Tea, Black/Green

Camellia sinensis (L.) Kuntze (syn. C. *sinensis* L.)

[Fam. *Theaceae*]

OVERVIEW

The use of tea as a beverage in China dates back to 2700 B.C.E. Next to water, tea is the most widely consumed beverage in the world. In addition, it is used widely in the traditional medicine systems of China, Hong Kong, Japan, and Korea. Green tea and black tea, although derived from the leaves of the same plant, have different concentrations of the active constituents. The immediate processing of harvested leaves used for green tea limits enzymatic changes, whereas leaves used for black tea are fermented before preparation, triggering the enzymatic process. Thus, green tea contains higher concentrations of the active catechin constituents compared to black tea. According to the United Nations Food and Agriculture Organization, scientific evidence increasingly shows that both black and green tea can contribute significantly to a healthy lifestyle.

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PRIMARY USES

Cardiovascular

• Reduced risk of atherosclerosis
• Reduced risk of cardiovascular disease
• Reduced risk of myocardial infarction
• Modulation of plasma antioxidant capacity
• Decreased serum lipid concentration

OTHER POTENTIAL USES

Oncology

• Prevention of colon cancer
• Reduced incidence of oral mucosal leukoplakia
• Decreased recurrence of Stage I and II breast cancer
• Reduced risk and incidence of pancreatic cancer
• Reduced risk and incidence of squamous cell lung cancer
• Reduced risk and incidence of esophageal cancer

Miscellaneous

• Symptomatic treatment of mild diarrhea
• Reduced risk of osteoporosis
• Promotes diuresis

• Digestive aid
• Dysuria; edema
• Weight loss
• Functional asthenia
• CNS stimulant
• Headache

PHARMACOLOGICAL ACTIONS

BLACK TEA: Protects against ischemic heart disease.

GREEN TEA: Increases plasma antioxidant capacity; decreases serum concentrations of total cholesterol, triglyceride and atherogenic index; inhibits endogenous formation of nitrosoproline. *Standardized Preparations:* Activate thermogenesis and fat oxidation.

BLACK AND GREEN TEA: Increase plasma antioxidant capacity; inhibit endogenous formation of nitrosoproline.

DOSAGE AND ADMINISTRATION

Clinical studies reveal that the regular long-term daily ingestion of tea is safe and contributes significantly to the prevention of some serious diseases.

GREEN TEA INFUSION: 150–250 ml boiling water poured over 1.0–2.5 g finely cut dried leaf, steeped 3–5 min. for use as a stimulant (alkaloids extract rapidly). Steeped at least 10 min. for use in treatment of diarrhea (catechins take longer to extract). Drunk several times daily. Tea should be steeped for 15–20 min. in order to maximize the yield of catechins, though this will make the tea taste bitter. At least 1 cup drunk daily for antioxidant effect.

GREEN TEA POWDER: 8 capsules (250 mg each) daily with meals to treat obesity.

BLACK TEA INFUSION: 150–250 ml boiling water poured over 2.5 g finely cut dried leaf, steeped 2–5 min. for use as a stimulant (alkaloids extract rapidly). Steeped at least 10 min. for use in treatment of diarrhea (catechins take longer to extract), 2–3 times daily. Drunk 3–4 times daily for protection against atherosclerosis; 1 or more times daily to reduce risk of myocardial infarction.

DRY ETHANOLIC GREEN TEA EXTRACT: two, 250 mg capsules, 3 times daily with meals for weight control [standardized to 25% catechins].

NOTE: Stimulant action of tea is strongest when allowed to steep for only 2–5 min. as caffeine dissolves quickly in hot water. Longer steeping times (10–20 min.) will increase the yield of catechins, which decreases the stimulant effect because the polyphenols bind the caffeine. Catechins from black and green tea are rapidly absorbed and milk does not impair their bioavailability, despite earlier studies reporting that adding milk results in the complexation of tea polyphenols by milk proteins, thereby completely inhibiting their antioxidant effects.

CONTRAINDICATIONS

There are a few contraindications known. Individuals with weakened cardiovascular systems, renal diseases, thyroid hyperfunction, elevated susceptibility to spasm, and certain psychic disorders (eg., panicky states of anxiety) should use tea with caution.

PREGNANCY AND LACTATION: No known restrictions during pregnancy or lactation. One reference recommends that pregnant women should not ingest more than 5 cups daily (approximately 300 mg caffeine daily). Tea ingestion while nursing may cause sleep disorders in infants.

ADVERSE EFFECTS

The side effects of tea and other nervous system stimulants may include nervousness, anxiety, heart irregularities, headaches, tremors, hypertension, restlessness, insomnia, daytime irritability, irritation of the gastric mucosa, and diuresis. These effects are generally for relatively high dosages and are not associated with the ingestion of reasonable amounts of tea (e.g., 1–10 cups per day).

DRUG INTERACTIONS

Xanthine (e.g., caffeine, theophylline) derivatives from black tea can diminish the effects of coronary vasodilator drugs such as dipyridamole and should not be taken concurrently. Green tea has possible synergistic effects when taken in combination with sulindac and/or tamoxifen and may reduce their adverse effects. Green tea is a source of vitamin K and one case report suggested probable antagonism of warfarin by green tea. Herbs high in tannins may impair the absorption of theophylline, a bronchodilator drug used to treat people with asthma. Tannins in tea can also interfere with intestinal absorption of nutrients and vitamins. In infants, tannins can bind iron and reduce its absorption contributing to the development of microcytic anemia. Resorption of alkaline medications can be delayed due to chemical bonding with tea tannins. Large amounts of caffeine may increase activity and the side effects of theophylline. Limiting the intake of caffeine-containing beverages to small amounts will prevent this potential interaction, as well as those associated with numerous other drugs that are affected by caffeine consumption.

CLINICAL REVIEW

Of 29 selected clinical studies on tea leaf that included a total of 68,242 subjects, all but three demonstrated positive effects for indications including cardiovascular health, cancer, osteoporosis, obesity, and bowel conditions. Most of the studies were large-population epidemiological studies on the influence of black and/or green tea consumption on disease prevention. They include 15 cardiovascular studies investigating a range of potential applications, including two crossover studies on plasma antioxidant activity, a randomized, placebo-controlled (R, PC) study on energy expenditure and fat oxidation, a PC study on the protective effect of tea against ischemic heart disease, a multi-center, case-controlled study on the protective effect of tea against myocardial infarction, and studies on its effects on serum lipid concentrations and resistance of LDL to oxidation. At least 13 large-population, case-control cancer studies have been published. Five recent case-control cancer studies evaluated the consumption of tea and its protective effect against development of pancreatic and colorectal cancer, stomach cancer, lung cancer, esophageal cancer, and various other cancers. Other studies investigated the use of tea in protecting against osteoporosis in older women and its effect on fecal flora in nursing home residents. One DB, PC study investigated its use in the treatment of severe obesity.

Tea, Black/Green

Camellia sinensis (L.) Kuntze (syn. *C. sinensis* L.)
[Fam. *Theaceae*]

OVERVIEW

The use of tea as a beverage in China dates back to 2700 B.C.E. Currently, it is widely used in the traditional medical systems of China, Hong Kong, Japan, and Korea. Next to water, tea is the most widely consumed beverage in the world today. Green and black tea, though from the same plant, are processed differently and contain varying strengths of chemical compounds.

USES

To reduce risk of atherosclerosis, cardiovascular disease, and myocardial infarction; in cases of elevated cholesterol (to help lower); possible prevention of certain cancers (breast, pancreatic, colon, lung, and esophageal); mild stimulant; possible aid in weight loss; diuretic action; possible reduced risk of osteoporosis.

DOSAGE

GREEN TEA INFUSION (TEA): Pour 150–250 ml boiling water over 1.0–2.5 g finely cut dried leaf, steep 3–5 minutes for use as a stimulant. Steep 15–20 minutes and drink several times daily for diarrhea. Drink at least 1 cup daily for antioxidant effect.

GREEN TEA POWDER: 8 capsules (250 mg each) daily with meals to help treat obesity.

BLACK TEA INFUSION (TEA): Pour 150–250 ml boiling water over 2.5 g finely cut dried leaf, steep 2–5 minutes for use as a stimulant (alkaloids extract rapidly). Steep at least 10 minutes for use in treatment of diarrhea (catechins take longer to extract), 2–3 times daily. Drink 3–4 times daily for protection against atherosclerosis, 1 or more times daily to reduce risk of myocardial infarction (heart attack).

DRY ALCOHOLIC GREEN TEA EXTRACT: 2 capsules (250 mg each), 3 times daily with meals for weight control [standardized to 25% catechins].
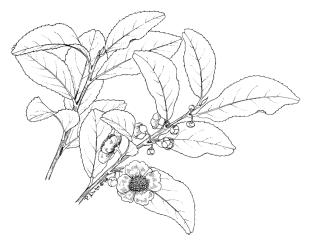
CONTRAINDICATIONS

Use with caution in weakened cardiovascular systems, kidney diseases, thyroid hyperfunction (hyperthyroid), increased susceptibility to muscle spasm, and panicky states of anxiety.

PREGNANCY AND LACTATION: Pregnant women should not ingest more than 5 cups daily (300 mg caffeine daily). Drinking tea while nursing may cause sleep disorders in infants.

ADVERSE EFFECTS

Nervousness, anxiety, heart irregularities, headaches, tremors, hypertension, restlessness, insomnia, daytime irritability, irritation of the stomach lining, and increased urination are possible adverse effects that can occur with use/overuse of central nervous system stimulants like the caffeine found in tea. However, these effects rarely occur with use of normal amounts.

DRUG INTERACTIONS

Compounds in black tea may reduce the effects of coronary vasodilator drugs, such as dipyridamole, if taken simultaneously. Green tea has possible synergistic effects when combined with sulindac and/or tamoxifen and may reduce their adverse effects. Green tea may also interact with drugs such as the blood-thinning drug warfarin (reducing its effects), and large amounts of caffeine may increase activity and side effects of the asthma drug theophylline. Tannins in tea can also interfere with intestinal absorption of nutrients and vitamins, and may lead to microcytic anemia in children.

Comments

When using a dietary supplement, purchase it from a reliable source. For best results, use the same brand of product throughout the period of use. As with all medications and dietary supplements, please inform your healthcare provider of all herbs and medications you are taking. Interactions may occur between medications and herbs or even among different herbs when taken at the same time. Treat your herbal supplement with care by taking it as directed, storing it as advised on the label, and keeping it out of the reach of children and pets. Consult your healthcare provider with any questions.

AMERICAN BOTANICAL COUNCIL

Tea, Black/Green

Patient Information Sheet

Tea, Black/Green

Camellia sinensis (L.) Kuntze (syn. C. *sinensis* L.)

[Fam. *Theaceae*]

OVERVIEW

The use of tea as a beverage in China dates back to at least 2700 B.C.E. (Huang, 1999). Tea continues to be used in the traditional medicine systems of China, Hong Kong, Japan, and Korea (But *et al.*, 1997). Next to water, tea is the most widely consumed beverage in the world (Bushman, 1998; Graham, 1992). International tea production is projected to increase from the 1993–95 average of 1.97 million tons to 2.7 million (UN FAO, 1999). In 1999, the U.S. imported 16,961,460 pounds of green tea, 187,765,660 pounds of black tea, and 7,777,542 pounds of instant tea (USDA, 2000). According to the United Nations Food and Agriculture Organization, there is an increasing body of scientific evidence that both green and black tea can contribute significantly to a healthy lifestyle, and their regular use should be promoted internationally (UN FAO, 1999). Most of the scientific evidence focuses on the cardiovascular and potentially cancer-preventive activity of tea polyphenols and other tea compounds (Gutman and Ryu, 1996; Dufresne and Farnworth, 2001).

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DESCRIPTION

Green tea and black tea, although they are derived from the leaves of the same plant *Camellia sinensis* (L.) Kuntz [Fam. *Theaceae*], have different concentrations of active constituents. The immediate processing of harvested leaves used for green tea limits enzymatic changes, whereas leaves used for black tea are fermented before preparation, which triggers the enzymatic process. Thus, green tea contains higher concentrations of the active constituents, catechins, compared to black tea.

Green tea is the young leaf of *C. sinensis* and its cultivated varieties. It is unfermented and subjected to rapid desiccation with applied heat. It contains no less than 2% caffeine (Bruneton, 1999; Ph.Fr.X, 1982–96). It must contain not less than 33% water-soluble extractive on a dry basis, and no less than 4%, or more than 7%, total ash (Health Canada, 1997).

Black tea is the young leaf of *C. sinensis* and its cultivated varieties, fully fermented, and subjected to rapid desiccation with applied heat. It contains no less than 2.5% caffeine (Bruneton, 1999; Ph.Fr.X, 1982–96), and must contain no less than 25% water-soluble extractive on a dry basis (Health Canada, 1997).

The U.S. Department of Agriculture (USDA) evaluates flavor characteristics of prepared tea using Standard A-2 of the Tea Association of the United States (USDA, 1995). Uniform standards of tea purity, quality, and fitness for consumption are established by the U.S. Secretary of Health and Human Services in accordance with section 3 of the Tea Importation Act (USCS, 1995; 1998). The International Organization for Standardization (ISO) has published standard methods for the classification of grades of tea (ISO, 1997; Willson and Clifford, 1992).

PRIMARY USES

Cardiovascular
- Reduced risk of atherosclerosis (Geleijnse *et al.*, 1999)
- Reduced risk of cardiovascular disease (Imai and Nakachi, 1995; Stensvold *et al.*, 1992)
- Reduced risk of myocardial infarction (Sesso *et al.*, 1999; Hertog *et al.*, 1993, 1995; Hertog, 1994; Knekt *et al.*, 1996; Stensvold *et al.*, 1992)
- Modulation of plasma antioxidant capacity (Leenen *et al.*, 2000; van het Hof *et al.*, 1999; Princen *et al.*, 1998; Ishikawa *et al.*, 1997)
- Decreased serum lipid concentration (Kono *et al.*, 1992, 1996)

OTHER POTENTIAL USES

Oncology
- Prevention of colon cancer (August *et al.*, 1999; Ji *et al.*, 1997)
- Reduced incidence of oral mucosal leukoplakia (Li *et al.*, 1999)
- Decreased recurrence of Stage I and II breast cancer (Nakachi *et al.*, 1998)
- Reduced risk and incidence of pancreatic cancer (Ji *et al.*, 1997)
- Reduced risk and incidence of squamous cell lung cancer (Ohno *et al.*, 1995)
- Reduced risk and incidence of esophageal cancer (Gao *et al.*, 1994)

Miscellaneous
- Symptomatic treatment of mild diarrhea (Bruneton, 1999; But *et al.,* 1997; Meyer-Buchtela, 1999)
- Reduced risk of osteoporosis (Hegarty *et al.*, 2000)
- Promotes diuresis (Bruneton, 1999; Shih-Chen, 1973)

- Digestive aid (Shih-Chen, 1973)
- Dysuria; edema (But *et al.*, 1997)
- Weight loss (Bruneton, 1999; Wichtl and Bisset, 1994)
- Functional asthenia (Bruneton, 1999)
- CNS stimulant (Leung and Foster, 1996; Meyer-Buchtela, 1999)
- Headache (But *et al.*, 1997; Leung and Foster, 1996)

DOSAGE

Internal

Crude Preparations

GREEN TEA INFUSION: 150–250 ml boiling water is poured over 1.0–2.5 g fine cut dried leaf, and steeped 3–5 minutes for use as a stimulant (alkaloids extract rapidly). Steeped at least 10 minutes for use in treatment of diarrhea (catechins take longer to extract). Drunk several times daily (Meyer-Buchtela, 1999). Tea should be steeped for 15–20 minutes to maximize the yield of catechins, though this will make the tea taste bitter (Schulz *et al.*, 1998). At least 1 cup daily for antioxidant effect (Leenen *et al.*, 2000).

GREEN TEA POWDER: 8 capsules (250 mg each) are taken daily, with meals, to treat obesity (Lecomte, 1985).

BLACK TEA INFUSION: 150–250 ml boiling water is poured over 2.5 g fine cut, dried leaf, and steeped 2–5 minutes for use as a stimulant (alkaloids extract rapidly). Steeped at least 10 minutes to treat diarrhea (catechins take longer to extract), 2–3 times daily (Meyer-Buchtela, 1999; Wichtl and Bisset, 1994). Drunk 3–4 times daily for protection against atherosclerosis (Geleijnse *et al.*, 1999), 1 or more times daily to reduce risk of myocardial infarction (Sesso *et al.*, 1999).

Standardized Preparations

DRY ETHANOLIC GREEN TEA EXTRACT: 25% catechins, 2 capsules (250 mg each), 3 times daily with meals for weight control (Dulloo *et al.,* 1999).

NOTE: Stimulant action of tea is strongest when allowed to steep for 2–5 minutes as caffeine dissolves quickly in hot water. Longer steeping (10–20 minutes) increases the catechin yield, and decreases the stimulant effect because the polyphenols bind the caffeine (Wichtl and Bisset, 1994). Green and black tea catechins are rapidly absorbed, and milk does not impair their bioavailability (Hollman *et al.,* 2001; Leenen *et al.,* 2000; van het Hof *et al.*, 1998). Earlier studies reported that adding milk results in complexation of tea polyphenols by milk proteins, completely inhibiting their antioxidant effects (Serafini *et al.*, 1996).

DURATION OF ADMINISTRATION

Internal

Most human studies conclude that the regular, long-term, daily use of tea is safe and contributes significantly to prevention (or at least some reduction of incidence) of some serious diseases.

CHEMISTRY

Green Tea

Green tea leaf contains 1–5% xanthine alkaloids (caffeine, theobromine, theophylline, xanthine) (Huang, 1999); 20–30% flavonols; 3–4% flavonols and flavone-glycosides; about 5% phenolic acids; 2–3% proanthocyanidins, 0.59–3.97% free amino acids; and minerals including significant amounts of aluminum, manganese, fluoride, and potassium (Meyer-Buchtela, 1999; Scholz and Bertram, 1995). Tea leaf polyphenols such as catechins, include (+)-catechin (C), (+)-gallocatechin (GC),

(–)-epicatechin (EC), (–)-epigallocatechin (EGC), (–)-epicatechin gallate (ECG), and (–)-epigallocatechin gallate (EGCG) (Miketova *et al.*, 1998). Components of prepared green tea infusion, measured in weight percentage of extracted solids include 30–42% catechins, 5–10% flavonols, 2–4% other flavonoids, 7–9% xanthine alkaloids, 6–8% minerals, 4–6% amino acids, 4–6% organic acids, and 1–2% ascorbic acid (Graham, 1992).

Black Tea

Black tea leaf contains polyphenols, such as catechins EGC, EC, EGCG, ECG (Bronner and Beecher, 1998); xanthine alkaloids (2.6–3.5% caffeine, 0.16–0.2% theobromine, 0.02–0.04% theophylline); 1–3% flavanols; 2–3% flavonols and flavone-glycosides; 2–4% phenolic acids; about 2% theaflavine; 6–30% thearubigins; 0.66–2.82% free amino acids; and minerals including significant amounts of aluminum, manganese, fluoride, and potassium (Meyer-Buchtela, 1999; Scholz and Bertram, 1995). After fermentation from green tea to black tea, about 15% of the catechins remain unchanged and the rest convert into theaflavines and thearubigins. The components of prepared black tea infusion measured in weight % of extracted solids include 3–10% catechins, 12–18% thearubigins, 3–6% theaflavines, 6–8% flavonols, 10–12% phenolic acids and depsides, 8–11% xanthine alkaloids, 13–15% amino acids, and about 10% minerals (Graham, 1992).

PHARMACOLOGICAL ACTIONS

Human

Crude Preparations

BLACK TEA: Protects against ischemic heart disease (Geleijnse *et al.*, 1999).

GREEN TEA: Increases plasma antioxidant capacity (Nakagawa *et al.*, 1999); decreases serum concentrations of total cholesterol, triglycerides, and atherogenic index (Imai and Nakachi, 1995); inhibits endogenous formation of nitrosoproline (Xu *et al.*, 1993).

BLACK AND GREEN TEA: Increase plasma antioxidant capacity (Leenen *et al.*, 2000); inhibit endogenous formation of nitrosoproline (Wang and Wu, 1991).

UNSPECIFIED: Inhibits alpha-amylase activity and lowers pH in digestive tract (Hara, 1997); inhibits endogenous formation of nitrosoproline (Stich, 1992).

Standardized Preparations

GREEN TEA: Activates thermogenesis and fat oxidation (Dulloo *et al.*, 1999).

UNSPECIFIED: Reduces fecal moisture, pH, ammonia, and sulfide, and potentially reduces oxidation (Goto *et al.*, 1999).

Animal

GREEN TEA: Inhibits angiogenesis (Cao and Cao, 1999); hypolipidemic (Chan *et al.*, 1999); inhibits unwanted fecal microbes (Isogai *et al.*, 1998); inhibits activity of nitrosamines, polycyclic aromatic hydrocarbons, and heterocyclic amines (Bu-Abbas *et al.*, 1994, 1995); inhibits the formation and growth of solid tumors (Hirose *et al.*, 1994; Mukhtar *et al.*, 1994; Yin *et al.,* 1994); increases the activity of antioxidant and detoxifying enzymes (glutathione reductase, glutathione peroxidase, glutathione S-transferase (GST), catalase, and quinone reductase) in lungs, liver, and small intestine (Khan *et al.*, 1992); has an antimutagenic effect on compounds that induce gastrointestinal epithelial cancers (Yamane *et al.*, 1991); lowers cholesterol (Muramatsu *et al.*, 1986; Yamaguchi *et al.* 1991).

BLACK AND GREEN TEA: Extracts of both green and black tea exhibit cancer chemopreventive action (Heber *et al.,* 1999); are anti-mutagenic and inhibit colon carcinogenesis (Hernaez *et al.*, 1998); inhibit activity of nitrosamines, polycyclic aromatic hydrocarbons, and heterocyclic amines (Weisburger *et al.*, 1994); inhibit formation and growth of solid tumors (Wang *et al.*, 1994).

UNSPECIFIED: Inhibits unwanted fecal microbes (Toda *et al.,* 1991). Green tea, but not its isolated catechins, has growth-promoting effects on mammary gland development (Sayama *et al.*, 1996); lowers cholesterol (Chisaka *et al.,* 1988).

In vitro
GREEN TEA: Inhibits enzyme urokinase (Jankun *et al.*, 1997); is antioxidant (Frankel, 1997); inhibits low density lipoprotein (LDL) cholesterol oxidation (Luo *et al.*, 1997); has inhibitory effect on growth of mammary cancer cell lines by inhibiting interaction of estrogen with its receptors (Komori *et al.,* 1993).

UNSPECIFIED: Exhibits radical-scavenging activity (Nanjo *et al.*, 1999); inhibits growth of human lung cancer cell line (Fujiki *et al.*, 1998); is antioxidant (Plumb *et al.*, 1999); inhibits enzyme catechol-*O*-methyl-transferase (COMT) (Borchardt and Huber, 1975).

MECHANISM OF ACTION
Anti-carcinogenesis
- Tea catechins are absorbed through the oral mucosa, which may assist in preventing oral and esophageal cancers. Levels of EGCG are higher in saliva than in blood after ingestion of a single cup of tea. Drinking tea slowly delivers high concentrations of catechins to the oral cavity and then the esophagus, whereas tea extract in solid dosage forms results in no detectable salivary catechin level (Yang *et al.*, 1999).
- Evidence (*in vitro*) suggests that the synergy of total catechins in whole green tea leaf infusion is more effective as a cancer preventive than isolated EGCG (Suganuma *et al.*, 1999).
- The mechanism of green tea's anti-carcinogenic effects against digestive tract cancers is unclear (Cao and Cao, 1999; Ji *et al.*, 1997).
- Green and black teas inhibit human carcinogens possibly due to antioxidative and antiproliferative effects of polyphenolic fraction (Katiyar, 1992; Yang and Wang, 1993).
- Polyphenols may inhibit carcinogenesis by blocking endogenous formation of nitrosamines, polycyclic aromatic hydrocarbons, and heterocyclic amines (Bu-Abbas *et al.,* 1994, 1995; Weisburger *et al.*, 1994).
- Green and black tea have comparable antioxidant effects that may diminish the formation of oxidized metabolites of DNA, with an associated lower risk of cancers (Weisburger, 1999).
- Green tea may alter gut flora. Its effects on reduction of dysbiosis suggest a mechanism for prevention of colon cancer (Yarnell, 1999).
- Tea catechins inhibit alpha-amylase activity in the small intestine, and some are absorbed into the portal vein. By lowering the pH in the digestive tract, tea catechins decrease putrefactive products and increase organic acids (Hara, 1997).

Antioxidant
- Green and black tea have comparable antioxidant effects that may play a role in lowering the oxidation of LDL cholesterol, with a consequent decreased risk of heart disease (Weisburger, 1999).
- Flavonoids in green or black tea may reduce the risk of myocardial infarction by inhibiting the oxidation of LDL cholesterol (Rimm *et al.*, 1996; van het Hof *et al.*, 1999), reducing platelet aggregation (Ho *et al.*, 1992), or reducing ischemic damage (Laughton *et al.*, 1991).
- Green tea contributes to the prevention of cardiovascular disease by increasing the antioxidant capacity of plasma (Nakagawa *et al.*, 1999).
- Proposed mechanisms of tea flavonoid antioxidant activity include its hydrogen-donating ability, delocalization of electrons, and metal ion chelation. Tea beverage has greater *in vitro* antioxidant capacity than most fruits and vegetables per serving and is more potent than vitamins C and E and the carotenoids. Tea and its flavonoids protect LDL cholesterol from oxidation following co-incubation *in vitro* (Najemnik *et al.,* 1999).

Central nervous system stimulant
- Tea contains water-soluble xanthine alkaloids such as caffeine, which stimulate the central nervous system and adrenal glands, increasing synthesis and release of specific neurotransmitters and hormones. Caffeine increases secretion of the neurotransmitter norepinephrine and the adrenal hormone epinephrine, while blocking central adenosine receptors (Gawin, 1988; Gilman *et al.,* 1985).

Thermogenesis
- By inhibiting catechol *O*-methyltransferase (COMT), the enzyme that degrades norepinephrine, tea catechins prolong the life of norepinephrine in the synaptic cleft, while tea alkaloids inhibit phosphodiesterases, which prolongs the life of cAMP in the cell, resulting in an increased, and more sustained effect, of norepinephrine on thermogenesis (Dulloo *et al.*, 1999).
- Epigallocatechin gallate (EGCG) can attenuate peroxide production in glial cells by either inhibiting the deamination of monoamines or acting as a free radical scavenger, thereby reducing oxidative neuronal damage associated with various neurodegenerative diseases (Mazzio, 1998).

CONTRAINDICATIONS
None known (Meyer-Buchtela, 1999). Persons with weakened cardiovascular systems, renal diseases, thyroid hyperfunction, elevated susceptibility to spasm, and certain psychic disorders (e.g., panicky states of anxiety) should use tea with caution (Fleming *et al.*, 2000).

PREGNANCY AND LACTATION: No known restrictions during pregnancy or lactation (McGuffin *et al.,* 1997), though pregnant women should typically not ingest more than five cups daily (about 300 mg caffeine daily) and ingestion of tea while nursing may cause sleep disorders in some infants (Fleming *et al.*, 2000).

ADVERSE EFFECTS
Side effects of nervous system stimulants may include nervousness, anxiety, heart irregularities, headaches, tremors, hypertension, restlessness, insomnia, daytime irritability, irritation of the gastric mucosa, and diuresis (McGuffin *et al.*, 1997).

These effects are generally for high dosages of caffeine-containing herbs and are not associated with the ingestion of reasonable amounts of tea (e.g., 1–10 cups per day).

DRUG INTERACTIONS

Xanthine (e.g., caffeine, theophylline) derivatives from black tea can diminish effects of coronary vasodilator drugs such as dipyridamole and should not be taken concurrently (Morant and Ruppanner, 2001). Green tea has a possible synergistic effect when taken with sulindac and/or tamoxifen and may reduce their adverse effects (Suganuma *et al.*, 1999). Green tea is a source of vitamin K; one case report suggests that green tea is a probable antagonist of warfarin (Taylor and Wilt, 1999). Herbs high in tannins may impair absorption of theophylline, a bronchodilator drug used to treat asthmatics (Austin, 1999; Brinker, 2001). Tea tannins can also interfere with intestinal absorption of nutrients and vitamins (Huang, 1999). In infants, tannins can bind iron and reduce its absorption, contributing to the development of microcytic anemia (Merhav, 1985). Resorption of alkaline medications can be delayed due to chemical bonding with tea tannins (Fleming *et al.*, 2000). *In vitro*, black tea constituents can cause precipitation of amitriptyline, fluphenazine, haloperidol, and Imipramine (Lasswell *et al.,* 1984; Kulhanek, 1981). Large amounts of caffeine may increase activity and side effects of theophylline. Limiting intake of caffeine-containing beverages to small amounts will avoid this potential interaction (Austin, 1999; Threlkeld, 1991), and those associated with numerous other drugs affected by caffeine consumption (Brinker, 2001).

AMERICAN HERBAL PRODUCTS ASSOCIATION (AHPA) SAFETY RATING

CLASS 2D: Black teas are not recommended for excessive or long-term use (McGuffin *et al.*, 1997). (EDITORS' NOTE: It is unclear why AHPA has given a Class 2d safety rating to black tea and not to green tea. Both black and green tea are, in fact, recommended for long-term use for health benefits.)

REGULATORY STATUS

BELGIUM: Permitted as a traditional herbal diuretic (De Smet *et al.*, 1993).

CANADA: Food (Health Canada, 1997). Substantiated health claims will be permitted with premarket authorization after Natural Health Product (NHP) regulations become final in 2001 or 2002.

FRANCE: Traditional Herbal Medicine listed in Annex I of the 1998 French Explanatory Note with four approved oral use indications and two topical use indications. Green and black tea are official in the *French Pharmacopoeia*, Ph.Fr. X (Bruneton, 1999).

GERMANY: Food. Not reviewed by the German Commission E. No monograph in the *German Pharmacopoeia*.

ITALY: Food.

SWEDEN: Classified as a foodstuff and natural product (De Smet *et al.*, 1993). No products containing tea leaf are presently registered in the Medical Products Agency's (MPA) "Authorized Natural Remedies," "Homeopathic Remedies" or "Drugs" listings (MPA, 2001).

SWITZERLAND: One multiple-ingredient digestive aid instant tea (Drosana® Verdauungs und Magentee) containing tea leaf dry extract is listed in the *Swiss Codex 2000/01* (Ruppanner and Schaefer, 2000). No monograph in the *Swiss Pharmacopoeia*.

U.K.: Food. Not entered in the *General Sale List* (GSL). No monograph in the *British Pharmacopoeia*.

U.S.: Generally Recognized as Safe (GRAS) (US FDA, 1998). Dietary supplement or food depending on label claim statement (USC, 1994). No monograph in the USP-NF.

CLINICAL REVIEW

Twenty-nine studies are outlined in the following table, "Clinical Studies on Tea Leaf," including a total of 68,242 subjects. All but three of these studies (Princen *et al.*, 1998; Nakachi *et al.*, 1998; Hartman *et al.,* 1998) demonstrated positive effects for indications in the areas of cardiovascular health, cancer, osteoporosis, obesity, and bowel conditions. Most of the studies are large-population epidemiological studies on the influence of black and/or green tea consumption on disease prevention. The table includes 15 cardiovascular studies investigating a range of potential applications, including two cross-over studies on plasma antioxidant activity (Leenen *et al.*, 2000; van het Hof *et al.*, 1999); a randomized, placebo-controlled (R, PC) study on energy expenditure and fat oxidation (Dulloo *et al.*, 1999); a PC study on tea's protective effect against ischemic heart disease (Geleijnse *et al.,* 1999); a multi-center, case-controlled (MC, CC) study on tea's protective effect against myocardial infarction (Sesso *et al.*, 1999); and tea's effects on serum lipid concentrations and resistance of LDL cholesterol to oxidation (Ishikawa *et al.*, 1997; Kono *et al.,* 1992, 1996; van het Hof *et al.,* 1997). At least 13 large-population, CC cancer studies have been published. Five recent CC cancer studies listed in the table evaluated the consumption of tea and its protective effect against development of pancreatic and colorectal cancers (Ji *et al.*, 1997); various cancers (Imai *et al.*, 1997); stomach cancer (Yu *et al.*, 1995); lung cancer (Ohno *et al.,* 1995); and esophageal cancer (Gao *et al.*, 1994). Other studies investigated tea's use in protecting older women against osteoporosis (Hegerty *et al.,* 2000), and tea's effect on fecal flora in nursing home residents (Goto *et al.*, 1998, 1999). One DB, PC study investigated tea's use in the treatment of severe obesity and found significant weight loss after 30 days (Lecomte, 1985). A recent meta-analysis examined the effect of tea on stroke, myocardial infarction, and all coronary heart disease. The estimated effects of tea on stroke and coronary heart disease were too heterogeneous to assess. The study found an estimated 11% decrease in the incidence rate of myocardial infarction (fixed-effects relative risk estimate = 0.89, 95% confidence interval: 0.79, 1.01).

BRANDED PRODUCTS

Arkocaps/Phytotrim®: Arkopharma Laboratories / BP 28-06511 / Carros Cedex / France / Tel: +33-49-32-91-128 / Email: info@arkopharma.com. Capsules contain 250 mg powdered green tea leaf.

Exolise®: Arkopharma Laboratories. Capsules contain 250 mg alcoholic green tea leaf dry extract standardized to 25% (250 mg/g) total catechins and 10% (100 mg/g) caffeine.

Lipton "Brisk" Tea® (black tea): Unilever Bestfoods North America / 800 Sylvan Ave. / Englewood Cliffs, NJ 07632 / U.S.A. / Tel: (800) 697-7887 / (888) LIPTON-T / Email: letters.liptontusa@unilever.com / www.liptont.com. 2.21 g tea leaf per single serve bag providing 46.9 mg total catechins (8.6 mg epicatechin, 14.2 mg epicatechin gallate, 7.0 mg epigallocatechin, 17.1 mg epigallocatechin gallate), 11.9 mg total

theafavines, 10.7 mg flavonols, 151.2 mg thearubigins and 220.7 mg total polyphenols.

Lipton® Green Tea: Unilever Bestfoods North America. 2.27 g tea leaf per single serve bag providing 186.3 mg total catechins (26.7 mg epicatechin, 30.3 mg epicatechin gallate, 50.6 mg epigallocatechin, 78.7 mg epigallocatechin gallate), 0.2 mg total theafavines, 12.0 mg flavonols, and 198.5 mg total polyphenols.

Twinings® Darjeeling Tea (black): Twinings London / 216 The Strand / London / U.K. / www.twinings.com. Each dose of 2.2 g leaf provides 7.6 mg epicatechin, 20.2 mg epigallocatechin, 43 mg epigallocatechin gallate, 2.2 mg theaflavin, 1.4 mg theaflavin monogallate, and 0.8 mg theaflavin digallate.

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Clinical Studies on Tea Leaf (*Camellia sinensis* [L.] Kuntze)

Cardiovascular

Author/Year	Subject	Design	Duration	Dosage	Preparation	Results/Conclusion
Leenen *et al.*, 2000	Plasma antioxidant activity	C, R, CO n=21 healthy volunteers, 10 male, 11 female	1 day (tests at baseline and several times up to 2 hours post-tea drinking)	300 ml black or green tea	Aqueous infusion of black or green tea. 2 g dried leaf in 300 ml boiled water, with or without milk (brands not stated) vs. water	Consumption of a single dose of black or green tea induced a significant rise in plasma antioxidant activity (p<0.001). Plasma was analyzed for total catechins and antioxidant activity using the ferric-reducing ability of plasma (FRAP) assay. Addition of milk did not interfere with the increase. A larger increase was observed for green tea vs. black tea.
Hodgson *et al.*, 2000	Lipoprotein oxidation	C, R, Cm n=20 healthy males	90 minutes	400 ml black or green tea/day	Aqueous infusion of black tea or sencha (Japanese green tea). 1.9 g dried leaf in 400 ml boiled water for 4 minutes (brands not stated) vs. water control with matched caffeine content	Significant increases in urinary 4–*O*-methylgallic acid for black and green tea (p<0.0001) were observed. Caffeine did not significantly influence lipoprotein oxidation. Only black tea had a mild acute effect on *ex vivo* lipoprotein oxidation in human serum, but effect was short-lived and of borderline significance.
Dulloo *et al.*, 1999	Energy expenditure and fat oxidation	R, PC n=10 healthy males	24 hours on 3 occasions	Two, 250 mg capsules 3x/day, green tea extract (150 mg caffeine, 375 mg catechins)	Exolise® green tea leaf alcoholic dry extract vs. 150 mg caffeine/day vs. placebo (cellulose)	Compared to placebo, tea extract resulted in a significant increase in 24-hour energy expenditure (4%; p< 0.01) and significant decrease in 24-hour respiratory quotient (from 0.88 to 0.85; p< 0.001) with no change in urinary nitrogen. Urinary norepinephrine excretion was higher in tea group than placebo (40%, p< 0.05). Authors concluded that tea has thermogenic properties and promotes fat oxidation.
Geleijnse et al., 1999	Aortic athero-sclerosis	P n=3,454 men and women, free of cardiovascular disease at baseline	2–3 years after baseline assessment; medium duration of follow-up was 1.9 years	125 ml black tea 3.0–3.5x/day	Aqueous infusion of black tea leaf (brands not stated)	Multivariable analyses showed a significant inverse association of tea intake with severe aortic atherosclerosis. Odds ratios (OR) decreased from 0.54 (95% confidence interval [CI], 0.32–0.92) for drinking 125~250 ml (1~2 cups) of tea per day to 0.31 (CI, 0.16–0.59) for drinking more than 500 ml/day (4 cups per day). Associations were stronger in women than men. Association of tea intake with mild and moderate atherosclerosis was not statistically significant. Authors concluded that drinking tea provides a protective effect against ischemic heart disease. (Often called the Rotterdam Study.)
Hodgson *et al.*, 1999	Blood pressure	C, R, Cm, CO n=20 healthy males	21 days; 7 days each intervention	400 ml black or green tea 4x/day	Aqueous infusion of black tea or sencha (Japanese green tea). 1.9 g dried leaf in 400 ml boiled water for 4 minutes (brands not stated) vs. water control with matched caffeine content	Black (and not green) tea produced a transient (within the first 30 minutes) increase in blood pressure relative to that produced by caffeine. Consumption over 7 days of either black or green tea had no effect on ambulatory blood pressure.

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Tea, Black/Green   Monograph

Cardiovascular (cont.)

Author/Year	Subject	Design	Duration	Dosage	Preparation	Results/Conclusion
Sesso *et al.*, 1999	Myocardial infarction	MC, CC n=340 case-control pairs, white men and women, no prior history of myocardial infarction or angina pectoris (<76 years)	Home interviews conducted 10 weeks after hospital discharge	0 to ≥ 1 cup/day green tea	Aqueous infusion of black tea leaf (brands not stated) vs. coffee and decaffeinated coffee	Only tea was inversely associated with risk of myocardial infarction. 24.9% of cases and 32.0% of controls drank >1 cup/day. Regular tea drinkers had a significantly lower risk of myocardial infarction compared to non-tea drinkers (OR=0.55, 95%, CI, 0.36–0.85), independent of coronary risk factors and lipids. The heaviest tea drinkers had more favorable HDL cholesterol levels.
van het Hof *et al.*, 1999	Plasma antioxidant activity	CO n=18 healthy adults	3 days	1 cup green tea, black tea, or black tea with milk 8x/day (1 cup every 2 hours)	Aqueous infusion of black tea leaf or green tea leaf (brands not stated) with or without milk vs. water	Catechin levels in blood rapidly increased upon repeated tea consumption. Addition of milk did not affect any parameters measured. Accumulation of catechins in LDL particles was not sufficient to improve intrinsic resistance of LDL to oxidation *ex vivo*.
Princen *et al.*, 1998	Plasma antioxidant activity	R, SB, PC n=29 healthy smokers, 13 male, 16 female	1 month	One, 150 ml cup black or green tea 6x/day, or 3.6 g isolated green tea polyphenols/ day	Aqueous infusion of black tea leaf or green tea leaf (brands not stated) vs. isolated green tea polyphenols vs. placebo	Authors concluded that black or green tea at 6 cups/day had no effect on plasma lipids and no sparing effect on plasma antioxidant vitamins, and that intake of a high dose of isolated green tea polyphenols decreases plasma vitamin E. No effect was found on LDL cholesterol oxidation ex vivo after consumption of green or black tea or intake of green tea polyphenol isolate.
Ishikawa *et al.*, 1997	Antioxidant activity; susceptibility of LDL cholesterol to oxidation	R, Cm n=22 normolipidemic healthy male volunteers	2 months (4 weeks no tea, 4 weeks tea; control group, 8 weeks water)	150 ml black tea 5x/day	Aqueous infusion of 2.2 g Twinings® Darjeeling black tea leaf vs. water	After 4-week treatment period, lag time before initiation of LDL cholesterol oxidation was significantly (p<0.01) prolonged from 54 to 62 minutes. LDL cholesterol exposed to tea had reduced oxidizability. 1 and 2 hours after tea ingestion, levels of EGCG and ECG in plasma increased significantly (p<0.05). Authors speculated that tea may ameliorate atherosclerosis by suppressing oxidation of LDL cholesterol.
van het Hof *et al.*, 1997	Antioxidant activity, resistance of LDL cholesterol to oxidation	PG, Cm n=45 healthy non-smoking volunteers	One month (2 weeks mineral water, 2 weeks tea) control group, 4 weeks water	150 ml, 6x/day black tea or green tea prepared from freeze-dried, water-soluble extractive	Aqueous infusions of 0.5 g Lipton® freeze-dried black tea leaf extract and 0.5 g Lipton green tea leaf extract vs. mineral water control	Significant increase in total antioxidant activity of plasma occurred after 4 weeks of green tea, or alter serum lipid concentrations. This tea preparation, dosage and duration of use had no effect on variables of oxidative stress to lipids or serum lipid concentrations or resistance of LDL cholesterol to oxidation *ex vivo*.
Kono *et al.*, 1996	Hypocholesterolemia	E, MC n=2,062 Japanese male self-defense officials	2 years (1991–92)	Average 1 cup, 3x/day green tea	Aqueous infusion of green tea leaf (brands not stated)	Green tea consumption was inversely associated with serum levels of total cholesterol (TC), and LDL cholesterol, but not with either high-density lipoprotein (HDL) cholesterol or triglycerides. 10 cups/day of green tea was associated with differences of 6.2 mg/dl in TC (95% CI, 0.4–12.1) and 6.2 mg/dl in LDL cholesterol (95% CI, 0.7–11.7). These findings of association of green tea with blood cholesterol suggest a possible causal relationship.
Imai and Nakachi, 1995	Cardiovascular disease and liver disorders	E, P, CS n=1,371 Japanese men (>40 years)	5 years (1986–90)	≤ 3 cups/day to ≥ 10 cups/day green tea	Aqueous infusion of green tea leaf (brands not stated)	As daily green tea intake increased from less than 3 to 4–9, and more than 10 cups, researchers observed significantly increased serum HDL and decreased LDL lipoprotein levels. Additionally, increased green tea consumption was associated with significantly improved liver profiles in which aspartate aminotransferase and alanine aminotransferase levels dropped. An inverse association between green tea ingestion and various serum markers shows that green tea may act protectively against cardiovascular disease and disorders of the liver.

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Clinical Studies on Tea Leaf (*Camellia sinensis* [L.] Kuntze) (cont.)

Cardiovascular (cont.)

Author/Year	Subject	Design	Duration	Dosage	Preparation	Results/Conclusion
Hertog *et al.*, 1993	Coronary heart disease	P n=805 elderly Dutch men	30 years (1960–1990)	1 cup, 2–4x/day black tea	Aqueous infusion of black tea leaf (brands not stated)	Black tea consumption contributed about 70% to daily flavonoid intake. Authors concluded that flavonoids in regularly consumed foods and beverages, such as black tea, may reduce the risk of death from coronary heart disease in elderly men.
Kono *et al.*, 1992	Serum lipid concentrations and atherosclerosis	E, CS n=1 306 male Japanese self-defense officials (49–56 years)	27 months (October 1986–December 1988)	0 to ≥ 9 cups/day green tea	Aqueous infusion of green tea leaf (brands not stated)	Increased green tea consumption, especially more than 9 cups/day, is associated with decreased total serum cholesterol and decreased LDL cholesterol, very low density lipoproteins and triglycerides, increased HDL, and reduced atherogenic index. Adjusted mean concentrations of total cholesterol were 8 mg/dl lower in men drinking 9 cups or more/day than those drinking zero to 2 cups/day.
Stensvold *et al.*, 1992	Coronary heart disease	CS, P n=20,089 Norwegian men and women (9,856 men, 10,233 women without history of cardiovascular disease or diabetes)	12 years (1976–1988)	0 to ≥ 5 cups/day black tea	Aqueous infusion of black tea leaf (brands not stated)	Men and women who drank 5 or more cups of black tea per day had lower cholesterol levels than non-tea drinkers. Tea drinkers were less likely to die from heart attack, and systolic blood pressure was inversely related to tea consumption. The mean serum cholesterol decreased with increasing tea consumption; the linear trend coefficient corresponded to a difference of 0.24 mmol/l (9.3 mg/dl) in men and 0.15 mmol/l (5.8 mg/dl) in women between drinkers of less than 1 cup and those of 5 or more cups/day.

Cancer

Author/Year	Subject	Design	Duration	Dosage	Preparation	Results/Conclusion
August *et al.*, 1999	Colon cancer	Phase I/II study n=14 normal volunteers	24 hours	0.6, 1.2, or 1.8 green tea solids	Green tea solids dissolved in warm water (brand not stated)	Blood samples taken 2, 4, 8, and 24 hours after tea ingestion. Rectal biopsies at 4, 8, and 24 hours. 71% of subjects responded to green tea with at least a 50% inhibition of prostaglandin E2 (PGE2) levels at 4 hours, indicating possible chemoprevention of colorectal cancer.
Li *et al.*, 1999	Oral mucosa leukoplakia	R, DB, PC n=59 oral mucosa leukoplakia patients	6 months	Two, 380 mg mixed tea extract capsules 4x/day, plus topical application of 10% mixed tea in glycerol smeared on mucosa lesion 3x/day	External: 10% mixed tea extract in glycerol vs. placebo and glycerin. Internal: 380 mg capsule of mixed tea extract composed of 66.7% green tea aqueous dry native extract, 16.7% green tea polyphenols, and 16.7% tea pigments (theaflavins, thearubigins, and theabromine)	After 6 months, size of oral lesion decreased in 37.9% of 29 treated patients and increased in 3.4% compared to decrease in 10% of 30 control patients and increase of 6.7%. Incidence of micronucleated exfoliated oral mucosa cells in treatment group was lower than in control group (p<0.01). Significant differences (p<0.05) in number and total volume of silver-stained Nucleolar Organizer Regions (AgNOR) and proliferating index of Proliferation Cell Nuclear Antigen (PCNA) indicating decrease of cell proliferation in treatment group. Overall results provide some direct evidence on protective effects of tea on oral cancer.
Nakachi *et al.*, 1998	Stage I, II, and III breast cancer	E n=472 patients with Stage I, II, and III breast cancer	7 years	≤ 4 cups/day vs. ≥ 5 cups/day green tea	Aqueous infusion of green tea leaf (brands not stated)	Increased consumption of green tea was correlated with decreased recurrence of Stage I and Stage II breast cancer (p<0.05 for crude disease-free survival). No improvement in prognosis was observed in Stage III breast cancer.

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Tea, Black/Green

Monograph

Cancer (cont.)

Author/Year	Subject	Design	Duration	Dosage	Preparation	Results/Conclusion
Hartman *et al.*, 1998	Rectal and colon cancer	E, CH n=27,111 male smokers (50–69 years)	8 years	0 cups/day vs. < 1 cup/day vs. ≥ 1 cup/day green tea	Aqueous infusion of black tea leaf. No standard preparation (brands not stated)	This study does not support the hypothesis that coffee and tea protect against colorectal cancer risk. Tea had little effect on incidence of rectal cancer. A positive association was seen for increased consumption of tea and colon cancer.
Ji *et al.*, 1997	Pancreatic and colorectal cancers	E, CC n=2,266 Chinese patients with newly diagnosed cancers: 931 colon, 884 rectum, 451 pancreas, 1,1552 controls	33 months (October 1990– June 1993)	1–199g/month to ≥ 300g/month green tea leaves	Aqueous infusion of green tea leaf (brands not stated)	Significant inverse association with each cancer was observed with increasing green tea dosage. Women with highest tea consumption had 33% reduced risk of colon cancer, 43% reduced risk of rectal cancer, and 47% reduced risk of pancreatic cancer (p=0.07, 0.001, and 0.008 respectively). For men, 18% reduced risk of colon cancer, 43% reduction risk of rectal cancer, and 47% reduced risk of pancreatic cancer (p=0.38,0.04 and 0.04, respectively).
Imai *et al.*, 1997	Cancer prevention (type not stated)	P, CH n=8,552 Japanese men and women	10 years	Range extending to > 10 cups/day green tea	Aqueous infusion of green tea leaf (brands not stated)	Green tea consumption delayed onset of cancer incidence, especially in females drinking more than 10 cups/day. Preventive effects were not statistically significant in males. Relative risk of cancer incidence (females RR = 0.57, 95%, CI = 0.33-0.98; males RR = 0.68, 95%, CI = 0.39-1.21) was lowest among those with highest consumption levels.
Yu *et al.*, 1995	Stomach cancer	CC, MC n=1,422 Chinese patients, 711 matched controls (<80 years)	27 months (October 1991– December 1993)	Varied	Aqueous infusion of green tea leaf (brands not stated)	Protective effect against stomach cancer from green tea (OR=0.71; 95% CI, 0.54–0.93). Adjusted OR decreased as consumption increased (p=0.006).
Ohno *et al.*, 1995	Lung cancer	CC n=999 333 Japanese male and female patients	4 years (1988–1991)	1–4 cups/day to ≥ 10 cups/day green tea	Aqueous infusion of green tea leaf (brands not stated)	Odds ratios in females: 1–4 cups/day 0.77 (0.28–3.13), 5–9 cups/day 0.77 (0.26–2.25), 10 or more cups/day 0.57 (0.31–1.06). Corresponding numbers for males: 0.85 (0.46–1.55), 0.85 (0.46–1.56), 0.57 (0.31–1.06). Risk reduction was detected mainly in squamous cell carcinoma.
Gao *et al.*, 1994	Esophageal cancer	E, RS, CC, MC n=734 Chinese patients, 1,552 controls (30–74 years)	28 months (October 1990– January 1993)	0 to ≥ 200 g /month green tea leaves	Aqueous infusion of green tea leaf (brands not stated)	Protective effect of green tea on esophageal cancer was observed among women (OR=0.50, 95% CI=0.30–0.83). Risk decreased significantly with increased consumption (p=0.05) in women, but not in men.

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Clinical Studies on Tea Leaf (*Camellia sinensis* [L.] Kuntze) (cont.)

Other

Author/Year	Subject	Design	Duration	Dosage	Preparation	Results/Conclusion
Hegarty *et al.*, 2000	Osteoporosis	CS n=1,256 post-menopausal women (65–76 years old) tea group n=1,134 non-tea group n=122	1 day (BMD measured and questionnaires filled out)	≥ 1 cup/day black or green tea	Aqueous infusions of green tea leaf and black tea leaf with or without milk (brands not stated)	Compared with non-tea drinkers, tea drinkers had significantly greater (~5%) mean bone mineral density (BMD) measurements, adjusted for age and body mass index, at lumbar spine (0.033 g/cm2; p=0.02). Differences at femoral neck (0.013 g/cm2) were not significant. Authors concluded that nutrients in tea, such as flavonoids, may influence BMD and tea may protect against osteoporosis in older women.
Goto *et al.*, 1999	Effect on fecal flora	O n=35 residents in long-term care facility fed same diet of rice gruel and minced food	6 weeks	Green tea extract, 3x/day with meals (300 mg total catechins/day)	Green tea leaf extract (brand not stated)	Compared to baseline, all fecal parameters decreased significantly during tea extract administration including moisture content, pH, ammonia, sulfide, and oxidation-reduction potential (ORP). These reductions indicated favorable improvements of subject's bowel conditions.
Goto *et al.*, 1998	Effect on fecal flora	O n=15 male and female nursing home residents fed by nasogastric or gastric tube	3 weeks	161.3 mg, 3x/day green tea extract (300 mg total catechins/day)	Green tea leaf extract, 62.5% total catechins (30.5% EGCG, 18.5% EGC, 7.0% ECG, 6.5% EC) (brand not stated)	Compared to baseline, lactobacilli and bifidobacteria levels increased significantly (p<0.01–0.05). Levels of enterobacteriaceae, bacteroidaceae, eubacteria, and total bacteria decreased significantly compared to baseline (p<0.01–0.05). Levels of unwanted bacterial metabolites decreased significantly at 21 days (p<0.01–0.05). Fecal pH lowered significantly (p<0.05). After 7 days of discontinuance, all levels returned to pretrial levels.
van het Hof *et al.*, 1998	Bioavailability of catechins	R, C, CO n=12 healthy male (5) and female (7) adults	3 weeks (crossover at 1-week intervals)	1 single dose (3 g tea solids) green tea, black tea, or black tea with milk	Aqueous infusions of 3 g green tea leaf (900 mg catechins) and 3 g black tea leaf (300 mg catechins), with and without milk	Consumption of green tea or black tea resulted in a rapid increase of catechin levels in blood. Maximum changes were reached after 2.3 hours for green and 2.2 hours for black tea. Addition of milk did not impair tea catechin bioavailability.
Lecomte, 1985	Obesity	R, DB, PC n=60 obese women (30–45 years)	1 month (follow-ups at 15 and 30 days treatment)	Eight, 250 mg capsules/day green tea leaf powder with meals (2 breakfast, 3 lunch, 3 dinner)	Arkocaps/ Phytotrim® green tea leaf powder (250 mg powdered leaf per capsule) vs. placebo	Significant average weight loss of 1.7 kg at day 15 and 2.9 kg at day 30 in green tea group. Significant decrease in waist measurement after 30 days. Significant reductions in total cholesterol and blood triglycerides but no reduction in HDL cholesterol. Author concluded that green tea powder caused significant weight loss compared to placebo and demonstrates utility in treatment of obesity.

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Tea, Black/Green

Monograph