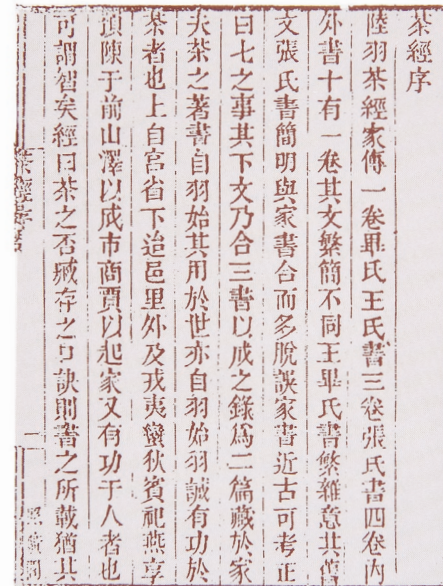




Health Benefits of Tea Drinking

Tea (*Camellia sinensis*) originate from Southern China and is consumed by over two thirds of the world population. The benefits of tea drinking in both aspects of mental and physical health have been discussed for thousands years in China and many other countries where the tea is consumed. The book of “ Tea sutra:Cha-Kyou(茶經);” a sample of which is shown on the right, is one instance. In 1211, a Zen priest, Eisai(榮西) in his book “ Kissa-jojoki (喫茶養生記)” explained about the effectiveness of green tea for maintaining good health and prolonging life. With the advance of modern chemistry, components of tea have been analyzed and the health benefits argued in the past have been attributed to the tea elements(see the table below)

"Tea sutra:Cha-Kyou"(written by Lu Yu in)



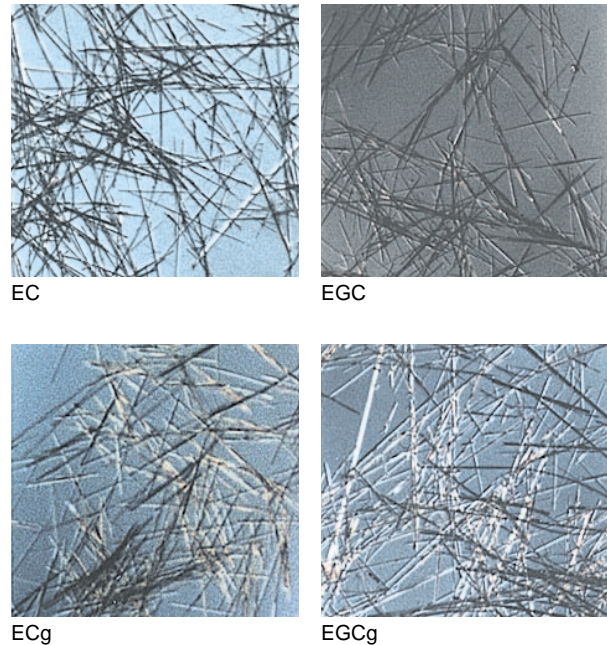
Physiological functions of green tea components

Green tea components	Contents(per dry weight)	Functions
Catechins	10 ~ 18 %	Anti-oxidative Radioprotective Anti-mutagenic Anti-tumor Enzyme inhibitory Anti-hypercholesterolemic Anti-hyperglycemic Fat reducing Anti-hypertensive Anti-ulcer Anti-bacterial Bowel modulating Anti-viral Anti-cariious etc.
Caffein	3 ~ 4 %	Removal of fatigue and sleepy feeling Diuretic
Vitamin C	150 ~ 250 mg %	Removal of stress Cold prevention
Vitamin B	1.4 mg %	Excitometabolic action of carbohydrates and amino acids
-amino butyric acid	0.1 ~ 0.2 %	Anti-hypertensive
Flavonoids	0.6 ~ 0.7 %	Halitosis prevention
Polysaccharide	0.6 %	Anti-hyperglycemic
Fluorine	4 ~ 190 mg %	Anti-cariious
Vitamin E	25 ~ 70 mg %	Anti-oxidative Aging prevention
Theanine	0.6 ~ 2 %	Anti-hypertensive

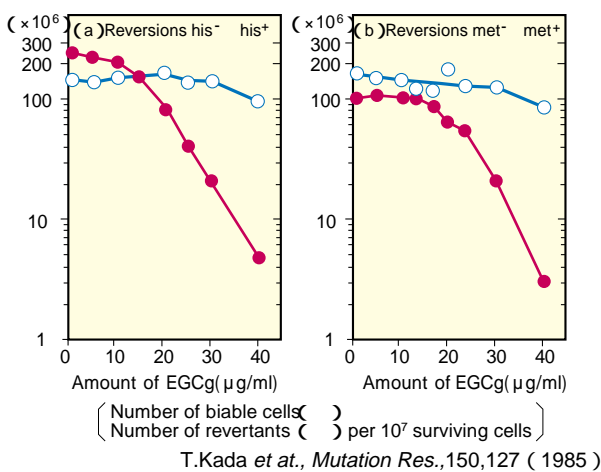
Catechins

Tea catechins are responsible for the astringent taste of green tea. Catechins of green tea leaves are account for about 10 % of dry weight, including (-)-epigallocatechin gallate (EGCg) 50 %, (-)-epigallocatechin (EGC) 30 %, (-)-epicatechin gallate (ECg) 10 % and (-)-epicatechin (EC) 10 %. Crystals of catechins are sampled in the photographs on the right. A variety of biological activities are attributed to anti-oxidative, radioprotective, anti-mutagenic, anti-tumor, anti-hyperglycemic, anti-hypercholesterolemic, fat reducing, anti-ulcer, anti-bacterial, bowel modulating, anti-viral, anti-cariou, anti-hypertensive actions and the inhibitory activity of some enzymes.

Crystals of tea catechins



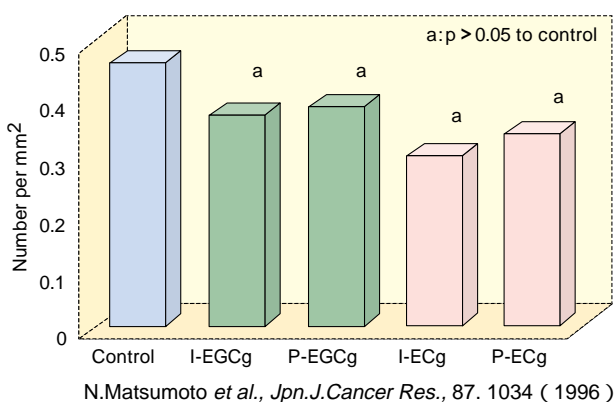
Effect of EGCg on the survival and mutability in the strain B, subtilis NIG 1125 (his met)



Cancer Chemoprevention

Recently, some review articles have reported the relationship between the tea consumption and the human cancer risk. A general overview of the pertinent epidemiological studies on tea consumption and cancer prevention in different organs such as bladder and urinary tract, breast, colon and rectum, esophagus, kidney, liver, lung, pancreas, stomach, and uterus is provided. These studies indicated that the green tea reduced human cancer risk in some cases. Catechins of tea are bio-antimutagens, and reduced the high spontaneous mutations due to altered DNA-polymerase III in a mutator strain of *Bacillus subtilis* (see figure left). Because of their antimutagenic activities, the tea catechins show various anti-tumor actions, too. For example, catechins significantly decreased the number and the area of preneoplastic glutathione S-transferase placental positive foci-form in the liver (see figure left). These results suggest that the tea catechins have a chemopreventive activity against cancer of the liver.

Number of GST-P positive foci in the liver

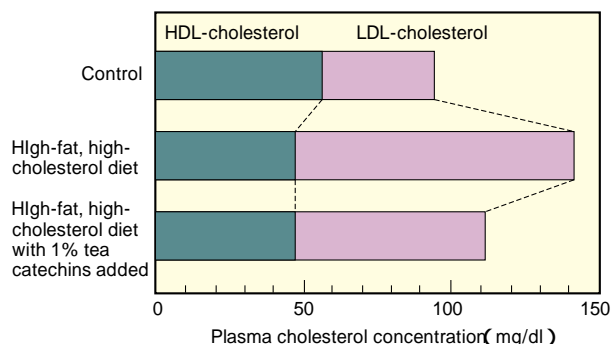


Health Benefits of Tea Drinking

Anti-Hypercholesterolemic Activity

In order to prevent cardiovascular diseases such as heart attack or brain stroke, it is very important to keep the cholesterol level in the blood within the normal range. The administration of tea catechins to rats was proved to suppress excessive rise of cholesterol concentration in the blood. As shown in figure right, addition of 1 % catechins to diet also suppressed the rise of total cholesterol concentration and particularly LDL-cholesterol concentration. The results demonstrate that tea catechins exert a hypercholesterolemic effect in cholesterol-fed rats.

Hypercholesterolemic effect of tea catechins

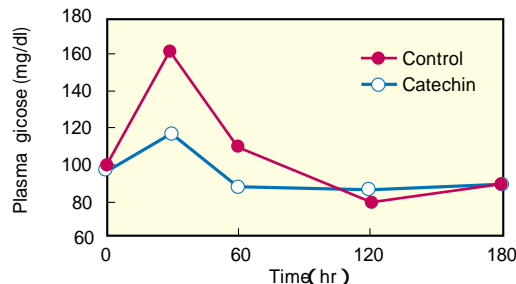
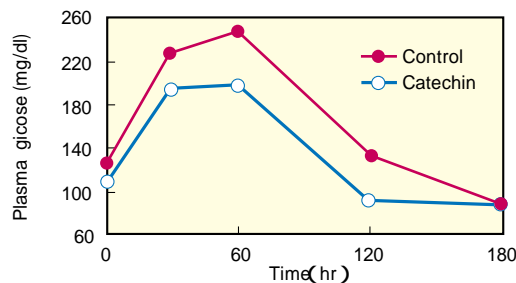


K.Muramatsu *et al.*, *J.Nutr. Sci. Vitaminol.*, 32, 613 (1986)

Anti-Hyperglycemic Activity

In our present affluent society, obesity and diabetes are serious problems, both of which are bases of various complicated disorders. In the both diseases, a well-programmed dietary control is crucial. Constantly higher concentrations of glucose in the blood renders the vein wall fragile and causes such various disorders as renal failure, heart attack, stroke, and high blood pressure. Tea catechins exhibit inhibitory behaviors on digestive enzymes such as α -amylase and sucrase. The administration of tea catechins to human was proved to suppress an excessive rise of plasma glucose concentration after starch or sucrose intake (figure right)

Effect of tea catechin on plasma glucose

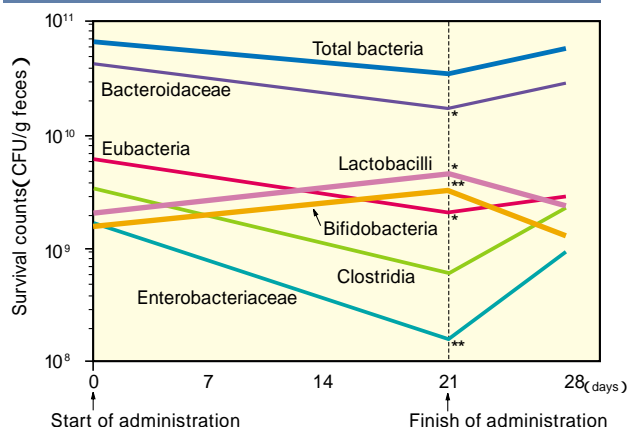


M,Sasaki *et al.*, *Shokuhin Kogyo*, 38 (No.8) , 77 (1985)

Bowel Modulating Activity

Intestinal flora of human is composed of 100 trillion viable bacteria belonged to 100 different species. The condition of the intestinal flora influences many factors pertaining to the host's health and vice versa. These factors include infection, immune response, cancer aging, physiological function, effect of medicines, nutrition. Significant changes in fecal flora (see figure right) and fecal odorous parameters were noted after administering tea catechins, indicating marked improvement of fecal conditions and the reduction of fecal odors.

Effect of green tea catechin administration (300 mg/day) on fecal flora of 15 human volunteers



Graph is expressed as mean \pm SD.

*, **, Significant difference (* $p < 0.05$. ** $p < 0.01$) from the value of day 0 (before the administration) .

K.Goto *et al.*, *Annals of Long-Term Care* 5(2),43(1998)

Caffeine

Caffeine, 1,3,7-trimethylxanthine, is widely distributed in natural products, i.e. tea, coffee, cocoa and as an additive in many soft drinks. During preparation of coffee and tea, the strength of brew influences the caffeine content of the beverage. Standard average caffeine contents per cup of these beverages are listed right.

As normally ingested from food sources, caffeine shows a variety of biological effects those have attracted the interest of pharmacologist and clinicians. Caffeine is regard as follows;

- Diuretic
- Cardiac muscle stimulant
- Central nervous system stimulant
- Smooth muscle relaxant
- Elevates free fatty acids and glucose in plasma

Effect on Sleep

Much interest also has been concerned in the possible role of caffeine intake to central nervous system. In adults, the most sensitive function modified by caffeine is going to sleep. In one experiment, caffeine or placebo was taken blindly 0.5 hr before retiring, and the time of going to sleep was assessed by questionnaires next morning. Sleep postponement in adults has been detected following ingestion of about 100 mg caffeine 0.5 hr before retiring, but not at lower intakes.

Effect on Spontaneous Motor Activity

Using mice as an animal model, Sagesaka et al. showed that a single oral administration of caffeine at the dose of 4 mg/kg increased the number of revolutions of the tread wheel at 30 min intervals, suggesting that caffeine induced the spontaneous motor activity in mice.

Dietary sources of caffeine and related compounds

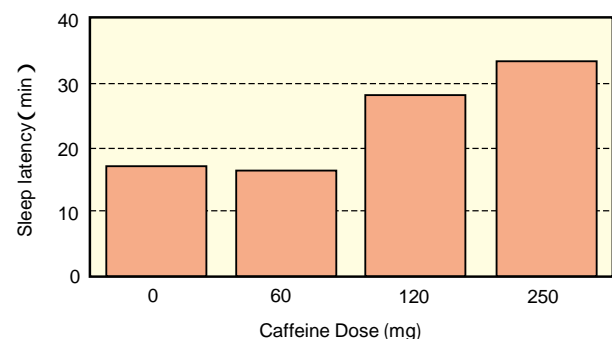
Beverage	Amount	Amount
Coffee	1 cup ^a	85 mg Caffeine
Tea	1 cup ^b	50 mg Caffeine
		2 mg Theobromine
		1 mg Theophylline
Cocoa	1 cup ^a	5 mg Caffeine 250 mg Theobromine
Cola Beverage	1 oz. ^b	4 mg Caffeine

(D.M.Graham,*Nutr.Rev.*,36,97-102(1978))

^a Depends on strength of brew.

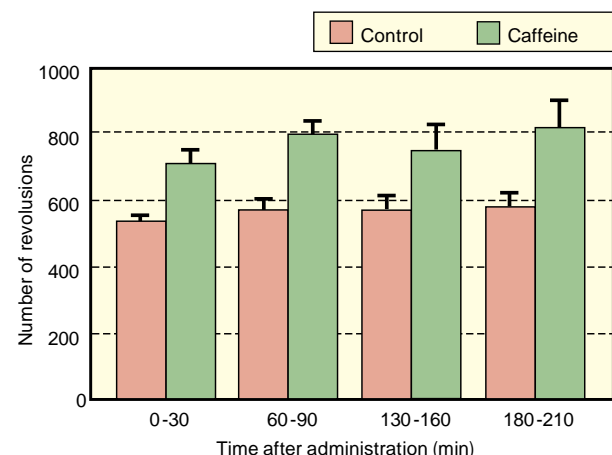
^b About one-half from cola beans and one-half from added caffeine; a common portion size is 10 oz providing 40 mg caffeine.

Dose-response effect of caffeine on sleep latency



(L.J.Dorfman & M.E.Jarvik, *Clin.Pharmacol. Ther.*11,869-872(1970))

Effect of caffeine administration on spontaneous motor activity of mice



Significant difference between control and caffeine was observed.

(Y.Sagesaka, *et al.*, in Proceedings of the International Symposium on Tea Science, Shizuoka,253-257(1991))

Health Benefits of Tea Drinking

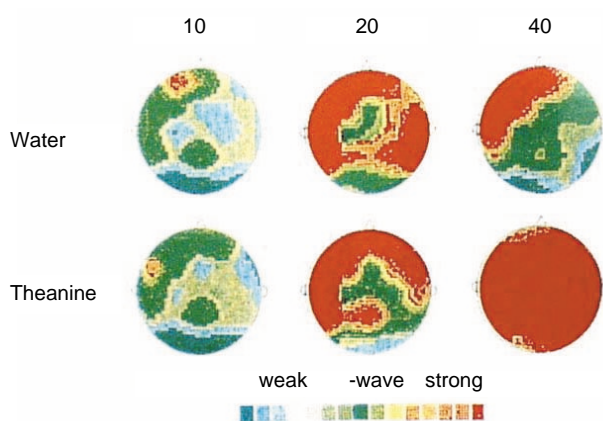
Theanine

Japanese green tea contains γ -glutamylethylamide, named theanine, at the level from 1 to 2 % in dried leafy materials. While most amino acids are found at lower level, theanine accounts for > 50 % of total free amino acids in tea. Theanine is the source of Japanese green tea's characteristic delicious taste (known as "umami"). There is a scientific interest about the biological effect of theanine on central nervous system.

Relaxation Effect

The relaxation feeling after drinking Japanese green tea may be linked with the presence of theanine. Studies on animals and human volunteers showed that oral administration of theanine generated α -waves in the brain, suggesting that theanine could bring about a relaxation feeling, because brain α -waves are generated under relaxing condition.

Changes in appearance of the α -brain wave

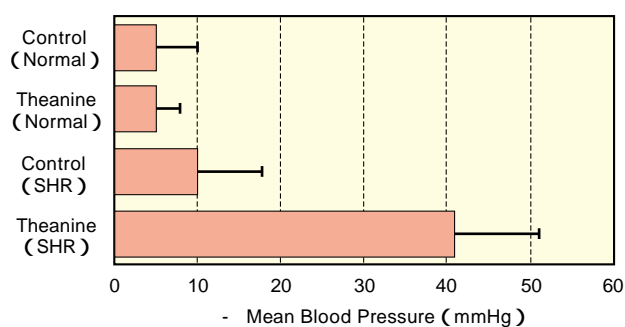


(Kobayashi, *et al. Nippon Nogeikagaku Kaishi*, 72, 153-157(1998))
 Difference in the appearance and the strength of the α -wave become clearer 40 min after the intake of a theanine solution (200 mg/100 ml water).

Effect on Blood Pressure

When theanine was orally administered to spontaneously hypertensive rats (SHR), their blood pressure was decreased in a dose dependent manner. However no reducing effect of theanine on the blood pressure of normal rats was observed.

Effect of theanine on mean blood pressure in normal and spontaneous hypertensive rats (SHR)



(H. Yokogoshi, *et al. Biosci. Biotechnol. Biochem.* 59, 615-618(1995))

Saponins

Saponins separated from tea seed have long been utilized as an emulsifier in the manufacturing of photo film. Some major saponins from seed and fresh leaves of green tea have so far identified. Recently pharmacological studies on tea seed saponins and tea leaf saponins demonstrated anti-influenza, anti-inflammatory, anti-microbial, neutrophil stimulating and anti-allergic function of these substances.

All over the world, influenza is a special threat to the aged, and infants with high mortality rates. Inactivation of influenza viruses by tea-seed saponins has been considered efficient in the prevention and therapy of influenza.

Water Soluble Macromolecules

Green tea contains various water soluble macromolecules. GTND (green tea non-dialysate) is one of these (molecular weight more than 12,000) GTND has anti-tumor function. GTND suppressed duodenal tumors in mice induced by ENNG (*N*-ethyl-*N*'nitro-*N*-nitrosoguanidine) (Figure on the right) When 0.05 % GTND was administered to mice in the drinking water, the number of mice with tumors, the number of total tumors, the number of tumors per one mouse and the weight of tumor were suppressed compared with controls. The number of total tumors was suppressed significantly. No suppression was observed when the level of GTND was reduced by 0.005 %.

Hetero-polysaccharides are other water soluble macromolecules of green tea that showed anti-glycemic action.

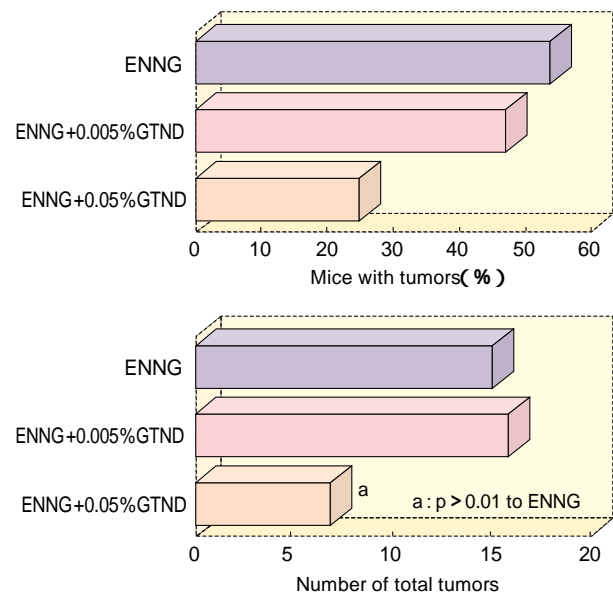
Flavonoids

Flavonoids, including more than 4,000 known individual compounds, are polyphenolic substances isolated from various plants. Beside catechins, Japanese green tea also contains other flavonoids, such as kaempferol, quercetin, myricetin and their glycosides derivatives. Flavonoids are found to have halitosis preventing effect, protective effects against lipid peroxidation of membranes, anti-mutagenic

Antioxidant Vitamins

Japanese green tea leaves are rich in antioxidant vitamins, such as vitamin C, vitamin E and β -carotene. In addition to antioxidative activity, these vitamins have anti-tumor effects and suppress aging. Commercial Japanese green tea leaves contain vitamin C approximately 280 mg per 100 g dried weight. By administration of vitamin C to rats, lipid peroxidation of liver was decreased. Vitamin C has also antimutagenic effect. Japanese green tea leaves

Effect of GTND on the incidence and the number of duodenal tumors



ENNG : *N*-ethyl-*N*-nitro-*N*-nitrosoguanidine
GTND : green tea non-dialysate

K.Nakamura.Proceedings of "ocha no power",p.22 Shizuoka(1998)

function, inhibition of tumor-promoting activity, inhibition of lipoxygenase and phospholipase, inhibition of histamine release, antihypertensive effects, antifungal, antiviral, antioxidative, hypocholesterolemic and diuretic functions. Therefore it appears that flavonoids can contribute significantly to the benefit of human health.

contain about 70 mg of vitamin E per 100 g dried weight. Vitamin E suppresses the peroxide lipid synthesis. β -carotene has a radical scavenging function which prevents skin cancer. Vitamin E and β -carotene are water insoluble matter. In order to ingest vitamin E and β -carotene, eating whole tea leaves as Matcha is necessary.