Comparative Evaluation of Antiplaque Efficacy of Chlorhexidine, Green Tea and Herbal Mouthwashes: A Randomized Clinical Trial

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Abstract

Background: Chemical antiplaque mouthwashes are used to improve oral health care. Nowadays, herbal mouthwashes with their "naturally occurring" active ingredients are beneficial in the treatment of gingival disease without any side effects. The aim of this study was to compare the antiplaque efficacy of chlorhexidine, green tea, and herbal mouthwashes.

Materials and methods: It is a randomized controlled trial in which 45 participants were equally divided into three groups: Group A – Chlorhexidine, Group B – Hiora, and Group C – Colgate plax. Oral prophylaxis followed by the prescription of mouthwash and plaque index, gingival index, stain index, taste perception, and CPITN index were recorded at baseline, on the 14th and 21st days.

Result: On comparing plaque index at baseline and after 21 days between Hiora, chlorhexidine, and Colgate plax, a statistically significant difference was found ($p = 0.00$), whereas CPITN index between Hiora and Colgate plax was also statistically significant ($p = 0.00$), while scores of stain index and taste perception of chlorhexidine group only were found statistically significant ($p = 0.00$).

Conclusion: Colgate plax mouthwash was found to be more effective in plaque reduction, less stain, and good taste perception rather than chlorhexidine and Hiora.

Keywords: Antiplaque efficacy, Chlorhexidine, Colgate plax, Hiora.

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Introduction

Gingivitis is an inflammatory reaction to a dental plaque that is reversible, affecting the gingival tissue. It is the most common human disease of the oral cavity.[1] Mechanical plaque control is considered to be the gold standard of periodontal therapy.[2] It includes toothbrush, interdental floss, interdental brushes, and wood sticks.[3] However, mechanical plaque control does not always suffice completely as its efficacy is dependent on the dexterity and motivation level of the patient.[2] Thus, chemical antiplaque mouthwash is used to improve oral health care. Among the various mouthwashes, the most persistent reduction of bacteria has been achieved by chlorhexidine mouthwash.[4] Chlorhexidine still remains the gold standard against which the efficacy of newer antiplaque agents is compared because of its superior antiplaque effect and its substantivity for a period of 10–12 h. However, the side effects of chlorhexidine such as tooth and tongue staining, taste alterations, and mucosal erosions limit patient compliance.[5,6] Though a wide array of allopathic antiplaque agents are available, nowadays, interest has been developed toward the traditional system of medicine in India – Ayurveda, due to the cost and adverse effects of allopathic agents on long-term usage.[7] Researchers believe that the association between intake of green tea and maintenance of oral health may result from green tea catechins.[8,9] Hiora is a herbal mouthwash, with Miswak (*Salvadora persica*) as an active herbal ingredient. It has been demonstrated that extracts of *S. persica* improved gingival health and inhibited the growth of carcinogenic bacteria.[10] Herbal mouthwashes usually do not contain alcohol or any added sugars or preservatives. This fact gives the herbal mouthwashes an edge over chlorhexidine mouthwashes. So,

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the main objective of our study was to determine the antiplaque efficacy of chlorhexidine, green tea, and herbal mouthwashes.

Materials and Methods

A sample of 45 patients aged 18–25 years who fulfilled the eligibility criteria was randomly selected from the OPD of the Department of Public Health Dentistry, Kothiwal Dental College, Moradabad. By using Fliess formula ($\alpha = 0.05$, $\beta = 0.2$, $P_0 = 0.5$, $P_1 = 0.21$, $r = 1$), the sample size was calculated, and the sample size estimation was 45. All 45 participants' oral prophylaxis was done and equally divided into three groups:

1. *Group A* (15 each) participants were provided oral hygiene instruction along with the usage of 0.12% chlorhexidine mouthwash.

Table 1: Comparison of mean difference of plaque index, gingival index, stain index, and CPITN index within groups at different time intervals

	Hiora		Chlorhexidine		Colgate plax	
	Mean difference	Sig.	Mean difference	Sig.	Mean difference	Sig.
Plaque (Baseline)	00		00		00	
Plaque (14 days)	0.59533	**0.000**	0.41200	0	0.84600	**0.000**
Plaque (21 days)	0.8140000	**0.000**	0.39533	**0.002**	1.14533	**0.000**
Gingival index (Baseline)	00		00		00	
Gingival index (14 days)	0.12267	0.051	0.189	0.021	0.843	0.045
Gingival index (21 days)	0.847	0.491	0.632	0.017	0.634	0.020
Stain index (Baseline)	00		00		00	
Stain index (14 days)	0.764	0.899	0.74133	**0.000**	0.731	0.016
Stain index (21 days)	0.621	0.712	1.1213333	**0.000**	0.873	0.017
CPITN (Baseline)	00		00		00	
CPITN (14 days)	0.5067	**0.000**	0.2800	0.018	0.5267	**0.000**
CPITN (21 days)	0.5533	**0.000**	0.2800	0.018	0.5267	**0.000**

$^*p < 0.05$

2. *Group B* (15 each) participants were provided oral hygiene instruction along with the usage of herbal mouthwash (Hiora).
3. *Group C* (15 each) participants were provided oral hygiene instruction along with the usage of green tea mouthwash (Colgate plax).

The demographic data were collected from each group. Plaque index by Silness and Loe (1967), gingival index by Loe and Silness (1963), stain index (Lobene Stain Index), and CPITN index (WHO, FDI) were recorded at baseline, on the 14th and 21st day. All were instructed to rinse twice daily with 5 mL of the allocated mouthwash (undiluted) for 30 seconds after 30 minutes of toothbrushing. Any side effects with the use of given products, either subjective or objective, were recorded.

Inclusion Criteria

- A minimum of 20 teeth should be present in the dentition.
- Subjects who had not received any periodontal therapy for the past 6 months.
- No clinical attachment loss.
- Subjects with no systemic disease and no allergic reactions.

Exclusion Criteria

- Subjects with severe malalignment, orthodontic appliances, and removable partial denture.
- Smokers.
- Oral soft-tissue pathology.
- Physical or mental handicap.
- Destructive periodontal disease.
- Subjects under any medications.
- Pregnant women.

Data description, analysis, and presentation were performed using Statistical Package for Social Science (SPSS version 19). Comparison of mean difference of plaque index, gingival index, stain index, and CPITN index within groups at different time intervals was done by *t*-test. *Post hoc* test was used for comparison of plaque index, gingival index, stain index, and CPITN index between the groups at different time intervals.

Results

Table 1 shows within-group comparison of plaque index, gingival index, stain index, and CPITN index at baseline, on the 14th and 21st day. Plaque index, gingival index, stain index, and CPITN index at baseline was zero. On comparing all the indexes at 14th and 21st days with baseline, there was an increase in scores of plaque index, gingival index, stain index, and CPITN index. On comparing plaque index among Hiora, chlorhexidine, and Colgate plax at baseline and 21st day, there was a statistically significant difference ($p = 0.00$), whereas CPITN index among Hiora and Colgate plax was also statistically significant, whereas Stain index of chlorhexidine was found statistically significant ($p = 0.00$).

Table 2 shows comparison between groups of Hiora, chlorhexidine, and Colgate plax at baseline, on the 14th and 21st day. Plaque index among chlorhexidine and Colgate plax at 21 days was found statistically significant ($p = 0.00$), whereas while comparing Hiora and Colgate plax with chlorhexidine at the 14th and 21st day, a statistically significant difference was also found ($p = 0.00$).

Stain index and taste perception of chlorhexidine group only was found statistically significant ($p = 0.00$).

Discussion

Chemical plaque-control agents act as effective adjuncts to mechanical plaque control in preventing plaque formation and gingival inflammation. Chlorhexidine is considered to be the "gold standard" antiplaque mouthwash due to its prolonged broad-spectrum antimicrobial and plaque-inhibitory potential.[11,12] However, its long-term use is limited due to side effects including extrinsic tooth staining, taste disturbance, enhanced supragingival calculus formation, and desquamation of the oral mucosa. As compared to this, herbal mouthwash due to its natural ingredients has no side effects for patients who wish to avoid alcohol, sugar, and any artificial preservatives in their mouthwash.[13,14] The practice of alternate medicine with the use of plant and plant products has evolved widely in the form of mouth rinses and toothpastes. They have been shown to possess beneficial effects in the control of plaque and gingival inflammation.[15] Hiora herbal oral rinse consists of *Piper betle* (Nagavalli), *Bhibhitika* (*Terminalia bellerica*), and *Pilu* (*S. persica*) commonly known as Meswak, *Gandharpura tailum*, *Yavani, Ela, Peppermint satva. Salvadora persica* (Meswak) prevents dental plaque accumulation and subsequent gingival inflammation. Green tea is made solely with the leaves of *Clonorchis sinensis* that have undergone minimal oxidation during processing, and hence it has more antioxidant and antibacterial properties.[16] The most

Table 2: Comparison of plaque index, gingival index, stain index, and CPITN index between the groups at different time intervals

Dependent variable	(I) Mouthwash	(J) Mouthwash	Mean difference (I-J)	Sig.
Plaque (14 days)	Hiora	Chlorhexidine	0.18333	0.473
		Colgate plax	−0.25067	0.253
	Chlorhexidine	Hiora	−0.18333	0.473
		Colgate plax	−0.43400*	0.021
	Colgate plax	Hiora	0.25067	0.253
		Chlorhexidine	0.43400*	0.021
Plaque (21 days)	Hiora	Chlorhexidine	0.4186667*	0.015
		Colgate plax	−0.3313333	0.066
	Chlorhexidine	Hiora	−0.4186667*	0.015
		Colgate plax	−0.7500000*	**0.000**
	Colgate plax	Hiora	0.3313333	0.066
		Chlorhexidine	0.7500000*	**0.000**
Stain index (14 days)	Hiora	Chlorhexidine	−0.74133*	**0.000**
		Colgate plax	0.00000	1.000
	Chlorhexidine	Hiora	0.74133*	**0.000**
		Colgate plax	0.74133*	**0.000**
	Colgate plax	Hiora	0.00000	1.000
		Chlorhexidine	−0.74133*	**0.000**
Stain index (21 days)	Hiora	Chlorhexidine	−1.1213333*	**0.000**
		Colgate plax	0.0000000	1.000
	Chlorhexidine	Hiora	1.1213333*	**0.000**
		Colgate plax	1.1213333*	**0.000**
	Colgate plax	Hiora	0.0000000	1.000
		Chlorhexidine	−1.1213333*	**0.000**
CPITN (14 days)	Hiora	Chlorhexidine	0.2267	0.160
		Colgate plax	−0.0200	0.985
	Chlorhexidine	Hiora	−0.2267	0.160
		Colgate plax	−0.2467	0.116
	Colgate plax	Hiora	0.0200	0.985
		Chlorhexidine	0.2467	0.116
CPITN (21 days)	Hiora	Chlorhexidine	0.2733	0.065
		Colgate plax	0.0267	0.972
	Chlorhexidine	Hiora	−0.2733	0.065
		Colgate plax	−0.2467	0.104
	Colgate plax	Hiora	−0.0267	0.972
		Chlorhexidine	0.2467	0.104

*$p < 0.05$

abundant components in green tea are polyphenols, in particular, flavonoids such as the catechins.[17] Major catechins found in green tea are epicatechin gallate (ECG), epicatechin (EC), epigallocatechin (EGC), and EGC gallate (EGCG).[18] The purpose of this study was to determine the antiplaque efficacy of chlorhexidine, green tea, and herbal mouthwashes.

In this study, plaque index among all the groups was found statistically significant at the 14th and 21st day ($p = 0.00$), while comparing between the groups, there was a statistically significant difference found in Colgate plax and chlorhexidine at 21 days ($p = 0.00$). The reduction in plaque value in Colgate plax group is because green tea catechin inhibits the growth of *Porphyromonas gingivalis*, *Prevotella intermedia*, and *Prevotella nigrescens*,[19,20] and the adherence of *P. gingivalis* onto human buccal epithelial cells.[20] In addition, green tea catechins with the steric structures of 3-galloyl radial, EGCG, (-)-epicatechin gallate (ECG), and (-)-gallocatechin gallate, which are the major tea polyphenols, inhibit the production of toxic end metabolites of *P. gingivalis*.[21]

In our study, CPITN index among Hiora and Colgate plax was also statistically significant ($p = 0.00$) at the 14th and 21st day, which was similar to the study done by Meena et al. Green tea decreases the periodontopathic bacteria and reduced inflammation could have attributed to the significant decrease in bleeding of probing.[22] In our study, it was also found that chlorhexidine had more staining compared with Hiora and Colgate plax (Table 2). It is due to the degradation of chlorhexidine to release parachloroniline, which appears not to occur on storage or as a result of metabolic processes. Nonenzymatic browning reactions (Maillard reactions) catalyzed by chlorhexidine cause staining.[23] In our study, there was no difference in taste perception among Hiora and Colgate plax. Chlorhexidine is reported to have decreased taste perception due to its strong cationic charge that binds to these taste pores and taste buds effectively, blocking the pathway required for the perception of saltiness.[24]

CONCLUSION

All the mouthwashes were equally effective in plaque reduction but chlorhexidine has considerable side effects, which restricts its use. So, Colgate plax can be recommended due to its antibacterial and antioxidant properties with no side effects to maintain good oral and gingival health.

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REFERENCES

1. Mariotti A. Plaque-induced gingival diseases. In: Ni P, Ja L, editors. Clinical Periodontology and Implant Dentistry. Iowa: Blackwell Munksgaard; 2008. pp. 405–420.
2. Priya BM, Anitha V, Shanmugam M, et al. Efficacy of chlorhexidine and green tea mouthwashes in the management of dental plaque induced gingivitis: A comparative clinical study. Contemp Clin Dent 2015;6(4):505–509. DOI: 10.4103/0976-237X.169845.
3. Bagchi S, Saha S, Jagannath GV, et al. Evaluation of efficacy of a commercially available herbal mouthwash on dental plaque and gingivitis: A double-blinded parallel randomized controlled trial. J Indian Assoc Public Health Dent 2015;13(3):222–227. DOI: 10.4103/2319-5932.165210.
4. Saini R, Saini S, Sharma S. Biofilm: A dental microbial infection. J Nat Sci Biol Med 2011;2(1):71–75. DOI: 10.4103/0976-9668.82317.
5. Jones CG. Chlorhexidine: Is it still the gold standard? Periodontol 2000 1997;15:55–62. DOI: 10.1111/j.1600-0757.1997.tb00105.x.
6. Mathur S, Mathur T, Shrivastava R, et al. Chlorhexidine: The gold standard in chemical plaque control. Natl J Physiol Pharm Pharmacol 2011;1(2):45–50.
7. Parwani SR, Parwani RN, Chitnis PJ, et al. Comparative evaluation of anti-plaque efficacy of herbal and 0.2% chlorhexidine gluconate mouthwash in a 4-day plaque re-growth study. J Indian Soc Periodontol 2013;17(1):72–77. DOI: 10.4103/0972-124X.107478.
8. Morang J, Addy M, Newconbe R. A clinical trial to assess the efficacy of sanguinarine–zinc mouthrinse (Veadent) compared with chlorhexidine mouthwash (Corsodyl). J Clin Periodontol 1988;15(10):612–616. DOI: 10.1111/j.1600-051x.1988.tb02260.x.
9. Ooshima T, Minami T, Aono W, et al. Reduction of dental plaque deposition in humans by oolong tea extract. Caries Res 1994;28(3):146–149. DOI: 10.1159/000261636.

10. Gupta R, Yadav OP, Khan M, et al. Comparative evaluation of efficacy of hiora, terminalia chebula and chlorhexidine as mouth wash on dental plaque. J Dent Health Oral Disord Ther 2017;8(4): 547–551. DOI: 10.15406/jdhodt.2017.08.00290.

11. Chikte UM, Lewis HA, Rudolph MJ. The effectiveness of a school based fluoride mouth rinse programme. J Dent Assoc S Afr 1996;51(11): 697–700. PMID: 9461935.

12. Guidelines for Acceptance of Chemotherapeutic Product for Control of Supragingival Dental Plaque and Gingivitis. Council on Dental Therapeutics. J Am Dent Assoc 1986;112(4):529–532. DOI: 10.1016/s0002-8177(86)24021-0.

13. Vaish S, Ahuja S, Dodwad V, et al. Comparative evaluation of 0.2% chlorhexidine versus herbal oral mouthrinse on plaque-induced gingivitis. J Indian Assoc Public Health Dent 2012;10(19): 55–62.

14. Malhotra R, Grover V, Kapoor A, et al. Comparison of the effectiveness of a commercially available herbal mouthrinse with chlorhexidine gluconate at the clinical and patient level. J Indian Soc Periodontol 2011;15(4):349–352. DOI: 10.4103/0972-124X.92567.

15. Rao NJ, Subash KR, Kumar KS. Role of phytotherapy in gingivitis: A review. Int J Pharmacol 2012;8(1):1–5. DOI: 10.3923/ijp.2012.1.5.

16. Kaur H, Jain S, Kaur A. Comparative evaluation of the antiplaque effectiveness of green tea catechin mouthwash with chlorhexidine gluconate. J Indian Soc Periodontol 2014;18(2):178–182. DOI: 10.4103/0972-124X.131320.

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. DOI: 10.4103/0970-9290.114933.

18. Okamoto M, Sugimoto A, Leung KP, et al. Inhibitory effect of green tea catechins on cysteine proteinases in *Porphyromonas gingivalis*. Oral Microbiol Immunol 2004;19(2):118–120. DOI: 10.1046/j.0902-0055.2003.00112.x.

19. Hirasawa M, Takada K, Makimura M, et al. Improvement of periodontal status by green tea catechin using a local delivery system: A clinical pilot study. J Periodontal Res 2002;37(6):433–438. DOI: 10.1034/j.1600-0765.2002.01640.x.

20. Sakanaka S, Aizawa M, Kim M, et al. Inhibitory effects of green tea polyphenols on growth and cellular adherence of an oral bacterium, *Porphyromonas gingivalis*. Biosci Biotechnol Biochem 1996;60(5): 745–749. DOI: 10.1271/bbb.60.745.

21. Sakanaka S, Okada Y. Inhibitory effects of green tea polyphenols on the production of a virulence factor of the periodontal-disease-causing anaerobic bacterium *Porphyromonas gingivalis*. J Agric Food Chem 2004;52(6):1688–1692. DOI: 10.1021/jf0302815.

22. Meena Priya B, Anitha V, Shanmugam M, et al. Efficacy of chlorhexidine and green tea mouthwashes in the management of dental plaque-induced gingivitis: A comparative clinical study. Contemp Clin Dent 2015;6(4):505–509. DOI: 10.4103/0976-237X.169845.

23. Chhabra P, Chhabra P, Kakkar A, et al. Chlorhexidine – A review. Int J Res Health Allied Sci 2018;4(5):47–51.

24. Wang MF, Marks LE, Frank ME. Taste coding after selective inhibition by chlorhexidine. Chem Senses 2009;34(8):653–666. DOI: 10.1093/chemse/bjp047.