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Review

Review of The therapeutic effects of *Camellia sinensis* (green tea) on oral and periodontal health

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Green Tea is one of the most ancient and popular therapeutic beverages consumed around the world. This product is made from the leaf of the plant called "*Camellia sinensis*". It can be prepared as a drink, which can have many systemic health effects or an "extract" can be made from the leaves to use as medicine. Green tea is reported to contain thousands of bioactive ingredients which are almost contributed by polyphenols which plays a key role in prevention and treatment of many diseases. Special consideration is given to antioxidant potential of the green tea and mechanisms by which it acts as antioxidant. The aim of this literature review was to illustrate therapeutic properties of the plant "Green tea" which is known as a medicinal herb on oral and periodontal health. In this study, first we introduced particular information about the tea, such as plant morphology, its active constituents and medicinal supplements. Then we described some important oral and periodontal diseases with essence of easy understanding and at the end explained documents of how green tea and its supplements could improve oral and periodontal health.

Key words: Green tea, periodontitis, oral cancer, antioxidant.

INTRODUCTION

Tea plants are recognized as *Camellia sinensis* by botanists. They are small bushy plants about 3 to 4 feet high. Tea leaves are picked three to four times between spring and fall of each year. Green tea is produced from leaves that are picked and heated quickly, either in a pan or with hot steam, to stop enzymatic action and to prevent fermentation. Fermentation involves air oxidation and polymerization of tea components including polyphenolic catechins that are major constituents of tea leaves. Some tea products are fermented to enhance taste and flavor. Oolong tea, often served in Chinese restaurants, is partially fermented, whereas black or red teas are extensively fermented and are most often consumed in Western societies (Liao et al., 2001). In oriental cultures it has been widely believed for a long time that tea has medicinal efficacy in the prevention and treatment of many diseases. According to Chinese history, about 47 centuries ago, Emperor Sheng-Nong found that a daily cup of tea could dissolve many poisons in the body (Committee, 1991).

In recognition of green tea possible importance in vascular health, polyphenolic flavonoids, like tea catechins, were once called vitamin P (Rusznyak and Szent, 1936). Green tea consumption may be linked to a lower incidence of various pathologies, including cancer, cardiovascular disease, diabetes and obesity. The major green tea catechin, (-)-epigallocatechin 3-gallate (EGCG), has been the focus of much of the research by the scientific community because of its ability to mimic some of the biological effects of green tea. To determine possible molecular mechanisms for the putative health benefits of green tea, pure green tea catechins have been used in numerous studies. Experimental studies on the physiological effects of some polyphenolic tannins indicate that they also may be beneficial for decreasing serum lipids, reducing blood pressure and modulating immune responses and for use as antitumorigenic and

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antibacterial agents and use in food preservation (Chung et al., 1998).

WHAT ARE THE INGREDIENTS OF TEA?

Tea is reported to contain nearly 4000 bioactive compounds of which one third is contributed by polyphenols (Tariq et al., 2010). Other compounds are alkaloids (caffeine, theophylline and theobromine), amino acids, carbohydrates, proteins, chlorophyll, volatile organic compounds (chemicals that readily produce vapors and contribute to the odor of tea), fluoride, aluminum, minerals and trace elements (Cabrera et al., 2003). Polyphenols found in tea are mostly flavonoids (Sumpio et al., 2006). The polyphenols, a large group of plant chemicals that includes the catechins, are thought to be responsible for the health benefits that have traditionally been attributed to tea, especially green tea (Cabrera et al., 2006). Major catechins are (–)-epicatechin gallate (ECG), (–)-epicatechin (EC), (–)-epigallocatechin (EGC) and (–)-epigallocatechin gallate (EGCG) (Table 1 and Figure 1). The most active and abundant catechin in green tea is epigallocatechin-3-gallate (EGCG). Black tea contains much lower concentrations of these catechins than green tea (Wu et al., 2006). Oolong tea contains a mixture of simple polyphenols, such as catechins and complex polyphenols (Mukhtar and Ahmad, 2000).

THE EFFECTS OF GREEN TEA ON ORAL AND PERIODONTAL HEALTH

Gingivitis and periodontitis

Gingivitis and periodontitis are major forms of inflammatory diseases of the mouth. In gingivitis, the gums become red and swollen. They can bleed easily. Gingivitis is a mild form of gum disease. It can usually be reversed with daily brushing and flossing and regular cleanings by a dentist or dental hygienist. Untreated gingivitis can lead to periodontitis. In periodontitis, the gums pull away from the teeth and form pockets that become infected. If not treated, the bones, gums and connective tissue that support the teeth are destroyed. Symptoms of gum disease include: Bad breath that won't go easily, red or swollen gums, tender or bleeding gums, painful chewing, loose teeth, sensitive teeth and receding gums or longer appearing teeth. Their primary etiology is bacteria, which can initiate destruction of the gingival tissues and periodontal attachment apparatus (American Academy of Periodontology, 1999).

Reduction of the periodontopathic bacteria by scaling and supragingival plaque control can lead to an improvement of the periodontal status (Slots et al., 1979; Magnusson et al., 1984; Hinrichs et al., 1985). Complete removal of plaque and calculus is more difficult in deep than in shallow pockets. Hence, the failure of periodontal treatment may be the result of bacterial plaque and calculus remaining after therapy (Rabbani et al., 1981). Therefore, the use of drugs to treat periodontal diseases is required. A number of reviews addressed the local application of antimicrobial agents to the subgingival area for the treatment of periodontitis (Needleman, 1991). Green tea has been reported to be useful for prevention of periodontal disease and maintenance of oral health. An epidemiologic study showed that there is an inverse association between the daily intake of green tea and periodontal disease and suggested that drinking green tea at meals and breaks is a relatively easy habit to maintain a healthy periodontium (Kushiyama et al., 2009). Several *in vitro* studies have suggested that green tea catechins, such as EGCG, inhibit the growth of *Porphyromonas gingivalis*, *Prevotella intermedia*, and *Prevotella nigrescens* and the adherence of *Porphyromonas gingivalis* onto human buccal epithelial cells (Makimura et al., 1993). These bacteria have been strongly implicated in destruction of periodontal tissues and their reduction can lead to the improvement of periodontitis (Magnusson et al., 1984). In addition, green tea catechins with the steric structures of 3-galloyl radial, EGCG, ECG and (-)-gallocatechin gallate (GCG), which are the major tea polyphenols, inhibit the production of toxic end metabolites of *P. gingivalis* (Sakanaka and Okada, 2004). These reports of the inhibitory effects of catechin contained in green tea on periodontal pathogens may provide the basis for the beneficial effect of the daily intake of green tea on periodontal health.

A pilot clinical study evaluated the slow-release local delivery of catechin on periodontal status. Hydroxypropylcellulose strips containing green tea catechin as a slow release local delivery system were applied in pockets in periodontal patients once a week for 8 weeks. Green tea catechin showed a bactericidal effect against black-pigmented, Gram-negative anaerobic rods and the combined use of mechanical treatment and the application of green tea catechin using a slow release local delivery system was effective in improving periodontal status (Hirasawa et al., 2002).

Several studies suggested that green tea catechin has a preventive effect against the development of oxidative stress and the effect has been related to the antioxidative mechanisms of catechin (Bors et al., 1990; Rizvi et al., 2005). Oxidative stress plays an important role in the pathogenesis of periodontal disease, as well as many other disorders and it is believed that antioxidants can defend against inflammatory diseases. Therefore, similar mechanisms might be involved in the effects of the intake of green tea (Kushiyama et al., 2009).

Green tea extract can be made from the leaves of the plant and use as a mouthwash for treating oral and

Table 1. Chemical composition of Green tea (dry weight of tea leaves).

Compound	Mean percent	Particles
Proteins	15	Enzymes
Aminoacides	4	Teanine, glutamic acid, tryptophan, glycine, serine, aspartic acid, tyrosine, valine, leucine, threonine, arginine, lysine.
Fibre	26	
Carbohydrates	7	Cellulose, pectins, glucose, fructose, sucrose
Lipids	7	Linoleic acids,
Pigments	2	Chlorophyll, carotenoids
Minerals	5	Ca, Mg, Cr, Mn, Fe, Cu, Zn, Mo, Se, Na, P, Co, Sr, Ni, K, F, Al
Phenolic compounds	30	Catechins

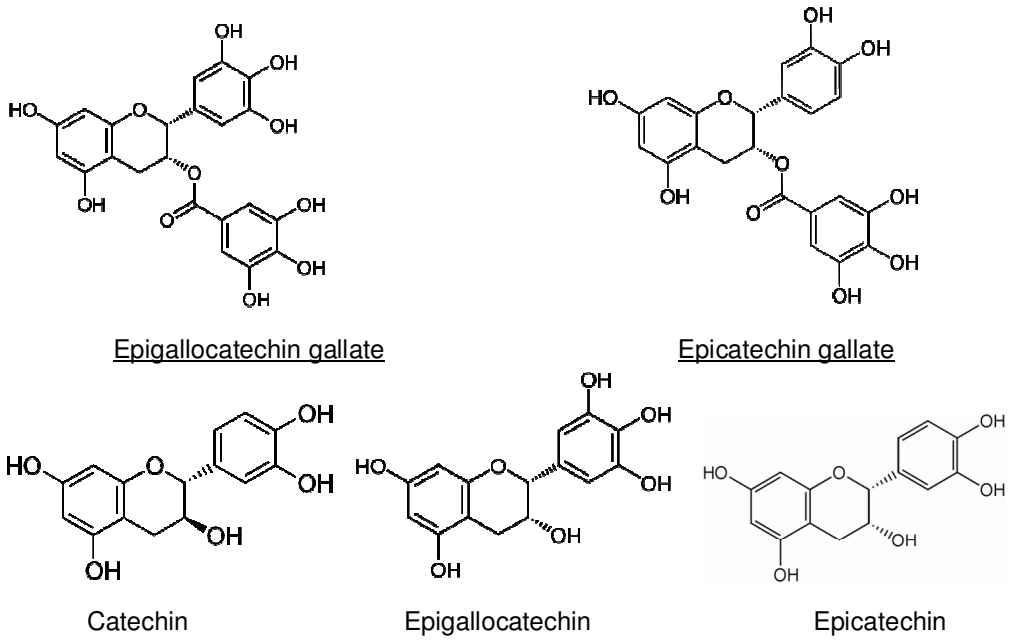

Figure 1. Basic structures of different green tea catechins.

periodontal disease. This extract has therapeutic effects on oral and periodontal diesase. Moghbel et al. (2010) prepared a nontoxic, safe and stable formulation of green tea extract and compared the antibacterial effects of this mouthwash with a same chemical brand (Chlorhexidine gluconate rines) on the mouth aerobic bacterial load. They reported no evidence of toxic effects such as irritation, burn, vesicle or mucous disturbance and in spite of similar antibacterial effects of green tea mouth wash with the chemical chlorhexidine; they showed that the use of herbal green tea mouthwash was more safe and economical. Maroofian (2011) manufactured an herbal mouthwash using dried leaves of green tea plants which was grown in the north part of Iran. They extracted green tea polyphenoles which were the most therapeutic ingredients of this plant in a safe and stable formula for using as a mouthwash. Ebrahimi et al. (2011) in a clinical trial evaluated the effects of this mouthwash on gingival indices of patients with generalized marginal gingivitis and demonstrated that green tea mouthwash had therapeutic effects and could improve gingival status of patients suffering from gingivitis.

Dental caries

Several studies have reported the efficacy of green tea on dental health (Liao et al., 2001). Tea leaves are rich in

fluoride, which is known to enhance dental health and prevents dental caries. However, the possible dental health benefits of tea are not limited to fluoride, but involve other tea components (Onisi et al., 1981a, b). Dental caries are induced by oral microflora. Among hundreds of microorganisms in the oral cavity, only the cariogenic *streptococci*, especially *Streptococcus mutans*, play an important role in causing dental caries (Hamada and Slade, 1980). Several green tea polyphenols have preventative effects on dental caries (Sakanaka et al., 1989, 1990, 1992). Among the catechins, GC and EGC are most active, inhibiting the growth of 10 strains of cariogenic bacteria (Sakanaka, 1989). Cariogenic bacteria synthesize water-soluble and -insoluble glucans using glucosyltransferase (GTase). Highly branched glucans are responsible for bacterial cell adherence to the tooth surface (Hamada and Slade, 1980). ECG, GCG and EGCG strongly inhibit GTase and inhibit adherence of the bacteria to dental surfaces (Sakanaka et al., 1990; Otake et al., 1991). In humans, a double-blind study showed that rinsing the mouth after meals with 0.05 to 0.5% green tea polyphenols for 3 days inhibits dental plaque formation by 30 to 43% (Sakanaka, 1997). In two primary schools, children drinking only one cup a day of green tea after school lunch have reduced dental caries. The effectiveness of green tea catechins against dental caries also has been observed in other countries (Rosen et al., 1984; Elvin-Lewis and Steelman, 1986). Tea polyphenols added to sugar-containing foods, such as chocolate, candy, and biscuits, reduce the incidence of dental caries in rats previously infected with *S. mutans*. Therefore, tea polyphenols have been added to various sweets. In fact, tea polyphenols added to chewing gum are effective in decreasing dental plaque formation in humans (Sakanaka, 1997).

Oral cancer

Among their many biological activities, the predominant polyphenols in green tea -EGCG, EGC, ECG, and EC- have antioxidant activity. These chemicals, especially EGCG and ECG, have substantial free radical scavenging activity and may protect cells from DNA damage caused by reactive oxygen species (Henning et al, 2004). Tea polyphenols have also been shown to inhibit tumor cell proliferation and induce apoptosis in laboratory and animal studies (Seeram et al., 2006). In addition, tea polyphenols may protect against damage caused by ultraviolet (UV) B radiation (Lambert and Yang, 2003), and they may modulate immune system function that can represents the possibility that consumption of green tea and its associated catechins may reduce cancer risk in humans (Steele et al., 2000). Several randomized trials evaluated the effects of tea extracts on premalignant oral Lesions (Tsao et al., 2009). One of the trials was a double-blind interventional trial involving 59 people with leukoplakia, which is a putative precursor lesion for oral cancer (Li et al., 1999). The trial's participants were randomly assigned to receive either 3 g of a mixed tea product, given both orally and topically, or a placebo. After 6 months, 38% of the participants in the treatment group had partial regression of their oral lesions compared with 10% of the participants in the placebo group. In addition, fewer participants in the treatment group than in the placebo group had an increase in lesion size (3% in the treatment group versus 7% in the placebo group). Furthermore, mucosal cell proliferation decreased in the treatment group, suggesting a possible protective effect of tea on the development of oral cancer.

Bad breath (halitosis)

The principal components of bad breath are volatile sulfide compounds, especially hydrogen sulfide (H_2S), methyl mercaptan (CH_3SH) and dimethylsulfide [$(CH_3)_2S$]. These compounds result from the proteolytic degradation by predominantly anaerobic Gram negative oral microorganisms of various sulfur-containing substrates in food debris, saliva, blood and epithelial cells (Tonzetich, 1977). Considering the role of periodontopathic bacteria in producing volatile sulfure compounds, antimicrobial polyphenoles in green tea can improve bad breath by suppressing these bacteria (Liao et al., 2001). The effect of tea catechins on methyl mercaptan (MSH), a main source of halitosis, has been studied (Ui et al., 1991). Deodorant activity decreased in the following order: EGCG > EGC > ECG > EC. Chewing gum containing tea catechins significantly decreased MSH production from saliva containing L-methionine and apparently was useful in reducing bad breath. The deodorizing effect of EGCG involves a chemical reaction between EGCG and MSH. The reaction involves introduction of a methylthio and/or a methylsulfinyl group into the B ring of EGCG. During this reaction, a methylthio group is added to the orthoquinone form of the catechin generated by oxidation with atmospheric oxygen and helps in reducing halitosis (Yasuda et al., 1995).

CONCLUSION

The present article suggests that there is an explicit association between the consumption of green tea and oral health. It is also evident that green tea products have been used for preventing and treating several oral and periodontal diseases. Drinking green tea at meals and breaks is a relatively easy habit to maintain and drinking green tea as frequently as possible may help to maintain a healthy mouth.

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