

A Closer Look at the Benefits of Green and White Tea

Robert Pastore, Ph.D.

Background

Archeological evidence suggests that tealeaves steeped in boiling water were consumed as many as 500,000 years ago. Botanical evidence indicates that India and China were among the first countries to cultivate tea. The English are known for their love of tea, Americans invented the tea bag and began the practice of drinking iced tea in the early 1900s. Today, hundreds of millions of people drink tea around the world, and studies are now suggesting that green and white tea have numerous health benefits.

The tea plant has long been cultivated in China. It is an evergreen and in either a shrub or tree form can grow to a height of 30 feet. However, it is usually maintained at a height of 2 to 3 feet by regular pruning. The shrub is heavily branched, with young hairy leaves. The parts used are the leaf bud, and the two adjacent young leaves together with the stem, broken between the second and third leaf. Older leaves are considered inferior in quality.

The plant *Camellia Sinensis* yields white, green and black tea. The production of black tea involves allowing the leaves to oxidize. During oxidation, enzymes present in the tea convert polyphenols, which possess outstanding therapeutic action, to a different compound with different pharmacological effects. Green tea is produced by lightly steaming the fresh cut leaf; therefore, oxidation doesn't take place because the steaming process inactivates these enzymes. Green tea is very high in polyphenols with potent antioxidant and anti-cancer properties. Oolong (black) tea is partially oxidized. White tea contains a higher proportion of buds, which are covered with fine 'silvery' hairs that impart a light white/grey color to the tea. White tea brews to a pale yellow/light red color, and has a slightly sweet flavor with no 'grassy' undertones sometimes associated with green tea. White tea has the most polyphenols of all types of tea.

Of the nearly 2.5 million tons of dried tea produced each year, only 20% is green tea. In other words, nearly four times as much black tea is produced and consumed compared to green tea. India and Sri Lanka are the major producers of black tea. Green tea is produced primarily in China, Japan and a few countries in North Africa and the Middle East. White tea is produced at a lower quantity. Among the most rare and expensive varieties of tea, white tea is produced almost exclusively in China.

Green Tea

The chemical composition of green tea varies with climate, season, horticultural practices, and age of the leaf (position of the leaf on the harvested shoot). The major components of interest are the polyphenols. The term polyphenol denotes the presence of multiple phenolic rings (a phenolic ring is a 6-carbon benzene ring with an

attached hydroxyl (OH) group -- also referred to as the hydroxyl functional group). The major polyphenols in green tea are flavonoids (e.g., catechin, epicatechin, epicatechin gallate, epigallocatechin gallate (EGCG), and proanthocyanidins. EGCG is viewed as the most significant active component. The leaf bud and first leaves are richest in EGCG. The usual concentration of total polyphenols in dried green tea leaves is around 8 to 12 percent.

Other compounds of interest in dried green tea leaves include caffeine (3.5 %), an amino acid known as theanine (4%), lignan (6.5 %), organic acids (1.5 %), protein (15%), and chlorophyll (0.5%).

One cup of green tea contains approximately 300 to 400 mg of polyphenols, but remember, only 8 to 12 percent of the entire cup will be polyphenols and a smaller portion will be of the most beneficial polyphenol EGCG.

Most of the studies on green tea have focused on the cancer protective aspects. Green tea polyphenols are potent antioxidant compounds that have demonstrated greater antioxidant protection than vitamins C and E in experimental studies. In addition to exerting antioxidant activity on its own, green tea may increase the activity of antioxidant enzymes. In one interesting study from the journal, *Cancer Research*, mice were fed green tea polyphenols via their drinking water for 30 days. Researchers discovered a significant increase in the activity of antioxidant and detoxifying enzymes (glutathione peroxidation, glutathione reductase and glutathione S transferase, catalase and quinone reductase) in the small intestine, liver, and lungs. Let's examine the clinical applications of EGCG and look further into the research.

Atherosclerosis

Population-based and clinical studies (population-based studies refer to studies that follow large groups of people over time and/or studies that are comparing groups of people living in different cultures or with different dietary habits, etc.), indicate that the antioxidant properties of green tea may help prevent atherosclerosis, particularly coronary artery disease (*Ann N Y Acad Sci.* 2001 Apr; 928:274-80). In clinical practice, I utilize 70% EGCG with a mixture of 90% white tea polyphenols as a potent tool in my nutritional arsenal not only as an antioxidant, but to address arterial inflammation. Highly sensitive C-reactive protein (hs-CRP) is a marker of arterial inflammation. Inflammation is also believed to play a role in heart disease; EGCG is a potent anti-inflammatory.

According to Japanese research, green tea reduces the levels of LDL or 'bad' blood cholesterol, thereby reducing the risk of coronary heart disease. Studies have found that regular consumption of tea protects against heart disease, with one study documenting that the risk was 36 per cent lower for tea drinkers (Black and green tea and heart disease: a review *Biofactors* 2000;13(1-4):127-32). It is believed that the polyphenols in tea help prevent atherosclerosis.

Preliminary research also indicates that tea polyphenols may reduce the activity of platelets, which are the clotting agents of the blood (Complex effects of different green tea catechins on human platelets. FEBS Lett 2003 Jul 10;546(2-3):265-70). This is good, because 'sticky' blood is more likely to form artery-blocking clots.

Green tea has demonstrated an ability to lower total cholesterol and raise HDL ("good") cholesterol in both animals and people. One population-based study found that men who drink green tea are more likely to have lower total cholesterol than those who do not drink green tea (Ann Epidemiol 2002 Apr;12(3):157-65). Results from one animal study suggest that polyphenols in green tea may block the intestinal absorption of cholesterol and promote its excretion from the body (J Nutr 2002 Jun;132(6):1282-8).

EGCG has been reported to inhibit lipid peroxidation, an oxidative process implicated in several pathologic conditions, including atherosclerosis (Pietta et al., 1996). Keep in mind that the oxidation of LDL-cholesterol might be associated with an increased risk of heart disease.

In a cross-cultural correlation study of sixteen cohorts, known as the Seven Countries Study, the average flavanol intake (antioxidant component of green tea) was inversely correlated with mortality rates of coronary heart disease after 25 years of follow-up (Hertog et al., 1995; Hollman et al., 1999).

Autoimmune Diseases

Dr. Stephen Hsu, a researcher at the Medical College of Georgia's School of Dentistry, suspected that there may be a link between green tea consumption and autoimmunity after noting that dry mouth, or xerostamina, an autoimmune disorder suffered by approximately 30 percent of elderly Americans, occurs in only one to two percent of Chinese people in the same age group. Autoimmune disorders occur when the immune system starts to attack the body's own tissues. They may be triggered by other health conditions, such as type 1 diabetes, rheumatoid arthritis, lupus and Sjogren's disease, and can have debilitating and even life threatening effects. Autoantigens are molecules that have useful functions, but changes in their amount or location can trigger an immune response.

The inquiry was driven by existing evidence that EGCG suppresses inflammation, caused when the immune system mounts a defense to a real or perceived enemy. By studying cells in salivary glands and skin tissue, Dr. Stephen Hsu saw that cells exposed to EGCG showed RNA and protein levels indicating autoantigen levels were suppressed in these normal cells, but not in tumor cells. More research is underway.

Cardiac Arrhythmias

A study presented at the Heart Rhythm Society's 25th Annual Scientific Sessions, held in San Francisco May 19-22, 2004, found that EGCG could help prevent the dangerous

alterations in heart rhythms known as ventricular arrhythmias, which can follow a heart attack. Ventricular arrhythmias include ventricular tachycardia and ventricular fibrillation, which are commonly associated with heart attacks or with the scarring of the heart muscle that occurred during the event.

Tea drinkers have been known to have a lower rate of death following a heart attack than those who do not drink tea. A team from the University of Heidelberg, in Heidelberg, Germany, sought to find out why. By studying frog egg cells, scientists from the University of Heidelberg found that EGCG inhibited HERG potassium channels, which are involved in cardiac repolarization. The HERG potassium channel is present in Long QT syndrome, a cardiac electrical disorder that can be inherited or caused by taking certain medications. Individuals with the disorder are susceptible to ventricular fibrillation. HERG potassium channels are also over expressed in extracardiac tumors.

Cancer

The cancer-protective effects of green tea have been reported in several population-based studies. For example, cancer rates tend to be low in countries such as Japan where green tea is regularly consumed. It is not possible to determine from these population-based studies whether green tea actually prevents cancer in people. However, emerging animal and clinical studies are beginning to suggest that EGCG may play an important role in the prevention of cancer.

It has been suggested that EGCG and other tea catechins suppress tumor promotion by inhibiting the release of tumor necrosis factor-alpha, which is believed to stimulate tumor promotion and progression of initiated cells as well as premalignant cells (Mutat Res 2003;523-524:119-125). Furthermore, EGCG was shown to reduce specific binding of both the 12-Otetradecanoylphorbol-13-acetate (TPA)-type and the okadaic acid-type tumor promoters (the two major classes of tumor-promoting agents) to their receptors. This “sealing” effect of EGCG is achieved by its interaction with the phospholipid bilayer of the cell membrane (Fujiki et al., 1999).

When non-Hodgkin’s lymphoma cells were transplanted into mice, green tea prevented 50% of the tumors from taking hold and significantly inhibited growth of the tumors (Leukemia 2000 Aug; 14(8): 1477-82).

Bladder Cancer

A few studies have examined the relationship between bladder cancer and green tea consumption. In one study that compared people with and without bladder cancer, researchers found that women who drank black tea and powdered green tea were less likely to develop bladder cancer (Nutr Cancer. 1998;31(3):151-159). A follow-up study by the same group of researchers revealed that bladder cancer patients (particularly men) who drank green tea had a substantially better 5-year survival rate than those who did not (Mutat Res. 1998 Jun 18;402(1-2):331-7).

In the February 15, 2005 issue of *Clinical Cancer Research*, researchers demonstrated that green tea extract interrupts a process that is crucial in allowing bladder cancer to become invasive. According to this study on human bladder cancer cell lines, green tea extract affects actin remodeling, an event associated with cell movement. For cancer to grow and spread, the malignant cells must be able to move in order to invade other healthy cells and eventually other organs. The cells rely on actin remodeling, which is carefully regulated by complex signaling pathways, including the Rho pathway. By inducing Rho signaling, green tea extract made the cancer cells more mature and made them bind together more closely - a process called cell adhesion. Both the maturity of the cells and the adhesion inhibited the mobility of the cancer cells.

Breast Cancer

Studies suggest that EGCG inhibits the growth of breast cancer cells, both in live animals and test tubes.

A Japanese study comparing 472 women with breast cancer who drank differing amounts of green tea indicates that EGCG may decrease both the severity of the initial diagnosis and the likelihood of recurrence (*J Cancer Res Clin Oncol*. 1999;125(11):589-97). The researchers found that the women with Stage I, II and III breast cancers that drank five or more cups of green tea per day were less likely to have cancer that spread to the lymph nodes. In addition, the greater consumption of green tea by women with Stage I or II breast cancer was associated with lower incidence of recurrence. No correlation was shown with women who had Stage III cancers. Another Japanese study showed less overall incidence of cancer among 8,000 people who drank ten or more cups of green tea a day.

Colorectal Cancer

A study at the Linus Pauling Institute at Oregon State University on mice that were genetically predisposed to develop tumors in their intestines, revealed after 12 weeks of treatment that mice that were given green tea had significantly fewer tumors than mice that received no treatment (*Carcinogenesis*, February 2003). Phenol-sulfotransferases are involved in cancer growth, and EGCG was shown to inhibit this activity in a human colon cancer cell line (*Biol Pharm Bull* 2000 Jun; 23(6):695-9).

Chinese scientists discovered that EGCG inhibits angiogenesis (the production of new blood vessels) in mice inoculated with human colon cancer (*Biomed Pharmacother* 2002; 56:296-301). This blocking of new blood vessel growth may be an important part of the overall anti-cancer action of polyphenols, since it impedes tumor growth.

Esophageal Cancer

Studies in laboratory animals have found that green tea polyphenols inhibit the growth of esophageal cancer cells (*Am J Clin Nutr* 2000;71(6 Suppl):1698S-702S;

discussion 1703S-4S). However, results of studies in people have been conflicting. In fact, some evidence suggests the hotter the tea (or any other hot beverage), the greater the risk of developing esophageal cancer. However, researchers reporting on a case-control study found that Chinese men and women who drink green tea have a reduced risk of up to 60 percent of developing esophageal cancer (Journal of the National Cancer Institute, June 1, 1994).

Lung Cancer

Consumption of green tea was found to be associated with a reduced risk of lung cancer among non-smokers. (Epidemiology 2001 Nov; 12(6): 695-700). Treatment of human lung cancer cell line A549 cells with EGCG significantly inhibited the expression levels of hnRNP B1 mRNA and the elevated levels of hnRNP B1 protein, both of which are constitutively elevated in cancer cells. Furthermore, both EGCG inhibited the promoter activity of hnRNP A2/B1 gene expression, preventing lung cancer (International Journal of Oncology 20: 1233-1239, 2002).

Pancreatic Cancer

Researchers in Japan determined whether EGCG affects proliferative and invasive activity of human pancreatic carcinoma cells. The results indicate that the growth of all three pancreatic carcinoma cells (PANC-1, MIA PaCa-2 and BxPC-3) was significantly suppressed by EGCG treatment in a dose-dependent manner. EGCG may be a potent biologic inhibitor of pancreatic carcinoma, reducing their proliferative and invasive activity (Pancreas, July 2002).

Prostate Cancer

In my opinion, EGCG is the most important component of green tea to the prostate cancer patient. The first evidence of its ability to induce prostate cancer apoptosis (programmed cell death) was published in Cancer Letters back in 1998 (130(1-2): 1-7 1998 Aug 14).

EGCG's pharmacologic activity extends beyond its action as an anti-oxidant. EGCG acts against urokinase (an enzyme often found in large amounts in human cancers), inhibits ornithine decarboxylase (a rate-limiting enzyme closely associated with tumor promotion), and blocks type 1 5-alpha reductase (5AR). Inhibitors of 5AR may be effective in the treatment of 5 alpha dihydrotestosterone-dependent abnormalities, such as benign prostate hyperplasia, prostate cancer, and certain skin diseases. Urokinase breaks down the basement membrane of cell junctions that may be a key step in the process of tumor cell metastasis as well as tumor growth. EGCG attaches to urokinase and prevents these actions.

EGCG was shown to inhibit growth and induce regression of human prostate and breast cancers in athymic mice (Liao S, Umekita Y, Guo J et al. Growth inhibition and regression of human prostate and breast tumors in athymic mice by tea

epigallocatechin gallate. Cancer Letters 96:239-243, 1995).

Skin Cancer

Studies suggest that EGCG and green tea polyphenols have anti-inflammatory and anti-cancer properties that may help prevent the onset and growth of skin tumors. Topical application of EGCG may prevent UV-B-induced immunosuppression and precancerous cell changes after UV-B exposure (J Leukoc Biol. 2001; 69:719-726). Additionally, white tea extract has been found to prevent damage to skin cells. More information on that study is found further down in this paper when I fully discuss white tea.

Stomach Cancer

Laboratory studies have found that green tea polyphenols inhibit the growth of stomach cancer cells in test tubes. The exposure of human stomach cancer KATO III cells to EGCG led to both growth inhibition and the induction of programmed cell death (apoptosis) (Oncol Rep, 5(2): 527-9 1998 Mar-Apr).

Leukemia

A study by Yean Lee, et al, (Blood, 2004; 104:788-794) looked at the effects of the main active green tea ingredient, EGCG, on chronic lymphocytic B cells isolated from leukemia patients. In the study, researchers showed that the addition of EGCG to these cells reduced the vascular endothelial growth factor (VEGF)-receptor phosphorylation. This led to the disruption of the VEGF-dependent autocrine pathway that protects the cells from apoptosis (cell death). VEGF is very important to tumor angiogenesis. Angiogenesis refers to the complex process that maintains nourishing blood flow to a biological structure, in this case a cancer cell. By the formation of new blood vessels to nourish the tumor, tumors grow and invade surrounding host tissue.

A study at the Mayo Clinic in 2003 revealed EGCG in green tea helps kill cells of the most common leukemia in the United States. The Research suggests EGCG works by inhibiting the pathway in the leukemia cells related to angiogenesis.

Components of green tea appear to have a strong inhibitory effect on the activity of the VEGF-receptor tyrosine kinase. This provides strong evidence that this inhibitory effect may have profound effects on tumors that depend on this cytokine (an inflammatory marker) for progression. This data suggests that green tea could be used in combination with other agents in addressing leukemia.

Using laboratory cell cultures, the Mayo Clinic research shows that EGCG helps kill leukemia cells by interrupting the communication signals they need to survive. The leukemia cells studied were from patients with B-cell chronic lymphocytic leukemia

(CLL)¹. The Mayo Clinic study, led by Neil E. Kay, M.D., shows that green tea's EGCG interrupted survival signals, prompting leukemia cells to die in eight of 10 patient samples tested in the laboratory.

Why Green Tea?

Mayo Clinic researchers focused on green tea for three reasons. One, since the 1970s, epidemiological studies of cancer have shown that in parts of the world where green tea is consumed, the incidence of solid tumor cancers such as breast, lung and gastrointestinal cancers is lower. Secondly, mouse-model testing of green tea's cancer-prevention properties has shown they protect against solid tumors. And third, in the laboratory, the EGCG component of green tea has been proven to induce death in cancer cells from solid tumors.

HIV/AIDS

EGCG prevents the binding of HIV to human T cells, the first step in HIV infection, according to a study and an accompanying editorial published in the November 2003 Journal of Allergy and Clinical Immunology. Researchers demonstrated that EGCG inhibited the binding of human immunodeficiency virus (HIV) to human CD4(+) lymphocytes, which is a crucial step in HIV infection. For infection to develop, the viruses need entry into CD4(+) lymphocytes, through a step dependent on adhesion to the CD4 molecule, and subsequent intracellular viral proliferation. EGCG showed a strong affinity for CD4, and by binding them, could effectively inhibit the binding of the HIV envelope (gp120). This report describes, for the first time, the inhibitory effect of EGCG in the early step of HIV infection, and it opens new perspectives for the treatment of this life-threatening disease. Additional research is necessary for the clinical application of EGCG as an anti-HIV drug.

Hope for Hairloss?

An animal study published in the Journal of the National Medical Association (vol. 97, No. 6, June 2005), found that thirty-three percent of the mice who received green tea extract in their drinking water developed hair regrowth within a period of six months. The researchers did not observe any spontaneous remission or hair regrowth among the controls. Moreover, 8% of the control rodents showed progressive hair loss during our study, whereas none of the mice who received green tea extract showed any progressive hair loss.

The control rodents developed secondary infections resultant of their extensive, progressive hair loss. The researchers concluded that anti-inflammatory and stress

¹CLL is most often diagnosed in patients in their mid-to-late 60s. Currently, there is no cure for CLL, though chemotherapy is administered in the most severe cases.

inhibitory effects of green tea polyphenols may influence hair regrowth among mice. Further studies are in progress to explore the mechanisms and factors involved in hair regrowth in association with the polyphenols in green tea.

Skin Health

Applicable research using pooled human keratinocytes (skin cells) to study the normal growth of the skin cells alone and compared it to the growth of the cells when exposed to EGCG, revealed that EGCG reactivated dying skin cells. Cells that migrate toward the surface of the skin normally live about 28 days, and by day 20, they sit on the upper layer of the skin getting ready to die and slough off. Current research seems to show that EGCG reactivates them (J Pharmacol Exp Ther 2003 306: 29-34). The skin consists of three layers: the epidermis (outer layer), dermis (mid-layer) and hypodermis (inner layer). Skin researcher Dr. Stephen Hsu, a cell biologist in the Medical College of Georgia Department of Oral Biology, learned that green tea polyphenols aren't absorbed beyond the epidermis, so any benefits are limited to that outer layer of skin. But the benefits, he stressed, seem significant.

Dr. Hsu thinks that EGCG may be a fountain of youth for skin cells. When exposed to EGCG, the old cells found in the upper layers of the epidermis appear to start dividing again. They make DNA and produce more energy. They are reactivated. In addition, the researchers found that EGCG accelerates the differentiation process among new cells.

Combining these effects of EGCG on skin cells in different layers of the epidermis, there may be potential benefits for skin conditions as diverse as aphthous ulcers, psoriasis, rosacea, wrinkles and wounds. Perhaps scar tissue could be prevented from forming with EGCG therapy. Diabetics with slow healing wounds may benefit from EGCG supplementation. As a faculty member of the American College for Advancement in Medicine who teaches an anti-aging workshop, all my patients with skin care concerns are put on EGCG.

Athletic Enhancement

A new study published in the American Journal of Physiology-Regulatory, Integrative and Comparative Physiology tested the effect of green tea extract on exercise endurance. Over ten weeks, endurance exercise performance was boosted up to 24% with green tea extract supplementation. It's important to note that EGCG alone did not have the same effect. A combination extract containing EGCG plus naturally occurring polyphenols improved endurance. Additionally, evidence indicates that the performance enhancement comes from green tea polyphenols and not caffeine.

Joint Health

Because green tea is a potent antioxidant and anti-inflammatory (it's been shown to decrease the production of inflammatory prostaglandin E2), it's a great tool to employ for patients with osteoarthritis, rheumatoid arthritis, and bursitis. Numerous

patients with arthritic complaints feel better while on EGCG, which plays a role in their tailored nutritional therapy program of diet, supplementation and exercise. Some interesting research in Europe shows that EGCG protects cartilage destruction in test-tube models of cartilage loss that mimic what happens in the arthritic joint (J Nutr, Mar 2002, 132(3) p341-6).

Inflammatory Bowel Disease (IBD)

Green tea may help reduce inflammation associated with Crohn's disease and ulcerative colitis, the two types of IBD. In addition, if green tea proves to be helpful for preventing colon cancer, this would be an added benefit for those with IBD because they are at a higher risk for the disease. In a recent study, scientists may have uncovered one of the mechanisms behind this effect. It was determined that EGCG can inhibit interleukin 8 (IL-8), a pro-inflammatory cytokine. Researchers believe their results require further study, and trials are currently underway (Cytokine 2002 Jun 7;18(5):266-73).

Diabetes

Green tea has been used traditionally to control blood sugar in the body. Animal studies suggest that green tea may help prevent the development of type 1 diabetes and slow the progression once it has developed (BMC Pharmacol, Aug 26 2004, 4(1) p18). People with type 1 diabetes produce little or no insulin, a hormone that ushers glucose (sugar) into cells. EGCG may help regulate glucose in the body because it has a slight inhibition on carbohydrate digesting enzymes.

Liver Disease

Population-based studies have shown that men who drink more than 10 cups of green tea per day are less likely to develop disorders of the liver. Green tea also appears to protect the liver from the damaging effects of toxic substances such as alcohol. Animal studies have shown that green tea helps protect against the development of liver tumors in mice.

Results from several animal and human studies suggest that EGCG may help treat viral hepatitis (inflammation of the liver from a virus - J Biomed Sci 2003 Mar-Apr;10(2):219-27, Food Chem Toxicol 2005 Feb;43(2):307-14, Cancer Lett (Ireland), Sep 10 2001, 170(1) p41-4).

Additionally, green tea has hepatoprotective qualities that include killing dangerous intestinal bacterial strains (Clostridium and Escherichia coli) and promoting the growth of friendly bacteria in the intestine; and lowering excessive iron levels in the liver that would interfere with ribavirin and interferon treatment for hepatitis C.

Neuroprotective Property

In the Journal of Neurochemistry, EGCG protected lab mice from a neurotoxin (N-methyl-4-phenyl-1,2,3,6-tetrahydropyridine) in the mouse model of Parkinson's disease.

N-Methyl-4-phenyl-1,2,3,6-tetrahydropyridine neurotoxin caused dopamine neuron loss in substantia nigra concomitant with a depletion in striatal dopamine and tyrosine hydroxylase protein levels. Pretreatment of mice with EGCG prevented these effects. In addition, EGCG increased the activities of antioxidant enzymes in the brain. The researchers believe the neuroprotective effects are due to EGCG's ability to pass the BBB (blood brain barrier) and promote antioxidant manufacture.

The researchers concluded that the brain penetrating property of green tea polyphenols, as well as their antioxidant and iron-chelating properties may make green tea compounds an important class of drugs to be developed for treatment of neurodegenerative diseases where oxidative stress has been implicated (J. Neurochem. (2001) 78, 1073-1082).

Antioxidant Properties

Researchers at the University of Kansas feel that EGCG is at least 100 times more effective than vitamin C and 25 times better than vitamin E at protecting cells and their genetic material, DNA, from damage believed to be linked to cancer, heart disease and other potentially life-threatening illnesses. EGCG carries twice the antioxidant punch of resveratrol, found in red wine.

University of Kansas researcher Dr. Mitscher says. "I'm not making any claims, but, used in conjunction with a healthful diet and exercise program, it's like an insurance policy. It [EGCG] increases your odds of avoiding or postponing diseases associated with free radicals." The early evidence of antioxidant properties of EGCG came from the experimental data that showed EGCG-induced inhibition of soybean lipoxygenase (IC₅₀ = 10 – 20 μM) (Ho et al., 1992). Later, it was reported that EGCG inhibited TPA-induced oxidative DNA base modification in HeLa cells, inhibited Cu²⁺-mediated oxidation of low density lipoprotein (LDL), reduced tert-butyl hydroperoxide-induced lipid peroxidation, and blocked the production of reactive oxygen species derived from NADPH-cytochrome P450-mediated oxidation of the cooked meat carcinogen, 2-amino-3-methylimidazo[4,5-f]quinoline (Surh, 1999).

Green tea, which is water soluble, has another advantage over vitamin E. Excessive amounts of antioxidants found in green tea are excreted by the body. The body absorbs and retains fat-based vitamins such as vitamin E, even at potentially harmful levels. Therefore, when taking EGCG, there is no potential for toxicity like there would be with fat-based vitamins such as vitamin E.

The antioxidant activity of EGCG helps tremendously to combat post muscle exercise

soreness.

Weight Loss

Studies suggest that EGCG may boost metabolism and help burn fat. In a French study, resting metabolic rate increased by 4% after 90mg of EGCG was consumed three times per day (Am J Clin Nutr. 1999 Dec;70(6):1040-5).

Scientists at the University of Chicago's Tang Center for Herbal Medicine Research have found that EGCG caused rats to lose up to 21 percent of their body weight. Rats injected with EGCG derived from green tea leaves lost their appetites and consumed up to 60 percent less food after seven days of daily injections. EGCG seems to desensitize leptin receptors (leptin may play a role in appetite) in the study animals (Endocrinology, March 2003). Researchers suspect that EGCG may work through other hormonal systems that control appetite and body weight that we don't know about yet.

I recommend EGCG as part of my weight loss protocols due to the thermogenesis (fat burning) increase that occurs with EGCG supplementation. The three theories of EGCG assisted weight loss are increasing metabolic rate, preventing the digestion of some carbohydrate (akin to a “starch blocker” effect), and reducing appetite. I have noticed an increase in my own metabolic rate since regularly taking 70% EGCG with 90% white tea polyphenols. I noticed beneficial effects in my weight loss clients with some saying that they note a reduction in appetite.

In the current marketplace, EGCG is rapidly replacing ephedra as a weight loss supplement.

White Tea

White tea dates back as far as the T'ang Dynasty (618-907 AD) and soon became the choice of royal courts. White tea did not undergo much change until 1885 when specific varietals of tea bushes were selected to make Silver Needle and other specialty white teas. Chinese exportation of these fine teas began in 1891.

If you are drinking tea for your health, you may want to consider white tea, known mostly to tea connoisseurs. There is also considerably less caffeine in white tea than the other varieties (15mg per serving, compared to 40mg for black tea, and 20mg for green).

Some teas are processed more than others. White tea is rapidly steamed and dried, leaving the leaves “fresh.” Green tea, composed of mainly leaves, is steamed or fired prior to being rolled. Oolong and black teas get their dark color and flavor from additional processing.

Cancer

White tea may have the strongest potential of all teas for fighting cancer, according to Oregon State University researchers at the Linus Pauling Institute. They presented the first research ever on white tea at a national meeting of the American Chemical Society on March 29, 2004. The theory at the Linus Pauling Institute was that white tea might have high levels of polyphenols. Researchers at the Linus Pauling Institute tested four types of white tea for their ability to inhibit mutations in bacteria, and subsequently examined the protective properties in a rat colon cancer model. In the former studies using bacteria, white teas were generally more effective than green tea in inhibiting mutagenicity (mutagenicity is a result of unrepaired/misrepaired DNA damage and an early step in the process leading to cancer). White teas contained many of the expected polyphenols, some of which were present at higher concentrations than in green tea brewed under the same conditions.

In the study, rats were given white tea (tea was brewed for 5 min, using 2g/100ml hot water) in the drinking water for up to 8 weeks. A second group was given the equivalent amount of caffeine alone. In weeks 3 and 4, animals were given a carcinogen. After 2 weeks of treatment, and prior to exposure to the carcinogen dosing, enzyme changes were detected in the liver, white tea being slightly more effective in this regard than caffeine alone. Overall, the altered enzyme profiles, and profiles of metabolites excreted in the urine, suggested that the carcinogen was more rapidly metabolized and detoxified. At the end of the study, rats given white tea had significantly fewer carcinogen-induced pre-cancerous lesions in the colon (called aberrant crypt foci, or ACF).

The data indicates that white tea, like other forms of tea, can block the DNA damage caused by some compounds using a test tube assay with bacteria as indicator organisms. Animal studies in which inhibition of colon tumor formation has been demonstrated cannot be simply extrapolated to protection in people. Linus Pauling researchers are now planning further studies with white tea in animal models (rats, mice, trout), and in a pilot human trial.

Immune System

A study at University Hospitals of Cleveland and Case Western Reserve University revealed that white tea extract protected against obliteration of the Langerhans cells. In the immune system, the Langerhans cells in the outer layer of the skin (epidermis) are the outermost reach of the immune system, and are the first to be exposed to foreign agents. They are thought of as 'watchdog cells', essential in detecting germs and mutated proteins produced by cancerous cells. However, because of their location, the Langerhans cells are very sensitive to damage by sunlight. The researchers tested whether the preserved immune system cells in the white tea extract-protected skin would still function properly after exposure to sunlight. They discovered the immune function was indeed restored by the extract. They also found that the DNA damage that can occur in cells after exposure to

sunlight was limited in the skin cells protected by the white tea extract.

Anti-ageing

Researchers from Case Western Reserve University believe the antioxidant properties of the white tea extract are the effective agent. After extensive research, the Case Western Reserve University concluded that the same process of oxidative stress in skin cells that leads to immune system damage (as discussed in the “immune system” section above) can also promote skin cancer and photo damage, such as wrinkling or mottled pigmentation. The DNA damage that can occur in cells after exposure to sunlight was limited in the skin cells protected by the white tea extract. Therefore, the researchers believe that that white tea may provide anti-ageing benefits.

White Tea Fights Germs

Studies conducted at Pace University have indicated that White Tea Extract (WTE) may have prophylactic applications in retarding growth of bacteria that cause Staphylococcus infections, Streptococcus infections, pneumonia and dental caries. Researchers presented these findings at the 104th General Meeting of the American Society for Microbiology.

"Past studies have shown that green tea stimulates the immune system to fight disease," says Milton Schiffenbauer, Ph.D., a microbiologist and professor in the Department of Biology at Pace University's Dyson College of Arts & Sciences and primary author of the research. "Our research shows White Tea Extract can actually destroy in vitro the organisms that cause disease. Study after study with tea extract proves that it has many healing properties. This is not an old wives tale, it's a fact." White tea is very effective at inactivating bacterial viruses. Results obtained with the bacterial virus, a model system, suggest that WTE may have an anti-viral effect on human pathogenic viruses. Studies have also indicated that WTE has an anti-fungal effect on *Penicillium chrysogenum* and *Saccharomyces cerevisiae*. In the presence of WTE, *Penicillium* spores and *Saccharomyces cerevisiae* yeast cells were totally inactivated. It is suggested that WTE may have an anti-fungal effect on pathogenic fungi.

Several findings in the new study are of particular interest:

- * The anti-viral and anti-bacterial effect of white tea is greater than that of green tea.
- * The anti-viral and anti-bacterial effect of several toothpastes including Aim, Aquafresh, Colgate, Crest and Orajel was enhanced by the addition of white tea extract.
- * White tea extract exhibited an anti-fungal effect on both *Penicillium chrysogenum* and *Saccharomyces cerevisiae*.
- * White tea extract may have application in the inactivation of pathogenic human microbes, i.e., bacteria, viruses, and fungi.

*****EGCG should not be used during pregnancy, and is contraindicated with seizure disorders and coumadin.

References

1. Anderson JW, Diwadkar VA, Bridges SR. Selective effects of different antioxidants on oxidation of lipoproteins from rats. *Proc Soc Exp Biol Med.* 1998 Sep;218(4):376-81.
2. Benzie IF, Szeto YT, Strain JJ, Tomlinson B. Consumption of green tea causes rapid increase in plasma antioxidant power in humans. *Nutr Cancer.* 1999;34(1):83-7.
3. Dulloo AG, Duret C, Rohrer D, Girardier L, Mensi N, Fathi M, Chantre P, Vandermander J. Efficacy of a green tea extract rich in catechin polyphenols and caffeine in increasing 24-h energy expenditure and fat oxidation in humans. *Am J Clin Nutr.* 1999 Dec;70(6):1040-5.
3. Dulloo AG, Seydoux J, Girardier L, Chantre P, Vandermander J. Green tea and thermogenesis: interactions between catechin-polyphenols, caffeine and sympathetic activity. *Int J Obes Relat Metab Disord.* 2000 Feb;24(2):252-8.
4. Graham HN. Green tea composition, consumption, and polyphenol chemistry. *Prev Med.* 1992 May;21(3):334-50.
5. Gupta S, Ahmad N, Mohan RR, Husain MM, Mukhtar H. Prostate cancer chemoprevention by green tea: in vitro and in vivo inhibition of testosterone-mediated induction of ornithine decarboxylase. *Cancer Res.* 1999 May 1;59(9):2115-20.
6. Hasegawa R, Chujo T, Sai-Kato K, Umemura T, Tanimura A, Kurokawa Y. Preventive effects of green tea against liver oxidative DNA damage and hepatotoxicity in rats treated with 2-nitropropane. *Food Chem Toxicol.* 1995 Nov;33(11):961-70.
7. Hirose M, Hoshiya T, Akagi K, Futakuchi M, Ito N. Inhibition of mammary gland carcinogenesis by green tea catechins and other naturally occurring antioxidants in female Sprague-Dawley rats pretreated with 7,12-dimethylbenz[alpha]anthracene. *Cancer Lett.* 1994 Aug 15;83(1-2):149-56.
8. Kao YH, Hiipakka RA, Liao S. Modulation of endocrine systems and food intake by green tea epigallocatechin gallate. *Endocrinology.* 2000 Mar;141(3):980-7.
9. Lin JK, Liang YC, Lin-Shiau SY. Cancer chemoprevention by tea polyphenols through mitotic signal transduction blockade. *Biochem Pharmacol.* 1999 Sep 15;58(6):911-5.
10. Muramatsu K, Fukuyo M, Hara Y. Effect of green tea catechins on plasma cholesterol level in cholesterol-fed rats. *J Nutr Sci Vitaminol (Tokyo).* 1986 Dec;32(6):613-22.
11. Sato D. Inhibition of urinary bladder tumors induced by N-butyl-N-(4-hydroxybutyl)-nitrosamine in rats by green tea. *Int J Urol.* 1999 Feb;6(2):93-9.
12. Satoh K, Sakagami H. Ascorbyl radical scavenging activity of polyphenols. *Anticancer Res.* 1996 Sep-Oct;16(5A):2885-90.
13. Sayama K, Lin S, Zheng G, Oguni I. Effects of green tea on growth, food utilization and lipid metabolism in mice. *In Vivo.* 2000 Jul-Aug;14(4):481-4.
14. Schubert SY, Lansky EP, Neeman I. Antioxidant and eicosanoid enzyme inhibition properties of pomegranate seed oil and fermented juice flavonoids. *J*

Ethnopharmacol. 1999 Jul;66(1):11-7.

15. Tanaka H, Hirose M, Kawabe M, Sano M, Takesada Y, Hagiwara A, Shirai T. Post-initiation inhibitory effects of green tea catechins on 7,12-dimethylbenz[a]anthracene-induced mammary gland carcinogenesis in female

Sprague-Dawley rats. *Cancer Lett.* 1997 Jun 3;116(1):47-52.

16. Wang ZY, Huang MT, Ho CT, Chang R, Ma W, Ferraro T, Reuhl KR, Yang CS, Conney AH. Inhibitory effect of green tea on the growth of established skin papillomas in mice. *Cancer Res.* 1992 Dec 1;52(23):6657-65.

17. Weisburger JH, Rivenson A, Aliaga C, Reinhardt J, Kelloff GJ, Boone CW, Steele VE, Balentine DA, Pittman B, Zang E. Effect of tea extracts, polyphenols, and epigallocatechin gallate on azoxymethane-induced colon cancer. *Proc Soc Exp Biol Med.* 1998 Jan;217(1):104-8.

18. Xu Y, Ho CT, Amin SG, Han C, Chung FL. Inhibition of tobacco-specific nitrosamine-induced lung tumorigenesis in A/J mice by green tea and its major polyphenol as antioxidants. *Cancer Res.* 1992 Jul 15;52(14):3875-9.

19. Yang TT, Koo MW. Chinese green tea lowers cholesterol level through an increase in fecal lipid excretion. *Life Sci.* 2000;66(5):411-23.

20. Yang TT, Koo MW. Hypocholesterolemic effects of Chinese tea. *Pharmacol Res.* 1997 Jun;35(6):505-12.

21. Zhu M, Gong Y, Ge G. Effects of green tea on growth inhibition and immune regulation of Lewis lung cancer in mice. *Chung Hua Yu Fang I Hsueh Tsa Chih.* 1997 Nov;31(6):325-9.

22. Khan SG, et al.: Enhancement of antioxidant and phase II enzymes by oral feeding of green tea polyphenols in drinking water to SKH-1 hairless mice: Possible role in cancer chemoprevention. *Cancer Res* 52- 4050-4052, 1992.

23. Kawai K, et al. Elements of green tea prevent HIV from binding to human T cells, November 2003 *Journal of Allergy and Clinical Immunology*.

24. Yona Levites, Orly Weinreb, Gila Maor, Moussa B. H. Youdim, Silvia Mandel, Green tea polyphenol epigallocatechin-3-gallate prevents N-methyl-4-phenyl-1,2,3,6-tetrahydropyridine-induced dopaminergic neurodegeneration, *Journal of Neurochemistry*, 2001, 78, 1073-1082.