REVIEW ARTICLE

Effects of green tea and its products on dental caries and periodontal diseases: A review

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Abstract

Green tea is a popular health drink routinely consumed by many people. Green tea is derived from the dried leaves of the plant *Camellia sinensis*. Green tea is usually available in the form of beverage, mouthwash containing extract of green tea, and as a chewing gum. Intake of green tea polyphenols has shown preventive effect against cancer and cardiovascular disease in experimental and epidemiologic studies. Green tea with its active chemical ingredients possesses diverse pharmacological properties that include anti-inflammatory, antioxidant, and antibacterial effects. It has been suggested that green tea promotes periodontal health by reducing inflammation, preventing bone resorption, and limiting the growth of certain bacteria associated with periodontal diseases. Periodontitis is a chronic disease of the supporting structures of teeth, which can destroy periodontal structures and result in tooth loss. The possible protective properties of green tea on oral health are related to the existence of fluoride, catechin, and polyphenols in its content. Polyphenols are the most common antioxidants in foodstuffs, which have an important role in the prevention of chronic diseases. Regarding the existing articles about polyphenols, it appears consumption of polyphenol-containing products may be effective in plaque control and prevention of periodontal diseases. Therefore, it is suggested that the results of *in vitro* studies be assessed by clinical trials. *In vitro* studies have shown that green tea polyphenols inhibit the growth and cellular adherence of periodontal pathogens, and their production of virulence factors. Green tea products might have an effective role in oral health by decreasing the incidence of dental caries and periodontal disease. Measures, which were used in periodontal studies, were more valuable clinically. The evaluation of the effect of green tea products on dental caries needs more longitudinal studies. The aim of this study is to review the effect of green tea in dental caries and periodontal diseases.

Keywords: Dental caries, green tea, periodontal disease

Introduction

Micro-organisms in oral cavity specially *Streptococcus mutans* and *Lactobacillus* can tolerate acidic environment and produce a significant amount of lactic acid.[1,2] Although antibacterial products can decrease the incident of caries, they disrupt the microflora of mouth and provide a good environment for the growth of opportunistic pathogens like *Candida albicans*. The benefits of green tea to decrease the incident of caries had been shown in animal and human studies.[3,4] Green tea can reduce the amount of *S. mutans* in the saliva and thus prevent dental caries.[5] There are some evidence about the indirect antibacterial effect of green tea by the stimulation of protective components such as immunoglobulins, lysosome, lactoferrin, histatin, and mucin.[5] One of the other proposed mechanisms is the effect of green tea on control of pH, green tea can inhibit lactat dehydrogenase and thus decrease acid production after sugar consumption.[6] Application of green tea causes significant reduction of *S. mutans* and *Lactobacillus* in saliva and plaque, and increases saliva pH.[4,7] Suyama *et al.*[8] showed that consumption of green tea gum increases the resistance of enamel to acid, and reinforces its remineralization. This will culminate in the prevention of dental caries. Soekanto *et al.*,[9] in his study, evaluated the students' saliva pH that had daily consumed green tea for a period of 1 month. He concluded that daily consumption of the green tea can significantly increase the saliva pH beyond the limit of pH = 5.5. Suyama *et al.*[8] revealed that green tea gums significantly increase the fluoride content of saliva. In another study, the minimum concentration

of 50 μg/ml catechine of green tea can efficiently frustrate the growth of *S. mutans* and *Streptococcus sobrinus*. Gingivitis and periodontitis are inflammatory diseases that their initial causative factors are bacterial plaque.[10] In gingivitis, the gum goes red and swells; periodontitis is characterized by its attachment loss. There can be found much research in the literature which indicates that natural substances are considerably effective to prevent and control periodontal diseases.[11] Some studies suggest the inhibitory effect of green tea on the periodontal pathogens such as *Porphyromonas gingivalis*, *Prevotella intermedia*, and *Prevotella nigrescens*. Green tea includes many polyphenol ingredients which have antioxidant effect.[12] About 30% of the green-tea-substance dry weight is polyphenols, with the major one being epigallocatechin gallate. It is believed that the anti-carcinogenic and anti-inflammatory effects of the green tea, as well as its positive effect on cardiovascular diseases is related to polyphenols.[13] In periodontal diseases subgingival bacterias, via lipopolysaccharides, may cause periodontal destruction, part of which is due to free radicals produced by host immune system.[14,15] The imbalance between oxidants and antioxidants is proved in periodontal diseases, with the increase of free radicals and decrease of antioxidants in saliva as its major manifestation.[16] There are some evidence that prove the effect of reactive oxygen species (ROS) in the periodontal destruction.[14,15] Polymorphonuclears (PMNs) are one of the major resources of ROS, which produce such free radicals in the process of phagocytosis.[17,18] Extra production of free radicals damages gingival tissues, periodontal ligaments, and alveolar bone.[1,19] Green tea is introduced as an anti-inflammatory, antioxidative, anti-mutanogenic, and anti-carcinogenic substance. Different green tea products can reduce the gingival bleeding index,[7] pocket depth, attachment loss and bleeding on probing, and promotion of periodontal regeneration.[12,20] Kudva *et al*.[21] showed that scaling, when accompanied by the local application of green tea, can reduce pocket depth and all bacterial species (except *P. gingivalis*), much more efficiently. Kushiyama *et al*.,[22] in his study on 940 participants, showed that one cup of green tea per day causes a reduction of 0.023 mm on pocket depth, 0.028 mm on attachment loss, and 0.63% on bleeding on probing, with all the results being statistically significant.

Antioxidant effect of polyphenols

Oxidative stress has a significant role on the pathogenesis of periodontal diseases.[23] Brock *et al*.[24] indicated that total antioxidant capacity decreases in the plasma of patients with the periodontitis. In the recent decade, researchers have considerably focused on the role of polyphenols as antioxidants on the periodontal diseases. Different studies prove the role of oxidative reaction and peroxidation of lipids-based products on periodontal pathogenesis. Paterniti *et al*.[25] stated that antioxidant activity of saliva in healthy volunteers was more than periodontal patients for about 40~50%. Activation of NF-KB that has a major role on the expression of the genes which are responsible for the production of inflammatory mediators and are affected by an oxidative and antioxidative process in the body.[26] Polyphenols decrease the expression of inflammatory mediators by suppression of its activation. Polyphenols reduce the expression of attachment molecules like P-selectin and ICAM1; thus, they can prevent the infiltration of PMNs to the inflammation site.[25]

Development of biofilm has an important role in the bacterial infections. It protects bacterias against mechanical and chemical threats. La *et al*.[27] showed that polyphenols, in the concentration of 50 μg/ml or more, impede the attachment *P. gingivalis* to the epithelial tissues; thus, they have no effect on the previously developed biofilm.[28] Polyphenols can also prohibit the coaggregation of periodontopathogens.[29] Steinberg *et al*.[30] indicated that polyphenols have anticariogenic effect by frustrating the development of bacterial biofilms such as *S. mutans* and *S. sobrinus*.

La *et al*.[27] indicated that polyphenols decrease the production of inflammatory cytokines secretion like interleukin 8 (IL-8); but, they have no effect on the concentration of IL-6. IL-8 is an important chemoattractant that has a considerable role on the attraction of neutrophils to the inflammatory site. Zdarilová *et al*.[31] showed that polyphenols, in the concentration of 50 μg/ml, may cause a decrease of secretion of IL-1β, IL-6, and tumor necrosis factor-alpha, from gingival fibroblasts that are exposed to lipopolysaccharide. However, minor effects have been observed for IL-6. Bodet *et al*.[32] discovered that polyphenols suppress the proteolytic activity of red complex pathogens. They can also suppress the replication of periodontal pocket bacteria's by limiting their required amino acids. Periodontal pathogens stimulate the expression of collagenase like MMP-9. Yun *et al*.[33] showed that polyphenols can reduce the expression of MMP-9 gene; on the other hand, by the suppression of osteoclast differentiation in 20 μg/ml concentration and induction of apoptosis in a dose-dependent manner, they suppress the bone resorption in periodontal diseases.[34] Furthermore, polyphenols suppress the expression of receptor activator of nuclear factor (RANK) by the osteoblasts and prevent the bone resorption. RANK expression suppress the osteoclast activity in both normal and inflammatory situations.[35] Polyphenols reinforce the collagen connections and also increase the collagen formation and accelerate the soluble-to-insoluble collagen conversion during the tissue regeneration.[36] Cysteine proteinase is an important virulence factor of *P. gingivalis*, which improves the infiltration of PMNs and activates the complement system. Okamoto *et al*.[37] have stated that the polyphenols in the green tea can control the activity of Arg-gingipain and Lys-gingipain, and can thus prevent the periodontal destruction.

Prostaglandin E2 (PGE2) is one of the inflammatory mediators that has a significant role in the periodontal destruction, and may even prevent the proliferation of gingival fibroblasts.[38] Polyphenols prohibits the production of PGE2 and can thus postpone the progress of periodontitis.[39] Bacterial plaque is a major initial risk factor for the periodontal diseases; So far, different chemicals have been proposed to control the bacterial plaque. Shinada *et al*.[40] have found that application of

0.1% polyphenol mouthwash decreases the reformation of plaque during three days. They thus recommended this mouthwash for the control of plaque in the periodontitis patients. Yaegaki *et al*.[41] found that employing polyphenol-content tablets might be an appropriate method to prevent the plaque formation on tooth surfaces. In their study, the patients solved the tablets (containing 20 mg polyphenols) in their mouths seven times each day, and swallowed them. In another study, a considerable reduction in plaque formation was observed for the patients who used (black) tea mouthwash (for one minute) eight times per day.[42] This might be due to the fact that black tea contains polyphenols, as is the case for the green tea. In a study by De la Fuente *et al*.,[43] consumption of foods enriched by polyphenols for a long time (15-30 weeks) reinforces the leukocyte activity and decreases the mal effect of aging on these cells in rats. A daily consumption of 2-3 cups of green tea (240-320 mg polyphenols) is recommended; however, there is a concern in the consumption of high concentration of polyphenols due to the imbalance of oxidative stress and also hepatic toxicity.[44] The first case of such toxicity was reported in Denmark by the usage of 4-6 cups of green tea during 6 months.[45] Green tea is not recommended for the patients using aspirin and warfarin. Herbal mouthwashes are valuable in the treatment of periodontal diseases by reducing the inflammation. Lamba *et al*. suggest that there is a significant reduction seen in the plaque, gingival and periodontal scores with both the mouthwashes but green tea mouthwash proved to be more beneficial than mint mouthwash with a modest reduction in the total leukocyte count. They claimed that herbal products have shown promising results with minimal side effects.[46]

Conclusion

Previous studies about the effect of green tea and polyphenols suggest that green tea products can be effective for plaque control and prevention of periodontitis. Because most of the articles about this idea limited to *in vitro* studies. Hence, it is proposed that future clinical studies can provide more evidence to support its usage as oral hygiene products. Furthermore, the role of green tea on the pathogenesis and progression of dental caries is still unknown and more studies with a long period of follow-up are needed.

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