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Article

Does Matcha tea enhance oral health? A narrative review

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ABSTRACT
Matcha tea is a fine-powdered green tea with a unique "Umami" taste. It is a popular beverage prepared from the leaves of *the Camellia sinensis* plant, which is growing under the shade a few weeks before harvesting the leaves. Consequently, Matcha tea is a green tea possessing distinctive proportions of bioactive chemicals. The health-promoting effects of Matcha tea are well-documented. Matcha tea constituents have diverse beneficial biological activities such as anti-carcinogenic, anti-stress, anti-inflammatory and antioxidant effects, and enhancing cognitive function. On the other hand, research regarding oral health-promoting properties of Matcha tea has yet to be conducted. Oral health benefits of Matcha tea are always granted to green tea. This review highlights the health-promoting properties of Matcha tea and its chemical composition. Also, it summarizes the oral health benefits of green tea as a representative of matcha tea. It is highly suggested to investigate the benefits of Matcha tea for enhancing oral health as it shares bioactive components with green tea but at different proportions.

Keywords: Matcha tea, oral health, *Camellia sinensis*

INTRODUCTION

Nowadays, tea is the second most consumed beverage after water worldwide. Many properties of tea, such as its pleasant taste and aroma, as well as many health-enhancing benefits, contribute to its widespread among populations in the world [1]. Tea is prepared from the leaves of the tea tree (Camellia sinensis). According processing the leaves after harvesting, many types of tea could be obtained, including black tea, Oolong tea and green tea. Both black tea and Oolong tea are prepared after complete or partial fermentation of the harvested leaves, respectively. On the contrary, the fermentation of freshly harvested leaves is thermally prohibited from producing green tea [2].

Much attention has been paid to green tea because of its well-documented health-promoting benefits. It has been reported that many chemical ingredients of green tea have diverse pharmacological properties with a potential impact for lowering the incidence of some pathological conditions such as oral cancer, stroke, cardiovascular diseases and obesity[3, 4]. Among constituents of green tea are phenolic compounds, particularly catechins, which have many beneficial biological activities [3].

Matcha tea is a Japanese fine-powdered green tea commonly consumed due to its health-promoting benefits[5]. It is prepared from the leaves of the Camellia sinensis plant, the same plant as green tea. Unlike conventional cultivation, the bushes used for preparing Matcha tea are cultivated in distinct circumstances. The tree bushes are protected from direct sunlight and shaded a few weeks before harvesting. [6]. This difference in cultivation leads to a higher content of theanine and caffeine in Matcha tea with fewer catechins, which therefore gives its pleasant taste of "Umami," different from the usual bitter taste of tea [7]. After harvesting, unrolled young leaves are steamed, dried, filtered to remove coarse contents, and milled to produce green fine powder of Matcha tea [6].

Regular consumption of Matcha tea has promising potential health benefits as it may support the body's efforts to maintain health and prevent diseases[8]. Matcha tea is rich in contents that have many beneficial biological activities, such as antioxidant properties[5]. This review focuses on the health benefits and chemical composition of Matcha tea.

Chemical Composition of Matcha Tea

Tea is a natural source of many biologically active compounds. Many confounding factors influence the content of such chemicals in tea extracts. During the preparation of tea extracts, the duration of brewing and the heating temperature of the water impacts the infusion of chemicals from tea powder. Soaking tea powder in water at a high temperature for an extended time could enhance the extraction of biologically active ingredients and consequently amplify the health-beneficial properties of tea beverages [23,24, 5]. For instance, the antioxidant properties of tea are proportional to the temperature of water used to prepare the infusion as more phenolic content could be extracted[9]. Other factors influencing the content of health-promoting substances in tea plants during cultivation are agroclimatic conditions such as the frequency of sunny and rainy days, fertilization and plant protection measures [10].

Catechins are a family of phenolic compounds found in Matcha tea [11]. Four main types of catechins are commonly detected in tea extracts. These include epicatechin, epicatechin-3-gallate, epigallocatechin and epigallocatechin-3-gallate (EGCG); the latter is the most biologically active and abundant catechin in tea [12, 13]. Catechins have a profound antioxidant activity even higher than glutathione, vitamin C and flavonoids[14]. They can neutralize free radicals and boost the detoxification activity of enzymes such as glutathione peroxidase, catalase and glutathione reductase [15, 16].

Matcha tea has been reported to have a lower polyphenol content than green tea. This finding might be due to differences in the cultivation of the tea plant, where shading for some time is essential before harvesting the leaves to produce matcha tea. This, in turn, influences the polyphenol synthesis within the plant[17]. Moreover, factors such as geographical location and leaf processing prior to drying also affect the content of catechins in tea [18,19,20].

Phenolic acids have excessive antioxidant and anti-inflammatory potentials and neuroprotective and hypoglycemic effects [21,22]. Some of these compounds, such as chlorogenic acid, may support the regulation of metabolic disorders by modulating lipid and carbohydrate metabolism [25].

Caffeine is a major component of tea beverages, which is responsible for its distinctive and desirable taste. Matcha tea has a relatively higher caffeine content than other green teas, contributing to matcha tea's unique aroma and flavor [26]. Generally, caffeine contents in Matcha tea varied between 18.9 and 44.4 mg/g[11]. Its level depends on the time of harvest, age of leaves, climatic conditions, and

brewing method [26,27,28]. Caffeine has antioxidant potential, neutralizing reactive oxygen species and enhancing antioxidant enzyme activity and total glutathione levels[11]. Regular caffeine intake may reduce oxidative stress and lower the prevalence of free radical-mediated diseases [22]. Additionally, caffeine may exhibit anti-inflammatory effects by inhibiting the secretion of proinflammatory cytokines [29].

Vitamin C is a fundamental micronutrient with pleiotropic features associated with its ability to donate electrons. It supports various cellular functions of both the innate and adaptive immune system. It also supports epithelial barrier function against pathogens and promotes the oxidant scavenging activity of the skin, thereby protecting against environmental oxidative stress. Furthermore, vitamin C is able to both prevent and treat respiratory and systemic infections. Vitamin C deficiency contributes to impaired immunity and increases susceptibility to infections [30]. Matcha tea contains the highest amount of vitamin C[11] among all tea types.

Theanine amino acid is one of the contents of tea. During growing of the tea plant under shade to produce Matcha tea, theanine does not break down. As a result, Matcha tea plant leaves contain large quantities of theanine compared to other types of tea [31]. The excessive theanine content in Matcha tea, with caffeine, contributes to its unique non-bitter umami taste[32,33].

Matcha tea has a high chlorophyll content, accounting for its vibrant colour[34]. Chlorophyll and its derivatives display a potent antioxidant and anti-inflammatory activity [35].

Rutin is a flavonoid compound found in many plants, and it has a wide range of biological activities, such as anti-inflammatory and antioxidant effects. In addition, rutin may protect against liver and kidney diseases. Matcha tea has been reported to have an exceptionally high rutin content, even higher than green tea[5].

Matcha tea is rich with quercetin [37]. Quercetin is a polyphenol with several biological activities. Evidence shows that quercetin has neuroprotective effects against neurotoxic chemicals and neurodegenerative diseases. Also, quercetin has been reported to normalize carbohydrate metabolism by inhibiting glucose absorption from the gastrointestinal tract, regulating insulin secretion and improving insulin sensitivity in tissues[39].

Health-Promoting Properties of Matcha Tea

Much attention has been paid to the health-promoting properties of Matcha tea. It is not surprising that many studies have been conducted to evaluate the benefits of Matcha tea and its constituents. In reviewing animal and molecular studies, tea polyphenols may exhibit anticarcinogenic effects. They inhibit cancer cell growth, invasion and metastasis and induce cancer cell apoptosis[40]. Crude extracts of Matcha tea exert anticarcinogenic effects by reducing the viability of T47D breast cancer cells and increasing the expression of peroxisome proliferator-activated receptors γ, a nuclear receptor with tumor-suppressing effects in breast cancer [41]. Consumption of catechins potentially decreases the incidence of metachronous colorectal adenomas. It has been reported that daily intake of catechins supplements for a prolonged time is an effective chemo-preventive measure of colorectal cancer[42]. Moreover, the intake of tea catechins could act synergistically with anticancer medications and, therefore, support cancer therapy [43].

There is accumulated evidence concluding that regular tea consumption is beneficial and could be considered a preventive measure against diabetes, obesity, cardiovascular diseases and neurological disorders. However, no

consensus about the gold standard frequency and daily dose has been achieved yet[44,45]. In a cohort study that followed 100,902 subjects for an average of 7.3 years, habitual tea drinkers were found to be less associated with the risk of atherosclerotic cardiovascular disease and mortality [46]. Further, tea EGCG may have a protective effect for those undergoing surgery and at risk of heart ischemic injury. It has been reported that EGCG inhibits the activation of stress-activated protein kinase and inflammation signaling pathways, thus protecting heart muscles from injury [47,48].

Previous animal studies concluded that extracts of Matcha tea enhance cognitive function [49] and the recovery of non-alcoholic fatty liver disease [50]. Tea EGCG promotes clarity of mind and cognitive function, inhibits LPS-induced production of reactive oxygen species, improves insulin sensitivity and reduces amyloid-β production in the brain, thus reducing neuroinflammation and preventing neuropathologies related to neurodegenerative diseases such as Alzheimer's disease [51]. A stress-reducing effect is another precious benefit of Matcha tea. No doubt, Matcha tea, which is rich in theanine, is effective in reducing anxiety; evidence has been concluded from animal and human studies [28].

Matcha tea may help reduce blood glucose levels [52], and its EGCG content may prevent starch digestion, thus decreasing the sudden release of glucose in the gastrointestinal tract[53]. EGCG might also have the potential to inhibit gluconeogenesis and the absorption of lipids and glucose from the gastrointestinal tract, as well as enhancing insulin sensitivity[54].

Finally, Matcha tea is a natural source of antioxidant chemicals. It was reported that the chlorophyll b content of Matcha tea is the main contributor to its antioxidant activity apart from other chemicals in Matcha tea[11].

Oral health-promoting Properties of Matcha tea

Despite Matcha tea's well-documented general health-promoting properties, much attention has been paid to green tea regarding oral health. After reviewing the literature, the oral health-promoting properties of Matcha tea are generally granted from green tea. It is obvious that match tea is a type of green tea, while there are significant differences in the proportions of chemicals between them. Such differences might contribute to possible incommensurate biological activities of these two beverages. However, the oral health benefits of green tea are highlighted in this review, proposing that match tea has almost similar activities.

Decades ago, the oral health benefits of green tea have been comprehensively evaluated. Many studies emphasize the link between the green tea intake and good oral health. Green tea consumption is recommended as a natural functional food to control periodontal diseases and dental caries, particularly in the elderly population [55]. In a survey conducted in Japan, the periodontal health of 940 subjects was clinically evaluated. The authors found that subjects who were habitual green tea drinkers had better periodontal health than green tea non-drinker peers [56]. Moreover, the frequency of green tea consumption is an essential cofactor that influences the magnitude of its effects. It was reported that intake of ≥3 cups of green tea per day positively impacts the oral health-related quality of life of older adults [57].

Periodontal disease is a bacterial-induced disease involving gingival inflammation and, in more advanced forms, destruction of periodontal tissue. Dental biofilm is an aggregation of bacteria considered the leading cause of periodontal diseases. Porphyromonas gingivalis is the most potent periodontal pathogen commonly identified in the subgingival biofilms of patients with

periodontal diseases. Many in vitro studies have investigated the potential benefits of green tea extracts for oral health. Green tea polyphenols were found to inhibit the growth of P. gingivalis at concentrations of 250-500 µ/ml [58]. Moreover, green tea chemicals have biological activities that potentially assist in resolving periodontal inflammation. For instance, green tea EGCG inhibits bone resorption by inducing apoptotic cell death of osteoclasts in a dose-dependent manner. Also, EGCG could prevent P. gingivalis-induced high expression of matrix metalloproteinase (MMP) from osteoblasts and lower the activity of MMP by inhibiting the gene expression of MMP-2 and MMP-9 via Mitogen-Activated Protein Kinase signaling pathway[59].

Recently, green tea extract and its (EGCG) has been reported to protect oral epithelial cells against deleterious effects of chemotherapeutic medication through its antioxidant and anti-inflammatory properties [60]. Also, they could protect against periodontal pathogens' invasion, such as P. gingivalis, by amplifying the integrity of the oral epithelium. Moreover, tea components inhibit the activity of the protease enzyme of P. gingivalis, restricting the spread of the pathogen in periodontal tissue and exhibiting preventive properties against periodontal diseases [61]. On the other hand, green tea extract has been reported to exhibit anti-cariogenic properties. Green tea extract effectively inhibits the growth of the main cariogenic oral flora, mutans streptococci and lactobacilli [62]. The abovementioned evidence supports the suggestion of using green tea extracts as natural preventive chemicals in promoting oral health.

Differences in tea drinking habits are likely to vary by population and could contribute to inconsistencies between studies comparing tea consumption and cancer risk. A population-based case-control study was used to evaluate how usual tea consumption patterns of an older population (n = 450) varied with history of squamous cell carcinoma (SCC) of the skin. A detailed tea questionnaire was developed to assess specific tea preparation methods and patterns of drinking. In this southwestern United States population, black tea was the predominant variety of tea consumed. We found no association between the broad definition of tea consumption and skin SCC. However, the adjusted odds ratios (ORs) for hot and iced black tea intake were 0.63 [95% confidence interval (CI), 0.36-1.10] and 1.02 (95% CI, 0.64-1.63), respectively. Controls were more likely to report usually drinking strong hot tea (OR, 0.74; 95% CI, 0.53-1.03) with increased brewing time (P for trend = 0.03). Adjusting for brewing time, the association between skin SCC and hot black tea consumption suggests a significantly lower risk in consumers of hot tea compared to nonconsumers (OR, 0.33; 95% CI, 0.12-0.87). This is one of the first studies to explore the relationship between different types of tea consumption and the occurrence of human cancers. Our results show that tea concentration (strength), brewing time, and beverage temperature majorly influence the potential protective effects of hot black tea in relation to skin SCC. Further studies with increased sample sizes are needed to evaluate the interrelationships between preparation techniques, tea type, and other lifestyle factors.

Evidence encourages using green tea as an adjunct in the non-surgical therapy of periodontitis. Daily intake of two cups of green tea for 6 weeks enhances the non-surgical treatment of periodontal diseases [63]. Green tea intake boosts the antioxidant capacity in periodontal tissue, as measured in gingival crevicular fluid, and exhibits anti-inflammatory effects during periodontal treatment [64]. As a mouthwash, it was reported that long-term rinsing with green tea is safe and positively impacts oral health for patients who have oral cancer and undergoing

cancer therapy [65]. Applying green tea topically after scaling and root planing during periodontal treatment could improve the treatment outcomes without considerable side effects [66]. It was reported that a four-week regimen of mouthwashing with a dilute catechin solution reduced halitosis associated with periodontal disease. Tea catechins could deodorize methyl mercaptan, the leading cause of halitosis [68]. However, in a recent systematic review and meta-analysis, using any form of green tea (infusion sachets, hydroxypropyl cellulose strips, dentifrice or gel) as a topical adjunct to mechanical instrumentation shows very low certainty of effectiveness for the periodontal treatment of diseased sites [69]. More clinical trials with rigorous methodologies are highly suggested to support the effectiveness of green tea extracts as an adjunct to periodontal treatment. Moreover, many studies have been conducted to document the benefits of green tea for oral health, whereas no attention has been paid to Matcha tea. It is strongly suggested to investigate Matcha tea's oral health-related biological activities in the future as it has distinctive phytochemical constituents.

CONCLUSION

Matcha tea is a beneficial beverage containing many bioactive chemicals which are reported to promote human health. The oral health benefits of Matcha tea still need to be discovered. Research to uncover the oral health-promoting properties of Matcha tea is highly suggested.

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