



Protective Effect of Tea on Different Diseases

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Tea is the most widely consumed beverage worldwide. The inhibition of tumorigenesis by tea extracts and tea polyphenols has been demonstrated in different animal models. Tea is consumed in different forms such as oolong, green and black. Being rich in natural antioxidants, tea is used in the management of different types of cancer, cardiovascular disease and cell signaling. The present review focuses on the protective effects of tea on different diseases.

Keywords: Tea; Cancer; Cardiovascular Disease; Polyphenols**Introduction**

Tea is one of the most widely consumed beverages in the whole world, second only to water, and its medicinal properties have been widely explored. It is believed that tea originated from China around 2737 B.C., although earliest documented evidence as mentioned in a Chinese dictionary can be traced back to 350 B.C. [1]. Tea was brought to Europe in 1559 A.D. The tea plant, *Camellia sinensis*, is a member of the Theaceae family. The three major forms of tea black, green and oolong are produced from the leaves of the tea plant. Tea leaves are dark green in colour, alternately arranged, oval in shape and have serrated edges. Green tea beverage contains 30 - 42% catechins by dry weight [2]. These catechins are present in higher quantities in green tea than in black or oolong tea, because of differences in the processing of tea leaves after harvest. For the green variety, fresh tea leaves from the plant *Camellia sinensis* are steamed and dried to inactivate the polyphenol oxidase enzyme, a process that essentially maintains the polyphenols in their monomeric forms. Black tea, on the other hand is produced by extended fermentation of tea leaves leading to the formation of polymeric compounds, thearubigins and theaflavins. Oolong tea is a partially fermented product and contains a mixture of the monomeric polyphenols and higher molecular weight theaflavins [2]. All these varieties of tea contain significant amounts of caffeine (3 - 6%) which is unaffected by the different processing methods [3]. There are several polyphenolic catechins in green tea, viz. (-) epicatechin (EC), (-) epicatechin-3-gallate (ECG), (-) epigallocatechin (EGC), (-) epigallocatechin-3-gallate (EGCG), (+) catechin and (+) gallic acid (GC). EGCG, the most abundant catechin in green tea, accounts for 65% of the total catechin content. A cup of green tea may contain 100 - 200 mg of EGCG, trace amounts of catechin and gallic acid [4]. Black tea contains 2 - 6% theaflavins, > 20% thea-

rubigins, and 3 - 10% catechins in the water-extractable portion. Tea leaves also contain flavonols, such as quercetin and myricetin, as well as nitrogenous compounds, such as caffeine and theobromine. Caffeine accounts for 2 - 5% of the water-extractable material in green, oolong, and black tea. Many health benefits including prevention of cancer, heart disease, hepato cellular carcinoma, cataracts etc have been ascribed to the consumption of this beverage.

Green Tea

Green tea and its constituent catechins are best known for their antioxidant properties, which has led to their evaluation in a number of diseases such as cancer associated with reactive oxygen species (ROS). The chemical composition of green tea is complex. It contains proteins (15 - 20% dry weight), the amino acids constituents of protein such as theanine or 5-N-ethylglutamine, glutamic acid, tryptophan, glycine, serine, aspartic acid, tyrosine, valine, leucine, threonine, arginine, and lysine and contributed towards (1 - 4% dry weight); carbohydrates (5 - 7% dry weight) such as cellulose, pectins, glucose, fructose, and sucrose; minerals and trace elements (5% dry weight) such as calcium, magnesium, chromium, manganese, iron, copper, zinc, molybdenum, selenium, sodium, phosphorus, cobalt, strontium, nickel, potassium, fluorine, and aluminum; and trace amounts of lipids (linoleic and α -linolenic acids), sterols (stigmaterol), vitamins (B, C and E), xanthic bases (caffeine, theophylline etc), pigments (chlorophyll, carotenoids etc) and volatile organic compounds (aldehydes, alcohols, esters, lactones, hydrocarbons etc) [5]. The yellowish green color of the unoxidized extract is attributed to the chlorophyll content. A cup of green tea contains about 300 to 400 mg of polyphenols, which are essentially colorless. Of the polyphenols, epigallocatechin gallate (EGCG) and epigallocatechin (EGC) are the most important and it is estimated that a typical cup of green tea contains 10 to 30 mg of

EGCG. Several epidemiological studies as well as studies in animal models have shown that green tea can offer protection against various cancers such as skin, breast, prostate and lung [6,7]. In addition to the cancer chemopreventive properties, green tea and EGCG have been shown to be anti-angiogenic (prevention of tumor blood vessel growth) [8,9] and anti-mutagenic [10,11]. Decaffeinated green tea extract is available as Polyphenol E.

Black Tea

Black tea is made from leaves that have been withered before being rolled and dried [12]. Quantitatively, black tea is the major type of tea produced worldwide [1]. In black tea, catechins, theaflavin (TF) and thearubigins (TR) accounts for 3 - 10, 2 - 6 and > 20% respectively. Theaflavins consist of two catechin molecules joined together and account for about 10% of the converted catechins, whereas the thearubigins are more complex flavonoid molecules, whose structural chemistry are still unknown, and may account for up to 70% of flavonoids in black tea [13]. Researchers from New Jersey, USA have shown that theaflavin-2 (TF-2), a compound unique to black tea and oolong tea kills cancer cells. Theaflavin-2 suppresses the activity of a gene that induces the inflammatory enzyme cyclooxygenase (COX 2), while also reducing the activity of other inflammatory molecules such as TNF- α and nuclear factor-kappa B (NF- κ B). Theaflavin-2 was also shown to produce a pattern of gene regulation similar to that found in the cancer cells.

Oolong Tea

Oolong tea also known as blue green tea or wu long tea is produced by partial oxidation. It is rolled by hand or machine and pan fried and then allowed to oxidize. This process is repeated several times until the desired level of oxidation is achieved. It contains catechins, theasinensins and other polymerized catechin derivatives but the amount of catechin content is less than that of green tea. Tea leaves also contain flavonols, such as quercetin and myricetin, as well as nitrogenous compounds, such as caffeine and theobromine. Caffeine accounts for 2 - 5% of the water-extractable material in green, oolong, and black tea. Oolong tea extract (OTE) contains substances, notably polyphenols that have antibacterial properties against oral pathogens, such as *Streptococcus mutans*, the bacteria closely associated with dental caries [14,15].

Effects of Tea on Health

Anticarcinogenic Effects

Studies in animal models have demonstrated that green tea and EGCG can inhibit carcinogenesis at all stages, viz. initiation, promotion and progression [16]. In animal model green tea and EGCG have also been shown to inhibit the process of angiogenesis, tumor metastasis and invasion [17-19]. Species differences in the pharmacokinetics of green tea and EGCG in humans and rodents may account for the more definitive evidence of the cancer chemo-preventive effect of green tea [20]. It is reported that both green and black tea exhibit potential chemo-preventive property against Ph1P induced tumorigenesis in Fischer rats [21]. Important information on the mechanism of action of tea polyphenols has been obtained by examining the influence of EGCG and ECG on protein kinase activator, an enzyme involved in the cell activation process and growth of tumour. While EGCG blocks the interactions between proteins and ligands [22], both EGCG and ECG inhibit the gap junctional inter-

cellular communication caused by tumour promoters [23]. Tea may affect the metabolism of carcinogens by induction or inhibition of various cytochrome P450s, but the practical importance of this mechanism is not known. Among the phase II enzymes, tea increases glucuronyl transferase activity, which may facilitate the detoxification pathway of certain carcinogens. Inhibition of tumour promotion-related enzymes, such as lipoxygenase and cyclooxygenase [24,25], ornithine decarboxylase [26-28] protein kinase C [28-30] and 5 α steroid reductase isoenzymes [31] helps in the prevention of cancer.

Tea Flavonoids and Cancer

Interaction of tea flavonoids with procarcinogens plays a prominent role for the beneficial effects of tea against cancer initiation. Cancer of the colon, breast and pancreas are associated with formation of heterocyclic amines and the genotoxic carcinogens from cooked food and meat that can be prevented by tea polyphenols [23]. Phase I enzymes are known to induce tumour formation by activating procarcinogens which modify genomic DNA and black tea polyphenols probably inhibit cytochrome P450 dependent bioactivation of the carcinogen [32]. Most of the commonly consumed teas (green, black and oolong) are shown to possess similar antimutagenic efficacy [33-39]. This leads to a general conclusion that development of cancer is prevented by tea consumption through antimutagenic protection paralleling to their antioxidant efficacy. EGCG has been most extensively studied against mutation and ROS-scavenging property and is perhaps the most potent antimutagenic agent protecting DNA scissions and non-enzymatic interception of superoxide anions. ECG emerges as the most potent enzymatic scavenger amongst the green tea polyphenols [40]. Antimutagenic property of black tea and its constituents has been widely documented in many reports, especially in Salmonella strains [41]. The effects of specific tea polyphenols (polyphenol 60 and polyphenol 100 from green tea and polyphenol B containing mixture of polyphenols from black tea) have been examined against a number of genotoxic carcinogens in Salmonella strains TA98, TA100 and TA1535. All of these polyphenols sharply decreased mutagenicity of a number of aryl and heterocyclic amines of aflatoxin B1, 1, 2-dibromomethane, 2-nitropropane, involving an cancer induced rat liver S9 fraction [42].

Cancer of Ectodermal or Endodermal origin

Oral Cancer

Oral cancer is the fifth most common cancer worldwide [43]. Oral pre malignancies are also very common in betel quid chewers and formation of micronucleus has been observed in precancerous lesions of the oral cavity of betel quid chewers [44]. The antioxidant properties of tea play a vital role to reduce the cancer biomarker (micronuclei) in oral cancer. The polyphenolic component of tea decreases its antioxidant property with combination of milk. The milk protein casein binds the antioxidant portion of the tea and reduces its property. So black tea i.e. tea without milk plays an important role for scavenging the free radicals thereby promoting good health (Adhikari and De 2013). It has been suggested that tea may play a role in the prevention of oral cancer [7]. One double-blind, randomised intervention trial suggest that treating patients with a mixture of black and green tea components could improve the clinical manifestations of precancerous oral lesions [45]

Leukoplakia and Erythroplakia (possible pre-cancerous conditions)

Leukoplakia and erythroplakia are terms used to describe certain types of abnormal tissue that can be seen in the mouth or throat: Leukoplakia is a white or gray patch. Erythroplakia is a flat or slightly raised, red area that often bleeds easily if it is scraped. Erythroleukoplakia is a patch with both red and white areas.

Oral cavity and oropharyngeal cancers

Several types of cancers can start in the mouth or throat.

Squamous cell carcinomas

More than 9 of 10 cancers of the oral cavity and oropharynx are squamous cell carcinomas, also called squamous cell cancers. These cancers begin in early forms of squamous cells, which are flat, scale-like cells that normally form the lining of the mouth and throat. The earliest form of squamous cell cancer is called carcinoma *in situ*, meaning that the cancer cells are present only in the outer layer of cells called the epithelium. Antimetastatic effect of black tea polyphenol extracts (BTE), which contain polyphenols including gallic acid, gallocatechin, catechin, epigallocatechin-3-gallate, epicatechin-3-gallate, and theaflavin 3,3'-digallate, in an oral squamous cell culture system by showing a nearly complete inhibition on the invasion of SCC-4 cells via reduced activities of MMP-2 and u-PA [46].

Verrucous carcinoma

Verrucous carcinoma is a type of squamous cell carcinoma that makes up less than 5% of all oral cancers [47]. It is a low-grade (slow growing) cancer that rarely spreads to other parts of the body, but it can grow deeply into surrounding tissue. Black tea exhibited antimutagenicity with N-methyl-N'-nitro-N-nitrosoguanidine (MNNG) in the Salmonella typhimurium TA100 strain and the tumor volumes for the groups treated with different concentrations of black tea were smaller than the control groups. Black tea had an improved antimutagenic effect and *in vivo* buccal mucosa cancer preventive activity compared with the untreated control in mice [48].

Minor salivary gland carcinomas

Minor salivary gland cancers can develop in the glands in the lining of the mouth and throat. There are several types of minor salivary gland cancers, including adenoid cystic carcinoma, mucoepidermoid carcinoma, and polymorphous low-grade adenocarcinoma.

Tea and Dental Health

Drinking tea has been associated with a number of beneficial effects in preventing tooth decay [49]. Epidemiological surveys have reported that some populations who drink tea on a regular basis have a reduced number of carious teeth [50-52]. Lingstrom, et al. [53] found that frequent mouth rinsing with black tea infusion may contribute to oral health by inhibition of plaque, its acidity and its

cariogenic microflora. Tea contains polyphenols, that were shown to have antibacterial properties against cariogenic bacteria, especially *S. mutans* [54,55]. The polyphenols in green tea are reported to have an inhibitory effect on growth and cellular adherence of *Porphyromonas gingivalis*, an oral bacterium that causes periodontal disease [56]. Apart from their polyphenol content, both green and black tea, are natural sources of fluoride and effective vehicle for fluoride delivery to the oral cavity. According to Simpson, et al. [57] after cleansing the mouth with tea, approximately 34% of the fluoride is retained and show a strong binding ability to interact with the oral tissues and their surface integuments. This fluoride content may have a beneficial impact on caries and may carry out a wide range of biological activities including prevention of tooth loss and oral cancer [58,59].

Stomach cancer

Green tea consumption is associated with lower risk of stomach cancer. Among drinkers of green tea, the risk of stomach cancer does not depend on the age when habitual green-tea drinking started. Green tea may disrupt gastric carcinogenesis at both the intermediate and the late stages [60]. Experimental and epidemiological studies indicated green tea possessed antimicrobial, immunostimulant, anti-oxidant and anti-inflammatory effects [61,62], and these properties made green tea, as a potential cancer preventive agent on the basis of numerous *in vitro* and *in vivo* studies [2,63,64]. Green tea is shown to have a preventive effect on gastric cancer by a meta-analysis with pooling case-control studies [65].

Esophageal cancer

Population-based, case-control study of esophageal cancer in urban Shanghai suggests a protective effect of green tea consumption. These findings are consistent with studies in laboratory animals, indicating that green tea can inhibit esophageal carcinogenesis. However, only a few epidemiologic studies have evaluated green tea as a potential inhibitor of human esophageal cancer [66]. The present meta-analysis are that any association between green tea and risk of esophageal cancer remains unclear. Subgroup analyses indicated that greater consumption of green tea might reduce the risk of esophageal cancer in female subjects. However, the results are based on limited research [67].

Lung Cancer

Small-cell lung carcinoma (SCLC)

Several cancers such as cancer in the lung is associated with cigarette smoking and tobacco use [68]. Formation of nitrosamines, the carcinogens also found in tobacco, can be prevented by phenolic compound present in green tea [69,70]. Pretreatment with black or green tea, decaffeinated tea and EGCG reduces the number of lung tumors induced by chemical carcinogens [71,72]. Studies with tea and its constituents (black and green) on sponta-

neously developing and induction of tobacco-specific nitrosamine (NNK) lung tumour show parallel results [73,74].

Non-small-cell lung carcinoma (NSCLC)

Green tea inhibits cyclooxygenase-2 in non-small cell lung cancer cells through the induction of Annexin-1 [75]. TF3, one of the major theaflavin monomers in black tea, Annexin and EGCG in combination with ascorbic acid (AA), a reducing agent can synergistically inhibit the proliferation of lung adenocarcinoma SPC-A-1 cells, and increased its cell population in G0/G1 phase of cell cycle. It suggested that the combination of EGCG with AA and TF3 with AA may be potent anticancer agents for cancer therapy [76]. Growth inhibition of human non-small lung cancer cells has been shown h460 by green tea and ginger polyphenols [77].

Colon Cancer

Epigallocatechin-3-gallate (EGCG) is an important bioactive constituent of green tea extract (GTE) that is widely believed to reduce proliferation of many cancer cell lines. Pro-apoptotic action of EGCG/GTE mediated positive effects on viability and mitogenicity of COLO 205 [78]. Green tea and colorectal cancer association, based on eight studies conducted in native China [79,80] and Japanese [81-85], indicated a statistically significant 18% reduction in risk associated with high green tea consumption. Black tea consumption is rare in Japan [81,82,86], whose main tea beverage is green tea. A protective effect of both green and black tea against the development of pre-cancerous lesions in rat colon also has been shown [87-90]. *In vivo* animal studies have demonstrated that both green and black tea extracts or specific tea polyphenols inhibit the development of carcinogen-induced colorectal tumour in rodents [91-94].

Breast Cancer

It is found that increased consumption of green tea is associated with decreased numbers of axillary lymph node metastases especially among premenopausal patients with stage I and II breast cancers [95]. A potential beneficial influence for breast cancer associated with moderate levels of tea consumption (three or more cups per day) among younger women is shown by Kumar, *et al* [96]. EGCG can inhibit the activation of HIF-1 α and NF κ B, and VEGF expression, thereby suppressing tumour angiogenesis and breast cancer progression [97]. Green Tea Polyphenol (GTP) reduce the incidence and progression of breast cancer and induce apoptosis of MDA-MB-231, an estrogen receptor negative highly invasive human breast cancer cell line [98].

Skin Cancer

Protective activities of tea against skin cancer have been studied extensively in UV-induced or chemically induced tumorigenesis models in mice [99]. The results show that both tea polyphenols and caffeine, when applied topically to the skin, inhibit skin carcinogenesis. When tea polyphenols are administered orally, their low bioavailability in the skin may limit the inhibitory effect. Therefore, the contribution of caffeine is more important to the inhibition carcinogenesis. The studies by Conney, *et al.* (2007) indicates that caffeine inhibits UVB-induced carcinogenesis in SKH-1 mice by enhancing apoptosis of DNA damaged cells and premalignant cells [100]. Initiation of skin carcinogenesis by AP1 is effectively blocked by EGCG and theaflavin-3-3-digallate [101-104].

Prostate Cancer

Gupta, *et al.* [105] reported that oral infusion of green tea polyphenols significantly inhibit tumour incidence and burden in the prostate as well as the metastases of the tumor to distant sites in an autochthonous transgenic adenocarcinoma of the mouse prostate (TRAMP) model. This inhibition is associated with decreasing insulin-like growth factor (IGF)-1 level and suppression of phosphorylation of Akt and Erk 1/2 [106].

Liver Cancer

Oral administration of black and green tea is shown to decrease the incidence of NNK-induced liver tumours in rats and the progression of diethylnitrosamine-induced liver tumours in mice [99].

Bladder and Pancreatic Cancer

Oral administration of green tea or green tea polyphenols during the promotion or entire experimental period inhibited N-butyl-N-(4-hydroxybutyl)-nitrosamine-induced urinary bladder tumours in rats. Inhibitory activity of tea is observed on nitrosamine-induced pancreatic cancer and related ductal lesions in hamsters [99].

Cancer of Mesenchymal origin

Sarcomas are given a number of different names based on the type of tissue that they most closely resemble. For example, osteosarcoma resembles bone, chondrosarcoma resembles cartilage, liposarcoma resembles fat, and leiomyosarcoma resembles smooth muscle.

Osteosarcoma

The ability of a polyphenolic fraction of green tea (GTP) has been shown to have antitumor effects on various malignant cell lines to inhibit growth and induce apoptosis in human osteosarcoma SAOS-2 cells. GTP is a candidate therapeutic for osteosarcoma that mediates its antiproliferative and apoptotic effects via activation of caspases and inhibition of NF-kappaB [107]. Green tea extract tested strongly suppressed the growth of tumors without adverse effects in nude mice, suggesting potential as an anticancer agent [108].

Chondrosarcoma

Epigallocatechin-3-gallate (EGCG), the major polyphenol in green tea, has been shown to inhibit tumorigenesis and cancer cell growth in animal models. EGCG induced cell apoptosis in human chondrosarcoma cell lines but not primary chondrocytes. EGCG induced upregulation of Bax and Bak, downregulation of Bcl-2 and Bcl-XL, and dysfunction of mitochondria in chondrosarcoma. Treatment of chondrosarcoma cells with EGCG induced p38 and c-jun-NH2-kinase (JNK) phosphorylation [109].

Liposarcoma

Liposarcoma is a malignant tumor that arises in fat cells in deep soft tissue. A nutrient mixture (NM) containing lysine, proline, ascorbic acid, and green tea extract has shown significant anticancer activity against a number of cancer cell lines. NM significantly inhibited liposarcoma cell growth, MMP activity, and invasion and induced apoptosis *in vitro*-important parameters for cancer development, suggesting NM as a potential treatment strategy for liposarcoma [110].

Leiomyosarcoma

EGCG significantly lowered the concentration of curcumin required to inhibit the AKT-mTOR pathway, reduce cell proliferation and induce apoptosis in uterine leiomyosarcoma cells [111].

Tea and Chromosome

Black tea and its two polyphenols (TF and TR) are investigated against chemically induced genetic damage as measured by chromosome aberrations and sister chromatid exchanges in mice [112]. The frequency of sister-chromatid exchange in lung cells is lower in smokers who consumed green tea [113]. Administration of tea extract for prolonged periods also showed protective effect on arsenic toxicity [114]. Chromosome breaks have been reported in oral exfoliated cells in chewers of betel quid with or without tobacco. Micro-nucleus formation has been observed in precancerous lesions of the

oral cavity of betel quid chewers [44]. Administration of black tea to subjects with oral leukoplakia resulted in a gradually reversal of the leukoplakia both on clinical observation and at cellular level as assessed by MN and chromosomal studies [115].

Signal transduction and cell cycle effects

Inactivation of carcinogens by EGCG mediates through inhibition of phase I enzymes and activation of phase II enzymes [69,116]. Flavonoids help to maintain normal cell growth by blocking the activation of an oncogene AP1 (activator protein), maintaining cell-cell communication and increasing apoptosis of malfunctioning cells. The factors NF-KB (nuclear factor kappa B) and AP1 are redox-regulated components of the signal transduction cascade and, thus, sensitive to the oxidant/antioxidant status of the cell [117]. EGCG and theaflavins were examined for inhibitory effects on 12-otetradecanoylphorbol-13-acetate (TPA) induced protein kinase C (PKC) and transcription activator protein-1 binding activities in N1H 3T3 cells. Fujiki, *et al.* [22] demonstrated that EGCG and other tea polyphenols inhibit growth of human lung cancer cells with a G2/M phase arrest of the cell cycle. The involvement of the tumor necrosis factor α pathway in the inhibition process has been suggested. EGCG and other tea polyphenols have been shown to inhibit the phosphorylation of Rb by Cdk2/4 [118] and the binding of epidermal growth factor and TPA to their respective receptors and thus inhibit tumor promotion [118,119]. Green tea polyphenols also enhance apoptosis, and this has been shown in many cancer cell lines such as PC-9, H661, KATO III, DU145, A431, LY-R, HaCaT, W138 and Molt-43 [120].

Tea and Cardiovascular Disease

Green tea consumption has been associated with a lower incidence of coronary artery disease in Japanese populations [121]. Miura, *et al.* [122] showed that oral intake of green tea extract by human volunteers increased resistance of plasma LDL to oxidation *in vivo*, an effect that may lower the risk of arterogenesis. In the apolipoprotein E-deficient mouse model of atherosclerosis, green tea extract administered in drinking water, prevented the development of atherosclerosis without affecting plasma lipid or cholesterol levels [123]. Similarly, EGCG at a dose of only 10 mg/kg given intraperitoneally significantly inhibited the developing atherosclerotic plaques in Apo E deficient mice [124]. Green tea has long been believed to possess hypotensive effects in popular Chinese medicine. Yang, *et al.* [125] concluded that habitual moderate strength green tea or oolong tea consumption, 120 mL/day or more for 1 year significantly reduces the risk of developing hypertension in the Chinese population. Hodgson, *et al.* [126] reported

that long-term regular ingestion of green tea may have a favorable effect on blood pressure in older women. Singh, *et al.* [127], and Murakami and Ohsato [128] reported that dietary green tea intake preserves and improves arterial compliance and endothelial function. The oxidation of LDL cholesterol, associated with a risk for atherosclerosis and heart disease, is inhibited by green tea due to EC and EGCG antioxidant activity. The *in vitro* antioxidant activity of EGCG on LDL oxidation is stronger than EC [129]. Raederstorff, *et al.* [130] investigated the dose-response and the mechanism of action of EGCG on these parameters in rats which were fed a diet high in cholesterol and fat. After 4 weeks of treatment, total cholesterol and LDL cholesterol plasma levels were significantly reduced in the group fed 1% EGCG when compared to the non-treatment group [131-135].

Conclusions

Tea is considered as one of the most promising dietary agents for the prevention and treatment of many diseases and consequently, it is being studied extensively worldwide. Numerous studies in a variety of experimental animal models have demonstrated that catechins (EGCG, EGC, ECG and EC) possess antioxidant, antimutagenic, antidiabetic, anti-inflammatory, antibacterial and antiviral and cancer preventive properties. Most of the effects of tea are associated with flavonoids and their antioxidant potential. The polyphenols present in tea can also decrease the risk factor of specific type of cancers by inducing phase I and phase II metabolic enzymes that increase the formation and excretion of detoxified metabolites of carcinogens. We have screened 311 subjects from different areas of Eastern, North Eastern India and also from RKMS Hospital, Kolkata, out of (311 subjects) which 61.09% has betel quid chewing habit. Percentage of micronuclei, which acts as a cancer biomarker are lower after supplementation of black tea.

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Bibliography

1. Wickremasinghe RL. "Tea". *Advances in Food Research* 24 (1978): 229-286.
2. Graham HN. "Green tea composition, consumption, and polyphenol chemistry". *Preventive Medicine* 21.3 (1992): 334-350.
3. Chu DC. "Green tea-its cultivation, processing of the tea leaves for drinking materials, and kinds of green tea". In: Juneja LR, Chu DC, Kim M (Eds.), *Chemistry and Applications of Green Tea*. CRC Press, Boca Raton (1997): 1-11.
4. Chu DC and Juneja LR. "General chemical composition of green tea and its infusion". In: Juneja LR, Chu DC, Kim M (Eds.), *Chemistry and Applications of Green Tea*. CRC Press, Boca Raton (1997): 13-22.
5. Belitz DH and Grosch W. *Química de los Alimentos Zaragoza: Acirbia* (1997).
6. Mukhtar H and Ahmad N. "Tea polyphenols: prevention of cancer and optimizing health". *American Journal of Clinical Nutrition* 71.6 (2000): 1698S-1702S.
7. Yang CS, *et al.* "Inhibition of carcinogenesis by tea". *Annual Reviews in Pharmacology and Toxicology* 42 (2002): 25-54.
8. Cao Y and Cao R. "Angiogenesis inhibited by drinking tea". *Nature* 398.6726 (1999): 381.
9. Pfeffer U, *et al.* "Antiangiogenic activity of chemopreventive drugs". *International Journal of Biological Markers* 18.1 (2003): 70-74.
10. Wang ZY, *et al.* "Antimutagenic activity of green tea polyphenols". *Mutation Research* 223.3 (1989): 273-285.
11. Han C. "Screening of anti carcinogenic ingredients in tea polyphenols". *Cancer Letters* 114.2 (1997): 153-158.
12. Bokuchava MA and Skobeleva NI. "The biochemistry and technology of tea manufacture". *Critical Reviews in Food Science and Nutrition* 12.4 (1980): 303-370.
13. "Tea consumption on oxidative damage and cancer". *ICMR Bulletin* 33.5 (2003): 39-51.

14. Kempler D., *et al.* "Caries rate in hamsters given non acidulated and acidulated tea". *Journal of Dental Research* 56 (1977): 89.
15. Hamilton-Miller JMT. "Antimicrobial properties of tea (*Camellia sinensis* L.)". *Antimicrobial Agents and Chemotherapy* 39.11 (1995): 2375-2377.
16. Chung FL., *et al.* "Tea and cancer prevention: studies in animals and humans". *Journal of Nutrition* 133.10 (2003): 3268S-3274S.
17. Fassina G., *et al.* "Mechanisms of inhibition of tumor angiogenesis and vascular tumor growth by epigallocatechin-3-gallate". *Clinical Cancer Research* 10.14 (2004): 4865-4873.
18. Jung YD and Ellis LM. "Inhibition of tumour invasion and angiogenesis by epigallocatechin gallate (EGCG), a major component of green tea". *International Journal of Experimental Pathology* 82.6 (2001): 309-316.
19. Garbisa S., *et al.* "Tumor gelatinases and invasion inhibited by the green tea flavanol epigallocatechin-3-gallate". *Cancer* 91.4 (2001): 822-832.
20. Kim S., *et al.* "Plasma and tissue levels of tea catechins in rats and mice during chronic consumption of green tea polyphenols". *Nutrition and Cancer* 37.1 (2000): 41-48.
21. Schut HA and Yoa AR. "Tea is a potential chemopreventive agent in (Ph1P) carcinogenesis: Effect of green tea and black tea on Ph1P-DNA adduct formation in female F-34 rats". *Nutrition and Cancer* 36.1 (2000): 52-58.
22. Fujiki H., *et al.* "Mechanistic findings of green tea as cancer preventive for humans". *Proceedings of the Society for Experimental Biology and Medicine* 220.4 (1999): 225-228.
23. Katiyar S and Mukhtar H. "Tea in chemoprevention of Cancer: Epidemiologic and experimental studies (Review)". *International Journal of Oncology* 8.2 (1996): 221-238.
24. Katiyar SK., *et al.* "(2)- Epigallocatechin-3-gallate in *Camellia sinensis* Leaves from Himalayan Region of sikkim: Inhibitory Effects Against Biochemical Events and Tumor Initiation in Sencar Mouse Skin". *Nutrition and Cancer* 18.1 (1992): 73-83.
25. Liu XD., *et al.* "Comparison of Tyrosinase Biosensor and Colorimetric Method for Polyphenol Analysis in Different Kinds of Teas". *Analytica Chimica Acta* 200 (1987): 421-430.
26. Katiyar S., *et al.* "Inhibition of 12-Otetradecanoylphorbol-13-acetate-caused Tumor Promotion in 7, 12-dimethylbenz (a) anthraceneinitiated SENCAR Mouse Skin by a Polyphenolic Fraction Isolated from Green Tea". *Cancer Research* 52.24 (1992): 6890-6897.
27. Huang MT., *et al.* "Inhibitory Effect of Topical Application of a Green Tea Polyphenol Fraction on Tumor Initiation and Promotion in Mouse Skin". *Carcinogenesis* 13.6 (1992): 947-954.
28. Hu G., *et al.* "Inhibition of Oncogene Expression by Green Tea and (2) - epigallocatechinGallate in Mice". *Nutrition and Cancer* 24.2 (1995): 203-209.
29. Komori A., *et al.* "Anticarcinogenic Activity of Green Tea Polyphenols". *Japanese Journal of Clinical Oncology* 23.3 (1993): 186-190.
30. Klaunig JE. "Chemopreventive Effects of Green Tea Components on Hepatic Carcinogenesis". *Preventive Medicine* 21.4 (1992): 510-519.
31. Liao S and Hiipakka RA. "Selective Inhibition of Steroid 5Alpha-reductase Isozymes by Tea Epicatechin-3-gallate and Epigallocatechin-3-gallate". *Biochemical and Biophysical Research Communications* 214 (1995): 833-838.
32. Catteral F., *et al.* "Contribution of theaflavins to the antimutagenicity of black tea: Their mechanism of action". *Mutagenesis* 13.6 (1998): 631-636.
33. Yamada J and Tomita Y. "Antimutagenic activity of water extracts of black tea and oolong tea". *Bioscience, Biotechnology, and Biochemistry* 58.12 (1994): 2197-2200.
34. Yen GC and Chen HY. "Antioxidant activity of various tea extracts in relation to their antimutagenicity". *Journal of Agricultural and Food Chemistry* 43.1 (1995): 27-32.
35. Kuroda Y and Hara Y. "Antimutagenic and anticarcinogenic activity of tea polyphenols". *Mutation Research* 436.1 (1999): 69-97.
36. Surono IS and Hosono A. "Bacterial mutagenicity of terasi and antimutagenicity of Indonesian Jasmine tea against terasi". *International Journal of Food Microbiology* 32.1-2 (1996): 49-58.
37. Bu-Abbas A., *et al.* "Fractionation of green tea extracts: Correlation of antimutagenic effect with flavanol content". *Journal of the Science of Food and Agriculture* 75.4 (1997): 453-462.
38. Hour TC., *et al.* "Inhibition of eleven mutagens by various tea extracts, (-) epigallocatechin .3- gallate, gallic acid and caffeine". *Food and Chemical Toxicology* 37.6 (1999): 569-579.
39. Steele VE., *et al.* "Comparative chemopreventive mechanisms of green tea, black tea and selected polyphenol extracts measured by in vitro bioassays". *Carcinogenesis* 21.1 (2000): 63-67.

40. Yoshioka H., *et al.* "Protective effect of a green tea percolate and its main constituents against gamma ray induced scission of DNA". *Bioscience, Biotechnology, and Biochemistry* 60.1 (1996): 117-119.
41. Gupta S., *et al.* "Antimutagenic effects of black tea (World Blend) and its two active polyphenols, theaflavins and thearubigins in Salmonella assays". *Phytotherapy Research* 16.7 (2002): 655-661.
42. Weisburger JH., *et al.* "Tea polyphenols as inhibitors of mutagenicity of major classes of carcinogens". *Mutation Research* 371.1-2 (1996): 57-63.
43. Parkin DM., *et al.* "Estimates of the worldwide incidence of eighteen major cancers in 1985". *International Journal of Cancer* 54.4 (1993): 594-606.
44. Nair U., *et al.* "Evaluation of frequency of micronucleated oral mucosa cells as a marker for genotoxic damage in chewers of betel quid with or without tobacco". *Mutation Research* 261.3 (1991): 163-168.
45. Li N., *et al.* "The Chemopreventive Effects of Tea on Human Oral Precancerous Mucosa Lesions". *Proceedings of the Society for Experimental Biology and Medicine* 220.4 (1999): 218-224.
46. Chang YC., *et al.* "Black tea polyphenols reverse epithelial-to-mesenchymal transition and suppress cancer invasion and proteases in human oral cancer cells". *Journal of Agricultural and Food Chemistry* 60.34 (2012): 8395-8403.
47. Ridge JA., *et al.* "Head and Neck Tumors". In Pazdur R, Wagman LD, Camphausen KA, Hoskins WJ (Eds) *Cancer Management: A Multidisciplinary Approach*. 11th edition (2008).
48. Yu Qian., *et al.* "Antimutagenic activity and preventive effect of black tea on buccal mucosa cancer". *Oncology Letters* 6.2 (2013): 595-599.
49. Hamilton-Miller JM. "Anti-cariogenic properties of tea (*Camellia sinensis*)". *Journal of Medical Microbiology* 50.4 (2001): 299-302.
50. Ramsey AC., *et al.* "Fluoride intakes and caries increments in relation to tea consumption by British children". *Caries Research* 9 (1975): 312.
51. Onisi M. "Analysis of data obtained from 5 years tea drinking program for the caries prevention by means of the linear caries extent/risk relation". *Journal of Dental Health* 35 (1985): 138-139.
52. Cao J., *et al.* "Observation of caries incidence among a tea-drinking population". *Journal of Dental Health* 31 (1987): 86-89.
53. Lingstrom P., *et al.* "In vivo effects of black tea infusion on dental plaque". *Journal of Dental Research* 79 (2000): 593.
54. Sakanaka S., *et al.* "Antibacterial substances in Japanese green tea extract against *Streptococcus mutans*, a cariogenic bacterium". *Agricultural and Biological Chemistry* 53.9 (1989): 2307-2311.
55. Hattori M., *et al.* "Effect of tea polyphenols on glucan synthesis by glucosyltransferase from *Streptococcus mutans*". *Chemical and Pharmaceutical Bulletin* 38.3 (1990): 717-720.
56. Sakanaka S., *et al.* "Inhibitory effects of green tea polyphenols on growth and cellular adherence of an oral bacterium, *Porphyromonas gingivalis*". *Bioscience, Biotechnology, and Biochemistry* 60.5 (1996): 745-749.
57. Simpson A., *et al.* "The bio-availability of fluoride from black tea". *Journal of Dentistry* 29.1 (2001): 15-21.
58. Okamoto M., *et al.* "Inhibitory effect of green tea catechins on cysteine proteinases in *Porphyromonas gingivalis*". *Oral Microbiology and Immunology* 19.2 (2004): 118-120.
59. Lee MJ., *et al.* "Delivery of tea polyphenols to the oral cavity by green tea labels and black tea extract". *Cancer Epidemiology, Biomarkers and Prevention* 13.1 (2004): 132-137.
60. Yu GP., *et al.* "Green-tea consumption and risk of stomach cancer: a population-based case-control study in Shanghai, China". *Cancer Causes Control* 6.6 (1995): 532-538.
61. Dufresne CJ and Farnworth ER. "A review of latest research findings on the health promotion properties of tea". *Journal of Nutritional Biochemistry* 12.7 (2001): 404-421.
62. Lambert JD and Yang CS. "Mechanisms of cancer prevention by tea constituents". *Journal of Nutrition* 133.10 (2003): 3262S-3267S.
63. Ahmad N., *et al.* "Green tea constituent epigallocatechin-3-gallate and induction of apoptosis and cell cycle arrest in human carcinoma cells". *Journal of the National Cancer Institute* 89.24 (1997): 1881-1886.
64. Yang GY., *et al.* "Inhibition of growth and induction of apoptosis in human cancer cell lines by tea polyphenols". *Carcinogenesis* 19.4 (1998): 611-616.
65. Myung SK., *et al.* "Green tea consumption and risk of stomach cancer: a meta-analysis of epidemiologic studies". *International Journal of Cancer* 124.3 (2009): 670-677.
66. Gao YT., *et al.* "Reduced Risk of Esophageal Cancer Associated With Green Tea Consumption". *Journal of the National Cancer Institute* 86.11 (1994): 855-858.

67. Li-Xuan Sang, *et al.* "Green Tea Consumption and Risk of Esophageal Cancer: A Meta-Analysis of Published Epidemiological Studies". *Nutrition and Cancer* 65.6 (2013): 802-812.
68. Wynder EL and Hoffman DH. "Smoking and lung cancer: Scientific challenges and opportunities". *Cancer Research* 54.20 (1994): 5284-5295.
69. Gordon MH. "Dietary antioxidants in disease prevention". *Natural Product Reports* 13.4 (1996): 265-273.
70. Hecht SS and Hoffmann D. "Tobacco-specific nitrosamines, an important group of carcinogens in tobacco and tobacco smoke". *Carcinogenesis* 9.6 (1998): 875-884.
71. Yang CS and Wang ZY. "Tea and cancer: Review". *Journal of the National Cancer Institute* 85.13 (1993): 1038-1049.
72. Cao G., *et al.* "Antioxidant capacity of tea and common vegetables". *Journal of Agricultural and Food Chemistry* 44.11 (1996): 3426-3431.
73. Xu Y., *et al.* "Inhibition of tobacco specific nitrosamine induced lung tumorigenesis in A/J mice by green tea and its major polyphenol and oxidants". *Cancer Research* 52.14 (1992): 3875-3879.
74. Landau JM., *et al.* "Inhibition of spontaneous formation of lung tumors and rhabdomyosarcomas in A/J mice by black and green tea". *Carcinogenesis* 19.3 (1998): 501-507.
75. Lu QY., *et al.* "Green tea inhibits cyclooxygenase-2 in non-small cell lung cancer cells through the induction of Annexin-1". *Biochemical and Biophysical Research Communications* 427.4 (2012): 725-730.
76. Li., *et al.* "Synergistic effects of tea polyphenols and ascorbic acid on human lung adenocarcinoma SPC-A-1 cells". *Journal of Zhejiang University Science B* 11.6 (2010): 458-464.
77. Hessian M., *et al.* "Growth inhibition of human non-small lung cancer cells h460 by green tea and ginger polyphenols". *Anti-Cancer Agents in Medicinal Chemistry* 12.4 (2012): 383-390.
78. Pajak B., *et al.* "Lipid rafts mediate epigallocatechin-3-gallate and green tea extract-dependent viability of human colon adenocarcinoma COLO 205 cells clusterin affects lipid raft-associated signaling pathways". *Journal of Physiology and Pharmacology* 62.4 (2011): 449-459.
79. Ji B T., *et al.* "Green tea consumption and the risk of pancreatic and colorectal cancers". *International Journal of Cancer* 70.3 (1997): 255-258.
80. Zhang B., *et al.* "A case-control study on risk of changing food consumption for colorectal cancer". *Cancer Investigation* 20.4 (2002): 458-463.
81. Inoue M., *et al.* "Tea and coffee consumption and the risk of digestive tract cancers: data from a comparative case-referent study in Japan". *Cancer Causes Control* 9.2 (1998): 209-216.
82. Kato I., *et al.* "A comparative case-control study of colorectal cancer and adenoma". *Japanese Journal of Cancer Research* 81.11 (1990): 1101-1108.
83. Nagano J., *et al.* "A prospective study of green tea consumption and cancer incidence, Hiroshima and Nagasaki (Japan)". *Cancer Causes Control* 12.6 (2001): 501-508.
84. Nakachi K., *et al.* "Preventive effects of drinking green tea on cancer and cardiovascular disease: epidemiological evidence for multiple targeting prevention". *Biofactors* 13.1-4 (2000): 49-54.
85. Suzuki Y., *et al.* "Green tea and the risk of colorectal cancer: pooled analysis of two prospective studies in Japan". *Journal of Epidemiology* 15.4 (2005): 118-124.
86. Heilbrun LK., *et al.* "Black tea consumption and cancer risk: a prospective study". *British Journal of Cancer* 54.4 (1986): 677-683.
87. Jia X and Han C. "Effects of green tea on colonic aberrant crypt foci and proliferative indexes in rats". *Nutrition and Cancer* 39.2 (2001): 239-243.
88. Metz N., *et al.* "Suppression of azoxymethane-induced preneoplastic lesions and inhibition of cyclooxygenase-2 activity in the colonic mucosa of rats drinking a crude green tea extract". *Nutrition and Cancer* 38.1 (2000): 60-64.
89. Weisburger J H., *et al.* "Tea, or tea and milk, inhibit mammary gland and colon carcinogenesis in rats". *Cancer Letters* 114.1-2 (1997): 323-327.
90. Xu M., *et al.* "Protection by green tea, black tea, and indole-3-carbinol against 2-amino-3-methylimidazo[4,5-f]quinoline-induced DNA adducts and colonic aberrant crypts in the F344 rat". *Carcinogenesis* 17.7 (1996): 1429-1434.
91. Caderni G., *et al.* "Effects of black tea, green tea and wine extracts on intestinal carcinogenesis induced by azoxymethane in F344 rats". *Carcinogenesis* 21.11 (2000): 1965-1969.
92. Yamane T., *et al.* "Inhibitory effects and toxicity of green tea polyphenols for gastrointestinal carcinogenesis". *Cancer* 77.8 (1996): 1662-1667.

93. Narisawa T and Fukaura Y. "A very low dose of green tea polyphenols in drinking water prevents N-methyl-N-nitrosourea-induced colon carcinogenesis in F344 rats". *Japanese Journal of Cancer Research* 84.10 (1993): 1007-1009.
94. Jung Y D., *et al.* "EGCG, a major component of green tea, inhibits tumour growth by inhibiting VEGF induction in human colon carcinoma cells". *British Journal of Cancer* 84.6 (2001): 844-850.
95. Nakachi K., *et al.* "Influence of Drinking Green Tea on Breast Cancer Malignancy among Japanese Patients". *Japanese Journal of Cancer Research* 89.3 (1998): 254-261.
96. Kumar N., *et al.* "Tea consumption and risk of breast cancer". *Cancer Epidemiology, Biomarkers and Prevention* 18.1 (2009): 341-345.
97. Gu JW., *et al.* "EGCG, a major green tea catechin suppresses breast tumor angiogenesis and growth via inhibiting the activation of HIF-1 α and NF κ B, and VEGF expression". *Vascular Cell* 5.1 (2013): 9.
98. Thangapazham RL., *et al.* "Green tea polyphenol and epigallocatechin gallate induce apoptosis and inhibit invasion in human breast cancer cells". *Cancer Biology and Therapy* 6.12 (2007): 1938-1943.
99. Ju J., *et al.* "Inhibition of carcinogenesis by tea constituents". *Seminars in Cancer Biology* 17.5 (2007): 395-402.
100. Lu YP., *et al.* "Caffeine and caffeine sodium benzoate have a sunscreen effect, enhance UVB-induced apoptosis and inhibit UVB-induced skin carcinogenesis in SKH-1 mice". *Carcinogenesis* 28.1 (2007): 199-206.
101. Chen YC., *et al.* "Inhibition of TPA induced protein kinase C and transcription activator protein1 binding activities by theaflavin-3, 3. - digallate from black tea in NIH3T3 cells". *Journal of Agricultural and Food Chemistry* 47.4 (1999): 1416-1421.
102. McNamee D. "Olives, tea and tamoxifen new and not so new ways to prevent cancer". *Lancet* 355.9205 (2000): 729.
103. McCarty MF. "Polyphenol-mediated inhibition of AP-1 transactivating activity may slow cancer growth impeding angiogenesis and tumor invasiveness". *Medical Hypotheses* 50.6 (1998): 511-514.
104. Chung JY., *et al.* "Inhibition of activator protein 1 activity and cell growth by purified green tea and black tea polyphenols in H-rastransformed cells: Structure-activity relationship and mechanisms involved". *Cancer Research* 59.18 (1999): 4610-4617.
105. Gupta S., *et al.* "Inhibition of prostate carcinogenesis in TRAMP mice by oral infusion of green tea polyphenols". *Proceedings of the National Academy of Sciences of the United States of America* 98.18 (2001): 10350-10355.
106. Khan N Afaq F., *et al.* "Targeting multiple signaling pathways by green tea polyphenol (-)-epigallocatechin-3-gallate". *Cancer Research* 66.5 (2006): 2500-2505.
107. Hafeez BB., *et al.* "Green tea polyphenols-induced apoptosis in human osteosarcoma SAOS-2 cells involves a caspase-dependent mechanism with downregulation of nuclear factor-kappaB". *Toxicology and Applied Pharmacology* 216.1 (2006): 11-19.
108. Roomi MW., *et al.* "Effect of ascorbic acid, lysine, proline, and green tea extract on human osteosarcoma cell line MNNG-HOS xenografts in nude mice: evaluation of tumor growth and immunohistochemistry". *Medical Oncology* 23.3 (2006): 411-417.
109. Yang WH., *et al.* "Epigallocatechin-3-gallate induces cell apoptosis of human chondrosarcoma cells through apoptosis signal-regulating kinase 1 pathway". *Journal of Cellular Biochemistry* 112.6 (2011): 1601-1611.
110. Roomi MW., *et al.* "Inhibition of cell invasion and MMP production by a nutrient mixture in malignant liposarcoma cell line SW-872". *Medical Oncology* 24.4 (2007): 394-401.
111. Kondo Akiko., *et al.* "Epigallocatechin-3-gallate potentiates curcumin's ability to suppress uterine leiomyosarcoma cell growth and induce apoptosis". *International Journal of Clinical Oncology* 18.3 (2013): 380-388.
112. Gupta S., *et al.* "Anticlastogenic effects of black tea (World Blend) and its two active polyphenols theaflavins and thearubigins *in vivo* in Swiss albino mice". *Life Sciences* 69.23 (2001): 2735-2744.
113. Lee IP., *et al.* "Chemopreventive Effect of Green Tea (*Camellia sinensis*) Against Cigarette Smoke induced Mutations (SCE) in Humans". *Journal of Cellular Biochemistry. Supplement* 27 (1997): 68-75.
114. Mukherjee P., *et al.* "Protection by black tea extract against chromosome damage induced by two heavy metals in mice". *Pharmaceutical Biology* 37.3 (1999): 243-247.
115. Halder A., *et al.* "Black tea(*Camellia sinensis*) as chemopreventive agent in oral precancerous lesions". *Journal of Environmental Pathology, Toxicology and Oncology* 24.2 (2005): 103-106.

116. Lin JK., *et al.* "Cancer chemoprevention by tea polyphenols through mitotic signal transduction blockade". *Biochemical Pharmacology* 58.6 (1992): 911-915.
117. Mates JM., *et al.* "Role of reactive oxygen species in apoptosis: implications for cancer therapy". *International Journal of Biochemistry and Cell Biology* 32.2 (2000): 157-170.
118. Liang YC., *et al.* "Suppression of Extracellular Signals and Cell Proliferation through EGF Receptor Binding by (2) - epigallocatechin Gallate in Human A431 Epidermoid Carcinoma Cells". *Journal of Cellular Biochemistry* 67.1 (1997): 55-65.
119. Kitano K., *et al.* "Sealing Effects of (2)-Epigallocatechin Gallate on Protein Kinase C and Protein Phosphatase 2A". *Biophysical Chemistry* 65.3 (1997): 157-164.
120. Okabe S., *et al.* "Mechanisms of Growth Inhibition of Human Lung Cancer Cell Line, PC-9, by Tea Polyphenols". *Japanese Journal of Cancer Research* 88.7 (1997): 639-643.
121. Sano J., *et al.* "Effects of green tea intake on the development of coronary artery disease". *Circulation Journal* 68.7 (2004): 665-670.
122. Miura Y., *et al.* "Green tea polyphenols (flavan 3-ols) prevent oxidative modification of low density lipoproteins: an ex vivo study in humans". *Journal of Nutritional Biochemistry* 11.4 (2000): 216-222.
123. Miura Y., *et al.* "Tea catechins prevent the development of atherosclerosis in apoprotein E-deficient mice". *Journal of Nutrition* 131.1 (2001): 27-32.
124. Chyu KY., *et al.* "Differential effects of green tea-derived catechin on developing versus established atherosclerosis in apolipoprotein E-null mice". *Circulation* 109.20 (2004): 2448-2453.
125. Yang YC., *et al.* "The protective effect of habitual tea consumption on hypertension". *Archives of Internal Medicine* 164.14 (2004): 1534-1540.
126. Hodgson JM., *et al.* "Tea intake is inversely related to blood pressure in older women". *Journal of Nutrition* 133 (2003): 2883-2886.
127. Singh AK., *et al.* "Green tea constituent epigallocatechin-3-gallate inhibits angiogenic differentiation of human endothelial cells". *Archives of Biochemistry and Biophysics* 401.1 (2002): 29-37.
128. Murakami T and Oshato K. "Dietary green tea intake preserves and improves arterial compliance and endothelial function". *Journal of the American College of Cardiology* 41 (2003): 271-274.
129. Gomikawa S and Ishikawa Y. "Effects of catechins and ground green tea drinking on the susceptibility of plasma and LDL to the oxidation *in vitro* and *ex vivo*". *Journal of Clinical Biochemistry and Nutrition* 32 (2002): 55-68.
130. Raederstoff DG., *et al.* "Effect of EGCG on lipid absorption and plasma lipid levels in rats". *Journal of Nutritional Biochemistry* 14.6 (2003): 326-332.
131. Chung HY., *et al.* "Peroxy-nitrite- scavenging activity of green tea tannin". *Journal of Agricultural and Food Chemistry* 46.11 (1998): 4484-4486.
132. Fujiki H., *et al.* "Cancer Inhibition by Green Tea". *Mutation Research* 402.2 (1998): 307-310.
133. Langley-Evans SC. "Consumption of black tea elicits an increase in plasma antioxidant potential in humans". *International Journal of Food Sciences and Nutrition* 51.5 (2000): 309-315.
134. Shraki M., *et al.* "Antioxidative and antimutagenic effect of theaflavins from black tea". *Mutation Research* 323.1-2 (1994): 29-34.
135. Yang CS., *et al.* "Inhibition of carcinogenesis by tea: Bioavailability of tea polyphenols and mechanism of action". *Proceedings of the Society for Experimental Biology and Medicine* 220.4 (1999): 213-217.

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