

# The Beneficial Effects of Green Tea in Oral Health and Dentistry

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## ABSTRACT

Green tea contains a variety of bioactive agents with many health benefits such as antioxidant, anti-inflammatory and anti-microbial properties. It has been reported to impart role in oral health by prevention from dental erosion, dental caries, alveolar bone resorption, oral malodor, etc. The health benefits of green tea are mostly related to the flavonoids which are the major components of the polyphenols existing in green tea. This paper reviewed the major oral health benefits of green tea extracts.

**Keywords:** Green Tea Extract Polyphenol E; Oral Health; Preventive Dentistry

**Abbreviations:** EGC: Epigallocatechin; EGCG: Epigallocatechin Gallate; ECG: Epicatechin Gallate; GCG: Gallocatechin Gallate; LDH: Lactate Dehydrogenase; CHX: Chlorhexidine; IBD: Inflammatory Bowel Disease

## Introduction

Drinking green tea is a common habit of people all over the world for about 4000 years. Green tea is obtained from the leaf of a tree in Southeast Asia, called *Camellia sinensis*. Many varieties of green tea are produced in different countries, depending on the growing conditions, harvesting time, and processing [1]. Green tea contains various health promoting bioactive compounds which have been used for many centuries. It is known as a functional food which has more positive health effects than only its nutritional effect. It has anti-oxidant, anti-inflammatory, antimicrobial and anti-mutagenic properties [2]. It contains a variety of enzymes, amino acids, carbohydrates, lipids, sterols, related compounds, dietary minerals, and phytochemicals such as polyphenols, flavanols, and caffeine. The most important compounds of green tea are the polyphenols. Polyphenols exist in many plants such as fruits, vegetables, teas and cocoa. Green tea compounds, especially polyphenols impart many health benefits like antioxidant, anti-inflammatory, hypoglycemic, and hypolipidemic properties, depression of hypertension, and other biological properties; which can be related to tea's abilities on metal chelating, free radical scavenging, and antioxidant activity [1,3].

Flavonoids are a major group of polyphenols. The main flavonoids in green tea are catechins (flavo-3-ols), such as epicatechin, epigallocatechin (EGC), epicatechin gallate (ECG), epigallocatechin gallate (EGCG), gallocatechin (GC), gallocatechin gallate (GCG), catechin, and catechin gallate (CG). Besides catechins, apigenin, apigenin-7-O-glucoside (Api-G), myricetin, kaempferol, and vitechin are reported as green tea flavonoids [4]. The main polyphenol found in green tea is epigallocatechin-3-gallate which comprises up to 65% of the total catechin. This catechin has a strong potential against carcinogenesis, angiogenesis, and tumor metastasis [3]. However, Scholl et al. reported that green tea polyphenols can have various beneficial or adverse health effects depending on the plasma levels of catechin [5].

## Materials and Method

The keywords used for this review were as follows: Green Tea Extract, Polyphenol, Oral Health, Preventive Dentistry. These keywords were searched in PubMed and among the 124 papers found, 39 English papers from 1994 to 2018 which were most related to the subject were selected and reviewed.

## Evaluation of Papers

### Anti-Cariogenic and Anti-Bacterial Effects of Green Tea

Green tea catechins have a bitter taste. They are water soluble and their biological activities affect cell membrane functions such as signaling, cell cycle, and mitochondrial activity. Catechins have inhibitory effect against *S. mutans* and *S. sobrinus*. Antibacterial effects of green tea against mutans streptococcus is reported in previous studies. Rasheed et al. indicated the bactericidal effect of catechins against *Escherichia coli*, *Streptococcus salivarius* and *Streptococcus mutans* [6]. It is suggested that EGCG damages the cytoplasmic membrane of the bacteriae by generation of hydrogen peroxide [7]. The antibacterial property of *Camellia Sinensis* extract against *Streptococcus mutans* and *Lactobacillus acidophilus* is also reported by Anita et al. [8]. Ferrazzano observed a significant reduction in colony counts of *Streptococcus mutans* and *Lactobacillus* in saliva after rinsing the patients' mouths by green tea extract for 1 minute 3 times a day during a 7-day period [9]. Tannin and catechins of green tea are able to inhibit enzymatic activity of amylase which is responsible for caries incidence by hydrolysis of starch in foods to lower molecular weight carbohydrates [10].

Tea catechins also prevent the attachment of oral streptococci to tooth surfaces and inhibit streptococcal glucosyl transferase. EGCG in specific concentration and application interval, can prevent acid production by cariogenic bacteria via inhibition of lactate dehydrogenase (LDH), and increases the minimum pH of the oral cavity from 4.8 to 6.5 [11]. LDH converts pyruvic acid to lactic acid. Although fluoride existing in green tea is a useful component for tooth caries resistance, it is suggested that the main component responsible for anti-caries properties of green tea are polyphenols and tannins [12]. Daneshyar et al. suggested green tea varnish to prevent root surface caries [13]. In a recent human study, the antimicrobial effects of green tea against *Streptococcus mutans*, *Lactobacilli* spp. and *Candida albicans* was compared with the gold standard antibacterial material, chlorhexidine (CHX). It was concluded that green tea was more effective than CHX for inhibition of *Streptococcus mutans* and less effective about *Lactobacilli* spp. Neither CHX nor green tea were sufficiently effective against *Candida albicans*. The authors suggested green tea as a cost-effective material for caries prevention [14].

### Gingival and Periodontal Health

Green tea catechins have also been studied for their effects on periodontal status. Due to the wide range of antibacterial effects of green tea against gram positive and gram-negative microorganisms, it is suggested as a useful antiplaque agent. Catechins keep the salivary and plaque pH at about neutral, so they prevent the colony growth and activity of streptococcus mutans. EGCG may inhibit the activity of matrix metalloproteinase-9 (MMP-9) which helps the formation of osteoclasts in periodontal disease, and therefore prevents alveolar bone resorption [15]. Kaur et al. compared the antiplaque effect of green tea catechin mouthwash

on patients and concluded that 7 day application of this mouthwash had comparable anti-plaque efficacy with chlorhexidine, and moreover, it did not have the bitter taste and side effects of CHX, including tooth discoloration and supra-gingival calculus formation related its long-term use [16]. Lagha et al. reported the efficacy of green tea catechins to protect the gingival epithelium against invasion by *Porphyromonas gingivalis*, so they have a promising effect on prevention from periodontal disease [17].

### Effects of Green Tea on Dental Erosion

MMPs in dentin and saliva are responsible for degradation of the organic matrix of dentin. They activate when the oral cavity pH drops by the acids produced during the cariogenic challenge. MMPs help the progression of dentin caries. MMPs responsible for the organic matrix degradation of dentin are MMPs 2, 8 and 9 [18,19]. Using materials that inhibit MMPs, such as CHX, can be helpful for caries prevention. The proposed mechanism of action for MMP inhibitors is maintenance of the demineralized organic matrix on dentin surface [20]. EGCG extract in green tea is reported as an MMP inhibitor [21,22]. Kato et al. studied the effect of green tea on dentin erosion and abrasion. They observed the protective effect of green tea. They also reported, in contrary to previous studies, that a delay of 30 minutes for tooth brushing after an erosive challenge did not reduce the amount of tooth wear, and it was the same as brushing immediately after erosion [23]. Barbosa et al. reported the effectiveness of supplementation of soft drinks with green tea extract on their reduced erosive potential. They suggested green tea as a natural supplement that does not any side effects or negative effects on taste of the drink [20].

### Antioxidant Potential of Green Tea

Green tea polyphenols are antioxidant agents and free radical scavengers. One of the major side effects of bleaching is impairment of the immediate bond strength of composite resin to the bleached tooth, due to the oxygen molecules remained in tooth structure [24]. Postponing the adhesive restorative treatment for at least one week is the most acceptable method for restoring the bond strength [25]. Antioxidant agents, especially sodium ascorbate 10%, are reported as effective in improving the bond strength of bleached teeth [26,27]. Flavonols of green tea leaves, especially EGCG, have antioxidant property [28,29]. Polyphenols prevent formation of free radicals, and neutralize the existing free radicals by exchanging electrons, via their trihydroxy and dihydroxy groups of B ring [30]. Khamverdi et al. suggested the application of EGCG as an antioxidant agent for reversal of the decreased bond strength to bleached enamel. They tested different concentrations and application times of EGCG and concluded that green tea catechins can be used for removal of free radicals from tooth structure, instead of two weeks delay between bleaching and adhesive restoration [30]. Berger et al. also confirmed green tea as an alternative antioxidant for adhesive restorations after bleaching [31]. However, Sharafeddin et al. did not report any improvement in bond strength of bleached teeth by application of green tea and some other natural materials [26].

## Bond Strength and Durability

Khamverdi et al. evaluated the effect of EGCG on bond strength and bond durability of self-etch adhesives. They observed that EGCG in high concentrations decreased the bond strength of Filtek Silorane adhesive, but the 25  $\mu$ M concentration of EGCG preserved the bond strength of Filtek Silorane adhesive after 6 months. For Clearfil SE Bond, higher concentrations of EGCG were necessary to preserve the bond strength after 6 months. The authors believed that the effect of EGCG is related to its ability to inhibit MMP [32]. In a similar study, Zhou indicated that incorporation of chlorhexidine, which is a known MMP-inhibitor, into primer of Clearfil SE Bond caused the preservation of dentin bond strength after 12 months [33]. Zheng et al. reported the potential of MMP inhibitors, including green tea extract, for prevention from decreasing the bond strength of etch & rinse adhesive after aging, while it was not effective for the studied self-etch adhesive [34]. Ozelin et al. suggested the minimum duration of 60 minutes for sodium ascorbate 10% and green tea extract 10% to improve the bond strength of bleached teeth [35].

## Halitosis

In addition to the mentioned benefits in the oral cavity, green tea extract is effective in reducing halitosis caused by volatile sulfur compounds. Therefore, green tea can be a beneficial herbal ingredient in oral hygiene products [36]. Morin et al. reported the ability of green tea extracts to inhibit the growth of *Solobacterium moorei*, a major bacterium playing role in halitosis [37]. However, the infusions of *Camellia sinensis* used as mouthwash was not effective for neutralizing the halitosis caused by volatile sulfur compounds [38].

## Other Health Benefits

Daily consumption of green tea has been associated with a lower risk of cancer, cardiovascular disease, diabetes, hyperlipidemia, and inflammatory bowel disease (IBD). EGCG compound in green tea is effective in weight loss by increasing metabolism. It has also other health effects on skin, joints and livers [39,40].

## Conclusion

Green tea seems a promising natural material for oral health, due to its polyphenols and other ingredients. Inclusion of EGCG polyphenol into oral health products and adhesive systems is supposed to protect better the soft and hard tissues of the mouth from erosion, bacterial infection, or mal-odor, and also increase the longevity of the tooth-colored restorations.

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