

Green Tea in the Prevention of Dental Caries – A Systematic Review

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ABSTRACT

To analyze the available scientific evidence on the effectiveness of green tea and its products in the prevention of dental caries. A broad literature search was performed using COCHRANECENTRAL, MEDLINE, GOOGLE SCHOLAR, EBSCO, PROQUEST for online search and hand search was performed in the central library of the institute. Articles that satisfied the inclusion criteria with description of randomized clinical trials regarding green tea in the prevention of dental caries were included. Initial search resulted in 196 articles; Our final review included 5 studies. Of these 2 studies evaluated both streptococcus mutans and lactobacillus, 1 study evaluated streptococcus mutans separately, 1 study evaluated salivary fluoride concentration, 1 study evaluated caries increment of the green tea polyphenol. Among the five studies two studies showed a significant reduction in the levels of streptococcus mutans. One study showed significant reduction in the levels of lactobacillus. One study showed that there was significant increase in the fluoride level. One study showed that the green tea and its extracts has an inhibitory effect on dental caries. With the constraints of limited available literature green tea and its extracts had a inhibitory effect on dental caries. But still further studies are recommended.

Key words: Tea, Polyphenols, Dental Caries

INTRODUCTION


Dental caries is an important public health predicament. The unique characteristic of dental diseases is that they are universally prevalent and do not undergo diminution or termination if untreated and require technically demanding expertise and time consuming professional treatment. The risk factors should be comprehensively studied so that the occurrence of dental caries can be prevented.^[1]

Many attempts have been made to eliminate S. mutans from the oral flora, antibiotics such as penicillin; ampicillin, tetracycline, erythromycin and vancomycin are very effective in preventing dental caries in vivo and in vitro.

However, their excessive use can result in alterations of the oral and intestinal flora and cause undesirable side-effects.^[2]

Tea is an infusion of the leaves of the Camellia sinensis plant. Which grows mainly in South East of Asia. Tea is the most popular beverage in the world after water, Drinking Green Tea, a suggestive of health beverage is common for more than 2000 years. In the last couple of year there is a growing interest in green tea in the western world due to scientific findings that show the health potentials of the beverage. Green tea has a unique composition, which includes proteins such as cellulose, pectin, glucose, fructose and sucrose and lipid components: linoleic and linolenic acids and sterols such as stigmaterol. Besides macronutrients, green tea also includes vitamins, pigments such as chlorophyll and carotenoids.^[3]

Other important green tea components are the polyphenols which constitute the most interesting group amongst the components of green tea leaves. The main polyphenols in green tea are catechins. The four main catechins are epigallocatechin a 3 gallate (EGCG), epigallocatechin (EGC), epicatechin 3 gallate (ECG), epicatechin (EC). Research suggests that green tea has an antioxidant property. Green tea is a non fermented tea and contains more catechins. Catechins are invitro and invivo strong

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antioxidants. These catechins possess antimutagenic, antidiabetic, anti-inflammatory, antibacterial and anti-viral properties.^[4]

Green Tea can be used as antioxidant, antimutagenic and anticariogenic. It is used to improve oral health including dental caries, periodontal disease and tooth loss, abolition of halitosis, oral malignancy prevention and regression. It has antihypertensive effect and it reduces cardiovascular disease risk. It helps in body weight control and also helps in glucose tolerance and insulin sensitivity.

Polyphenols constitute one of the most common and widespread groups of substances in plants. The main sources of polyphenols present in the human diet are plants like tea, coffee, cereals and fruits. Subsequent *in vitro* studies on plant extracts suggest an activity against several metabolic activities of mutans streptococci, resulting in decrease in growth and virulence. Smullen *et al* have shown that extracts from unfermented green tea have a bacteriostatic effect on streptococcus mutans.

Studies on the development of anti-plaque agents in the prevention of dental caries have investigated the effect of some tea preparations and their individual components on the glucan synthesis catalyzed by glucosyl transferase from mutans streptococci. Extracts of green tea showed appreciable inhibition in the synthesis of insoluble glucan. A point that should be mentioned is that the *in vitro* property of green tea has also been much investigated previously, but *in vivo* evidence able to establish its real contributions to caries reduction is not consistent for these reasons a non-invasive method of *in vivo* investigation has been developed.^[5]

AIM

The Aim of the study is to systematically analyze the available Scientific evidence on the effectiveness of Green Tea and its products in the prevention of Dental caries.

METHODS

Focused Question: What is the clinical impact of green tea extract in prevention of dental caries?

Selection Criteria:

Inclusion Criteria:

Type of Studies : Randomized clinical trials.

Subjects: Any one who received green tea or green tea extract as a preventive agent for dental caries. Randomized clinical trials were included only when they

- 1) Assess the *in-vivo* role of green tea extract on caries lesion development and in reducing Streptococcus mutans and Lactobacillus.
- 2) Consider human studies without any medical condition.
- 3) Were published in English language.
- 4) Involve any extract of green tea

Exclusion Criteria:

- 1) All *in-vitro* studies.
- 2) All studies not focusing on green tea extract for caries prevention.
- 3) All studies where green tea extract is used for other reasons were excluded.

Types of outcome measures:

- Levels of Streptococcus Mutans and Lactobacillus.
- Levels of salivary fluoride concentration.
- Caries increment of green tea.

Search Strategy: The main important available data bases searched are MEDLINE, GOOGLE SCHOLAR, EBSCOHOST, PROQUEST and COCHRANE CENTRAL.

The search was focused on seeing the keywords: green tea, prevention of dental caries, Streptococcus mutans, Lactobacillus which were used as isolated or in combinations using different Boolean Operators. Comparisons of different searches were carried out to delete the repeated studies. Then abstracts of all available articles were examined. All studies, which appeared to meet the inclusion criteria, were obtained in the full text format & they go for validity assessment. Application of the Cochrane Collaboration tool for evaluating the risk of bias was done. Then selected were grouped into high risk bias and low risk bias articles.

RESULTS

The initial search resulted in 196 articles. After analyzing the full text from clinical trials duplicating articles (90) were excluded. After that exclusion of non-clinical trials (74) has been done. Final assessment of inclusion criteria for clinical trials is 32. After analyzing the full text from 32 clinical trials, 27 articles were excluded because they did not fulfill all the selection criteria. Our final review included 5 articles.

Levels of streptococcus mutans and lactobacillus: -

Thomas A *et al* (2015) evaluated the count of streptococcus mutans, lactobacilli. It was found that against *S. mutans* and lactobacilli, after chlorhexidine mouth rinse, garlic with lime mouth rinse was found to be significantly more effective than sodium fluoride ($p=0.053$, $P=0.001$), fluoride with essential oils ($P<0.001$, $P<0.001$), alum ($P<0.001$, $P<0.001$), and green tea ($P<0.001$, $P<0.001$) mouth rinses. Chlorhexidine mouth rinse was significantly better than green tea mouth rinse. Mean zone of inhibition of chlorhexidine against streptococcus mutans is higher when compared to green tea. Mean zone of inhibition of chlorhexidine against lactobacillus (19.5) is significantly higher than green tea (11.167). However, further studies are needed in this field.^[7] Ibrahim Awadalla H *et al* (2011) evaluated the count of streptococcus mutans. There was a statistically significant difference ($p<0.001$) in means of Sm count in saliva after 7 days follow up between cases (normal oral hygiene + 2% of green tea) and controls (mouth wash without an active ingredient) concerning their response to intervention by rinsing with 2% green tea solution. There was a statistically significant difference ($p<0.001$) in means of Sm count in plaque after 7 days follow up between cases and controls concerning their response to intervention by rinsing with 2% green tea solution.

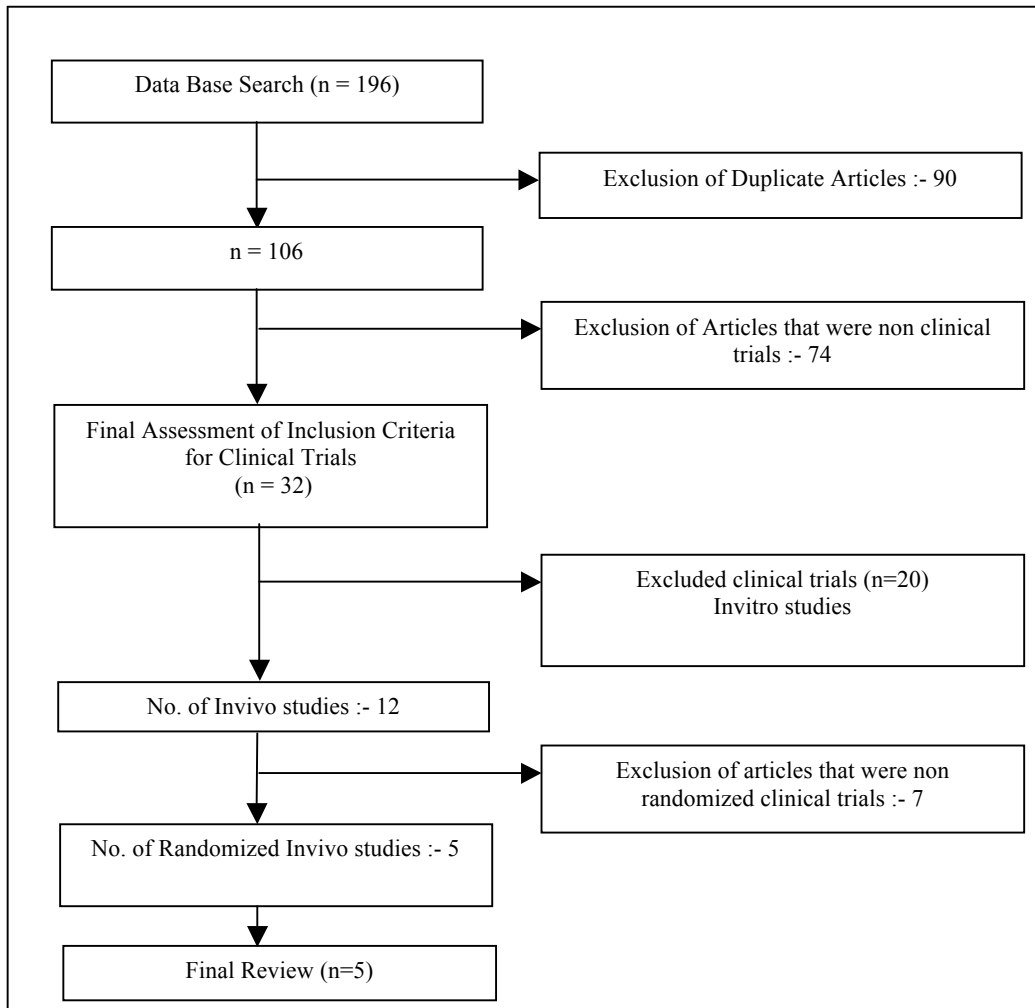


Figure – 1, Flow Chart Showing Analysis of Articles

Table – 1:- The Cochrane Collaboration's tool for assessing risk of bias

Domain	Support for judgement	Review author's judgement
Random sequence generation	Describe the method used to generate the allocation sequence in sufficient detail to allow an assessment of whether it should produce comparable groups.	Selection bias (biased allocation to interventions) due to inadequate generation of a randomised sequence.
Allocation concealment	Describe the method used to conceal the allocation sequence in sufficient detail to determine whether intervention allocations could have been foreseen in advance of, or during, enrolment.	Selection bias (biased allocation to interventions) due to inadequate concealment of allocations prior to assignment.
Performance bias. Blinding of participants and personnel Assessments should be made for each main outcome (or class of outcomes).	Describe all measures used, if any, to blind study participants and personnel from knowledge of which intervention a participant received. Provide any information relating to whether the intended blinding was effective.	Performance bias due to knowledge of the allocated interventions by participants and personnel during the study.
Detection bias Blinding of outcome assessment Assessments should be made for each main outcome (or class of outcomes).	Describe all measures used, if any, to blind outcome assessors from knowledge of which intervention a participant received. Provide any information relating to whether the intended blinding was effective.	Detection bias due to knowledge of the allocated interventions by outcome assessors.

Attrition bias			
Incomplete outcome data	Assessments should be made for each main outcome (or class of outcomes).	Describe the completeness of outcome data for each main outcome, including attrition and exclusions from the analysis. State whether attrition and exclusions were reported, the numbers in each intervention group (compared with total randomized participants), reasons for attrition / exclusions where reported, and any re-inclusions in analyses performed by the review authors.	Attrition bias due to amount, nature or handling of incomplete outcome data.
Reporting bias			
Selective reporting		State how the possibility of selective outcome reporting was examined by the review authors, and what was found.	Reporting bias due to selective outcome reporting.
Other bias			
Other sources of bias		State any important concerns about bias not addressed in the other domains in the tool. If particular questions/entries were pre-specified in the review's protocol, responses should be provided for each question / entry.	Bias due to problems not covered elsewhere in the table.

Table 2 :- Demographic and Clinical Characteristics of the studies included in the review

Author	Study Design	Sample Size	Age (Years)	M: F	Study Group		Outcome	Result
					Test	Control		
Suyama E et al. ^[5] (2011)	Double blind randomized, crossover design.	45	23 to 55	20: 25	44 members	45 members (placebo group)	1) Measuring the salivary fluoride concentrations 2) Measuring the fluoride content of remineralized enamel	Both groups were statistically significant. study group (chewing gum containing fluoride extracted from green tea) placebo group (gum which doesn't contain fluoride). The fluoride content in the FCG group was higher than in the placebo group
Gianmaria F et al. ^[6] (2011)	Invivo Study	66	12 to 18	30: 36	33 members	33 members	Levels of Streptococci mutans and lacto bacilli	Experimental group showed a statistically significant reduction in colony counts of mutans streptococci and lactobacilli
Thomas A et al. ^[7] (2016)	Randomized Clinical Trial	30	4 to 6	-	15 members	15 members	Levels of Streptococci mutans, lacto bacilli and Candida albicans	Chlorhexidine mouth rinse was significantly better than green tea mouth rinse. Chlorhexidine Mean zone of inhibition (18.667) is higher when compared to green tea (11.167) against streptococcus mutans.
Ying Tao D et al. ^[8] (2013)	Randomized Clinical Trial	157	8 to 9	-	52 members	104 members	Caries increment of green tea	The caries-free rate in the polyphenol gum group was significantly higher than that in the other two groups (p < 0.05) after two years
Ibrahim Awadalla H et al. ^[9] (2011)	Randomized Clinical Trial	60	20 to 35	30: 30	30 members	30 members	Levels of Streptococci mutans	There was a significant difference among study group (normal oral hygiene + 2% of green tea) and control group (mouth wash without an active ingredient) concerning streptococcus mutans

Table 3:- Articles excluded from the study

Author Name	Title of Article	Reason for exclusion
Hirao et al ^[10]	Tea catechins reduce inflammatory reactions via mitogen activated protein kinase pathways in toll-like receptor 2 ligand – stimulated dental pulp cells.	Invitro Study
Maruyama et al ^[11]	Supplementation of green tea catechins in dentifrices suppresses gingival oxidative stress and periodontal inflammation.	Protection from oral oxidative stress and inflammation
Srinivasan et al ^[12]	Chemopreventive and therapeutic modulation of green tea polyphenols on drug metabolizing enzymes in 4- Nitroquinoline 1-oxide induced oral cancer.	Oral malignancy prevention and regression
Subramaniam P et al ^[13]	Effect of different types of tea on Streptococcus mutans: an in vitro study.	Invitro Study
Halder A et al ^[14]	Black tea (Camellia sinensis) as a chemopreventive agent in oral precancerous lesions.	Oral Cancer
Liu T et al ^[15]	Experimental study on polyphenol anti-plaque effect in human.	Not a randomized trail
Najmeh A et al ^[16]	In Vitro Antimicrobial Activities against Streptococcus Mutans: A Comparative Study of Green Versus Black Tea Extracts and 0.2% Chlorhexidine and Fluoride	Invitro Study

Table 4:- Bias assessment for the studies

Author	Randomization	Concealment of randomization sequence	Blinding	Proper reporting of incomplete outcomes (dropout)	Free of bias for selective outcome	Free of another source of bias
Suyama E et al (2011) ^[5]	Yes	Yes	Yes	No	Yes	No
Gianmaria F et al (2011) ^[6]	Yes	No	No	No	Yes	No
Thomas A et al (2016) ^[7]	Yes	Yes	Yes	No	Yes	No
Ying Tao D et al (2013) ^[8]	Yes	No	No	No	Yes	No
Ibrahim Awadalla H et al (2011) ^[9]	Yes	No	No	Yes	Yes	No

Table 5:- Studies having high risk of bias

Improper Randomization	3 Studies	Gianmaria F et al (2011); Ying Tao D et al (2013); Ibrahim Awadalla H et al (2011) ^[6,8,9]
Improper Blinding	3 Studies	Gianmaria F et al (2011); Ying Tao D et al (2013); Ibrahim Awadalla H et al (2011) ^[6,8,9]
Improper Blinding and Improper Randomization	3 Studies	Gianmaria F et al (2011); Ying Tao D et al (2013); Ibrahim Awadalla H et al (2011) ^[6,8,9]
Improper Randomization, Improper Blinding and Improper Reporting of the incomplete outcomes.	5 Studies	Suyama E et al (2011); Gianmaria F et al (2011); Thomas A et al (2016); Ying Tao D et al (2013); Ibrahim Awadalla H et al (2011) ^[5-9]

There was a reduction in GBI between cases and controls and this difference was statistically significant ($p < 0.001$) concerning gingival bleeding index (GBI) among their response to intervention by rinsing with 2% green tea solution after 7 days follow up. This study supports the effectiveness of green tea as anti bacterial and anticariogenic material.^[9] Ferrazzano G et al (2011) evaluated the count of streptococcus mutans and lactobacilli in saliva. Green tea polyphenols was used in the experiment. The experimental group showed a statistically significant reduction in colony counts of mutans streptococci and lactobacilli relative to the control group (mouth rinse other green tea). These findings showed the efficacy of a green tea extract against cariogenic oral flora, opening a promising avenue of clinical applications in the preparation of specific and natural anticariogenic remedies.^[6]

3 Studies evaluated the count of Streptococcus mutans. Two studies evaluated the count of lactobacillus. Two studies showed a significant reduction in the levels of streptococcus mutans. One study showed significant reduction in the levels of lactobacillus.^[6-9]

Levels of salivary fluoride concentration: -

Suyama E et al (2011) evaluated Salivary fluoride concentrations in green tea and fluoride content of remineralized enamel. It was found that the peak salivary fluoride concentration was 3.93 ± 1.28 ppm (mean \pm SD). The elevated salivary fluoride concentration resulted in a higher fluoride concentration of 656 ± 95 ppm in the remineralized region versus 159 ± 26 ppm for placebo gum ($p < 0.001$). The fluoride content in the FCG group was higher than in the placebo group (gum which doesn't

contain fluoride). After an acid challenge, the FCG group was lower than the placebo gum group. Both were statistically significant. FCG produced a superior level of remineralization and acid resistance as compared to the placebo gum. The results suggest that regular use of FCG is useful for preventing dental caries.^[5]

One study evaluated the salivary fluoride concentrations in green tea. It was found that both groups were statistically significant study group (chewing gum containing fluoride extracted from green tea) placebo group (gum which doesn't contain fluoride). The fluoride content in the FCG group was higher than in the placebo group.^[5]

Cariostatic Potential of Green Tea:-

Ying Tao D et al (2013) evaluated the cario static potential of the chewing gum containing tea polyphenol. It was found that the mean DMFT increment was 0.17 for the polyphenol gum group, 0.60 for the control gum (gum not containing polyphenol), and 1.15 for the no gum group. Children who chewed gum containing tea polyphenol had a significantly lower mean DMFS increment over the 24 – month period than did the other two groups ($p < 0.05$). The caries – free rate in the polyphenol gum group was significantly higher than that in the other two groups ($p < 0.05$) after two years. These finding indicated that the oral application of chewing gum with tea polyphenol has an inhibitory effect on dental caries.^[8]

DISCUSSION

One study evaluated the caries increment of the green tea polyphenol. It was found that green tea and its extracts has an inhibitory effect on dental caries.^[8]

There are many well documented health benefits of Green Tea including prevention of dental caries. Thus, goal of this systematic review was to determine whether the use of Green Tea has clinical beneficial effects in the prevention of dental caries. Subjects who received Green Tea or Green Tea extract as a preventive agent for dental caries were the study subjects. Studies which assess the in vivo role of Green Tea extract on caries lesion development and in reducing streptococcus mutans and lactobacillus were included in this study. Among five studies which satisfied the inclusion criteria two studies (Gianmaria F et al, Thomas A et al) evaluated streptococcus mutans and lactobacillus levels in saliva. After experimentation with Green Tea extracts, among the two studies only one study showed significant reduction in streptococcus mutans and lactobacillus. Green Tea extract presented a significant lowering of levels of streptococcus mutans and lactobacillus compared with subjects using placebo. This is probably due to the antibacterial properties of polyphenols associated with the inhibition of adherence of bacterial cells to tooth surfaces.^[6,7] One study (Ibrahim Awadalla H et al) evaluated only streptococcus mutans levels in saliva. After exposure to Green Tea extracts which showed a significant reduction in streptococcus mutans level supporting Green Tea as anticariogenic agent. The release of active ingredient from Green Tea (Catechins) reduces plaque acidity and preserve PH towards neutrality which represented unfavourable medium for streptococcus mutans as the level of bacteria in saliva and plaque is related to caries development.^[9] One study (Suyama E et al) evaluated salivary fluoride and fluoride content of remineralized enamel. After exposure to chewing Gum extracted from Green Tea superior level of remineralization an acid resistance was demonstrated by fluoride containing Gum extracted from Green Tea compared to placebo. The promotion of remineralization and the acquisition of acid-resistant property of enamel was mainly due to fluoride ion released from the Fluoride chewing gum derived from Green Tea extract.^[5] One study (Ying Tao D et al) evaluated the caries increment of the Green Tea polyphenol. It was found that Green Tea and its extracts has an inhibitory effect on dental caries. The antibacterial effect of green tea extract had valuable anti-cariogenic activities including inhibitory effect on cariogenic bacteria by inhibiting the adherence of bacterial cells to the tooth surfaces. And also green tea catechins maintain the salivary pH at a normal range (6.2-7.5) which is not a favorable condition for cariogenic bacteria to flourish.^[8]

CONCLUSION

The use of green tea extract for caries prevention showed promising results even though only few studies have demonstrated clear clinical outcomes. Therefore, the scientific evidence is still poor.

RECOMMENDATION

The results of this systematic review confirm that more studies are necessary to evaluate the efficacy of Green Tea with correct methodological design, without private

funding in broader population samples and over longer periods of time. Comparative trials of different extracts of Green Tea would also be interesting.

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