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Health benefits of Green and Black Tea: A Review

K.H.G.K. Kodagoda, I. Wickramasinghe

Department of Food Science and Technology, Faculty of Applied Sciences, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka

***Abstract*—** *Tea, (Camellia sinensis) is grown in about thirty countries and next to water, is the most widely consumed beverage in theworld. Based on the type of the processing, three tea types can be identified as Green, Black and Oolong tea. Drinking tea has beenconsidered a health-promoting habit since ancient times. The modern medicinal research isproviding a scientific basis for this belief. Various studies have suggested the health promoting effects of green and black tea is due to its polyphenolic compounds mainly catechins. Unlike green tea, health benefits of consuming black tea are not extensively discussed. This review is mainly focused on the health benefits of consuming green and black tea.*

***Keywords*— Black tea, Green tea, health benefits, polyphenols.**

I. INTRODUCTION

Tea is the most consumed beverage in the world after water. Legends of China and India have indicated that the tea consumption is one of the very ancient habits. Traditionally, tea was drunk to improve blood flow, eliminate toxins, and to improve resistance to diseases [1]. The spread of tea cultivation to India between 1818 and 1834 can be considered as the origin of the modern tea industry. Through cultivation, tea has become an important agricultural product throughout the world, particularly in regions lying close to the equator [2]. Tea, from the plant *Camellia sinensis*, is consumed in different parts of the world as green, black or oolong tea [3].

Green tea is prepared by dehydration of tea leaves which does not lead to the oxidation of constituent polyphenols, therefore green tea, contains high concentrations of monomeric polyphenols from the catechins group [4]. Black tea, obtained by tea leaves with fermentation, is oxidized and contains mainly multimeric polyphenols, whose biological activity is not well documented [5]. And Oolong teais a partially oxidized product [6].Green tea is best studied for decades for its health benefits, including cancer chemo preventive and chemotherapeutic effects [7], [8] butin recent years, black tea is also extensively investigated mainly regarding its influence on human health [9].

II. PROCESSING OF GREEN AND BLACK TEA

Green and black tea is mainly produced from *Camellia sinensis* var. *sinensis*. The primary goal in the manufacture of green tea is the preservation of the leaf catechins. The steps of processing include plucking, rapid enzyme inactivation by steaming or pan firing, rolling, and high temperature air drying. Glycosides of aromatic and terpene alcohols found in the growing leaf are rapidly hydrolyzed after plucking to form the free volatile alcohols. The rolling process imparts a twist which improves appearance. During the final drying step many new aromatic compounds are formed which impart important characteristics of green tea flavour. Green tea composition is similar to that of the fresh leaf with regard to the major components [6].

The black tea production begins with plucking, withering,maceration (rolling) and finally drying. During withering,the leaves take on a form facilitating the rolling process. Thisprocess results in disrupting the cell structure of the leavesand the fermentation process then begins[10]. In the black tea production process, about 75% of catechins contained in the tea leaves undergo enzymatic transformation consisting in oxidation and partial polymerization [11],[12]. Because the main enzyme taking part in these processes is tea leaf polyphenol oxidase, it is essential to assure its direct contact with polyphenols and atmospheric oxygen. The resulting black tea composition depends on the technological process of its production [10].

III. COMPOSITION OF GREEN AND BLACK TEA

Normally the composition of tea leaf varies with climate, season, horticultural practices, variety of the plant, and age of the leaf, i.e. the position of the leaf on the harvested shoot[6]. With regard to the major components, green tea composition is similar to that of the fresh leaf. Green tea contains polyphenoliccompounds, which include flavanols, flavandiols, flavonoids, and phenolic acids. These compounds account for up to 30% of the dry weight of green tea leaves. Most of the polyphenols present in green tea are flavanols, commonly known as catechins. Some major catechins present in green tea are (-)-epicatechin

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(EC^2), (-)- epicatechin-3-gallate (ECG), (-)-epigallocatechin (EGC), and (-)-epigallocatechin- 3-gallate (EGCG). In addition, caffeine, theobromine, theophylline, and phenolic acids such as gallic acids are also present in green tea [11].

It is difficult tostate a definitive composition for black tea beverage, as it varies with different preparations [6]. In the process of manufacturing of black tea catechins are mostly oxidized to theaflavins or thearubigins. For tropical black tea they occur as 15-20% thearubigins, 1-2% theaflavins and 5-10% catechins on a dry-weight basis[13].In addition, methylxanthines are present with 2 to 4% as caffeine and as a small amount of theophylline and of theobromine[14].

Table.1: Green and Black Tea composition [2]

Compound	Green Tea (% wt/wt solids)	Black tea (% wt/wt solids)
Catechin	30	9
Theaflavins	-	4
Simple polyphenols	2	3
Flavonols	2	1
Other polyphenols	6	23
Theanine	3	3
Amino acids	3	3
Peptides/Proteins	6	6
Organic acids	2	2
Sugars	7	7
Other Carbohydrates	4	4
Lipids	3	3
Caffeine	3	3
Other methylxanthines	<1	<1
Potassium	5	5
Other minerals/ash	5	5
Aroma	Trace	Trace

IV. HEALTH BENEFITS OF GREEN AND BLACK TEA

4.1 Cancer prevention

Accumulation of reactive oxygen species in cells and resulting modifications in DNA structure, enzymatic activity, and defense mechanisms all influence the development of the cancer pathogenesis [15]. Tea consumption has been reported to have beneficial effects against different types of cancers due to its antioxidants which have the ability to prevent and control cancer development. Many *in vivo* studies conducted with rodents have shown that tea protects against many types of cancer and at most stages of carcinogenesis [16].Green tea and green tea polyphenols have been shown to have anti-cancer activity in a number of laboratory studies, which could be mediated through antioxidant or pro-oxidant mechanisms [17].Green tea polyphenols such as EGCG inhibit cell viability and induce apoptosis in a number of cancer cell lines such as osteogenic sarcoma [18], lymphoblastoid cells [19], leukemia cells [20], melanoma cells [21], T lymphocytes [22] and larynx carcinoma [23]. EGC can inhibit breast cancer cell viability through induction of apoptosis, yet not in normal breast cells [24]. Green tea can induce apoptotic cell death in cancer better than other teas as it has the highest concentration of polyphenols [25].

The activity of the tea and its polyphenols on the inhibition of the skin tumergenesis has been well studied [4]. Early studies have demonstrated that topical application or ingestion ofgreen tea polyphenols or EGCG inhibit tumor initiation and promotion by chemical carcinogens and UV light in mice [26]-[29]. Black tea has similar effects [29]-[32]. Topical application of a greentea polyphenolic fraction on mice skin papillomas can decrease significantly the conversion of benign tumors tomalignant tumors [33]. Reduction in lung tumor number is observed when mice are treated with green or black tea, EGCG, or decaffeinated teas prior to chemical induction of lung tumorigenesis[25],[34].

Tea polyphenols; theaflavine gallate of black tea and epigallocatechin gallate of green tea can inhibit the formation of heterocyclic amines from cooked fish and meat which are genotoxic carcinogens associated with cancer of the breast, colon and pancreas [11].

Tea drinking was associated with reduced risk of lung cancer in male cigarette smokers in a case control study in Uruguay [35]. In a population-based case-control study in Shanghai, China, consumption of green tea was associated with a reduced risk of lung cancer among non-smoking women and the risk decreased with increasing consumption [36]. In a case control study, a protective effect of frequent,daily or several times/week black tea drinking appeared among non-smoking women [37].

4.2 Cardiovascular disease (CVD) prevention

Consumption of tea is increasingly being shown to be associated with enhanced cardiovascular and metabolic health [25]. In coronary heart diseases, atherosclerotic plaque formation is caused by the deposition and the oxidation of low-density lipoprotein (LDL) at the lesion sites of artery walls when the tocopherol levels are depleted. Studies testing the antioxidant effect of tea polyphenols on LDL and VLDL (very low-density lipoproteins) oxidation indicate that EGCG is very effective and has a lipoprotein bound antioxidant activity greater than tocopherol [38]. Black tea extract also increases the resistance of LDL to oxidation in a concentration dependent manner [39], but at low concentrations, tocopherol is more effective [40].Green tea catechins affect lipid metabolism by different pathways and prevent the appearance ofatherosclerotic plaque [25].

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4.3 Diabetes

Various studies have shown that tea may affect glucose metabolism and insulin signaling, causing interest in the health effects of tea consumption on diabetes [25]. Green tea can reduce blood glucose levels in aged rats, an indicator of diabetes frequently observed in the agingpopulation [41]. Tea suppresses the activity of glucosetransporters in the intestinal epithelium and is believed toreduce dietary glucose intake [42]. In another study conducted in Iran with forty-six patients with type II diabetes mellitus, it was found that regular intake of black tea extracts had anti-oxidative and anti-inflammatory effects in the patients [43].

4.4 Anti-bacterial effect

Tea polyphenols are also known for their antibacterial activity. In general, antibacterial activity decreases when the extent of tea fermentation is increased, implying stronger activity in green tea than black tea [44],[45].Green tea catechins, particularly EGCG and ECG, have antibacterial activity against both Gram-positive and Gram-negative bacteria [46]-[48]. Broadly, Gram-positive bacteria are more sensitive to tea extracts than Gram-negative bacteria [47]. The antibacterial activity of black tea has also been reported [44]-[46]. Tea extracts exhibits inhibitory effects against several food pathogens, including *Staphylococcus aureus*, *Shigelladisenteriae*, *Vibrio cholerae*, *Campylobacter jejuni*, *Listeria monocytogenes*, etc. [49],[50]. Drinking tea also leads to a reduction of enterobacteria which produce ammonia, skatole and other harmful amines and a beneficial increase in the level of *lactobacilli* and *bifidobacteria* which produce organic acids and lower the intestinal pH [51],[52].

4.5 Oral health

Linke and LeGeros[53] indicated that frequent intake of green tea can significantly decrease caries formation, even in the presence of sugars in the diet. In vivo animal studies have shown that specific pathogen-free rats infected with *Streptococcus mutans* and then fed with a cariogenic diet containing green tea polyphenols have significantly lower caries scores [54]. Several studies have indicated that polyphenols from green tea inhibit growth, acid production, metabolism, and glucosyltransferase enzyme activity of *S. mutans* and dental plaque bacteria [55].

Adults rinsing with black tea 10 times a day for 7 days had a significantly less pronounced pH fall, lower plaque index ($P < 0.05$), and numerically fewer *S. mutans* and total oral *Streptococci* in plaque but not in saliva. Fluoride concentrations in plaque and saliva increased, reaching a maximum at day 7 [56]. It is evident that black tea and its polyphenols also benefit human oral health by inhibition of dental plaque, its acidity, and its cariogenic microflora [55].

4.6 Bone mineral density

Bone Mineral Density also is positively associated with tea consumption, which may optimize bone health [57]. Specifically, green tea appeared to benefit bone health more than other kinds of tea (e.g., black, oolong), which may be due to decreased oxidative stress [58], [59], increased activity of antioxidant enzymes [58], and decreased expression of pro-inflammatory mediators [58],[59]. Tea-derived flavonoids and lignans may also improve bone mineral density [60]-[62], particularly in older women with low concentrations of endogenous oestrogen.

4.7 Obesity

Obesity and the comorbidities associated with obesity remain a global health problem [63]. Epidemiological evidence and several randomized controlled intervention trials have shown an inverse relationship between habitual tea consumption (predominately green tea) and levels of body fat and waist circumference [64],[65]. While green tea contains an array of compounds, the putative antiobesity effects have been most commonly attributed to the polyphenolic fraction of green tea, specifically the catechins [66].Green tea catechins induces antiobesity effects by thermogenesis and substrate oxidation which are mediated by sympathetic nervous system activity, modifications in appetite control, down-regulation of enzymes involved in hepatic lipid metabolism, and decreased nutrient absorption [63]. But according to Pan etal.,[67]black tea polyphenols are more effective than green tea polyphenols in body weight reduction. Black tea polyphenols inhibit lipid and saccharide digestion, absorption and intake, promote lipid metabolism and block pathological processes of obesity and the comorbidities of obesity by reducing oxidative stress [67].

V. CONCLUSION

Green and black tea can be considered as a healthy drink rather than a traditional beverage due to its pharmacologically active molecules. It is increasingly recognized that tea contains polyphenols and other components that may reduce the risk of developing chronic diseases such as cancer, cardiovascular diseases, diabetes, promote weight loss and oral health and increase bone mineral density. 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. The development of biomarkers for green and black tea consumption, as well as molecular markers for their biological effects, will facilitate future research in this area.

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