

Green Tea – A Magical Herbal Therapy

Pooja Palwankar^{1,*}, Lipika Gopal², Ashish Verma³

¹Professor and Head, ²Postgraduate Student, ³Associate Professor, Department of Periodontology, Manav Rachna Dental College, Faridabad,

*Corresponding Author:

E-mail: poojapalwankar@gmail.com

Abstract:

Green tea is one of the commonly ingested drinks in day to day routine. 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 extract has been used in the form of chewing gums, mouth rinses, gum paints and dentifrices as a part of preventive (proactive) periodontal maintenance regimen. Extracts from green tea have been shown to inhibit bacterial growth. The most important green tea polyphenols are tannins and flavonoids. Polyphenols constitute the most interesting group of green tea leaf components, and in consequence, green tea can be considered an important dietary source of polyphenols, particularly flavonoids. The main flavonoids present in green tea include Catechins. The 4 major catechins are Epigallocatechin-3-gallate of total catechins, epigallocatechin, epicatechin-3-gallate 1 and epicatechin. Green tea also contains gallic acid (GA) and other phenolic acids such as chlorogenic acid and caffeic acid, and flavonols such as kaempferol, myricetin and quercetin. Green tea from the leaves of plant *Camellia sinensis* has been shown to have wide range of antioxidant, anti-inflammatory, anti-carcinogenic and anti-bacterial activity.

Keywords: Green tea, Polyphenols, Flavonoids, Catechins, Antioxidant

Introduction:

An increasing number of people all around the world are turning to the nature by using the natural herbal products in both prophylaxis and treatment of different diseases. Tea has been linked to a group of medicaments -Ayurveda, the ancient Indian system of medicine, known as ‘Rasayanas’ that confer attainment of positive health, resistance to diseases and assured full lifespan of quality living, unlike drugs that cure after disease has struck. Tea is the most popular beverage in the world after water¹. Drinking green tea, a suggestive of health beverage is gaining popularity in Asian countries. Green tea is produced from fresh leaves of *Camellia sinensis* and is not traditionally fermented. Green tea contains antioxidants and other beneficial nutrients such as

protein, carbohydrates, minerals, vitamins, and flavonoid-like polyphenols. The most prominent effects of tea on human health have been attributed to green tea, and the health-promoting effects of green tea are mainly attributed to catechins, which belong to a family of compounds known as flavonoid-like polyphenols or flavanols². Catechins include catechin gallate (Cg), galocatechin, galocatechin gallate (GCg), epicatechin, epicatechin gallate (ECg), epigallocatechin, and epigallocatechin gallate (EGCg). Normally, 10–20% of the catechins in green tea leaves are epigallocatechin and EGCg³.

This review emphasizes on the various health benefits of green tea, its effect in oral cavity and periodontal health.

Table 1: Effect of individual components of green tea.

Component	%	Effect
Phenolic Compounds • Catechins	25-30%	<ul style="list-style-type: none"> ➤ Antioxidant⁴ ➤ Anti-cancer effect⁴ ➤ Decreases blood cholesterol⁵ ➤ Anti-hyperglycemic effect⁶ ➤ Body fat reduction⁷ ➤ Anti-influenza effect⁸ ➤ Inhibits hypertension⁹ ➤ Inhibits halitosis¹⁰ ➤ Antibacterial effect¹¹ ➤ Anticaries effect¹¹
Caffeine	1-2%	<ul style="list-style-type: none"> ➤ Increases alertness ➤ Increases stamina ➤ Hangover prevention ➤ Mild diuretic
Theanine	4-6%	<ul style="list-style-type: none"> ➤ Neuronal Cell protection ➤ Relaxation effect ➤ Lowering blood pressure

Vitamins & Minerals • Vitamin C • Vitamin B ₂ • Folic acid • β-carotene • Vitamin E • Minerals(Phosphorus, Potassium, Calcium, Manganese) • Fluoride	6-8%	➤ Maintenance of healthy skin and mucous membrane ➤ Antioxidant ➤ Maintenance of healthy skin and mucous membrane ➤ Prevention of fetal neural tube defects ➤ Prevention of arterial sclerosis ➤ Maintenance of night time vision ➤ Antioxidant ➤ Biological Regulators ➤ Anti-caries effect
Pigments (chlorophyll)	2%	➤ Prevents halitosis ¹⁰
Fiber	26%	➤ Decreases body weight
Proteins	15-20%	➤ Growth and development

Various studies showing effect of green tea on periodontal health are shown in table 2

Table 2: Studies showing effect of green tea on periodontal health.

Year	Authors	Results
1993	Masaharu, Masatomo et al ¹²	Inhibits collagenase activity
1993	Kaneko et al ¹³	Decreases halitosis associated with periodontal disease
1995	Yasuda And Arakawa ¹⁴	Reduction of halitosis by deodorizing methyl mercaptan
1996	Sakanaka et al ¹⁵	Inhibition of growth and adherence of P.gingivalis to buccal epithelial cells
2002	Hirasawa et al ¹⁶	Reduction of markers of gingivitis by use of slow release devices. Bactericidal activity of green tea catechins against P. gingivalis and Prevotella.
2004	Okamoto et al ¹⁷ Sakanaka And Okada et al ¹⁸	Neutralizes etiological agent like gingipains, protein tyrosine phosphatase.
2007	Yunh, Pang et al ¹⁹ Yun, Kim et al ²⁰ .	Inhibits bone resorption by preventing expression of MMP-9 from osteoblasts induced by P. gingivalis extracts.
2009	Nakamura, Ukai et al ²¹	Inhibition of bone resorption by inducing apoptotic cell death of osteoclasts via caspases. Inhibition of nuclear translocation of NF kappa β activated by lipopolysaccharide. Inhibits IL-1β production, directly inhibits osteoclastogenesis. Inhibit Oncostatin M induced CXCL-10 production in human gingival fibroblasts. Inhibits IL-17 which induces CCL-20 production in human gingival fibroblasts.
2011	Maryama T et al ²²	Topical application of green tea catechin containing dentifrice reduced inflammatory cell infiltration in periodontal lesions. Gingival showed lower levels of expression of hexanoyl-lysine, nitro tyrosine and TNF-α.
2012	Hara K et al ²³	EGCg inhibited activity of α-amylase by non-competitive inhibition. Therefore, EGCg inhibits the formation of fermentable carbohydrates involved in caries formation. α-amylase decreased antimicrobial activity of EGCG against periodontal bacteria <i>A. actinomycetamcomitans</i>
2013	Lei Zhao, Vu Dang La, Daniel Grenier ²⁴	Inhibits secretion of IL-6, 8 and chemokine ligand S by P.gingivalis- stimulated oral epithelial cells.
2014	TB Lombardo Bedran et al ²⁵	Induce hBD Genes secretion by epithelial cells and to protect hBDs from proteolytic degradation by P.gingivalis, have potential to strengthen epithelial antimicrobial barrier.

Other effects of green tea:

On chondrocytes²⁶: EGCg inhibits IL-1β induced cartilage proteoglycan degradation and expression of MMP-1 and MMP-13 in human chondrocytes at micromolar concentration. Studies show complete

inhibition of MMP-1 and MMP-13 at a concentration of 100 μg EGCg. This concentration can be achieved only by local administration. This inhibitory effect is by inhibition of IL-1β induced expression of m-RNAs signifying that the effect is at transcriptional level.

Therefore, EGCg may inhibit the activities of MMPs involved in the degradation of native collagen which may further have suppressive effects on the cartilage degradation in arthritic joints.

Green Tea and Periodontal health: *Porphyromonas gingivalis*, a gram-negative anaerobe, a major periodontopathic organism, has the virulent factors, cysteine proteinases, which include Arg-gingipain (Rgp) and Lys-gingipain (Kgp), are regarded as important virulence determinants as demonstrated by various *in vitro* assays. Previous *in vitro* studies showed that green tea catechin inhibits the growth of *P. gingivalis*, *Prevotella intermedia*, and *Prevotella nigrescens*¹⁶. It inhibits the adherence of *P. gingivalis* onto human buccal epithelial cells¹⁵. In addition, green tea catechins inhibit the production of toxic metabolites of *P. gingivalis*. A study showed that green tea catechins, EGCg and Ecg, inhibit the activity of *P. gingivalis*-derived collagenase¹². EGCg completely inhibits the growth of three strains of *P. gingivalis* at concentration of 250 or 500 µg/ml and that of *P. melaninogenicus* at MICs of 2000 µg/ml. Other polyphenols were not as effective as EGCg and their MICs against *P. gingivalis* and *P. melaninogenicus* were 1000 µg/ml or >2000 µg/ml. This mechanism is mainly by binding of polyphenols to fimbriae of *P. gingivalis*²⁶. EGCg has been shown to inhibit the activity and expression of collagenase or gelatinase [matrix metalloproteinase (MMP)-2 and MMP-9]. Studies suggested that EGCg caused the reduction in MMP activities by inhibiting the gene expression of MMP-2 and MMP-9 by suppressing the phosphorylation of extracellular signal regulated kinase in cancer cells. The protein kinase belongs to the mitogen-activated protein kinase (MAPK) family of enzymes, which is known to regulate MMP expression. Furthermore, several studies have provided evidence suggesting that EGCg inhibits MAPK, resulting in the down regulation of MMPs²⁷. EGCg inhibits protein tyrosine phosphatase activity in *P. intermedia*. It also possesses bactericidal activity against a variety of microorganisms like *Helicobacter pylori*.

Bone resorbing activity of osteoclasts plays a crucial role in bone resorption. EGCg, with its ability to inhibit the formation of osteoclasts, might have the potential to be used in the treatment of bone diseases such as periodontitis. Furthermore, it has been reported that EGCg could induce the apoptotic cell death of osteoclasts. However, the biological effect of EGCg on alveolar bone destruction has not been documented. These findings suggest that *P. gingivalis* may contribute to the alveolar bone loss observed in periodontal diseases by stimulating host osteoblastic cells to produce MMP²⁸.

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^{16, 29}. It has also been suggested that epigallocatechin-3-gallate, the major polyphenol in green tea, may represent a novel preventive/therapeutic agent for smoking-related periodontitis³⁰. It has also been reported that green tea polyphenols is of prime importance in treatment of gingivitis. Continuous application of tea catechins on a daily basis can be considered as a useful and practical method for the prevention of periodontal diseases¹².

Green tea is safe for most of the people when used in moderate quantities. The most adverse effects of green tea administered orally are gastrointestinal upset and central nervous system stimulation from the caffeine content in the tea. Allergic reactions have been reported with topical green tea ointment, which may cause cervical and vaginal inflammation, irritation and sensation¹⁶. The caffeine in green tea, when taken in large amounts, can worsen diarrhea and also might worsen symptoms of Irritable Bowel Syndrome. Green tea extract supplements have been linked to several cases of liver damage and liver disease worse.

Conclusion:

There is an increasing interest in the health benefits of green tea in the field of oral health. The non tea drinkers can switch over to green tea oral care products and the ones who relish their cup of tea should turn on the kettle to brew the green tea only. However, although all the evidence from research on green tea is very promising, future studies are necessary to fully understand its contributions to human health.

References:

1. Carmen Cabrera, Reyes Artacho, Rafael Giménez. Beneficial Effects of Green Tea—A Review. *Journal of the American College of Nutrition*. 2006;25(2):79–99.
2. Kushiya M, Shimazaki Y, Murakami M and Yamashita Y. Relationship between Intake of Green Tea and Periodontal Disease. *J Periodontol* 2009;80:372-377.
3. Graham HN. Green tea composition, consumption, and polyphenol chemistry. *Prev Med* 1992;21:334–50.
4. Michael D. Brown. Green Tea (*Camellia Sinensis*) Extract and Its Possible Role in the Prevention of Cancer. *Alternative Medicine Review*. 1999 4,(5):360-370.
5. Zheng XX, Xu YL, Li SH, Liu XX, Hui R, Huang XH. Green tea intake lowers fasting serum total and LDL cholesterol in adults: a meta-analysis of 14 randomized controlled trials. *Am J Clin Nutr*. 2011 Aug;94(2):601-10.
6. Nishiumi S et al. Green and black tea suppress hyperglycemia and insulin resistance by retaining the expression of glucose transporter 4 in muscle of high-fat diet-fed C57BL/6J mice. *J Agric Food Chem*. 2010 Dec 22;58(24):12916-23. doi: 10.1021/jf102840w. Epub 2010 Nov 24.

7. Tomonori Nagao, Yumiko Komine, Satoko Soga, Shinichi Meguro, Tadashi Hase, Yukitaka Tanaka, and Ichiro Tokimitsu. Ingestion of a tea rich in catechins leads to a reduction in body fat and malondialdehyde-modified LDL in men. *Am J Clin Nutr* January 2005vol. 81 no. 1 122-129.
8. Ide K, Yamada H, Matsushita K, Ito M, Nojiri K, et al. (2014) Effects of Green Tea Gargling on the Prevention of Influenza Infection in High School Students: A Randomized Controlled Study. *PLoS ONE* 9(5):1-7.
9. Xiaoli Peng. Effect of green tea consumption on blood pressure: A meta-analysis of 13 randomized controlled trials. *Sci. Rep.*2014; 4: 6251.
10. Lodhia P et al. Effect of green tea on volatile sulfur compounds in mouth air. *J Nutr Sci Vitaminol.* 2008 Feb;54(1):89-94.
11. Awadalla et al. Green tea use on oral health. *Int J Dent Hygiene* 9, 2011; 110–116.
12. Makimura M, Hirasawa M, Kobayashi K, Indo J, Sakanaka S, Taguchi T, et al. Inhibitory effect of tea catechins on collagenase activity. *J Periodontol* 1993;64:630-6.
13. Kaneko K, Shimano N, Suzuki Y, Nakamukaim, Ikazaki R, Ishida N, et al. Effects of tea catechins on oral odor and dental plaque. *J Oral Ther Pharmacol* 1993;12:189-97.
14. Yasuda H, Arakawa T. Deodorizing mechanism of (-)-epigallocatechin against methyl mercaptan. *Biosci Biotechnol Biochem* 1995;59:1232-6.
15. Sakanaka S, Aizawa M, Kim M, Yamamoto T. Inhibitory effects of green tea polyphenols on growth and cellular adherence of an oral bacterium, *Porphyromonas gingivalis*. *Biosci Biotechnol Biochem* 1996;60:745-9.
16. Hirasawa M, Takada K, Makimura M, Otake S. Improvement of periodontal status by green tea catechin using a local delivery system: a clinical pilot study. *J Periodontal Res* 2002;37:433-8.
17. Okamoto M, Sugimoto A, Leung KP, Nakayama K, Kamaguchi A, Maeda N. Inhibitory effect of green tea catechins on cysteine proteinases in *Porphyromonas gingivalis*. *Oral Microbiol Immunol* 2004;19:118-20.
18. Sakanaka S, Okada Y. Inhibitory effects of green tea polyphenols on the production of a virulence factor of the periodontal-disease-causing anaerobic bacterium *Porphyromonas gingivalis*. *J Agric Food Chem* 2004;52:1688-92.
19. Yun JH, Pang EK, Kim CS, Yoo YJ, Cho KS, Chai JK, et al. Inhibitory effects of green tea polyphenol (-)-epigallocatechin gallate on the expression of matrix metalloproteinase-9 and on the formation of osteoclasts. *J Periodontal Res* 2004;39:300-7.
20. Yun JH, Pang EK, Kim CS, Yoo YJ, Cho KS, Chai JK, et al. Inhibitory effects of green tea polyphenol (-)-epigallocatechin gallate on the expression of matrix metalloproteinase-9 and on the formation of osteoclasts. *J Periodontal Res* 2007;42:212-8.
21. Nakamura H, Ukai T, Yoshimura A, Kozuka Y, Yoshioka H, Yoshinaga Y, et al. *In vivo* Green tea catechin inhibits lipopolysaccharide-induced bone resorption. *J Periodontal Res* 2009;45:23-30.
22. Maruyama T et al. Supplementation of green tea catechins in dentifrices suppresses gingival oxidative stress and periodontal inflammation. *Arc Oral Biol.* 2011;56(1):48–53.
23. Hara K et al. The green tea polyphenol (-)-epigallocatechin gallate precipitates salivary proteins including alpha-amylase: biochemical implications for oral health. *European Journal of Oral Sciences.* 2012;120(2):132-139.
24. Lei Zhao, Vu Dang La, and Daniel Grenier. Antibacterial, Antiadherence, Antiprotease, and Anti-Inflammatory Activities of Various Tea Extracts: Potential Benefits for Periodontal Diseases. *Journal of Medicinal Food.* 2013;16(5): 428-436.
25. T. B. Lombardo Bedran, K. Feghali, L. Zhao, D. M. Palomari Spolidorio and D. Grenier. Green tea extract and its major constituent, epigallocatechin-3-gallate, induce epithelial beta-defensin secretion and prevent beta-defensin degradation by *Porphyromonas gingivalis*. *Journal of Periodontal Research.* 2014;49(5):615-623.
26. Babu Venkateswara, K Sirisha, Vijay K Chava. Green tea extract for periodontal health. *J Ind Soc Periodontol.* 2011;15(1):18-22.
27. Joshua D. Lambert and Chung S. Yang. Mechanisms of cancer prevention by tea constituents. *J.Nutr.*2003;3262S-3267S.
28. Chwan-Li Shen, James K. Yeh, Jay Cao and Jia-Sheng Wang. Green Tea and bone metabolism. *Nutr Res.* 2009;29(7):437-456.
29. Chava VK and Vedula BD. Thermo-Reversible Green Tea Catechin Gel for Local Application in Chronic Periodontitis: A 4-Week Clinical Trial. *J Periodontol* 2013;84:1290-1296.
30. Jacynthe Desjardins & Daniel Grenier. Neutralizing effect of green tea epigallocatechin-3-gallate on nicotine-induced toxicity and chemokine (C-C motif) ligand 5 secretion in human oral epithelial cells and fibroblasts. *Journal of Investigative and Clinical Dentistry* 2012;3:189–197.