



GREEN TEA

Also Known As:

EGCG, Epigallo Catechin Gallate, Epigallocatechin Gallate, Green Tea Extract, Green Tea Polyphenolic Fraction, GTP, GTPF, Japanese Tea, Kunecatechins, Poly E, Polyphenon E, Tea, Tea Extract, Tea Green.

CAUTION: See separate listings for Black Tea, Caffeine, Cocoa, Coffee, Cola Nut, Guarana, Oolong Tea, and Mate.

Scientific Name:

Camellia sinensis, synonyms Camellia thea, Camellia theifera, Thea bohea, Thea sinensis, Thea viridis.

Family: Theaceae.

People Use This For:

Orally, green tea is used to improve cognitive performance and mental alertness. It is also used to treat stomach disorders, vomiting, diarrhea, and headaches. Green tea is also used for weight loss, osteoporosis, solid tumor cancers, and to reduce the risk of breast cancer, cervical cancer, prostate cancer, colon cancer, gastric cancer, lung cancer, and skin cancer related to ultraviolet (UV) radiation (e.g., sunburn) and other environmental causes. It is also used for human papilloma virus (HPV), genital warts, perianal warts, cervical dysplasia, Crohn's disease, Parkinson's disease, cardiovascular disease, diabetes, hypotension, chronic fatigue syndrome (CFS), dental caries, kidney stones, and skin damage.

Topically, green tea bags are used as a wash to soothe sunburn, as a poultice for bags under the eyes, as a compress for headache or tired eyes, and to stop the bleeding of tooth sockets. Green tea in chewable candy is used for gingivitis. Green tea is also used topically to prevent skin damage and cancer related to ultraviolet (UV) radiation (e.g., sunburn) and other environmental causes.

In foods, green tea is consumed as a beverage.

Safety:

LIKELY SAFE ...when consumed as a beverage in moderate amounts (733, 6031, 9222, 9223, 9225, 9226, 9227, 9228). Green tea is often consumed daily in Asian cultures and has not been associated with significant adverse effects (6031). ...when used topically and appropriately. A specific green tea extract ointment (Veregen, Bradley Pharmaceuticals) providing 15% kunecatechins is an FDA-approved prescription product. It has been safely used in trials lasting up to 16 weeks (15067). The safety of treatment beyond 16 weeks or multiple treatment courses is not known.

POSSIBLY SAFE ...when green tea extract is used orally. Green tea extract containing 7% caffeine has been used safely for six months (8117). ...when used topically and appropriately (6065, 11310).

POSSIBLY UNSAFE ...when used orally long-term in high doses. Green tea contains a significant amount of caffeine. Chronic use, especially in large amounts, can produce tolerance, habituation, psychological dependence, and other significant adverse effects. Doses greater than 250-300 mg per day have been associated with significant adverse effects such as tachyarrhythmias and sleep disturbances (11832). These effects would not be expected to occur with the consumption of decaffeinated green tea.

LIKELY UNSAFE ...when used orally in very high doses. The fatal acute oral dose of caffeine in green tea is estimated to be 10-14 grams (150-200 mg per kilogram). Serious toxicity can occur at lower doses depending on variables in caffeine sensitivity such as smoking, age, prior caffeine use, etc (11832).

CHILDREN: POSSIBLY SAFE ...when used in amounts commonly found in foods and beverages (4912, 11833).

PREGNANCY: POSSIBLY SAFE ...when used orally in moderate amounts. Due to the caffeine content of green tea, mothers should closely monitor their intake to ensure moderate consumption. Fetal blood concentrations of caffeine approximate maternal concentrations (4260). Use of caffeine in pregnancy is controversial; however, moderate consumption has not been associated with clinically important adverse fetal effects (2708, 2709, 2710, 2711, 9606). Caffeine crosses the human placenta, but is not considered a teratogen. Mothers should keep caffeine consumption below 300 mg per day. This is similar to the amount of caffeine found in about 3 cups of coffee or tea (2708). Based on animal models, green tea extract catechins are transferred to the fetus, but in amounts 50-100 times less than maternal concentrations (15010). The potential impact of these catechins on the human fetus is not known, but animal models suggest that the catechins are not teratogenic (15011). **POSSIBLY UNSAFE** ...when used orally in large amounts. Caffeine crosses the placenta, producing fetal blood concentrations similar to maternal levels (4260). Mothers should avoid consuming more than 300 mg of caffeine daily or more than 3 cups of tea or coffee per day (2708). High maternal doses of caffeine throughout pregnancy have resulted in symptoms of caffeine withdrawal in newborn infants (9891). High doses of caffeine have been associated with spontaneous abortion, premature delivery, and low birth weight (2709, 2711). Fetal birth weight is reduced by 28 grams for every 100 mg/day of caffeine consumed during pregnancy. But this is unlikely to be clinically important except for women consuming more than 600 mg of caffeine daily (9606). There is also concern that green tea consumption might have antifolate activity and potentially increase the risk of folic acid deficiency-related birth defects. Catechins in green tea inhibit the enzyme dihydrofolate reductase in vitro (15012). This enzyme is responsible for converting folic acid to its active form. Preliminary evidence suggests that increasing maternal tea consumption is associated with increased risk of spina bifida (15068). More evidence is needed to determine the safety of using green tea during pregnancy. For now, advise pregnant women to avoid consuming significant quantities of green tea. There is insufficient reliable information available about the safety of green tea extracts when applied topically during pregnancy.

LACTATION: POSSIBLY SAFE ...when used orally in moderate amounts. Due to the caffeine content of green tea, nursing mothers should closely monitor caffeine intake. Breast milk concentrations of caffeine are thought to be approximately 50% of maternal serum concentrations. Minimal consumption would likely result in limited exposure to a nursing infant (9892). **POSSIBLY UNSAFE** ...when used orally in large amounts. Consumption of green tea might cause irritability and increased bowel activity in nursing infants (6026). Large doses or excessive intake of green tea should

be avoided during lactation. There is insufficient reliable information available about the safety of green tea extracts when applied topically during breastfeeding.

Effectiveness:

LIKELY EFFECTIVE

Genital warts. A specific green tea extract ointment (Veregen, Bradley Pharmaceuticals) providing 15% kunecatechins completely clears external genital and perianal warts in 24% to 60% of patients after 10-16 weeks of treatment. This green tea extract is an FDA-approved prescription product (15067).

Mental alertness. Consumption of green tea and other caffeinated beverages seems to prevent a decline in alertness and cognitive capacity when consumed throughout the day (4221, 4224). Combining caffeine with glucose as an "energy drink" seems to improve mental performance better than placebo or either caffeine or glucose alone (13732).

POSSIBLY EFFECTIVE

Bladder cancer, esophageal cancer, and pancreatic cancer. Drinking green tea is associated with a reduced the risk of bladder cancer, esophageal cancer, and pancreatic cancer (733, 1457, 1458, 1459, 6031).

Cervical dysplasia. Green tea as an oral or topical preparation seems to reduce cervical dysplasia caused by human papilloma virus (HPV) infection (11310).

Hyperlipidemia. Green tea taken orally seems to lower cholesterol and triglycerides. A theaflavin-enriched green tea extract, 375 mg daily for 12 weeks, seems to cause mild reductions in low-density lipoprotein (LDL) levels (11308). Epidemiological evidence suggests that higher consumption of green tea is associated with significantly lowered serum total cholesterol, triglycerides, LDL, and increased high-density lipoprotein (HDL) levels (6403).

Hypotension. Consuming caffeinated beverages seems to increase blood pressure in elderly people with postprandial hypotension (11834, 11835).

Oral leukoplakia. Drinking green tea orally seems to decrease the size of lesions in patients with oral leukoplakia (4213).

Ovarian cancer. Women who regularly consume tea, including green tea or black tea, appear to have a significantly lower risk of developing ovarian cancer compared to women who never or seldom consume tea (9228, 13208). In one prospective population study, women who consume 2 or more cups of tea daily have a 46% lower risk of ovarian cancer compared to women who don't regularly consume tea (13208). There also appears to be a trend that suggests higher consumption of tea or longer duration of use further reduces the risk of ovarian cancer (9228, 13208).

Parkinson's disease. Consuming green tea orally seems to help prevent or delay the onset of Parkinson's disease. There is some evidence from large-scale epidemiological studies that people who consume caffeinated beverages such as coffee, tea, and cola have a decreased risk of Parkinson's disease. For men, the effects seem to be dose related. Men consuming a total of 421-2716 mg of caffeine (approximately 5-33 cups of tea) from any source daily seem to have the greatest reduction in risk. However, there seems to be a significant reduction in risk even with consumption of as little as 124-208 mg caffeine per day (approximately one to three cups tea) (6022). In women, the effects do not seem to be dose related. Moderate consumption of approximately

one to four cups daily seems to provide the most reduction in risk (1238).

POSSIBLY INEFFECTIVE

Colorectal cancer. Epidemiological evidence suggests that consuming green tea does not have any effect on colon cancer risk (9222, 9223, 14498).

INSUFFICIENT RELIABLE EVIDENCE to RATE

Breast cancer. Population studies suggest that green tea does not seem to reduce the risk of initially developing breast cancer in Asian populations (13189, 14426); however, in Asian-American populations some evidence suggests that drinking green tea might reduce the risk of developing breast cancer (14427).

Additional population research suggests that Asian women who have had stage I or II breast cancer who drink 3-5 or more cups of green tea daily seem to have reduced risk of breast cancer recurrence (3926, 13189). But drinking green tea does not seem to significantly reduce the risk of recurrence of later-stage breast cancer.

A protective effect of green tea on breast cancer risk might depend on patient genotype. Green tea consumption does not seem to lower breast cancer risk in Asian women with low-activity angiotensin-converting enzyme (ACE) genotype. But it does seem to decrease breast cancer risk in Asian women with high-activity ACE genotype (14430). Similarly, Asian-American women who drink green tea seem to have a lower breast cancer risk if they have low-activity catechol-O-methyltransferase (COMT) genotype. But they don't seem to benefit if they do not have the low-activity COMT genotype (14431).

Most research on green tea for breast cancer has been in Asian populations. The effect of green tea on breast cancer risk in Western populations is less clear.

Cardiovascular disease. A large-scale population study in Japan suggests that consuming 3 or more cups of green tea daily significantly decreases the risk of cardiovascular and all-cause mortality compared to drinking less than one cup daily. This association appears to be primarily related to a decrease in risk for cerebral infarction. The association also appears to be stronger in women compared to men (14498). Other population studies suggest that general tea consumption might protect against ischemic heart disease and death after myocardial infarction; however, most of the tea drinkers in these studies consumed black tea rather than green tea (8119, 8120, 8121).

Diabetes. Epidemiological research suggests that Japanese adults who consume 6 or more cups/day of green tea have a 33% lower risk of developing type 2 diabetes compared to those who consume one cup/day or less. Risk reduction appears to be more pronounced in women compared to men (14313).

Gastric cancer. There is conflicting evidence about the effects of green tea on gastric cancer risk. A large-scale population study in Japan suggests that drinking 5 or more cups of green tea daily does not significantly reduce the risk of cancer related mortality compared to drinking less than one cup daily (14498).

But other population research suggests that drinking 10 or more cups of green tea daily does reduce the risk of stomach cancer (8903, 9222, 9225, 9226, 9227). Consuming less than 10 cups daily might not consistently reduce risk (7033, 9223).

Gingivitis. Green tea extract in chewable candy appears to reduce plaque accumulation and gingival inflammation (7594).

Hypertension. There is contradictory evidence about tea consumption and

hypertension. Epidemiological research in Chinese people shows that drinking 120-599 mL of green tea or oolong tea daily is associated with a lower risk of developing hypertension by 46% compared with non-habitual tea drinkers. Drinking more than 600 mL per day is associated with a 65% reduced risk (12518). However, several small clinical studies on normotensive and hypertensive patients shows that green tea or black tea has no effect on blood pressure (15655).

Lung cancer. There is conflicting evidence about the effects of green tea on lung cancer risk. A large-scale population study in Japan suggests that drinking more 5 or more cups of green tea daily does not significantly reduce the risk of lung cancer related mortality compared to drinking less than one cup daily (14498). Other epidemiological research suggests that men who consume a higher amount of dietary phytoestrogens, such as the lignan precursors found in green and black tea, have up to a 27% lower risk of developing lung cancer compared to those who consume smaller amounts (13190).

Obesity. Preliminary evidence suggests that a specific green tea extract (AR25, Exolise) standardized to 25% epigallocatechin gallate (EGCG) might help reduce weight in moderately obese patients (8114). However, other evidence suggests that taking a green tea extract plus caffeine does not help maintain weight following a period of weight loss (14428).

Osteoporosis. Population research suggests that drinking green tea for 10 years is associated with increased bone mineral density (8116).

Prostate cancer. Chinese men who consume more green tea seem to have a lower risk of developing prostate cancer. The effect appears to be dose-dependent. Higher consumption of green tea seems to result in greater reduction in risk (14128).

Preliminary clinical research suggests that men with high-grade prostate intraepithelial neoplasia who take green tea catechins 200 mg three times daily for a year seem to have a reduced risk of progression to prostate cancer (14127). However, contradictory clinical research suggests that consuming large amounts of green tea does not have any effect on PSA levels in patients with androgen-independent prostate cancer (11366).

Stroke. A large-scale population study in Japan suggests that consuming 3 or more cups of green tea daily significantly decreases the risk of cardiovascular and all-cause mortality compared to drinking less than one cup daily. This association appears to be primarily related to a decrease in risk for cerebral infarction (14498).

More evidence is needed to rate green tea for these uses.

Mechanism of Action:

The applicable parts of green tea are the leaf bud, leaf, and stem. Green tea is different than black and oolong teas because it is not fermented. Black tea is fully fermented and oolong tea is partially fermented. Green tea is produced by steaming fresh leaves at high temperatures. This process inactivates certain oxidizing enzymes, but doesn't decrease polyphenols. Polyphenols such as flavanols, flavandiol, flavonoids, and phenolic acids are abundant in green tea. Flavanols including epigallocatechin gallate (EGCG), epigallocatechin (EGC), epicatechin gallate (ECG), and epicatechin (EC), are all referred to as catechins. These seem to be responsible for many of the proposed benefits of green tea (6031, 8118, 11310). The amount of polyphenols and catechins in green tea is affected by growing conditions, leaf age, and storage during and after transport. Catechins in green tea range from 69 to 103 mg/gram of tea (14129, 14130). Unlike fermented teas such as black and oolong teas, green tea does not contain theaflavins, pigments that are produced during the

fermentation process (15656). Green tea also contains phytoestrogens including beta-sitosterol and the lignan precursors Matairesinol and Secoisolariciresinol (13190). Catechins in green tea might have anti-inflammatory activity. Catechins derived from green tea are a laboratory standard for COX-1 inhibition (12849). Catechins from green tea also might inhibit the production of leukotriene-B4 and the activity of 5-lipoxygenase (12850). EGCG inhibits IL-1 beta-induced COX-2 and nitric oxide synthase activity (12485). EGCG and other catechins in green tea might also reduce inflammation and protect cartilage by inhibiting proteoglycan and collagen breakdown (12486). Green tea polyphenols seem to lessen joint degeneration in laboratory models of rheumatoid arthritis (12487).

It's often thought that green tea has more polyphenols, and therefore greater potential health benefits, than black tea. But there is some evidence that suggests there is no difference in quantity and quality of polyphenols between green and black teas (12087). Green tea also contains 2% to 4% caffeine (519) or 10-80 mg caffeine per cup (4218). The caffeine in green tea stimulates the central nervous system (CNS), heart, muscles, and possibly the pressor centers that control blood pressure (2722). Possible mechanisms include adenosine receptor blockade and phosphodiesterase inhibition (2722). By blocking adenosine receptors, caffeine is thought to increase the release of neurotransmitters such as dopamine (6370). Caffeine also decreases airway resistance and stimulates respiration, via adenosine receptor blockade and phosphodiesterase inhibition (11836). It has also been proposed that caffeine may decrease GABA and serotonin signaling (6370). Caffeine stimulates gastric acid secretion, and increases plasma catecholamine levels (11837). Caffeine can have positive inotropic and chronotropic effects on the heart (11836). Caffeine can also acutely elevate both diastolic and systolic blood pressure, but might not have this effect in habitual users (2722).

Caffeine exerts a diuretic effect, with water losses estimated at 1.17 mL per milligram of caffeine (2712). Tachyphylaxis to the diuretic effect develops rapidly, diminishing fluid losses associated with caffeine intake (10206). Caffeine-containing beverages consumed during moderate endurance exercise do not appear to compromise bodily hydration status (2713). Caffeine doesn't substantially affect the fluid status of people who drink caffeinated beverages on a regular basis (10206). The caffeine content is also thought to be responsible for green tea's effects on cognitive performance (4221). Some preliminary studies show that flavonoids found in green tea might reduce lipoprotein oxidation (6032, 6033, 9232). In vitro tests indicate that catechins in green tea reduce proliferation of vascular smooth muscle that occurs with high concentrations of low-density lipoproteins (9229). There is some evidence green tea suppresses thromboxane formation during blood clotting by inhibiting the release of arachidonic acid from platelets (8028). However, when used in humans, green tea doesn't consistently exhibit useful effects on cardiovascular risk factors. Green tea doesn't reduce inflammation, vascular reactivity, or lipid oxidation. This may be due to low bioavailability of polyphenols (9230, 9231).

Caffeine has been reported to cause increases and decreases in blood glucose. In people with type 2 diabetes, acute administration of caffeine impairs postprandial glucose metabolism, while acute abstention from caffeine reduces postprandial glucose levels by 21%. Whether these effects also occur with caffeinated beverages and herbs is unknown (12374). Other research in obese people suggests that caffeine ingestion may contribute to insulin resistance (12375, 13744). However, one study found that patients with type 1 diabetes taking 200 mg of caffeine twice daily had increased frequency and intensity of warning signs of hypoglycemia. This may be due to a

reduction in blood flow to the brain and an increase in glucose utilization by the brain (6024). Some clinical research suggests symptoms of hypoglycemia are more intense at onset in the absence of caffeine, but with increasing duration of hypoglycemia, symptoms are greater with caffeine (13740).

Green tea may protect against some kinds of cancer. Polyphenols in tea appear to have antimutagenic effects and may protect DNA (12523). Preliminary animal research suggests EGCG might prevent new blood vessel growth (angiogenesis) in tumors. EGCG may also inhibit tumor cell proliferation, causing cell cycle arrest or apoptosis (1454, 1455, 1456, 8117, 11309). ECG appears to induce apoptosis in cancer cells by reactive oxygen species formation and mitochondrial depolarization (8118). Green tea may also reduce oxidative DNA damage, lipid peroxidation, and free radical generation (4212); and might reduce mutagenic activity in smokers (4217).

Green tea polyphenols also appear to have activity against skin cancer. In animal models of skin cancer, applying green tea polyphenols topically reduces progression of skin papillomas to squamous cell carcinoma (15066, 15068).

Green tea polyphenols also appear to have activity against human papilloma virus (HPV)-related cervical dysplasia and genital and perianal warts (*Condylomata acuminata*) (11310, 15067); however, the mechanism of action is not known.

There is preliminary evidence that green tea might enhance the effects of doxorubicin (Adriamycin) on tumor cells (3940). The caffeine, theanine, and EGCG constituents appear to increase the concentration of doxorubicin inside tumor cells by inhibiting the efflux mechanisms that remove doxorubicin from the cell (7690).

EGCG from green tea is structurally similar to methotrexate and aminopterin and also appears to inhibit the enzyme dihydrofolate reductase. This antifolate activity results in inhibition of lymphoma cell growth and apoptosis *in vitro* (15012). Green tea catechins have also been shown to induce apoptosis (cell death) in human leukemia cells (15662).

The polyphenols in green tea appear to reduce the cellular adhesiveness of bacteria associated with dental disease (7594). Some evidence suggests that EGCG and EGC might inhibit 5 alpha-reductase and might potentially be useful in androgen-mediated skin disorders such as androgenic alopecia, hirsutism, and acne (8113).

The catechins in green tea also have *in vitro* activity against HIV replication, although less so than black tea, which contains theaflavins (15658).

Green tea is thought to be beneficial for preventing skin damage and cancer from ultraviolet (UV) radiation due to the antioxidant effects of polyphenols in green tea. Polyphenolic extracts of green tea, specifically EGCG and epicatechin-3-gallate, seem to produce dose-dependent topical protection against UVA and UVB sunburn. Areas of skin where green tea extracts were applied had fewer sunburned cells and less damage to epidermal Langerhans cells, which are responsible for cutaneous immune response. Green tea extracts also seem to prevent UV radiation-induced DNA damage (1359). Animal models indicate that green tea extracts reduce oxidative skin damage, skin inflammation, and epidermal hyperplasia due to UV radiation and other causes (6065). Unlike conventional sunscreens, green tea extracts do not absorb significant amounts of light in the UV range (1359).

Green tea is also used for weight loss. Early evidence indicates that a green tea extract rich in EGCG can increase calorie and fat metabolism. The caffeine, catechin, and theanine constituents of green tea might contribute to this effect (1453, 8115, 11960).

Caffeine increases resting energy expenditure (REE) and cellular thermogenesis. It also causes an increase in nonoxidative fatty acid turnover and lipid oxidation; however, the net effect on lipid oxidation is small. The effects of caffeine on energy

expenditure and lipid metabolism seem to be mediated by both sympathetic and nonsympathetic mechanisms (13733). There is also some evidence that EGCG might suppress appetite. However, there is some question about how well EGCG is absorbed orally (3922). The impact of EGCG and green tea on weight loss remains to be determined with well-designed studies in obese people.

Tannins in green tea can produce antidiarrheal effects. The polyphenols in green tea might increase the level of lactobacilli and bifidobacteria and reduce the population of enterobacteria (3941).

For prevention of Parkinson's disease, caffeine in green tea may prevent adenosine's inhibition of dopaminergic transmission. This may result in a reduction in the clinical expression of Parkinsonism (6022). Preliminary evidence suggests that EGCG may prevent oxidation and apoptosis of neurons, which may protect people from developing Alzheimer's disease (9224). Epidemiological research suggests that drinking green tea for at least ten years increases bone mineral density. The exact mechanism for the effects on bone is unknown, but several possibilities have been suggested. Tea leaves contain fluoride, which might slow osteoporosis. Tea also contains flavonoids and phytoestrogens, which might affect bone mineral density. Other proposed mechanisms include inhibition of bone resorption and effects on mineral metabolism by polyphenols and tannins (8116).

A decaffeinated green tea extract does not seem to significantly affect cytochrome P450 3A4 (CYP3A4) or 2D6 (CYP2D6) enzyme metabolism of drugs in healthy volunteers (14429).

Adverse Reactions:

Orally, green tea can cause nausea, vomiting, abdominal bloating and pain, dyspepsia, flatulence, and diarrhea. It can also cause central nervous system stimulation and adverse effects such as dizziness, insomnia, fatigue, agitation, tremors, restlessness, and confusion. These effects are more common with higher doses of green tea or green tea extract, equivalent to 5-6 liters of tea per day (8117, 11366).

There is concern that some green tea products might cause hepatotoxicity in some people. There have been at least 14 cases of hepatotoxicity, primarily linked to green tea extract products in pill form (14136, 15026); however, there has been at least one report associated with consumption of a green tea-containing beverage (15026). Most cases of toxicity have had a hepatocellular-cholestatic presentation. Onset of hepatotoxic symptoms after initiation of the green tea extract supplement has ranged from 5-120 days. In most cases, liver function returned to normal after discontinuation of the green tea product (14136, 15026). In at least one case, use of a specific ethanolic green tea extract (Exolise, Arkopharma) resulted in hepatotoxicity requiring a liver transplant. Due to concerns about hepatotoxicity, this specific extract was removed from the market by the manufacturer (14310). The mechanism for this potential adverse effect is unknown. It does not appear to be an allergic reaction. It is possible that certain extraction processes, for example, ethanolic extracts, produce hepatotoxic constituents. In most cases, green tea products were not assessed to determine if any contaminants were present.

Although acute administration of green tea can cause increased blood pressure, regular consumption doesn't seem to increase either blood pressure or pulse when consumed on a regular basis, even in mildly hypertensive patients (1451, 1452). Epidemiological research suggests there is no association of caffeine consumption with incidence of hypertension. Habitual coffee consumption doesn't seem to be related to hypertension, but habitual consumption of sugared or diet cola is associated with development of

hypertension (13739). Consumption of green tea seems to reduce the risk of hypertension (12518).

Large doses of caffeine can cause massive catecholamine release and subsequent sinus tachycardia, metabolic acidosis, hyperglycemia, and ketosis (13734). Other symptoms include headache, anxiety, ringing in the ears, hypokalemia, respiratory alkalosis, chest pain, premature heartbeat, and arrhythmia (11832, 11838, 13735).

Caffeine in green tea may exacerbate sleep disturbances in patients with acquired immunodeficiency syndrome (AIDS) (10204).

Allergic reactions to green tea include cough, dyspnea, loss of consciousness, and asthma. Occupational exposure to green tea dust can also cause sensitization, which may include nasal and asthmatic symptoms (11365). Caffeine in green tea can cause anaphylaxis in sensitive individuals, although true IgE-mediated caffeine allergy seems to be relatively rare (11315).

The existence or clinical importance of caffeine withdrawal is controversial. Some researchers think that if it exists, it appears to be of little clinical significance (11839). Other researchers suggest symptoms such as headache; tiredness and fatigue; decreased energy, alertness, and attentiveness; drowsiness; decreased contentedness; depressed mood; difficulty concentrating; irritability; and lack of clear-headedness are typical of caffeine withdrawal (13738). Withdrawal symptoms such as delirium, nausea, vomiting, rhinorrhea, nervousness, restlessness, anxiety, muscle tension, muscle pains, and flushed face have been described. However, these symptoms may be from nonpharmacological factors related to knowledge and expectation of effects. Clinically significant symptoms caused by caffeine withdrawal may be uncommon (2723, 11839).

Some evidence shows caffeine in green tea is associated with fibrocystic breast disease, breast cancer, and endometriosis in women; however, this is controversial since findings are conflicting (8043). Restricting caffeine in women with fibrocystic breast conditions doesn't seem to affect breast nodularity, swelling, or pain (8996). Epidemiological evidence regarding the relationship between caffeinated beverages such as green tea and the risk for osteoporosis is contradictory. Caffeine can increase urinary excretion of calcium (2669, 10202, 11317). Women identified with a genetic variant of the vitamin D receptor appear to be at an increased risk for the detrimental effect of caffeine on bone mass (2669). However, moderate caffeine intake, less than 300 mg per day, doesn't seem to significantly increase osteoporosis risk in most postmenopausal women with normal calcium intake (2669, 6025, 10202, 11317). Combining ephedra with caffeine can increase the risk of adverse effects. Jitteriness, hypertension, seizures, temporary loss of consciousness, and hospitalization requiring life support has been associated with the combined use of ephedra and caffeine (2729). There is also a report of ischemic stroke in an athlete who consumed ephedra 40-60 mg, creatine monohydrate 6 grams, caffeine 400-600 mg, and a variety of other supplements daily for six weeks (1275).

Topically, green tea extract ointment applied to the cervix can cause cervical and vaginal inflammation, vaginal irritation, and vulval burning (11310). When applied to external genital or perianal warts, a specific green tea extract ointment (Veregen, Bradley Pharmaceuticals) providing 15% kunecatechins can cause erythema, pruritus, local pain, discomfort and burning, ulceration, induration, edema, and vesicular rash (15067).

Interactions with Herbs & Supplements:

BITTER ORANGE: Bitter orange in combination with caffeine or caffeine-containing herbs, such as green tea, can increase blood pressure and heart rate in otherwise healthy normotensive adults, potentially increasing the risk of serious cardiovascular adverse effects (13657).

CAFFEINE-CONTAINING HERBS/SUPPLEMENTS: Concomitant use can have additive effects with the caffeine in green tea, and can increase the risk of adverse effects. Some natural products that contain caffeine include coffee, black tea, oolong tea, guarana, mate, cola, and others.

CREATINE: There is some concern that combining caffeine, ephedra, and creatine might increase the risk of serious adverse effects. There is a report of ischemic stroke in an athlete who consumed creatine monohydrate 6 grams, caffeine 400-600 mg, ephedra 40-60 mg, and a variety of other supplements daily for 6 weeks (1275). Caffeine might also decrease creatine's possible beneficial effects on athletic performance. Some researchers think caffeine can inhibit phosphocreatine resynthesis (2117, 4575).

EPHEDRA (Ma Huang): Use of ephedra with green tea can increase the risk of stimulatory adverse effects due to its caffeine content. There is evidence that using ephedra with caffeine might increase the risk of serious life-threatening or debilitating adverse effects such as hypertension, myocardial infarction, stroke, seizures, and death (6486, 10307). Tell patients to avoid taking green tea with ephedra and other stimulants.

FOLIC ACID: There is some concern that green tea might decrease activity of folic acid. The green tea catechin epigallocatechin gallate (EGCG) appears to inhibit the enzyme dihydrofolate reductase activity in vitro (15012). Dihydrofolate reductase is responsible for converting folic acid to its active form, tetrahydrofolate. Theoretically, green tea inhibition of dihydrofolate reductase could lead to functional folic acid deficiency.

HEPATOTOXIC HERBS: Green tea extract supplements have been linked to several cases of hepatotoxicity (14136, 14310). Theoretically, taking green tea extracts with other hepatotoxic herbs or supplements might have additive effects. Other products that might adversely affect the liver include bishop's weed, borage, chaparral, uva ursi, and others.

IRON: Green tea appears to reduce absorption of non-heme iron from foods (8110, 8904). Infants given tea to drink seem to have an increased risk of microcytic anemia (631). However, a study of iron-deficient elderly patients suggests that concomitant use doesn't alter iron absorption in this population (185). Theoretically, green tea might reduce the absorption of iron supplements. For most patients, this effect will not be clinically significant. Advise patients with iron deficiency to consume tea between meals rather than with meals to lessen this interaction (8904).

Interactions with Drugs:

ADENOSINE (Adenocard)

Interaction Rating = **Moderate** Be cautious with this combination
 Severity = Moderate " Occurrence = Possible " Level of Evidence = B

The caffeine in green tea is a competitive inhibitor of adenosine at the cellular level. However, caffeine doesn't seem to affect supplemental adenosine because high interstitial levels of adenosine overcome the antagonistic effects of caffeine (11771). It is recommended that methylxanthines and methylxanthine-containing products be stopped 24 hours prior to pharmacological stress tests (11770). However,

methylxanthines appear more likely to interfere with dipyridamole (Persantine) than adenosine-induced stress testing (11771).

ALCOHOL (Ethanol)

Interaction Rating = **Minor** Be watchful with this combination
 Severity = Mild " Occurrence = Possible " Level of Evidence = D

Concomitant use of alcohol can increase caffeine serum concentrations and the risk of caffeine adverse effects. Alcohol reduces caffeine metabolism (6370).

AMPHETAMINES

Interaction Rating = **Major** Do not use this combination
 Severity = High " Occurrence = Probable " Level of Evidence = D

Theoretically, the caffeine in green tea might increase the risk of additive CNS effects (2719).

ANTICOAGULANT/ANTIPLATELET DRUGS

Interaction Rating = **Moderate** Be cautious with this combination
 Severity = High " Occurrence = Unlikely " Level of Evidence = D

Catechins in green tea and caffeine are reported to have antiplatelet activity (733, 8028, 8029, 12882). Theoretically, green tea might increase the risk of bleeding when used with antiplatelet or anticoagulant drugs. This interaction has not been reported in humans; however a contradictory case report suggest that green tea might actually decrease the anticoagulant effect of warfarin. This could be due to vitamin K or other constituents contained in green tea (1460, 1461, 1463). Antiplatelet agents include aspirin, clopidogrel (Plavix), dipyridamole (Persantine), ticlopidine (Ticlid), and others. Anticoagulant agents include ardeparin (Normiflo), dalteparin (Fragmin), enoxaparin (Lovenox), heparin, and warfarin (Coumadin).

ANTIDIABETES DRUGS

Interaction Rating = **Minor** Be watchful with this combination
 Severity = Moderate " Occurrence = Unlikely " Level of Evidence = B

Theoretically, concomitant use of green tea and diabetes drugs might interfere with blood glucose control due to the caffeine in green tea. The data are conflicting. Reports claim that caffeine might increase or decrease blood sugar (6024, 8646).

CIMETIDINE (Tagamet)

Interaction Rating = **Moderate** Be cautious with this combination
 Severity = Mild " Occurrence = Likely " Level of Evidence = B

Concomitant use might increase the effects and adverse effects of caffeine in green tea. Cimetidine can reduce caffeine clearance by 31% to 42% (11736).

CLOZAPINE (Clozaril)

Interaction Rating = **Moderate** Be cautious with this combination
 Severity = High " Occurrence = Possible " Level of Evidence = B

Theoretically, concomitant administration might cause acute exacerbation of psychotic symptoms due to the caffeine in green tea. Caffeine can increase the effects and toxicity of clozapine. Caffeine doses of 400-1000 mg per day inhibit clozapine metabolism (5051). Clozapine is metabolized by cytochrome P450 1A2 (CYP1A2). Researchers speculate that caffeine might inhibit CYP1A2. But there is no reliable evidence that caffeine affects CYP1A2. There is also speculation that genetic factors might make some patients be more sensitive to the interaction between clozapine and caffeine (13741).

COCAINE

Interaction Rating = **Major** Do not use this combination
 Severity = High " Occurrence = Probable " Level of Evidence = D

Theoretically, the caffeine in green tea might increase the risk of additive CNS effects (2719).

CONTRACEPTIVE DRUGS

Interaction Rating = **Moderate** Be cautious with this combination
 Severity = Mild " Occurrence = Probable " Level of Evidence = B

Concomitant use might increase the effects and adverse effects of caffeine in green tea. Oral contraceptives can decrease caffeine clearance by 40% to 65% (8644).

DIPYRIDAMOLE (Persantine)

Interaction Rating = **Moderate** Be cautious with this combination
 Severity = Moderate " Occurrence = Probable " Level of Evidence = B

The caffeine in green tea might inhibit dipyridamole-induced vasodilation (11770, 11772). It is recommended that methylxanthines and methylxanthine-containing products be stopped 24 hours prior to pharmacological stress tests (11770). Methylxanthines appear more likely to interfere with dipyridamole (Persantine) than adenosine-induced stress testing (11771).

DISULFIRAM (Antabuse)

Interaction Rating = **Moderate** Be cautious with this combination
 Severity = Mild " Occurrence = Probable " Level of Evidence = B

Concomitant use might increase the risk of adverse effects of caffeine in green tea. Disulfiram decreases the clearance and increases the half-life of caffeine (11840).

EPHEDRINE

Interaction Rating = **Major** Do not use this combination
 Severity = High " Occurrence = Probable " Level of Evidence = D

Use of ephedrine with caffeine-containing products can increase the risk of stimulatory adverse effects. There is evidence that using ephedrine with caffeine might increase the risk of serious life-threatening or debilitating adverse effects such as hypertension, myocardial infarction, stroke, seizures, and death (6486, 10307). Tell patients to avoid taking caffeine with ephedrine or other stimulants.

ESTROGENS

Interaction Rating = **Moderate** Be cautious with this combination
 Severity = Mild " Occurrence = Probable " Level of Evidence = B

Concomitant use can increase serum concentrations of caffeine and the risk of caffeine adverse effects. Estrogen inhibits caffeine metabolism (2714).

FLUCONAZOLE (Diflucan)

Interaction Rating = **Minor** Be watchful with this combination
 Severity = Mild " Occurrence = Possible " Level of Evidence = B

Concomitant use might increase the effects of caffeine in green tea. Fluconazole decreases caffeine clearance by approximately 25% (11022).

FLUVOXAMINE (Luvox)

Interaction Rating = **Moderate** Be cautious with this combination
 Severity = Mild " Occurrence = Probable " Level of Evidence = D

Concomitant use can increase serum concentrations of caffeine and the risk of caffeine adverse effects. Fluvoxamine reduces caffeine metabolism (6370).

HEPATOTOXIC DRUGS

Interaction Rating = **Moderate** Be cautious with this combination
 Severity = High " Occurrence = Unlikely " Level of Evidence = D

Green tea extract supplements have been linked to several cases of hepatotoxicity (14136, 14310). Theoretically, taking green tea extracts with hepatotoxic drugs might have additive effects. Some drugs that can adversely effect the liver include acetaminophen (Tylenol), amiodarone (Cordarone), carbamazepine (Tegretol), isoniazid (INH), methotrexate (Rheumatrex), methyl dopa (Aldomet), and many others.

LITHIUM

Interaction Rating = **Moderate** Be cautious with this combination
 Severity = Moderate " Occurrence = Probable " Level of Evidence = D

Abrupt caffeine withdrawal can increase serum lithium levels (609). Two cases of lithium tremor which worsened with abrupt coffee withdrawal have been reported (610)

MEXILETINE (Mexitil)

Interaction Rating = **Minor** Be watchful with this combination
 Severity = Mild " Occurrence = Possible " Level of Evidence = B

Concomitant use might increase the effects and adverse effects of caffeine in green tea. Mexiletine can decrease caffeine elimination by 50% (1260).

MONOAMINE OXIDASE INHIBITORS (MAOIs)

Interaction Rating = **Moderate** Be cautious with this combination
 Severity = High " Occurrence = Possible " Level of Evidence = D

Theoretically, concomitant intake of large amounts of green tea with MAOIs might precipitate a hypertensive crisis, due to the caffeine contained in green tea. This is based on the claim that intake of large amounts of caffeine with MAOIs might precipitate a hypertensive crisis (15).

NICOTINE

Interaction Rating = **Moderate** Be cautious with this combination
 Severity = Moderate " Occurrence = Probable " Level of Evidence = D

Theoretically, the caffeine in green tea might increase the risk of additive CNS effects (2719).

PENTOBARBITAL (Nembutal)

Interaction Rating = **Moderate** Be cautious with this combination
 Severity = Moderate " Occurrence = Possible " Level of Evidence = B

The caffeine in green tea might negate the hypnotic effects of pentobarbital (13742).

PHENYLPROPANOLAMINE

Interaction Rating = **Moderate** Be cautious with this combination
 Severity = Moderate " Occurrence = Probable " Level of Evidence = B

Concomitant use of phenylpropanolamine and green tea might cause an additive increase in blood pressure due to the caffeine in green tea (11738). Phenylpropanolamine also seems to increase caffeine serum levels (13743).

QUINOLONE ANTIBIOTICS

Interaction Rating = **Moderate** Be cautious with this combination
 Severity = Mild " Occurrence = Probable " Level of Evidence = B

Concomitant use might increase the effects and risk of adverse effects of caffeine in green tea. Quinolones decrease caffeine clearance (606, 607, 608). Quinolones include ciprofloxacin (Cipro), enoxacin (Penetrex), norfloxacin (Chibroxin, Noroxin),

sparfloxacin (Zagam), trovafloxacin (Trovan), and grepafloxacin (Raxar).

RILUZOLE (Rilutek)

Interaction Rating = **Moderate** Be cautious with this combination

Severity = Moderate " Occurrence = Possible " Level of Evidence = D

Theoretically, concomitant use of riluzole and caffeinated beverages such as green tea might increase serum caffeine and riluzole concentrations and the risk of adverse effects of both caffeine and riluzole, due to the caffeine contained in green tea.

Caffeine and riluzole are both metabolized by cytochrome P450 1A2, and concomitant use might reduce metabolism of one or both agents (11739).

TERBINAFINE (Lamisil)

Interaction Rating = **Minor** Be watchful with this combination

Severity = Mild " Occurrence = Possible " Level of Evidence = B

Concomitant use can increase serum caffeine concentrations and the risk of caffeine adverse effects. Terbinafine decreases the clearance of intravenous caffeine by 19% (11740).

THEOPHYLLINE

Interaction Rating = **Moderate** Be cautious with this combination

Severity = Moderate " Occurrence = Probable " Level of Evidence = B

Concomitant use might increase the effects and adverse effects of theophylline due to the caffeine in green tea. Caffeine can reduce theophylline clearance, increase elimination half-life, and increase serum levels (11862).

VERAPAMIL (Calan, Covera, Isoptin, Verelan)

Interaction Rating = **Moderate** Be cautious with this combination

Severity = Moderate " Occurrence = Possible " Level of Evidence = D

Theoretically, concomitant use of verapamil and caffeinated beverages such as green tea might increase plasma caffeine concentrations and the risk of adverse effects, due to the caffeine contained in green tea. Verapamil increases plasma caffeine concentrations by 25% (11741).

WARFARIN (Coumadin)

Interaction Rating = **Moderate** Be cautious with this combination

Severity = High " Occurrence = Unlikely " Level of Evidence = D

In one case, consumption of large amounts of green tea is reported to decrease the effects of warfarin. This has been attributed to the vitamin K1 in green tea (4211). But, there is so little vitamin K1 in green tea (0.03 +/- 0.1 mcg/mL) that the interaction might be due to other constituents (1460, 1461, 1463, 8028). Contradictory evidence suggests that catechins and caffeine in green tea have antiplatelet activity (733, 8028, 8029, 12882).

Theoretically, this could increase the risk of bleeding in warfarin patients; however, this interaction has never been reported. Monitor international normalized ratios (INR) carefully.

Interactions with Foods:

IRON: Green tea appears to reduce absorption of non-heme iron from foods (631, 8110, 9237).

MILK: Adding milk to tea appears to reduce some of the beneficial cardiovascular effects of drinking tea (220, 15219). Milk might bind and prevent absorption of the antioxidant flavonoids in tea. However, some contradictory evidence suggests that this interaction does not occur (6032). More evidence is needed to determine the clinical significance of this potential interaction.

Interactions with Lab Tests:

5-HYDROXYINDOLEACETIC ACID: Green tea might increase urine 5-hydroxyindoleacetic acid concentrations and test results, due to its caffeine content. Caffeine can increase urine catecholamine concentrations (15).

BLEEDING TIME: Theoretically, green tea might increase bleeding time. Caffeine theoretically can prolong bleeding time and increase the results of a bleeding time test, but this has not been reported in humans (1701). Caffeine is reported to have antiplatelet activity (8028, 8029).

CATECHOLAMINE: The caffeine in green tea can increase plasma catecholamine levels (8646).

CREATINE: The caffeine in green tea can increase urine creatine levels (1701).

DIPYRIDAMOLE THALLIUM IMAGING: Green tea might interfere with dipyridamole thallium imaging studies, due to its caffeine content. Caffeine attenuates the characteristic cardiovascular responses to dipyridamole and has altered test results (11742).

FERRITIN: Drinking green tea may cause a reduction in serum ferritin in iron-deficient people (9237).

GLUCOSE: Caffeine has been reported to cause increases and decreases in blood glucose (8646).

HEMOGLOBIN: Drinking green tea may cause a reduction in hemoglobin in iron-deficient people (9237).

IRON: In people with iron deficiency, green tea may further reduce the concentration of serum iron (9237).

LACTATE: The combination of ephedrine, a constituent of ephedra, and the caffeine in green tea can increase blood lactate levels (8646).

LIVER FUNCTION TESTS: Green tea extract supplements have been associated with several cases of liver toxicity. Green tea extract might increase liver function tests including alkaline phosphatase, aspartic acid transaminase (AST,SGOT), alanine aminotransferase (ALT, SGPT), and bilirubin (14136, 14310).

NEUROBLASTOMA TESTS: Green tea (due to its caffeine content) might cause false-positive diagnosis of neuroblastoma, when diagnosis is based on tests of urine vanillylmandelic acid (VMA) or catecholamine concentrations. Caffeine can increase urine catecholamine and VMA concentrations (15).

PHARMACOLOGICAL STRESS TESTS: The caffeine in green tea is a competitive antagonist for adenosine receptors (11771). It is recommended that caffeine and caffeine-containing products be stopped 24 hours prior to pharmacological stress tests (11770). However, caffeine appears more likely to interfere with dipyridamole (Persantine) than adenosine (Adenocard) stress testing (11771). The interaction between caffeine and dipyridamole is unlikely to be significant in stress testing if the heart rate increase is greater than 5% after dipyridamole infusion (11772).

PHEOCHROMOCYTOMA TESTS: Green tea (due to its caffeine content) might cause false-positive diagnosis of pheochromocytoma, when diagnosis is based on tests of urine vanillylmandelic acid (VMA) or catecholamine concentrations. Caffeine can increase urine catecholamine and VMA concentrations (15).

PULMONARY FUNCTION TESTS: People may need to avoid caffeine and caffeinated beverages such as green tea for at least four hours prior to lung function testing. Forced expiratory volume in one minute (FEV1) seems to show a small improvement up to two hours after caffeine use. Mid-expiratory flow rates may also improve with caffeine for up to four hours (9607).

THEOPHYLLINE: Theophylline is a metabolite of caffeine. Caffeine in overdose can cause significant increases in theophylline serum concentrations (13734). Theoretically, very large doses of green tea might cause measurable theophylline levels.

URATE: Green tea might falsely increase serum urate test results determined by the Bittner method, due to its caffeine content. Caffeine causes false elevations in serum urate test results determined by the Bittner method (11844).

URINARY CALCIUM: The caffeine in green tea can increase urinary calcium levels (11317).

VANILLYLMANDELIC ACID (VMA): Green tea might increase urine VMA concentrations and test results, due to its caffeine content. Caffeine can increase urine VMA concentrations (15).

Interactions with Diseases or Conditions:

ANEMIA: Drinking green tea may worsen anemia in people with iron deficiency (9237).

ANXIETY DISORDERS: The caffeine in green tea might aggravate anxiety disorders (11743).

BLEEDING DISORDERS: Theoretically, caffeine in green tea might aggravate these conditions. Caffeine is reported to have antiplatelet activity (8028, 8029); however, this interaction has not been reported in humans (1701). Caffeine can prolong bleeding time and increase the results of a bleeding time test (1701).

CARDIAC CONDITIONS: Caffeine in green tea can induce cardiac arrhythmias in sensitive individuals (11845); use with caution.

DIABETES: Some research suggests that caffeine may impair postprandial glucose metabolism in people with diabetes and contribute to insulin resistance. The effect of caffeinated beverages and herbs has not been studied (12374, 12375). Caffeine in green tea may enhance the frequency and intensity of hypoglycemic warning symptoms in people with type 1 diabetes. Theoretically, this may increase the ability of diabetic patients to detect and treat hypoglycemia early. However, it might also increase the frequency of hypoglycemic events (6024). Some clinical research suggests symptoms of hypoglycemia are more intense at onset in the absence of caffeine, but with increasing duration of hypoglycemia, symptoms are greater with caffeine (13740). Caffeine has been reported to cause increases and decreases in blood glucose (8646); use with caution.

GLAUCOMA: Drinking caffeinated green tea increases intraocular pressure. The increase occurs within 30 minutes and persists for at least 90 minutes (8540).

HYPERTENSION: The caffeine in green tea might increase blood pressure in people with high blood pressure. However, this does not seem to occur in people who regularly consume green tea or other caffeinated products (1451, 1452, 2722, 15655).

LIVER DISEASE: Green tea extract supplements have been linked to several cases of hepatotoxicity (14136, 14310). Theoretically, green tea extracts might exacerbate liver dysfunction in patients with liver disease.

OSTEOPOROSIS: Consuming caffeinated green tea can increase urinary excretion of calcium. Caffeine consumption should be limited to less than 300 mg per day (approximately 2-3 cups of green tea). Adequate calcium supplementation may partially compensate for calcium losses (2669, 10202, 11317). Postmenopausal women identified with a genetic variant of the vitamin D receptor should use caffeine with caution (2669).

Dosage/Administration:

ORAL: Doses of green tea vary significantly, but usually range between 1-10 cups daily. The commonly used dose of green tea is based on the amount typically consumed in Asian countries, which is about 3 cups per day, providing 240-320 mg of polyphenols. The typical dose of caffeine for headache or restoring mental alertness is up to 250 mg per day (2718, 11743).

For improving cognitive performance, tea providing 60 mg of caffeine, or approximately one cup, has been used (4221).

For reducing cholesterol, 10 or greater cups per day has been associated with decreased cholesterol levels (6403). Theaflavin-enriched green tea extract, 375 mg daily for 12 weeks, has also been used for cholesterol reduction (11308).

For preventing breast cancer or breast cancer recurrence, three or more cups of green tea per day have been used (3926).

For human papilloma virus (HPV) infected cervical lesions, green tea extract, 200 mg daily alone or in combination with topical green tea ointment, for 8-12 weeks has been used (11310).

For preventing Parkinson's disease, men consuming 421-2716 mg total caffeine (approximately 5-33 cups of green tea) daily have the lowest risk of developing Parkinson's disease. However, a significantly lower risk is also associated with consumption of as little as 124-208 mg of caffeine (approximately 1-3 cups of green tea) daily (6022).

In women, more moderate caffeine consumption seems to be best, equivalent to approximately 1-4 cups of green tea per day (1238).

To make tea, people typically use 1 teaspoon of tea leaves in 8 ounces boiling water.

TOPICAL: For human papillomavirus (HPV)-infected cervical lesions, green tea ointment in an unspecified concentration has been used alone or in combination with oral green tea extract, twice weekly for 8-12 weeks (11310).

For genital warts, a specific green tea extract ointment (Veregen, Bradley Pharmaceuticals) providing 15% kunecatechins applied three times daily to external warts for up to 16 weeks has been used (15067).

Editor's Comments:

Camellia sinensis leaves and stems are used to manufacture green tea (non-fermented), oolong tea (partially fermented), and black tea (fermented) (4218). Leaves used for green tea are prepared immediately after harvest to limit enzymatic changes.

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