventions

Participants in the test group were given commercially available herbal non-fluoridated dentifrice (Sudanta toothpaste, Sriveda Sattva Pvt Ltd, Bangalore, India) containing extracts of Cloves (*Syzygium aromaticum* - stem and buds oil-2mg), Cinnamon (*Cinnamomum zeylanica* - bark oil 0.5 mg), Black pepper (*Piper nigrum* - fruit-liquid extract-2mg), Bakul (*Mimusops elengi* - bark liquid extract-5mg), Mayaphal (*Quercus infectoria* - Galls liquid extract-1mg) and Camphor (*Cinnamomum camphora*), Sodium benzoate

(Preservative - 5 mg), Base-Q, S, Aqua-Q.S. Participants in the control group were given commercially available 1000 ppm fluoridated dentifrice (Colgate Total, Colgate-Palmolive India Pvt Ltd, Solan, Himachal Pradesh, India). All the dentifrices were dispensed after masking with thick black adhesive tape to ensure proper blinding of the product.

2.2. Outcome assessment

Plaque was evaluated by Turesky, Gilmore, Glickman modification¹⁷ of Quigley-Hein Plaque Index¹⁸ using a disclosing agent (range: 0 to 5). Gingivitis was assessed by Talbott, Mandel, Chilton modification¹⁹ of Loe and Silness Gingival index (range: 0 to 3).²⁰ Two secondary measures were calculated from the above plaque and gingival indices as described previously.²¹ The plaque severity score was calculated by assessing the number of teeth with a score of 3 or more divided by the number of teeth evaluated. The gingivitis severity score was calculated by determining the number of teeth with bleeding divided by the total number of teeth examined. Halitosis was evaluated using a handheld breath analyzer (Tanita Corporation of America Inc, IL, USA) as per the manufacturer instructions. Unstimulated Saliva pH assessment was done using pH ion strips as per the manufacturer instructions. All the assessments were done at baseline and at the end of one month. Clinical evaluation was done by a trained calibrated periodontist (MA). Allocation concealment, participant allocation, halitosis score measurement, and salivary pH assessment was done by a trained calibrated examiner (HS). Intra-examiner reliability for plaque and gingivitis were 0.93 and 0.92 respectively.

2.3. Instructions to the participants

All the participants were given new toothbrushes one week before the start of the study. They were asked to brush with the designated dentifrices for 2–4 min/day, twice daily for one month. A record of the tooth brushing was given to participants to evaluate tooth brushing behavior. All the participants have reported to perform tongue cleaning. Participants were asked to refrain from using any other oral health care products during the course of the study.

2.4. Statistical analysis

All the analysis was done using SPSS version 18. A p-value of <0.05 was considered statistically significant. Independent sample t-test was done to evaluate the inter-group group comparisons. ANCOVA was done to assess the inter-group differences at one month after adjusting for baseline values.

3. Results

A total of 295 participants were screened for inclusion, and 79 participants were recruited for this study, out of which 75 (test = 37 and control = 38) participants completed the follow-up. Of this, majority were males (n = 60). The mean age of the participants in the test and control group was 20.32 ± 5.86 and 18.97 ± 3.47 respectively. Four participants could not attend the follow-up examinations due to their academic schedules (three participants were selected for industrial tour and one participant had failed in the examinations due to which they could not attend the follow-up visits). Taste of the toothpastes was acceptable to all the participants and no discomfort was reported with the use of either of the toothpastes.

Inter-group comparisons of all the variables at baseline showed no significant differences in the mean plaque index (P = 0.969),

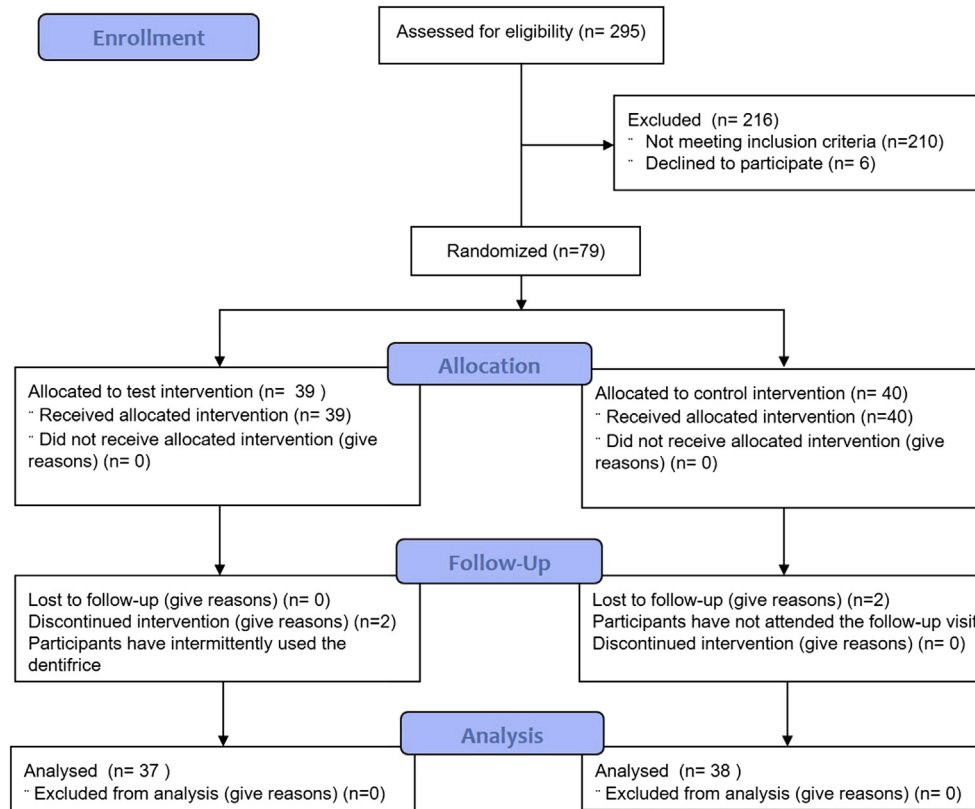


Fig. 1. Flowchart of participants at various stages of the trial.

plaque severity index ($P=0.733$), gingival index ($P=0.553$), gingival severity index ($P=0.626$), halitosis ($P=0.821$), pH ($P=0.539$) between test and control groups respectively (Table 1).

Intra-group comparisons were done for all the variables in test and control groups. It was seen that there was a significant decrease in mean plaque, plaque severity, gingival, gingival severity and halitosis at follow-up than at baseline in both test and control groups. However, there was a significant increase in salivary pH at follow-up than baseline in both test and control groups (Table 1).

Table 1
Inter and intra-group comparisons between baseline and 1 month follow-up scores.

	Group	Baseline		Follow-up		P-value [‡]
		Mean	SD	Mean	SD	
Plaque index	Control	2.47	.70	1.27	.44	<0.001
	Test	2.46	.58	1.30	.51	<0.001
	P-value [†]	0.969				
Plaque severity index	Control	10.42	9.57	1.58	3.77	<0.001
	Test	11.19	9.85	2.22	5.42	<0.001
	P-value [†]	0.733				
Gingival index	Control	1.20	.23	.90	.18	<0.001
	Test	1.16	.27	.94	.17	<0.001
	P-value [†]	0.553				
Gingivitis severity index	Control	5.55	6.53	.87	1.76	<0.001
	Test	4.89	5.06	.68	1.73	<0.001
	P-value [†]	0.626				
Halitosis	Control	1.26	.72	.58	.64	<0.001
	Test	1.30	.57	.43	.65	<0.001
	P-value [†]	0.821				
pH	Control	6.46	.34	6.72	.36	<0.001
	Test	6.41	.43	6.67	.40	0.001
	P-value [†]	0.539				

[†] P-value for inter-group comparisons (independent sample *t* test); [‡] P-value for intra-group comparisons (paired *t* test).

Inter-group comparisons of all the variables at follow-up after adjusting the respective baseline scores was done using ANCOVA. No significant differences were seen in the mean plaque index ($P=0.792$), plaque severity index ($P=0.607$), gingival index ($P=0.292$), gingival severity index ($P=0.649$), halitosis ($P=0.266$), pH ($P=0.742$) between test and control groups respectively (Table 2).

4. Discussion

Plaque is the major etiologic factor for gingivitis, periodontitis, caries, and halitosis. Mechanical plaque control is the best approach for the elimination of plaque. Several chemotherapeutic plaque control agents have been studied. However most of them have side effects when used for an extended duration. Hence, numerous herbal products have emerged in the markets with more emphasis on herbal dentifrices. With increased awareness about the healthy lifestyle and natural products among the consumers, this has led to a growing demand for herbal oral health care products globally.

Herbal products used in indigenous medicine are of growing interest in the field of dental disease prevention. They can be safe and long term alternatives for the maintenance of optimal oral health. Our study has evaluated the effectiveness of one such novel herbal dentifrice over the control dentifrice. The test dentifrice in our study had polyherbal ingredients like cloves, cinnamon, black pepper, bakul, mayaphal and camphor. *Syzygium aromaticum* has medicinal properties like antimicrobial effect against various periodontal pathogens and opportunistic microorganisms. *Cinnamomum zeylanica* used as a flavor in sweets, and chewing gum was shown to have pleasant and refreshing effect in the mouth. It is used for toothaches, oral infections, remove bad breath and has a coagulant effect. Moreover, it possesses potent antibacterial and

Table 2
Inter-group comparisons at follow-up after adjusting for baseline values.

	Adjusted baseline	Test Mean±SE	Control Mean±SE	P-value
Plaque index	2.47	1.3 ± 0.07	1.27 ± 0.07	0.792
Plaque severity index	10.8	2.16 ± 0.75	1.63 ± 0.74	0.607
Gingival index	1.18	0.94 ± 0.03	0.9 ± 0.03	0.292
Gingivitis severity index	5.23	0.68 ± 0.29	0.87 ± 0.29	0.649
Halitosis	1.28	0.43 ± 0.1	0.59 ± 0.1	0.266
pH	6.43	6.68 ± 0.06	6.7 ± 0.06	0.742

antifungal properties.²² Pradeep et al. showed that piperine has an inhibitory action on nitric oxide production and tumor necrosis factor-alpha production, both of which have a known role in the pathology of inflammation in periodontal disease.²³ Another study reported that *Piper nigrum* (Piperine) could be used as potential therapeutic tools to regulate inflammatory responses and prevent/attenuate carcinogenesis.²⁴ More recently, Bae et al. showed that administration of Piperine inhibited lipopolysaccharide (LPS)-induced inflammatory responses, leukocyte accumulation, and the production of tumor necrosis factor-alpha.²⁵ Dwivedi and Singh have shown that Piperine has significant anti-biofilm effect of *Streptococcus mutans*.²⁶ *Quercus infectoria* has also been pharmacologically documented to possess astringent, antibacterial, antiviral, antifungal, local anesthetic and anti-inflammatory properties.²⁷ *Mimusops elengi* has various medicinal properties, like anti-viral, anti-inflammatory, antimicrobial antioxidant, analgesic, and astringent actions. *Cinnamomum camphora* has anti-inflammatory property and reduces the swelling and pain associated with inflammation.²⁷

All the ingredients used in the novel polyherbal dentifrice have anti-inflammatory, antibacterial, antioxidant properties. The effect of these ingredients in the present study was evident, and no significant differences concerning the mean plaque, plaque severity, gingivitis, gingival severity, halitosis and mean pH levels were seen between the novel and control dentifrice after one-month follow-up after adjusting for respective baseline scores. These findings suggested that the herbal dentifrice could be an effective alternative as the control dentifrice. Direct comparisons of the findings of our study were not possible as the dentifrice with these ingredients is novel and has not been studied earlier. Howshigan et al.,¹³ and Jayashankar et al.,¹⁴ conducted a study on polyherbal dentifrice which had many similar constituents to the test dentifrice (*Acacia chundra*, *Adhatoda vasica*, *Mimusops elengi*, *Piper nigrum*, *Pongamia pinnata*, *Quercus infectoria*, *Syzygium aromaticum*, *Terminalia chebula*, and *Zingiber officinale*) significantly improved with respect to plaque, gingivitis, and bleeding indices. Previous studies with herbal dentifrices were effective in reducing plaque and gingivitis. Hosadurga et al.,¹² Ozaki et al.,¹⁰ Saxer et al.,²⁸ and Mullaly et al.,²⁹ showed that there was a significant reduction in both plaque and gingival indices at the end of trial within the group, but there were no significant differences between the groups when herbal dentifrices were used. Willerhausen et al.,³⁰ reported that herbal dentifrice significantly reduced plaque and bleeding indices than the placebo group. The salivary pH shifted towards more alkaline from the baseline in both control and test group. However no significant difference was seen between them. Willerhausen et al.³⁰ reported a similar shift of pH to alkaline ranges in herbal dentifrice but not in the placebo group. Hosadurga et al. showed no change saliva pH in any of the groups studied.¹²

Limited clinical studies have evaluated the effect of herbal dentifrices on halitosis. Halitosis in our study was assessed using handheld portable breath analyzer. In the present study, the halitosis reduced from that of the baseline values in both the test and

control group. The constituents of test dentifrice have an antimicrobial activity which could have had a decreased the scores of breath analyzer.³¹ Similarly, control dentifrice also had antimicrobials which had a significant effect. Moreover, the role of such antimicrobials to prevent caries cannot be underestimated with the constituents of the test dentifrice. The extracts of *Syzygium aromaticum* essential oil,^{32,33} *Mimusops elengi*,^{34,35} *Quercus infectoria* galls^{36,37} have been shown to have antibacterial action on biofilms of *Streptococcus mutans* that has a potential role in caries initiation and development.

The possibility of hypersensitivity to herbal ingredients cannot be ruled out with the contents of the test dentifrice. One such ingredient that may have the potential for allergic reactions is Cinnamon which can cause Cinnamon contact stomatitis in some individuals. A recent review³⁸ reported 12 case series and case reports involving 35 cases (24 females) secondary to the use of Cinnamon flavoured chewing gums. Most of them recovered after discontinuation of the same. Such allergies are rare in the mouth and is mainly due to the protective role of saliva and high vascularization in oral epithelium.³⁹ Individuals and health care professionals should be well aware of this possible potential of allergic reactions to Cinnamon and the fact that the discontinuation of the same may be enough to diagnose and manage same.

Few limitations are noted in our study. Although an attempt was made to blind the participants for the dentifrices, there was still a possibility that participants could know the control interventions as it was routinely used dentifrice. Conversely, the participants in the test dentifrice might have also known due to the herbal flavour of the dentifrice. Hence, the possibility of bias could have occurred in both the groups. Also, evaluation of halitosis and pH in our study was evaluated using handheld portable breath analyzer and pH strips which are not a standard method. However, in this field study, it was not feasible to use any of the conventional techniques. Within the limitations of the study, the herbal dentifrice could be an alternative for the maintenance of oral health. Further, studies are needed to evaluate the long term benefits of the same with respect to the incidence of caries.

Conflicts of interest

Dr. Pentapati reports that product samples of both test and control groups, disclosing agent and hand held breath analyser were provided by Sriveda Sattva Pvt Ltd, Bangalore, India. .

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jtcme.2019.06.006>.

References

- Gurenlian JR. The role of dental plaque biofilm in oral health. *J Dent Hyg.* 2007;81:1–10.
- Tadikonda A, Pentapati K-C, Urala A-S, Acharya S. Anti-plaque and anti-

- gingivitis effect of Papain, Bromelain, Miswak and Neem containing dentifrice: a randomized controlled trial. *J Clin Exp Dent*. 2017;9.
3. Holmen L, Mejare M, Malmgren B, Thylstrup A. The effect of regular professional plaque removal on dental caries in vivo. *Caries Res*. 1988;22:250–256.
 4. van den Broek AMWT, Feenstra L, de Baat C. A review of the current literature on aetiology and measurement methods of halitosis. *J Dent*. 2007;35:627–635.
 5. Barnes VM, Richter R, DeVizio W. Comparison of the short-term antiplaque/antibacterial efficacy of two commercial dentifrices. *J Clin Dent*. 2010;21:101–104.
 6. Oliver RC, Brown LJ, Løe H. Periodontal diseases in the United States population. *J Periodontol*. 1998;69:269–278.
 7. de Oliveira SMA, Torres TC, Pereira SL da S, Mota OM de L, Carlos MX. Effect of a dentifrice containing Aloe vera on plaque and gingivitis control. A double-blind clinical study in humans. *J Appl Oral Sci*. 2008;16:293–296.
 8. Fine DH. Chemical agents to prevent and regulate plaque development. *Periodontol*. 1995;8:87–107, 2000.
 9. George J, Hegde S, Rajesh K, Kumar A. The efficacy of a herbal-based toothpaste in the control of plaque and gingivitis: a clinico-biochemical study. *Indian J Dent Res*. 2009;20:480.
 10. Ozaki F, Pannuti CM, Imbrunite AV, et al. Efficacy of a herbal toothpaste on patients with established gingivitis—a randomized controlled trial. *Braz Oral Res*. 2006;20:172–177.
 11. Pannuti CM, Mattos JP de, Ranoya PN, Jesus AM de, Lotufo RFM, Romito GA. Clinical effect of a herbal dentifrice on the control of plaque and gingivitis: a double-blind study. *Pesqui Odontol Bras*. 2003;17:314–318.
 12. Hosadurga R, Bolor VA, Rao SN, MeghRani N. Effectiveness of two different herbal toothpaste formulations in the reduction of plaque and gingival inflammation in patients with established gingivitis – a randomized controlled trial. *J Tradit Complement Med*. 2018;8:113–119.
 13. Howshigan J, Perera K, Samita S, Rajapakse PS. The effects of an Ayurvedic medicinal toothpaste on clinical, microbiological and oral hygiene parameters in patients with chronic gingivitis: a double-blind, randomised, placebo-controlled, parallel allocation clinical trial. *Ceylon Med J*. 2016;60:126.
 14. Jayashankar S, Panagoda GJ, Amaratunga EAPD, Perera K, Rajapakse PS. A randomised double-blind placebo-controlled study on the effects of a herbal toothpaste on gingival bleeding, oral hygiene and microbial variables. *Ceylon Med J*. 2011;56:5–9.
 15. Al-Kholani AI. Comparison between the efficacy of herbal and conventional dentifrices on established gingivitis. *Dent Res J (Isfahan)*. 2011;8:57–63.
 16. Dupont WD, Plummer WD. Power and sample size calculations. A review and computer program. *Contr Clin Trials*. 1990;11:116–128.
 17. Turesky S, Gilmore ND, Glickman I. Reduced plaque formation by the chloromethyl analogue of vitamin C. *J Periodontol*. 1970;41:41–43.
 18. Quigley GA, Hein JW. Comparative cleansing efficiency of manual and power brushing. *J Am Dent Assoc*. 1962;65:26–29.
 19. Talbott K, Mandel ID, Chilton NW. Reduction of baseline gingivitis scores with repeated prophylaxes. *J Prev Dent*. 4:28–29.
 20. Loe H, Silness J. Periodontal disease in pregnancy. I. Prevalence and severity. *Acta Odontol Scand*. 1963;21:533–551.
 21. Triratana T, Rustogi KN, Volpe AR, DeVizio W, Petrone M, Giniger M. Clinical effect of a new liquid dentifrice containing triclosan/copolymer on existing plaque and gingivitis. *J Am Dent Assoc*. 2002;133:219–225.
 22. Rao PV, Gan SH. Cinnamon: a multifaceted medicinal plant. *Evidence-Based Complement Altern Med*. 2014;2014:1–12.
 23. Pradeep CR, Kuttan G. Effect of piperine on the inhibition of nitric oxide (NO) and TNF-alpha production. *Immunopharmacol Immunotoxicol*. 2003;25:337–346.
 24. Majdalawieh AF, Carr RI. In vitro investigation of the potential immunomodulatory and anti-cancer activities of black pepper (*Piper nigrum*) and cardamom (*Elettaria cardamomum*). *J Med Food*. 2010;13:371–381.
 25. Bae G-S, Kim M-S, Jung W-S, et al. Inhibition of lipopolysaccharide-induced inflammatory responses by piperine. *Eur J Pharmacol*. 2010;642:154–162.
 26. Dwivedi D, Singh V. Effects of the natural compounds embelin and piperine on the biofilm-producing property of *Streptococcus mutans*. *J Tradit Complement Med*. 2016;6:57–61.
 27. Safiaghdam H, Oveissi V, Bahramsoltani R, Farzaei MH, Rahimi R. Medicinal plants for gingivitis: a review of clinical trials. *Iran J Basic Med Sci*. 2018;21:978–991.
 28. Saxer UP, Menghini G, Bohnert KJ, Ley F. The effect of two toothpastes on plaque and gingival inflammation. *J Clin Dent*. 1995;6:154–156.
 29. Mullally BH, James JA, Coulter WA, Linden GJ. The efficacy of a herbal-based toothpaste on the control of plaque and gingivitis. *J Clin Periodontol*. 1995;22:686–689.
 30. Willershausen B, Gruber I, Hamm G. The influence of herbal ingredients on the plaque index and bleeding tendency of the gingiva. *J Clin Dent*. 1991;2:75–78.
 31. 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.
 32. Yanti Y, Juniardi S, Lay BW. Anti-halitosis activity of *Syzygium aromaticum* essential oil against *Streptococcus sanguinis*. *Int J Infect Dis*. 2018;73:143.
 33. Cai L, Wu CD. Compounds from *Syzygium aromaticum* possessing growth inhibitory activity against oral pathogens. *J Nat Prod*. 1996;59:987–990.
 34. Prabhat A, Navneet Avnish C. Evaluation of antimicrobial activity of six medicinal plants against dental pathogens. *Rep Opin*. 2010;2:37–42.
 35. Gami B, Pathak S, Parabia M. Ethnobotanical, phytochemical and pharmacological review of *Mimusops elengi* Linn. *Asian Pac J Trop Biomed*. 2012;2:743–748.
 36. Vermani A, Navneet Prabhat. Screening of *Quercus infectoria* gall extracts as anti-bacterial agents against dental pathogens. *Indian J Dent Res*. 2009;20:337.
 37. Mohammadi-Sichani M, Karbasizadeh V, Dokhaharani S. Evaluation of biofilm removal activity of *Quercus infectoria* galls against *Streptococcus mutans*. *Dent Res J (Isfahan)*. 2016;13:46.
 38. Calapai G, Miroddi M, Mannucci C, Minciullo P, Gangemi S. Oral adverse reactions due to cinnamon-flavoured chewing gums consumption. *Oral Dis*. 2014;20:637–643.
 39. Georgakopoulou EA. Cinnamon contact stomatitis. *J Dermatol Case Rep*. 2010;4:28–29.