

Therapeutic effects of green tea as an antioxidant on oral health- A review

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ABSTRACT

Green tea has protective effects against various diseases such as malignancies, cardiovascular and metabolic disorders. Green tea has been suggested to promote periodontal health by reducing inflammation, preventing the resorption of bones and restricting the growth of certain periodontal-related bacteria. Green tea has antioxidant, carcinogenic, antimicrobial and non-inflammatory properties. This traditional drink is also used to treat systemic chronic diseases, including carcinoma. Recent studies have shown that host immuno-inflammatory reactions, in addition to microbial activity, are more likely to destroy oral tissues. In such cases, green tea is considered to be a natural preventive and curative agent. The potential benefits of green tea and its polyphenols in oral health is capturing the interest of the researchers; hence, this review discusses the therapeutic effects of green tea in the prevention of periodontal and oral diseases.

Keywords: Antioxidant, *Camellia Sinensis*, green tea, inflammation, oral health

Introduction

Tea plants by botanists are known as *Camellia sinensis*. These are small, bushy and 3–4-feet high. Between spring and fall of each year, the tea leaves are picked three to four times. After water, the most commonly consumed drink in the world is tea. Two principal varieties of tea, black and green, are produced from the same plant *Camellia sinensis*. Black tea is consumed more frequently and accounts for 75% of global consumption and approximately 98% of international tea trading. Green tea remains popular in China and Japan, and in many Westernised countries, it is becoming increasingly popular because of its perceived health benefits. It has been reported that the vast majority of

green and black tea is imported, with a yearly consumption of 2000 tonnes.^[1] Tea contains almost 4000 bioactive compounds, one-third of which are made up of polyphenols. Green and black tea are rich in polyphenolic compounds, primarily flavonoids such as catechins, epicatechin gallate (ECG), epicatechin (EC), epigallocatechin (EGC) and epigallocatechin gallate (EGCG). Flavonoids have been found to possess antioxidant activity; however, the hypothesis that dietary flavonoids can reduce oxides significantly is still not clear.^[1,2] Other compounds are alkaloids, amino acids, carbohydrates, proteins, chlorophyll, organic volatile compounds, fluoride, aluminium, minerals and trace elements that easily generate vapours and contribute to the aroma of the tea.

The main difference between green and black tea is in their method of processing and content of flavonoids.^[3,4] Green tea is unfermented produced from the leaves that are quickly picked and heated in a pot or by hot steam to inhibit the action

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of enzyme polyphenol oxidase, hence no fermentation ensues. Fermentation involves air oxidation and polymerisation of tea parts, including polyphenolic catechins that are the main components of tea leaf. Some tea products are fermented to improve flavour and taste. Oolong tea is partly fermented, frequently served in Chinese restaurants, while black or red teas are heavily fermented and consumed by western societies.^[3,4]

Herbal teas have been documented as an effective alternative treatment for cancer, heart and liver disease in oriental cultures.^[5] According to the history of China, Emperor Sheng-Nong discovered about 47 centuries ago that a cup of tea could dissolve a great many poisons in the body. Polyphenolic flavonoids, such as tea catechins, were once called vitamin P in recognition of the possible importance of green tea in vascular health. The incidence of different disorders, including cancer, cardiovascular diseases, diabetes and obesity, may be reduced as a result of green tea consumption.^[5,6] Polyphenols are thought to be responsible for the health benefits of herbal teas, particularly green tea, attributed to the presence of EGCG, one of the most active and abundant catechins in green tea. EGCG was the focal point of the scientists' research as it can mimic some of the biological effects of green tea. Antioxidant, anti-inflammatory and anticarcinogenic properties of green tea are enhanced by the presence of higher amounts of (EGCG) epigallocatechin 3 gallate than black tea. A mix of single polyphenols such as catechins and complex polyphenols is contained in oolong tea.^[7,8] Experimental trials on the physiologic effects of some polyphenolic tannins indicate that they may also be useful as anti-tumour and antibacterial agents for the reduction of serum lipids, reduction of blood pressure, modulation of immune responses and use in food preservation.^[6] This review focusses on the potential benefits of green tea and its polyphenols on periodontal and oral health.

The Effects of Green Tea on Oral and Periodontal Health

Gingivitis and periodontitis

Green tea has been reported to be useful for prevention of periodontal disease progression. Several *in vitro* studies have shown that the growth of *porphyromonas gingivalis*, *prevotella intermedia* and *prevotella nigrescens* on human buccal epithelial cells is inhibited by the green tea component EGCG.^[7,8] These bacteria are heavily involved in the destruction of periodontal tissues and can lead to a reduction in periodontal tissue. In addition, the slow release of catechins into the periodontal tissues has been found to inhibit the production of toxic end metabolites of *P. gingivalis*.^[9] Studies have shown that the green tea catechin plays a key role in the prevention of oxidative stress.^[10] Overproduction of free radicals damages gingival tissues, periodontal ligaments, and alveolar bone in periodontal disease pathogenesis. Green tea has potent antioxidant and anti-inflammatory properties and is believed to defend against inflammatory conditions by reducing the production of pro-inflammatory cytokines particularly

interleukin 8 (IL-8). Green tea products have been found to increase the total antioxidant capacity of gingival crevicular fluid, along with potent anti-inflammatory and antiplaque effects. Regular consumption of green tea can reduce gingival bleeding index, pocket depth and promote periodontal healing. Periodontal regeneration may be attributed to the presence of polyphenols by a decrease in expression of matrix metalloproteins (MMP 9), suppression of osteoclast differentiation, and induction of apoptosis in a dose-dependent manner.^[7-10]

Recently, the use of green tea herbal mouthwash to improve periodontal health is becoming popular. Maroofian *et al.*^[10] prepared a herbal mouthwash using dried leaves of green tea plants which were grown in the North part of Iran. They extracted green tea polyphenols, one of the most therapeutic ingredients of the plant, in a safe and stable formula for use as a mouthwash. Studies have suggested that green tea mouthwash can effectively reduce the microbial pathogens, can be used as an adjunct to periodontal therapy in chronic periodontitis and, along with scaling and root planning for a period of two weeks, could improve the scores of various periodontal parameters. Additionally, no evidence of toxic effects such as irritation, burn, vesicle or mucous disturbance was observed, and despite similar antibacterial effects of green tea mouth wash with the chemical chlorhexidine, they showed that the use of herbal green tea mouthwash was safer and more economical.^[11] In another clinical trial, it was concluded that green tea mouthwash could improve the gingival health of patients with marginal gingivitis.^[12] Lagha *et al.*^[12] found the promising results of green tea catechins to protect the gingival epithelium against invasion by *P. gingivalis* and in reduction of periodontal disease progression.

Dental caries

Green tea leaves contain a high concentration of fluorides, which contribute towards its cariostatic action along with other components present in the tea.^[13] Microbial dysbiosis of oral microflora comprising gram-positive and gram-negative aerobic bacteria and anaerobic bacteria can result in the development of cariogenic dental plaque on the teeth and initiation of dental caries. Among them, *Streptococcus mutans* and *Lactobacillus* play a major role in the initiation and progression of dental caries due to their capability to tolerate lower pH, with higher metabolic activity at pH 6–6.5. In addition, antibiotics such as penicillin, erythromycin and tetracycline are being used to eliminate *S. mutans*; however, their prolonged use can result in alteration in microbial flora and antimicrobial resistance.^[14] To this consideration, green tea extracts were studied to have inhibitory effects on oral pathogens to prevent tooth decay. The antimicrobial mechanisms proposed include: i) disruption of the bacterial cell membrane; ii) inhibition of the activity of enzymes such as glucosyl transferase and lactate dehydrogenase; iii) inhibition of efflux pump activity; iv) decrease in acid production after sugar consumption and v) stimulation of antimicrobial components such as immunoglobulins, lysosome, lactoferrin, histatin and mucin.^[14]

Additionally, several polyphenols of green tea have preventive effects on tooth decay. ECG, GCG and EGCG are most active among catechins and can strongly inhibit glucosyl transferase, thereby preventing adherence of bacteria to tooth enamel. EGCG has been reported to inhibit sugar transport and acid production by lactate dehydrogenase.^[13] It has been suggested that catechins on a daily basis can effectively reduce dental caries and that use of green tea extract herbal mouthwash reduces the acidity of saliva and inhibits bacterial colonisation.^[14] Studies have documented that daily intake of green tea for one month can increase the salivary pH beyond 5.5.^[13,14] Study conducted on forty healthy school children aged between 6 and 8 years has shown an increase in salivary pH from 6.15 to 7.65 after rinsing with green tea and reduced incidence of dental caries.^[15] Currently, use of green tea dark chocolate combination is gaining popularity for prevention of dental plaque and consequent dental caries; however, the role of green tea in the prevention and progression of dental caries is still unclear and requires more evidence-based trials to be carried out.^[16]

Oral cancer

The predominant polyphenols of green tea, EGCG, EGC, ECG and EC, are active antioxidants in their numerous biological activities. Substantial free radical scavenging activity may protect the cells from the DNA damage caused by reactive oxygen species. In laboratory and animal studies, tea polyphenols have been proven to be a promising agent for cancer chemoprevention owing to their ability to prevent the malignant transformation of oral premalignant lesions, inhibition of the proliferation and invasion of the cancerous cells, induction of apoptosis and disruption of the mitochondria of cancer cells. Tea polyphenols may also protect against radiation-induced damage and modulate the function of the immune system, thus reducing the risk of cancer.^[17,18] Several randomised trials assessed the effect of green tea extracts on premalignant oral lesions; a double-blinded randomised trial on 59 Oral Leukoplakia (OL) patients were given 3-g oral and topical mixed tea product. After 6 months, a partial regression in oral lesions occurred in 38% of patients, and reduction in lesion size was observed in 3% of patients in a treatment group.^[18]

Researchers at the University of Texas M.D. Anderson Cancer Centre found that more than half of the OL patients who consumed the green tea extract showed promising results. In their phase II trial, OL patients consumed green tea extract as an oral agent for three months at one of three doses (500, 750 or 1000 mg/m²) thrice a day. A higher extract dose is equivalent to eight cups of green tea three times a day. There was a clinical response in 58.8% of patients who took the two highest doses, compared to 36.4 percent of those who took the lowest dose. The extract was well tolerated, although mild symptoms of insomnia and nervousness were experienced by the high-extract-dose group, no serious toxicity was noted.^[19] The results of green tea in the prevention of progression of premalignant lesions to cancer are promising; however, more clinical trials should

be encouraged to evaluate the long-term benefits of green tea products as a chemo-preventive agent.

Smoking and inflammation

Tobacco use in both smoke and smokeless form has a harmful effect on periodontal and oral health. In addition, smokers are at higher risk to develop oral cancer, which may be due to a decrease in the activity of many salivary enzymes, disruption of salivary oxidant-antioxidant balance and induction of oxidative stress.^[17,20] Smoke from tobacco induces the production of superoxides (ROS) and reactive nitric oxides (NO); as a result, chronic inflammation in tissues ensues even by exposure to a very minute dose of smoke.^[21-24]

Another smoke compound (acrolein) has been found to prevent gingival fibroblasts from functioning normally due to cell interruptions and proliferation. This can propagate various inflammatory conditions in the oral cavity and may cause progression of gingival and periodontal disease.^[24] It has been hypothesised that green tea catechin EGCG can reduce the toxicity of acrolein and other unsaturated aldehydes. Green tea has proven to be a miracle medicine for oral health, and reports have shown that it can help to quit smoking.^[21] As green tea has a potent antioxidant potential, it can restore the oxidant-antioxidant imbalance in tobacco users who have successfully attempted habit cessation. Additionally, L-theanine found in green tea gives relaxation, reduces stress and urge of nicotine in people who have quit tobacco use.^[21]

Bad breath (halitosis)

Volatile sulphide compounds, particularly hydrogen sulphide (H₂S), methyl mercaptan (CH₃SH), and dimethylsulphide (CH₃)₂S, are the principal components of bad breath. The proteolytic degradation of these compounds is caused mainly by anaerobic gram-negative oral microorganisms in food debris, saliva, blood and epithelial cells of different sulphur-containing substrates.^[25] Taking into account the role of gram-negative anaerobic bacteria present in the periodontal pockets and crypts at the back of the tongue in the production of volatile sulphides, antimicrobial polyphenols in green tea may improve breathing capacity by the elimination of these bacteria. Green tea mouthwash containing 1% tannin can effectively reduce the microbial load in the oral cavity, prevent dental plaque formation and improve the oral malodour caused by bacterial infection. Tea catechins reduce the production of the methyl mercaptan, a major source of halitosis. A methylthion and/or a mechanical sulfinyl group is inserted in the EGCG. During this reaction, a methylthion group is added to the orthoquinone, an oxidised form of the catechin, and helps in reducing halitosis.^[16] Hence, green tea products are beneficial in reducing oral malodour because of their excellent deodorant and disinfectant properties.^[26]

Adverse Effects and Drug Interactions

Excessive consumption of green tea may cause sleep disturbances at night and decrease the bioavailability of iron from the diet.

Aluminium present in green tea products can lead to neurological diseases; patients on Warfarin therapy should not take green tea due to the presence of vitamin K as a component, and it may increase the risk of bleeding in patients on aspirin therapy. Pregnant and lactating women should limit the consumption to 1–2 cups/day as it can increase the heart rhythm.^[27]

Conclusion

There is an explicit association between the consumption of green tea and oral health. Green tea and polyphenols have a beneficial role in the prevention of periodontal and oral diseases due to their antioxidant, antimutagenic, antidiabetic, anti-inflammatory, antibacterial, antiviral, and above all, cancer-preventive properties. Drinking green tea at meals and at breaks is a relatively easy habit and can improve the oral health status.

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Conflicts of interest

There are no conflicts of interest.

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