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REVIEW ARTICLE

ROLE OF GREEN TEA IN DENTAL PROBLEMS

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Abstract

Green tea is particularly rich in health-promoting flavonoids (which account for 30% of the dry weight of a leaf), including catechins and their derivatives. The most abundant catechin in green tea is epigallocatechin-3-gallate, which is thought to play a pivotal role in the green tea's anticancer and antioxidant effects. Catechins should be considered right alongside of the better-known antioxidants like vitamins E and C as potent free radical scavengers and health-supportive for this reason. It has been suggested that green tea also promotes periodontal health by reducing inflammation, preventing bone resorption and limiting the growth of certain bacteria associated with periodontal diseases. The health benefits of green tea for a wide variety of ailments, including different types of cancer, heart disease, and liver disease, were reported. Many of these beneficial effects of green tea are related to its catechin, particularly (-)-epigallocatechin-3-gallate, content. There is evidence from *in vitro* and animal studies on the underlying mechanisms of green tea catechins and their biological actions. There are also human studies on using green tea catechins to treat metabolic syndrome, such as obesity, type II diabetes, and cardiovascular risk factors. Long-term consumption of tea catechins could be beneficial against high-fat diet-induced obesity and type II diabetes and could reduce the risk of coronary disease. It has very important role in dental implications such as caries, halitosis and periodontal problems. Further research that conforms to international standards should be performed to monitor the pharmacological and clinical effects of green tea and to elucidate its mechanisms of action.
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Keywords: Green tea, Dental implications, Halitosis, Caries, Periodontal problems

Introduction

Tea is one of the most popular beverages consumed worldwide. Tea, from the plant *Camellia sinensis*, is consumed in different parts of the world as green, black, or Oolong tea. Among all of these, however, the most significant effects on human health have been observed with the consumption of green tea (Cabrera et al., 2006). The first green tea was exported from India to Japan during the 17th century. It is estimated that about 2.5 million tons of tea leaves are produced each year throughout the world, with 20% produced as green tea, which is mainly consumed in Asia, some parts of North Africa, the United States, and Europe (Japanese Green Tea Online.com [http://www.Japanese greenteaonline.com]). The association between tea consumption, especially green tea, and human health has long been appreciated (Weisburger, 2000; Sato and Miyata, 2000) . Green tea and black tea are processed differently during manufacturing. To produce green tea, freshly harvested leaves are immediately steamed to prevent fermentation, yielding a dry, stable product. This steaming process destroys the enzymes responsible for breaking down the color pigments in the leaves and allows the tea to maintain its green color during the subsequent rolling and drying processes. These processes preserve natural polyphenols with respect to the health-promoting properties. As green tea is fermented to Oolong and then to black tea, polyphenol compounds (catechins) in green tea are dimerized to form a variety of theaflavins, such that these teas may have different biological activities.

Origin

The tea plant is believed to have originated in the landmass encompassing Tibet, western China and northern India. According to ancient Chinese legend, tea was discovered by the Chinese emperor Shen-Nung in 2737 BC, when leaves from a wild tea bush accidentally fell into a pot of water that he was boiling. The drink name derives from the Chinese Amoy dialect word "t'e," pronounced "tay," which has developed into a fine art. Today, "cha" means tea in Chinese. As this word moved westward into the Middle Eastern languages, it sometimes became altered to "chai."

India attributes the discovery of tea to the Buddhist monk Siddhartha in the 6th century. Inspired by divine intervention, he picked and chewed the leaves of a nearby tree, discovering, to his delight, a great sense of alertness and well being. The tree whose health-giving properties enabled him to keep his vow was, of course, *Camellia sinesis*.

Composition of green tea

The active compounds in green tea are from a group of polyphenols called catechins. Four catechins present in green tea are: Epicatechin gallate (ECg), epicatechin, epigallocatechin and epigallocatechin gallate (EGCG).

Green tea also contains carotenoids, tocopherols, ascorbic acid and minerals like chromium, magnesium, selenium and zinc.

Green tea also contains caffeine, although half of that found in coffee. The amount of caffeine in a cup of green tea will vary according to the amount of tea used, the length of time the leaves are infused and if a person drinks the first or second infusion. Most of the caffeine in green tea is extracted into water the first time the tea is infused. A study found that the caffeine content of 1 g of black tea ranged from 22 to 28 mg, while the caffeine content of 1 g of green tea ranged from 11 to 20 mg, reflecting a significant difference (Ensminger et al., 1983).

The safety of caffeine consumption remains a topic of major debate in the research literature. No studies have shown problems with caffeine consumption of less than 75 mg per day. Most studies have shown potentially problematic effects of caffeine consumption on intakes above 200 mg. In addition, there appears to be a significant difference in people's sensitivity to caffeine (Ensminger et al., 1983).

Two beneficial components in green tea, i.e. catechins and amino acid L-theanine, lessen the impact of its caffeine. When green tea is brewed, its caffeine combines with catechins in the water, reducing the caffeine's activity compared with that of coffee or cocoa. In addition, L-theanine, which is only found in tea plants and some mushrooms, directly stimulates the production of alfa brain waves, calming the body while promoting a state of relaxed awareness.

Dental implications of green tea
Caries

The effects of green tea extract on caries inhibition of hamsters and on acid resistance of human tooth enamel have been suggested by both *in vivo* and *in vitro* studies. The dialyzed tea solution in which the fluoride was removed almost completely also showed remarkable effects, similar to the original tea extract. The results obtained from this study suggested that fluoride in green tea may play a role in increasing the cariostatic action along with other components in tea. However, the action of fluoride does not seem to be so important because its concentration is very low. The effect of green tea on caries inhibition as well as on the increment of acid resistance appears to be more correlative with the nondialysable substances in tea (Yu et al., 1992).

Periodontal implications

Various authors have studied the inhibitory effects of catechin contained in green tea on periodontal pathogens, which may provide the basis for beneficial effect of daily intake of green tea on periodontal health.

Green tea catechin inhibit the growth of *P. gingivalis*, *Prevotella intermedia* and *Prevotella nigrescens*and adherence of *P. gingivalis* on to human buccal epithelial cells (Sakanaka et al., 1996).

Green tea catechins with steric structures of 3-galloyl radial, EGCG, ECg and gallocatechin gallate, which are major tea polyphenols, inhibit production of toxic end metabolites of *P. gingivalis*. A study showed that green tea catechin, EGCG and ECg inhibit the activity of *P. gingivalis*-derived collagenase (Sakanaka and Okada, 2004).

Green tea catechin showed a bactericidal effect against black-pigmented, Gram-negative anaerobic rods, *Porphyromonas gingivalis* and Prevotella species, 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 the periodontal status. The peptidase activities in the gingival fluid were maintained at lower levels during the experimental period in the test sites, while it reached 70% of that at baseline in the placebo sites (Hirasawa et al., 2002).

Alveolar bone resorption is a characteristic feature of periodontal disease and involves removal of both the mineral and the organic constituents of the bone matrix, a process mainly carried out by multinucleated osteoclast cells or matrix metalloproteinases (MMPs). EGCG inhibited osteoclast formation in a coculture of primary osteoclastic cells and bone marrow cells, and it induced apoptotic cell death of osteoclast-like multinucleated cells in a dose-dependent manner thus suggesting the role of green tea in the prevention of bone resorption (Nakagawa et al., 2002).

The Gram-negative bacterium, *Porphyromonas gingivalis*, has been reported to stimulate the activity and expression of several groups of MMPs, whereas EGCG has inhibitory effects on the activity and expression of MMPs.

EGCG may prevent alveolar bone resorption that occurs in periodontal diseases by inhibiting the expression of MMP-9 in osteoblasts and formation of osteoclast (Yun et al., 2004).

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 (Coimbra et al., 2006).

Daily intake of green tea was significantly associated with bleeding on probing (BOP), probing depth (PD) and clinical attachment loss (CAL), such that the more frequently subjects drank green tea, better was their periodontal condition. As in a study in which the author involved 940 men and examined their PD, CAL and BOP, the relationship between the intake of green tea and periodontal parameters was examined. The intake of green tea was defined as the number of cups per day. Results showed that the intake of green tea was inversely correlated with the mean PD, mean CAL and BOP (Kushiyama et al., 2009).

Smoking habit and frequency of tooth brushing, which are important lifestyle factors for periodontal disease, were significantly associated with periodontal parameters and were also found to be associated with intake of green tea.

Halitosis

Halitosis is caused mainly by volatile sulfur compounds (VSCs) such as H_2S and CH_3SH produced in the oral cavity. Oral microorganisms degrade proteinaceous substrates to cysteine and methionine, which are then converted to VSCs. Because tea polyphenols have been shown to have antimicrobial and deodorant effects, researchers investigated whether green tea powder reduces VSCs in mouth air, and compared its effectiveness with that of other foods that are claimed to control halitosis. Immediately after administering the products, green tea showed the largest reduction in concentration of both H_2S and CH_3SH gases, especially CH_3SH, which also demonstrated a better correlation with odor strength than H_2S; however, no reduction was observed at 1, 2 and 3 h after administration. In an *in vitro* study, toothpaste, mints and green tea strongly inhibited VSCs production in a saliva-putrefaction system, but chewing gum and parsley-seed oil product could not inhibit saliva putrefaction. Toothpaste and green tea also demonstrated strong deodorant activities, but no significant deodorant activity of mints, chewing gum or parsley-seed oil product were observed. Therefore, it was concluded that green tea was very effective in reducing oral malodor temporarily because of its disinfectant and deodorant activities, whereas other foods were not effective (Lodhia et al., 2008).

Adverse effects of green tea

Although green tea has several beneficial effects on health, the effects of green tea and its constituents may be beneficial up to a certain dose yet higher doses may cause some unknown adverse effects. Moreover, the effects of green tea catechins may not be similar in all individuals. EGCG of green tea extract is cytotoxic, and higher consumption of green tea can exert acute cytotoxicity in liver cells, a major metabolic organ in the body (Schmidt et al., 2005). Another study found that higher intake of green tea might cause oxidative DNA damage of hamster pancreas and liver (Takabayashi et al., 2004). Yun et al.(2006) clarified that EGCG acts as a pro-oxidant, rather than an antioxidant, in pancreatic β cells in vivo. Therefore, high intake of green tea may be detrimental for diabetic animals to control hyperglycemia. At a high dose (5% of diet for 13 wk), green tea extract induced a thyroid

enlargement (goiter) in normal rats (Sakamoto et al., 2001; Satoh et al., 2002). This high-level treatment modified the plasma concentrations of the thyroid hormones. However, drinking even a very high dietary amount of green tea would be unlikely to cause these adverse effects in humans.

Harmful effects of tea overconsumption (black or green) are due to three main factors: (1) its caffeine content, (2) the presence of aluminum, and (3) the effects of tea polyphenols on iron bioavailability. Green tea should not be taken by patients suffering from heart conditions or major cardiovascular problems. Pregnant and breast-feeding women should drink no more than one or two cups per day, because caffeine can cause an increase in heart rhythm. It is also important to control the concomitant consumption of green tea and some drugs, due to caffeine's diuretic effects (Bruneton , 2001). Some studies revealed the capacity of tea plants to accumulate high levels of aluminum. This aspect is important for patients with renal failure because aluminum can be accumulated by the body, resulting in neurological diseases; it is therefore necessary to control the intake of food with high amounts of this metal (Costa et al., 2002). Likewise, green tea catechins may have an affinity for iron, and green tea infusions can cause a significant decrease of the iron bioavailability from the diet (Hamdaoui et al., 2003).

Conclusion

Laboratory studies showed the health effects of green tea. As the human clinical evidence is still limited, future research needs to define the actual magnitude of health benefits, establishes the safe range of tea consumption associated with these benefits, and elucidates the mechanisms of action. Development of more specific and sensitive methods with more representative models along with the development of good predictive biomarkers will give a better understanding of how green tea interacts with endogenous systems and other exogenous factors. Definitive conclusions concerning the protective effect of green tea have to come from well-designed observational epidemiological studies and intervention trials. The development of biomarkers for green tea consumption, as well as molecular markers for its biological effects, will facilitate future research in this area.

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