



J Indian Soc Periodontol. 2014 Mar-Apr; 18(2): 178–182.

PMCID: PMC4033883

doi: [10.4103/0972-124X.131320](https://doi.org/10.4103/0972-124X.131320)

## Comparative evaluation of the antiplaque effectiveness of green tea catechin mouthwash with chlorhexidine gluconate

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Received 2013 Jan 31; Accepted 2013 Oct 7.

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### Abstract

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#### Aim:

The aim of this study is to compare the antiplaque efficacy of green tea catechin mouthwash with chlorhexidine gluconate mouthwash.

#### Materials and Methods:

A single blinded cross-over study was conducted among 30 participants in the age group of 18-25 years. The mouthwash samples for the study were previously labeled assigning the letters: A (0.25% of green tea catechin mouthwash) and B (0.12% of chlorhexidine mouthwash). The study subjects were randomly divided into two groups of 15 each and the study was divided into two phases. In phase I, the mouthwash A was given to one group and other group was given mouthwash B. After a 15 day washout period, in phase II, both groups were given other mouthwash. At the end of each phase of 1 week, plaque score was recorded by using Turesky modification of the Quigley-Hein plaque index.

#### Results:

The plaque scores were compared and the difference between the green tea catechin and chlorhexidine mouthwash was determined by *t*-test. The difference between plaque scores were not statistically significant ( $P > 0.05$ ). The results showed that both the groups that is green tea catechin mouthwash (0.25%) and chlorhexidine mouthwash (0.12%) have comparable results in plaque reduction.

#### Conclusion:

This study supports the effectiveness of green tea catechin mouthwash as an antiplaque agent. It should be explored as a cost-effective, long-term antiplaque rinse with prophylactic benefits.

**Keywords:** Dental plaque, gingivitis, green tea, periodontitis

## INTRODUCTION

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Periodontal diseases are chronic inflammatory conditions characterized by loss of connective tissue, alveolar bone resorption and formation of periodontal pockets as a result of the complex interaction between pathogenic bacteria and the host's immune response. Periodontitis starts with inflammatory lesions of the gingiva, which, if left untreated, may progress and eventually involve and compromise the entire periodontal apparatus of the affected teeth. Dental plaque is the primary etiologic factor in periodontal disease.[1]

The onset or progression of periodontal disease can be controlled by regular plaque control practices. Mechanical plaque control is the most dependable oral hygiene measure, but mechanical oral hygiene methods of plaque removal require time, motivation and manual dexterity.[2] Oral hygiene routines (daily toothbrushing and flossing) are neither practiced consistently nor are they done for an adequate amount of time to thoroughly remove plaque and also they are not 100% successful because of various anatomic features, crowding and tooth alignment in the arch. These limitations on home oral care practices suggest the need for other strategies.

Many of the chemical antiplaque agents in various formulations have been tried as adjunct to mechanical measures for improving oral health. Many of the reviews have supported the feasibility of chemical approach in the control of plaque formation, thereby aiding individuals in achieving acceptable gingival status.[3] These antiplaque agents can be delivered in the form of mouthwashes, dentifrices, chewing gums, gels and chips. Mouthwashes, a safe and effective delivery system for antimicrobials, can play an important role in plaque reduction.

Out of all the antiplaque agents, chlorhexidine is considered the gold standard agent for its clinical efficacy in chemical plaque control.[4] It has broad antibacterial activity, with very low toxicity and strong affinity for epithelial tissue and mucous membranes. Besides its antiplaque effect, chlorhexidine is substantive, thus reducing levels of microorganisms in saliva up to 90% for several hours. The use of chlorhexidine is burdened by some side-effects that could affect patient compliance. The most notable of these is the staining it produces,[5] others being the alteration in taste and mucosal erosions, but these are less common.[6] Essential oil rinses have also been evaluated and shown to be of value as an adjunct to mechanical oral procedures. However, the alcohol content of essential oil rinses and their unpleasant taste is unacceptable to some patients. Thus none of these chemical agents is without shortcomings. So the search for an ideal and safe antiplaque agent continues.

An increasing number of people all around the world are turning to the nature by using the natural herbal products in both prophylaxis and treatment of different diseases. Plants are the source of more than 25% of prescription and over-the-counter preparations and the potential of natural agents for oral prophylaxis should therefore be considered. Green tea is one of these. Green tea is made solely with the leaves of *Camellia sinensis* that have undergone minimal oxidation during processing. The most abundant components in green tea are polyphenols, in particular flavonoids such as the catechins, catechin gallates (Cg) and proanthocyanidins.[7] Many of the biological properties of green tea have been ascribed to the catechin fraction, which constitutes up to 30% of the dry leaf weight. These potent antioxidants comprise free catechins such as (+)-catechin, (+)-gallocatechin, (-)-epicatechin and (-)-epigallocatechin and the galloyl catechins such as (-)-epicatechin gallate (ECg), (-)-epigallocatechin gallate (EGCg), (-)-Cg and (-)-gallocatechin gallate. Green tea also contains carotenoids, tocopherols, ascorbic acid, minerals such as Cr, Mn, Se or Zn and certain phytochemical compounds. Various reported therapeutic and biological activities of catechin are lower incidences of various pathological conditions, including cardiovascular disease, strokes, obesity and cancer. These effects have been attributed, in part, to the antioxidative and free radical scavenging activities of the polyphenolic components of green tea.[7] Studies conducted in the past have shown that the green tea poly phenolic catechins, in particular (-)-(EGCg) and (-)-(ECg), can inhibit the growth of a wide range of Gram-positive and Gram-negative bacterial species with moderate potency. Evidence is emerging that these molecules may be useful in the control of common oral infections, such as dental caries and periodontal disease.[7]

A modest inverse association between the intake of green tea and periodontal disease has also been shown and the authors suggested that the application of concentrated green tea components, such as catechin may have a more beneficial effect on the periodontal condition.[8]

Though the literature shows the biological activities of green tea, much research has not been cited regarding its use as an antiplaque agent and the data regarding comparative efficacy to chlorhexidine gluconate (the gold standard) is also not available. Therefore, the present study was performed to determine whether daily mouth rinsing with green tea catechin could have an effect as an antiplaque agent and to compare the antiplaque effectiveness of green tea catechin mouthwash with 0.12% of chlorhexidine gluconate mouthwash.

## MATERIALS AND METHODS

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A single blinded cross-over study was conducted among 30 participants (students) of GND Dental College, Sunam from 1<sup>st</sup> March' 2012 to 10<sup>th</sup> June' 2012. The subjects were in the age group of 18-25 years and were living under similar environment conditions in the hostels of the institution.

### Eligibility criteria

Patients having a full complement of teeth (excluding 3<sup>rd</sup> molars), normal occlusion, absence of caries and/or restorations and a healthy periodontium were included in the study. Subjects who wore fixed or removable orthodontic appliances or prosthesis, were having any type of restorations, were prescribed antibiotics or other medications from last three months, had undergone periodontal treatment in the previous 6 months, having any systemic illness and not willing to comply with the study protocol were excluded. Informed consent was taken. The official permission and ethical approval was obtained from the ethical committee of the institution (Regd. No. GNDDC/2011/S/4056).

The mouthwash samples for study were previously labeled assigning the letters:

- A (0.25% green tea catechin mouthwash)
- B (0.12% commercially available chlorhexidine mouthwash). Mouthrinse A (Green tea catechin) was prepared by Guru Nanak Institute of pharmacy, Hyderabad.

### Catechin mouth wash (0.25% w/v)

Name of the ingredient	Quantity	Purpose
Catechin	250 mg	Medicament
Sodium chloride	100 mg	Antiseptic
Sodium benzoate	50 mg	Sodium ion provider with preservative action
Sodium bi carbonate	50 mg	Alkaliser
Amaranth solution	0.012 ml	Coloring agent
Distilled water q.s	100 ml	Vehicle

### Experimental procedures

The study subjects were selected by stratified randomized sampling method. A total of 30 subjects were selected and were divided into two groups each having 15 subjects. Before starting with first phase, professional oral hygiene, which included scaling and root planning with polishing was done and plaque score was brought to zero. The mouthwash A (green tea catechin) was given to one group and other group was given mouthwash B (chlorhexidine gluconate) [Figure 1]. Each subject was instructed to use 15 ml dose of first mouthwash for 1 min twice daily (morning and evening) for 1 week. The subjects were refrained from all kinds of oral hygiene

measures including toothbrushes and interdental cleaning aids during the study phase and were instructed not to drink coffee, wine, or tea 1 h before or after using the mouthwash. At the end of 1 week, plaque score was recorded. Then a 15 days washout period was given. During this period, the subjects were provided with colgate super soft toothbrush and colgate strong teeth toothpaste and the standardized oral hygiene instructions were given.



[Figure 1](#)

Experimental design

Again starting with the second phase, plaque score was brought to zero and both groups were given other mouthwash. At the end of 1 week, plaque score was recorded by a similar method [Figures 2–4]. All measurements were carried out under the same conditions by the same investigator who was unaware of the allocation of the mouthrinse to the participants.



[Figure 2](#)

Baseline (zero plaque)



[Figure 4](#)

Plaque score after 1 week use of chlorhexidine mouthwash



[Figure 3](#)

Plaque score after 1 week use of green tea mouthwash

### Data collection

The plaque score was recorded after 1 week by using basic fuchsin dye as a disclosing agent. The scoring of plaque was performed using Turesky *et al.* modification of the Quigley-Hein plaque index.[9]

### Statistical analysis

Data were analyzed using Statistical Package for the Social Sciences version 13 (SPSS, Chicago, IL, USA). Frequency and percentage distributions were calculated. Student's t-test was used to find the statistical difference in the means of antiplaque efficacy of green tea catechin mouthwash with chlorhexidine gluconate at  $P < 0.05$ .

## RESULTS

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All the 30 subjects completed the study. The results are presented in Tables 1–5. The plaque scores were recorded and comparisons were made for anterior teeth, posterior teeth, buccal surfaces, lingual surfaces, and for whole dentition. For buccal surfaces, the mean plaque score for green tea was  $2.8267 \pm 0.19286$  and for chlorhexidine mean score was  $2.8433 \pm 0.19772$ . The difference between plaque scores on buccal surfaces were not statistically significant ( $P > 0.05$ ). For lingual surfaces, the mean plaque score for green tea was  $2.7633 \pm 0.27353$  and for chlorhexidine it was  $2.7900 \pm 0.23245$  and after comparing the plaque scores on lingual surfaces, results were not statistically significant ( $P > 0.05$ ). The mean plaque score for whole dentition, for green tea was  $2.8333 \pm 0.32940$  and for chlorhexidine, it was  $2.8467 \pm 0.34813$  and  $P$  value after comparing plaque scores was more than 0.05, which was not statistically significant. For anterior teeth, the mean plaque score for green tea was  $2.7633 \pm 0.30113$ , and for chlorhexidine, it was  $2.7467 \pm 0.32982$  and difference between both of them were not

statistically significant ( $P > 0.05$ ). The mean plaque score for posterior teeth for green tea was  $2.8633 \pm 0.32535$  and for chlorhexidine, it was  $2.9034 \pm 0.33646$  and difference was not statistically significant ( $P > 0.05$ ). All these comparisons suggest that the two rinses i.e., green tea and chlorhexidine have shown similar clinical antiplaque efficacy over a 7 day period.

Group	Buccal surfaces Mean±SD	P value
Green tea	2.8633±0.32535	0.742
Chlorhexidine	2.9034±0.33646	
SD: Standard deviation		

[Table 1](#)

Comparison between green tea and chlorhexidine for buccal surfaces

Group	Posterior teeth Mean±SD	P value
Green tea	2.8633±0.32535	0.682
Chlorhexidine	2.9034±0.33646	
SD: Standard deviation		

[Table 5](#)

Comparison between green tea and chlorhexidine for posterior teeth

## DISCUSSION

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Bacterial biofilm development in the marginal gingiva and periodontal pockets is important in the pathogenesis of periodontal disease. Scaling and root planning are effective in altering the flora and the green tea catechin has also been shown to be effective in altering the flora and acting as an adjunct to scaling and root planning.[10] Oxidative stress plays a vital role in the pathogenesis of periodontal disease, as well as many other disorders and it is believed that antioxidants can defend against inflammatory diseases.[11] Similar mechanisms might be involved in the effects of the intake of green tea. Numerous health benefits of green tea and its constituents have been reported. It is a powerful antioxidant and has anti-inflammatory properties. Catechin was found to have antiplaque and antibacterial properties and contributed in caries prevention and gingival enhancement. Rasheed and Haider described the antibacterial effect of green tea catechins against *Streptococcus mutans* bacteria and stated that catechins were of great value in reduction of *S. mutans* and caries prevalence.[12] The present study dealt with the antiplaque efficacy of 0.25% green tea catechin mouthwash and 0.12% chlorhexidine served as comparison. It was a short time study for 7 days only which was according to the studies done by Lotufo *et al.*[13] and Quirynen *et al.*[14] who studied the efficacy of mouthrinses on *de novo* plaque formation over a period of 7 days and 11 days respectively. In this study, subjects were refrained from all types of adjunctive mechanical oral hygiene practices and only above two mouthwashes were used. To eliminate bias, a crossover design was planned between the subjects. The results of the present study as shown in [Table 1](#), [Table 2](#), [Table 3](#), [Table 4](#), [Table 5](#), showed that the green tea mouthwash has a comparable antiplaque effect over a 7 day period with gold standard chlorhexidine, which cannot be given for extended periods due to certain side effects. The plaque inhibitory effects can be attributed to the ability to remove dental plaque bacteria from teeth. Many of the biological properties of green tea have been ascribed to the catechin fraction, which is having certain therapeutic and biological properties. Cgs such as ECg intercalate into phospholipid bilayers and it is likely that they effect both virulence and antibiotic resistance by perturbing the function of key processes associated with the bacterial cytoplasmic membrane.[7] It exerts inhibitory effect on *S. mutans* growth, which are mainly responsible for caries and gingivitis. Catechins found in green tea have marked effect on pH value of saliva and dental plaque and preserve it in normal range (7.2-7.4), which is not a favorable condition for *S. mutans*.[15] According to a pilot study conducted by Awadalla *et al.* in 2011, green tea has inhibitory effect on *S. mutans* count, gingival bleeding and acidic plaque.[16]

Group	Lingual surfaces Mean±SD	P value
Green tea	2.7833±0.32535	0.682
Chlorhexidine	2.7834±0.33646	
SD: Standard deviation		

[Table 2](#)

Comparison between green tea and chlorhexidine for lingual surfaces

Group	All surfaces of all teeth Mean±SD	P value
Green tea	2.8633±0.32535	0.682
Chlorhexidine	2.9034±0.33646	
SD: Standard deviation		

[Table 3](#)

Comparison between green tea and chlorhexidine for whole dentition

[Table 4](#)

Group	Anterior teeth Mean±SD	P value
Green tea	2.78±0.45	0.001
Chlorhexidine	2.78±0.45	
SD: Standard deviation		

## Comparison between green tea and chlorhexidine for anterior teeth

A 4-week regimen of mouth washing with a dilute catechin solution reduced the mouth odor (halitosis) associated with periodontal disease.[17] It was subsequently established that tea catechins deodorized methyl mercaptan, the main cause of halitosis.[7] The property of *Porphyromonas gingivalis* to adhere onto oral epithelial cells is strongly correlated with the cause of periodontal disease. In a study conducted by Sakanaka *et al.* in 1996, Cgs, especially EGCg (active at 250-500 µg/ml), inhibited growth and adherence of *P. gingivalis* to buccal epithelial cells.[18] The number of adherent bacterial cells decreased in a dose dependent manner. They postulated that the underlying mechanism of adherence inhibition by tea polyphenols is the result of the binding of tea polyphenols to fimbria of *P. gingivalis*. Hirasawa *et al.* demonstrated bactericidal activity of green tea catechins at 1 mg/ml against species of *Prevotella* and *P. gingivalis* and found a significant reduction in markers of gingivitis after the use of a slow-release buccal delivery system applied over a period of 8 weeks.[19] Green tea catechin also has an inhibitory effect on collagenase activity, thus limiting tissue destruction. It significantly reduces the expression of matrix metalloproteinase-9 in osteoblasts and also inhibits the formation of osteoclasts. Thus, EGCg may prevent alveolar bone resorption that occurs in periodontal disease.[20,21]

A study by Kudva *et al.* in 2010 on local drug delivery of green tea catechin showed that there was significant reduction in pocket probing depth and reduction in the number of various periodontopathogenic bacteria such as *Aggregatibacter actinomycetemcomitans*, *Prevotella intermedia*, *Fusobacterium species* and *Capnocytophaga*. [10] Green tea extract has numerous effects on periodontal pathogens and periodontal tissues. Greater the concentration of catechins better the health benefits. Hence the consumption of green tea in comparison to other beverages may be widely recommended.[22] During this study, no side-effects were observed in any of the patient.

This is the study in which the antiplaque efficacy of a green tea catechin mouthwash has been tested and compared to chlorhexidine gluconate over a 7 day period. One shortcoming of this study is small sample size. However, the sample size was found to be sufficient when power calculations were made prior to the beginning of the study.

More studies using a longer duration and regarding substantivity of green tea when compared to chlorhexidine gluconate can be performed.

## CONCLUSION

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The results of the study indicate that green tea catechin mouthwash has a comparable antiplaque efficacy to chlorhexidine gluconate when used for a period of 7 days. Furthermore, green tea catechin mouthwash due to its better taste and no known side-effects can be used on a daily basis as an alternative for chlorhexidine gluconate as an anti-plaque agent. It should be explored as a long term antiplaque rinse with prophylactic benefits.

## Footnotes

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**Source of Support:** Nil

**Conflict of Interest:** None declared.

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