

Health and Longevity Through Chai: The Wonder Beverage



International Life Sciences Institute-India

PREFACE

Tea is the most consumed beverage after water. Most people drink tea because it is refreshing with a seductive aroma. Tea does more than that. It is a functional food that has extensive health benefits which can be made most of if tea is consumed in right quantities, in right ways and at right times.

The health benefits of tea have been known for quite some time though it is only recently that they have been scientifically proved. With science and technology, it has been possible to identify the different compounds in tea and to establish the link between tea and its health benefits.

There has been considerable scientific investigation to establish the health benefits of tea. ILSI-India tracked the research done by renowned institutions and universities in a number of countries, more particularly India, Japan and Italy. There is undoubtedly a common view that tea contains useful compounds that can fight disease.

Tea contains many times more antioxidants than fruits and vegetables. Antioxidants detoxify the cell damaging free radicals and enable longevity. The polyphenols found in tea can fight cancer. Evidence is also high about tea reducing the risk of CVD and stroke. It has also been confirmed that tea enhances immunity.

To discuss and identify the numerous health benefits of tea, a Conference on 'Health and Longevity through Chai: the Wonder Beverage' was organized by ILSI-India in collaboration with National Institute of Nutrition, National Tea Research Foundation and Tea Board, Ministry of Commerce, Government of India.

It has been the endeavor of ILSI-India to deliver science to the people to promote public health. Tea has been found to be a wonder beverage which has significant health benefits. This Monograph puts together evidence based research findings from different projects to bring out comprehensively the different health benefits of tea. The intention is to reach out to the people to use tea not as another beverage but as a respectable health drink. I appreciate the inputs given by Ms. Swapna Chaturvedi, Dietician, All India Institute of Medical Sciences and Ms. Rekha Sinha, Executive Director, ILSI-India for their contributions in preparing this monograph.

I would like to express my gratitude to the scientists who made presentations at the Conference. The research behind the findings was undoubtedly painstaking but has been worthwhile since it would immensely benefit a large section of people. We received support and expertise from Brook Bond Tea Council, DSM Nutritional Products India Pvt. Ltd. and Synthite Industries Ltd. for which I am grateful.



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INTRODUCTION

TEA is a traditional beverage consumed in many countries for centuries. . The health benefits associated with TEA have fascinated the scientific community – national and international – leading to research to identify the components and their functions that make TEA “the wonder beverage”.

Although health benefits of TEA were recognized ages ago , it is only recently, with the advancement of science and technology, that the different compounds in TEA could be identified and the scientific underpinning behind the health benefits better understood.

The benefits range from reducing the risk of cardio vascular diseases, type 2 diabetes, antiviral and germicidal activities to weight management, cancer risk reduction, and mental alertness properties.

Research on health benefits of TEA assumes considerable significance as it is a popular beverage and could be considered as an important vehicle to deal with the rising incidence of non communicable diseases like diabetes or cardiovascular diseases.

To discuss the latest in science behind this wonder beverage, ILSI-India organized a conference on “Health and Longevity Through Chai: the Wonder Beverage”. The Conference was organized in collaboration with National Institute of Nutrition, National Tea Research Foundation, and Tea Board, Ministry of Commerce, Government of India.

This monograph is based on presentations made at the conference but is not a summary of the presentations. It aims to reach out to the larger health care community and public and convey that TEA is a wonder beverage through which health and longevity can be achieved.

SECTION ONE

BASIC FACTS ABOUT TEA AND ITS COMPONENTS

1. TEA-History And Processing

TEA has charmed people, particularly the East, for the last 5000 years. It is nature's low calorie wonder drink, second only to water. This aromatic beverage is prepared from the leaves and buds of a plant called *Camellia sinensis*. The beverage has been described as relaxing, refreshing, invigorating and health promoting.

TEA is believed to have originated in China. The common terms for TEA used all over the world, "teh" and "cha", are of Chinese origin. The Chinese emperor, Shen-Nung (2737 BC) is credited with the discovery of the fine aroma of leaves that fell accidentally into boiling water while sitting under a tree. These leaves were later identified as wild TEA.

2. Cultivation And Harvesting of TEA

The plants brought from China to India by the British did not last for long while the local TEA plants with thick leaves traditionally grown in Assam were found to be very promising in growth trials in Assam, the Himalayas and the South Indian hills. These were subsequently grown in several areas. Large scale TEA cultivation in India started in the 19th century, especially in the North Eastern region. In South India, commercial TEA planting started in 1859 in the Nilgiris. Today India has 521,500 ha under TEA and the major TEA growing states are Assam, West Bengal, Tamil Nadu and Kerala.

There are two main varieties of TEA, the smaller leaf China variety (*Camellia sinensis* var. *sinensis*), typically used for Green TEA manufacture, and the larger leaf Assamica variety (*Camellia sinensis* var. *assamica*), typically used in Black TEA manufacture. The 3,000 varieties of TEA which exist, result from breeding and differences such as climate, region and soil conditions. Different names from the region of origin

and traditional names are also given to some TEAs. Indian and Ceylon TEAs are usually named after the region of origin: Darjeeling, Assam, Ceylon, etc. Chinese and Japanese TEAs have their traditional Japanese or Chinese names. Some of the traditional names are related to region of TEA production, TEA processing, and quality standard.

Under natural conditions TEA plants grow into trees and if left unpruned may reach a height of 30-50 feet. For commercial production, however, they are brought into bush form, both for the convenience of harvesting and for getting TEA of high quality. TEA is made from the tender shoots, consisting of 2 to 3 leaves and a bud. These shoot are harvested at 7 to 10 days interval, depending on the weather and other conditions. The TEA bushes are pruned once in four to five years to reduce their height and to revitalize them. Unique TEA plant cultivars are used exclusively in the making of different types of TEA.

In many countries, including India, TEA plantations are grown under shade trees, which help in the conservation

of moisture, reduce temperature and provide organic matter through leaf litter.

3. Processing Of TEA

After picking, the leaves of *Camellia sinensis* soon begin to wilt and oxidize, unless they are immediately dried. The leaves turn progressively darker as their chlorophyll breaks down and tannins are released. This *enzymatic oxidation* process, known as *fermentation* in the TEA industry, is caused by the

plant's intracellular enzymes and causes the TEA to darken. In TEA processing, the darkening is stopped at a predetermined stage by heating, which deactivates the enzymes. In the production of black TEAS, the halting of oxidization by heating is carried out simultaneously with drying.

4. TEA Production

Assam, West Bengal, Tamil Nadu and Kerala are the major TEA growing states of India. Other states include Darjeeling, Terai, Tripura, Himachal Pradesh, Nagaland, Manipur, Arunachal Pradesh, and Karnataka.

India with more than 520,000 hectares under TEA is a major producer today (966 million kg per year) next only to China (1370 million kg). The total world production of TEA was 4066 million Kg in 2010(Fig.1).

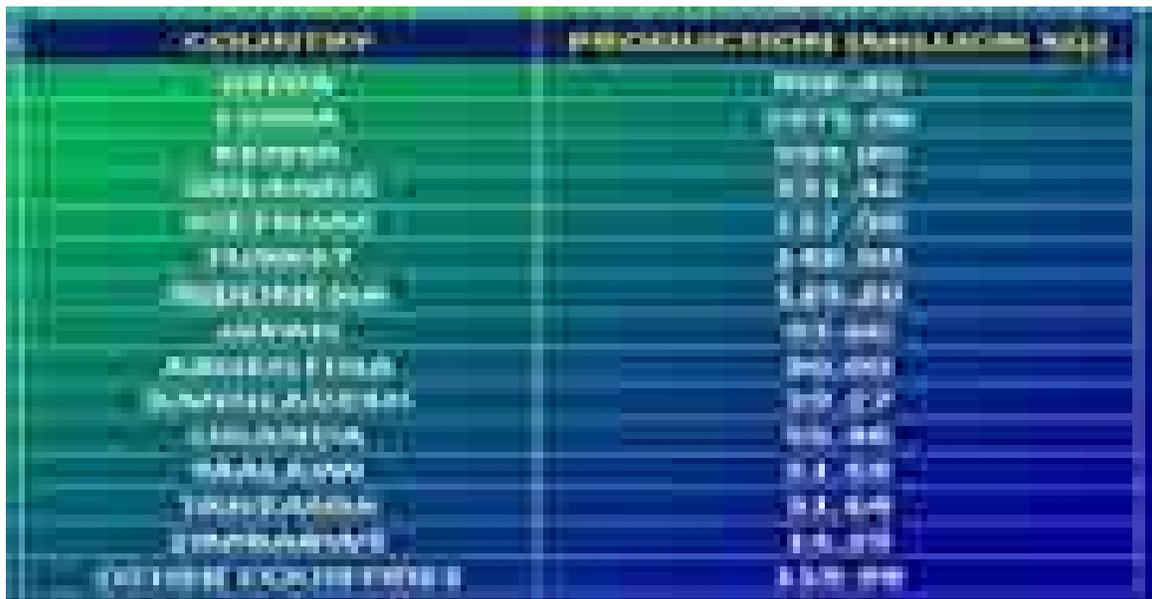


Fig.1 Global Production of TEA, Dr N Muraleedharan, Advisor, Tea Research Foundation

TEA consumption in India has gone up from 771 million kg in 2006 to more than 830 million kg in 2010. Almost 80% of the TEA produced in India is consumed within the country. However, the average annual per capita consumption is only around 0.70 kg. TEA is packaged in Plywood TEA chests, Jute bags, Paper Sacks, HDPE bags, Chestlets, Paper

cartons, etc. The minimum quality standards for TEA are stipulated under the Prevention of Food Adulteration Act, India (now replaced by the Food Safety and Standards Act) and these are the same as those prescribed under ISO3720.

TEA industry is an eco- friendly industry. It employs more than one million workers.

5. Varieties And Composition Of TEA

TEA is traditionally classified based on the techniques with which it is produced and processed.(Fig.2)

The tea journey

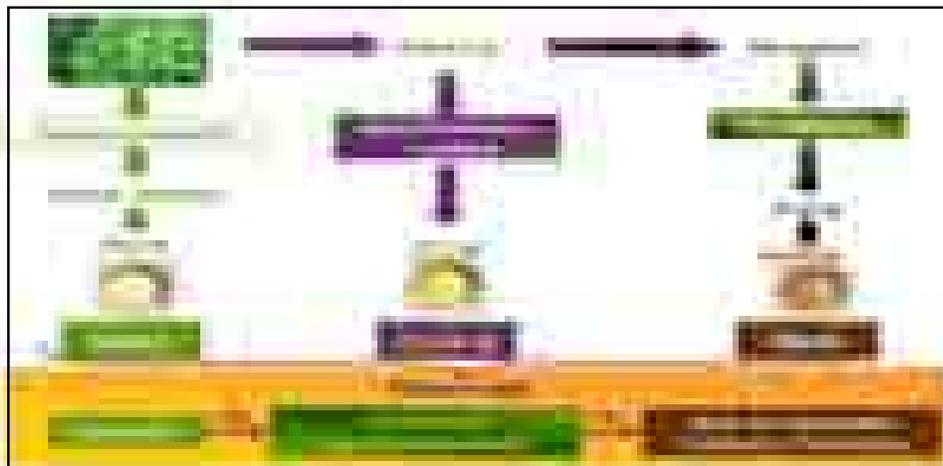


Fig. 2 Processing of TEA, Dr. Dharini Krishnan, Dietitian, Former National President, Indian Dietetic Association

The Difference Between Black And Green TEAS

Black and Green TEAs refer to the colour of the TEA leaf after processing. Both come from the leaves of the *Camellia Sinensis* plant. The difference lies in the way they are processed. Regular (Black) TEA (like the TEA consumed in India) is produced when newly harvested leaves are crushed and exposed to air. In the presence of air/oxygen, an enzymatic reaction takes place, which

allows for the catechins, naturally found in the tea plant, to be polymerized into other flavonoids called thearubigins and theaflavins, which provide the darker color and rich flavor of black tea. Green TEA leaves are typically heated with steam or pan roasted. This stops enzymatic activity, allowing for the color and flavor to most closely resemble the raw TEA leaf. Therefore, Green TEA is rich in catechins. The final drying process in Green TEA is achieved by roasting or baking. The baked green TEA is

the raw material for Scented TEAS such as Jasmine TEA and Rose TEA. Both Black and Green TEA are almost equally rich in antioxidants and have similar health giving properties (Fig.3). Black TEA is normally consumed with or without milk but green TEA is generally consumed without milk.



Fig.3 Compositional Differences Between Black And Green TEA, Prof. Sandip K Bandopadhyay, Advisor, National Tea Research Foundation

Other Varieties Of TEA

White TEA

White TEA is produced from the unopened buds of TEA shoots. These buds are withered and dried under special controlled conditions. White TEA is very expensive and produced only in small quantities. White TEA is produced using “minimal processing”, involving, for example, gentle drying of the TEA leaves. The delicate processing of the TEA allows for a light, subtle and fruity taste. In common with other types of TEA, there are many different styles of white TEA available, including “snow buds”.

Yellow TEA

Yellow TEA is a special TEA processed in the same way as Green TEA, but with a slower drying phase, where the damp TEA leaves are allowed to sit and turn yellow. The final product is similar to Green and White TEA in terms of taste and appearance. TEA brewed from these buds has a pale yellow hue with a light honey-sweet scent. Its taste is delicate with a clean mellow sweetness. The aftertaste is lightly sweet and refreshing. Yellow TEA is very rare and expensive.

Oolong TEA

Oolong is a greenish-brown TEA whose flavor, color and aroma are richer than those of Green TEA, but more delicate than that of Black. Oolong Tea is made from leaves that are practically fermented before being dried. It falls midway between Green and Black TEAS.

Organic TEA

Black, Green and Oolong TEAs are cultivated using natural manure and under conditions specified for organic farming. No synthetic fertilizers or chemicals are used

Besides these, there are a number of other varieties which include scented TEA, ready to drink TEA(RTD) instant TEA, brick TEA, etc. Among the various types, black TEA is the most common, accounting for about 75% of the world TEA production.

6. Preparation Of TEA

The traditional method of making a cup of TEA is to place loose TEA leaves, either directly or in a TEA Infuser, into a TEA pot and pour hot water over the leaves, allowing the tea to brew for 4 to 5 minutes. To capture the full flavor, the pot should be covered with a

TEA-cozy after placing the lid. Desired amount of milk and sugar can be added to each cup after pouring the steaming hot TEA. The leaves are removed, either by removing the infuser, or by straining the TEA while serving.

Most Green TEAS should be allowed to steep for about two to three minutes, although some types of TEA require as much as ten minutes, and others as little as thirty seconds.

The best temperature for brewing TEA depends on its type. For example:

- TEAS that have little or no oxidation period, such as a Green or White TEA, are best brewed at lower temperatures, between 65° and 85 °C (149° and 185 °F).
- TEAS with longer oxidation periods should be brewed at higher temperatures around 100 °C (212 °F). The higher temperatures are required to extract the large, complex, flavorful phenolic molecules found in fermented TEA, although boiling the water reduces the amount of dissolved oxygen in the water.

How Much TEA To Drink?

TEA is a beverage consumed by the masses for centuries. An average TEA drinker consumes about three to four cups of TEA in a day. Dr J. H. Weisburger, Director Emeritus, American Health Foundation recommends that a regular intake of six to ten cups a day, will contribute to health and well being.

- Population studies have shown that 2-3 cups of TEA per day may have positive effects on cardiovascular health.
- Studies have indicated drinking 3-4 cups of TEA can help mental clarity

- For optimal hydration, experts recommend between 4 to 6 cups of TEA per day.
- For people worried about excessive caffeine intake, up to 8 cups of TEA per day has been shown to be safe.

How Much Milk And Sugar To Add?

Most of the research done on TEA has been done on Black TEA (without milk and sugar) owing to the populations they have been tested in – European and South East Asian. A review of nine published human studies on bioavailability of TEA flavonoids in presence of milk shows that upto 20% milk does not effect blood plasma levels of TEA flavonoids

However, flavonoids could bind to milk proteins driven by hydrophobic interactions and hence there could be a delay in their release into the blood stream. Though there is a delayed effect of the flavonoids, there has been no noted reduction.

In a study done in UK it has been seen that a standard addition of 10-15% milk did not influence plasma antioxidant activity (R. Leenen, AJC Roodenburg, JBM Tijnburg and SA Wiseman, A single dose of TEA with or without milk increases plasma antioxidant activity in humans, (European Journal of Clinical Nutrition 2000). Nothing has been known against adding sugar to taste except in case of diabetes.

To minimize any negative effects of TEA on iron absorption, TEA drinking occasion may be spaced at least an hour apart from mealtime.

7. Products From TEA

With the advancement in science and technology many products are being developed with TEA extracts / leaf to benefit consumers. **Dietary supplements** are sold as dried leaf TEA in capsule form. There are **liquid extracts** made

from the leaves and leaf buds. **Decaffeinated Green TEA** products contain concentrated polyphenols. Caffeine free supplements also are available.

TEA is a zero calorie healthy beverage. It can be a good carrier for delivering nutrients. TEA can be fortified with micronutrients, flavors and herbs. Since micronutrient deficiency is widely prevalent in India, fortified TEA can benefit a large section of the population as it is a popular beverage in the country.

A randomized double blind cross over trial in India revealed that regular consumption of TEA fortified with ayurvedic herbs enhances NK cell activity, which

is an important aspect of the (early) innate immune response to infections.(Banerjee et al)(Fig.4).

Other Products

Many other products can be made using TEA extracts. These include: Anti Viral products, Catechin Air Cleaner, Catechin Candy, Anti Oxidant Capsules, Catechin Eggs, Deodorant Catechin Products, Ointments for genital warts, Preservation of Fish Color etc.



Fig 4: Different Indian Herbs Used For TEA Fortification, Dr Gautam Banerjee, Hindustan Unilever Research Center

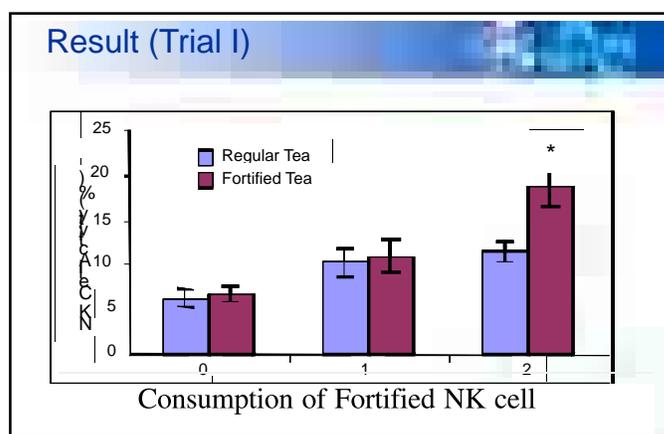


Fig. 5 Improvement of NK Cell Activity by Consumption of Fortified TEA, Dr Gautam Banerjee, Hindustan Unilever Research Center

SECTION TWO

HEALTH BENEFITS OF TEA

1. The Components Of Tea

TEA is composed of polyphenols, alkaloids (caffeine, theophylline, and theobromine), amino acids, carbohydrates, proteins, chlorophyll, volatile organic compounds (chemicals that readily produce vapors and contribute to the odor of TEA), fluoride, aluminum, minerals, and trace elements. (Table 1),

COMPOUNDS	PERSENTAGE
Total polyphenois	27-40
Caffeine	3-4
Amino acids (Theanine and others)	4
Carbohydrates polysaccharides (starch)	2-5
Protein	12
Inorganic materials	5
Lipids	3
Cellulose	7
Lignin	6

Table 1. Composition of TEA

The components of TEA leaves are depicted in Fig. 6.

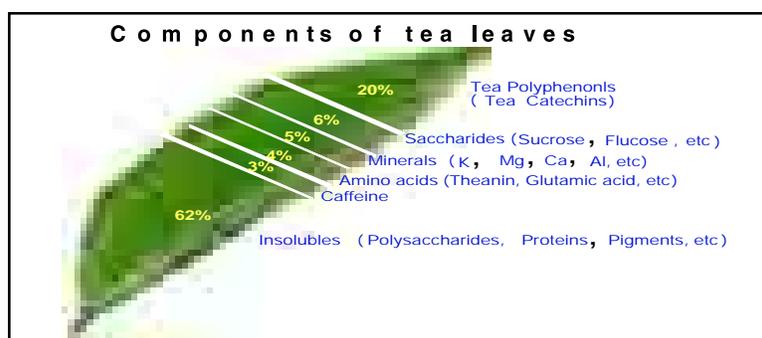


Fig. 6 Components of TEA leaves, Dr Yukihiro Hara President, Tea Solutions & Visiting Professor of School of Food and Nutritional Science, Univ. of Shizuoka

TEA is one of the rich natural sources of antioxidants. **Flavonoids** in TEA are more powerful antioxidants than the commonly recognized antioxidants like vitamin C, vitamin E and beta-carotene, found in many fruits and vegetables. It is important to remember that TEA is not a substitute for fruits and vegetables, since the latter provide a range of essential nutrients. Drinking TEA in a diet with a combination of fruits and vegetables is a refreshing way to health.

The most remarkable feature of the TEA shoots is their content of polyphenols, a group of flavanols also known as catechins, a type of antioxidant.

Catechins, a type of flavanols are thought to be responsible for the health benefits that have traditionally been attributed to TEA, especially Green TEA. In a freshly picked TEA leaf, catechins compose up to 30% of the dry weight. Both Black and Green TEAS naturally contain a high amount of flavonoids. The fresh TEA leaves contain four catechin derivatives, namely, epicatechin (EC), epi gallo catechin (EGC), epi gallo catechin gallete (EGCG), and epicatechin gallete (EG). Infusion of TEA contains only the catechin derivatives or its oxidative products, caffeine and the amino acid theanine. Fig.7 depicts the polyphenols found in TEA.

Polyphenols



Fig.7 Polyphenols in TEA, Dr. Dharini Krishnan, Dietitian, Former National President, Indian Dietetic Association

The most active and abundant catechin in green TEA is epigallocatechin-3-gallate (EGCG). The active catechins and their respective concentrations in Green TEA infusions are listed in the Table 2 below.

Catechin in Green TEA Infusion	Catechin Concentration (mg/L)*	Catechin Concentration (mg/8 fl oz)*
Epigallocatechin-3-gallate (EGCG)	117-442	25-106
Epigallocatechin (EGC)	203-471	49-113
Epicatechin-3-gallate (ECG)	17-150	4-36
Epicatechin (EC)	25-81	6-19

*mg = milligram; L = liter; fl oz = fluid ounce..

Table 2.Catechin Concentrations of Green TEA Infusions

Black TEA contains lesser concentrations of these catechins than Green TEA. The extended oxidation of Black TEA increases the concentrations of thearubigins and theaflavins, two types of complex polyphenols. Oolong TEA contains a mixture of simple polyphenols, such as catechins, and complex polyphenols. White and Green TEA contains similar amounts of EGCG but different amounts of other polyphenols.

The polyphenol concentration of any particular TEA beverage depends on the type of TEA, the amount used,

the brew time, and the temperature. The highest polyphenol concentration is found in brewed hot TEA, less in instant preparations, and lower amounts in iced and ready-to-drink TEAS. As the percentage of TEA solids (i.e., dried TEA leaves and buds) decreases, so does the polyphenol content. Ready-to-drink TEAS frequently have lower levels of TEA solids and lower polyphenol contents because their base ingredient may not be brewed TEA. The addition of other liquids, such as juice, will further dilute the TEA solids. Decaffeination reduces the catechin content of TEAS.

2 How TEA Works In The Body?

TEA contains flavonoids, naturally occurring compounds that have been shown to have antioxidant properties. These work to neutralize free radicals, which over time, damage elements in the body, such as genetic material and lipids, and contribute to many chronic diseases.

Flavonoids are widely distributed among other plant foods, with citrus fruits, berries, onions and soya contributing substantial amounts. However, in the Western population, nearly two thirds of the dietary flavonoids are reported to come from Black TEA consumption (Hertog et al, 1993).

Health benefits of TEA can be divided into short term and long term. Under **immediate effects** are those effects which occur within one hour of TEA consumption like hydration, quenching of thirst, mild caffeine boost, relaxation with alertness from theanine, and improved glucose metabolism. **Within some weeks and months** of TEA intake, several health benefits are attributed to regular TEA drinking such as lower risk of cardiovascular disease, protection against cognitive decline especially in the elderly and bone loss. Most of these benefits are ascribed to TEA flavonoids, which are plant polyphenols.

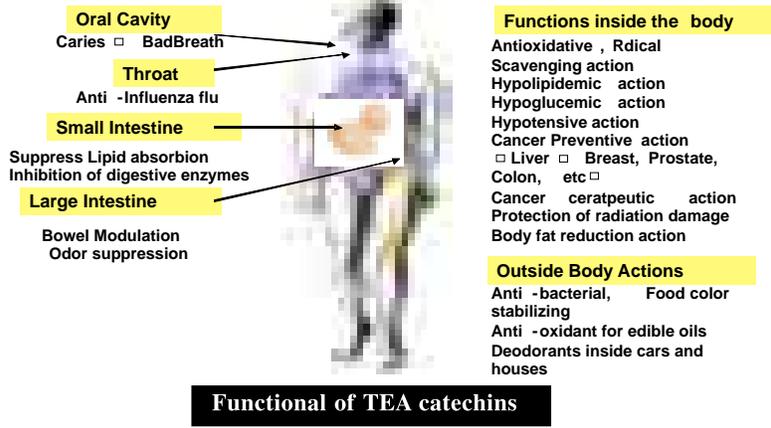


Fig.8: Functions of TEA Catechins Dr Yukihiro Hara President, Tea Solutions & Visiting Professor of School of Food and Nutritional Science, Univ. of Shizuoka

3. TEA And Its Health Benefits

Some of the major health benefits of TEA along with the research findings are given in the following sections.

A. Type 2 Diabetes

Research findings point out that TEA may reduce risk for diabetes and may also improve insulin sensitivity.

In cell culture studies, black, green and oolong TEAS have been reported to improve insulin sensitivity. In animal studies, green TEA has also been reported to increase insulin sensitivity and reduce blood glucose levels.

1. A scientific research study conducted on rats on the role of TEA in diabetes has shown that hot water extract of Black TEA significantly reduced the blood glucose level and had both preventive and curative effects on experimentally produced diabetes in rats (A.Gomes et al,1994).
2. A cohort study in humans in Japan reports a risk reduction of type 2 diabetes for individuals consuming more than 6 cups of Green TEA per day. (David J.Baer."Tea Consumption, Insulin Sensitivity and Diabetes" Abstracts. Page 12 of Proceedings of 4th International Scientific Symposium on Tea and Human Health.2007).
3. A clinical study conducted in Taiwan, showed that Oolong TEA reduced blood glucose and improved fructosamine levels in free-living subjects with type 2 diabetes. (David J.Baer. "Tea Consumption, Insulin Sensitivity and Diabetes" Abstracts. Page 12 of Proceedings of 4th International Scientific Symposium on Tea and Human Health.2007).
4. Clinical trials conducted by the University of Geneva and the University of Birmingham indicate

that Green TEA raises metabolic rates, speeds up fat oxidation and improves insulin sensitivity and glucose tolerance.(Venables MC et al(2008) "Green tea extract ingestion, fat oxidation, and glucose tolerance in healthy humans". *Am.J.Clin.Nutr.*87(3):778-84).

5. Green tea contains catechin phenolics that raise thermogenesis, and hence increases energy expenditure. (Dulloo AG et al(1999)."Efficacy of a Green TEA extract rich in catechin polyphenols and caffeine in increasing 24 hour energy expenditure and fat oxidation in humans" *Am.J.Clin.Nutr.*70(6).1040-5).
6. Scientists have found in lab research, that epigallocatechin gallate (a compound abundant in Green TEA) may help protect against diabetes by affecting several biological processes (including metabolism).(Wolfram S, Raederstorff D, Preller M, et al. Epigallocatechin gallate supplementation alleviates diabetes in rodents. *J Nutr.* 2006 Oct;136(10):2512-8).
7. Findings from one small study also suggest that drinking Oolong TEA may help lower blood sugar levels in diabetes patients. (*Diabetes Care*,: Antihyperglycemic Effect of Oolong Tea in Type 2 Diabetes : Kazuaki Hosoda, BS, Ming-Fu Wang, PHD, Mei-Ling Liao, MS, , Chin-Kuang Chuang, MD, Miyuki Iha, BS, Beverly Clevidence, PHD and Shigeru Yamamoto, PHD).
8. Research on polysaccharide levels of Green, Oolong and Black TEAS in Tianjin Key Laboratory in China showed that of the three TEAS, the polysaccharides in black TEA had the most glucose-inhibiting properties. The Black TEA polysaccharides also

showed the highest scavenging effect on free radicals, which are involved in the onset of diseases such as cancer and rheumatoid arthritis.

Polysaccharides, a type of carbohydrate that includes starch and cellulose, may benefit people with diabetes because they help retard absorption of glucose.

B. Cardiovascular Health

TEA flavonoids are thought to support cardiovascular health through several mechanisms: help temper inflammatory markers such as C-reactive protein; reducing blood cholesterol levels; and providing dilation of blood vessels to help manage blood pressure.

1. A total of 3,430 men and women aged 30-70 years from the Saudi Coronary Artery Disease Study (2002) were examined and 6.3 percent were found to have indications of coronary heart disease (CHD). The researchers found that those who drank more than six cups of TEA per day (>480 mL) had significantly lower prevalence of CHD than non-TEA drinkers, even after adjustment for risk factors like age and smoking. The researchers also found that drinking six or more cups of Black TEA per day was associated with decreased serum cholesterol and triglyceride concentrations.
2. The Zutphen study (1993), which assessed 805 male subjects over a period of five years, found that the incidence of fatal and nonfatal first myocardial infarction and mortality from stroke decreased significantly as intake of flavonoids, derived mainly from TEA, increased in a dose-dependent manner. (*Dietary antioxidant flavonoids and risk of coronary heart disease: the Zutphen Elderly Study ;The Lancet, Volume 342, Issue 8878, 23 October 1993 , Pages 1007-1011*).
3. Hertog and his colleagues have observed an inverse association between flavanol intake and CVD in Europe, where black TEA, together with apples and onions, contribute substantially to total flavanol consumption. Dietary antioxidant flavonoids and risk of coronary heart disease.(the Zutphen Elderly Study ;The Lancet, Volume 342, Issue 8878, 23 October 1993 , Pages 1007-1011).
4. Consistent with these observations, an inverse correlation between flavonoid intake and CHD mortality was found after the 25 year follow-up of 12,763 men from Seven Countries Study. Similarly, men and women from the Boston Area Health Study who consumed one or more cups a day of TEA in the previous year had a 44% lower risk of myocardial infarction than those who drank no TEA independently of other coronary risk factors.(*Sesso et al*).
5. Another recent Harvard study of 1,900 people found that those who consumed TEA during the year prior to a heart attack were up to 44 percent more likely to survive over the three to four years following the event. Those who consumed fewer than 14 cups of TEA per week experienced a 28 percent reduced death rate, and those who consumed more than 14 cups of TEA per week were found to have a 44 percent reduced death rate, as compared to non-TEA drinkers (*Mukamal et al*).
6. A recent meta-analysis discovered that consumption of three cups of TEA per day was associated with an estimated decrease of 11 percent in the incidence of myocardial infarction (heart attack). (*Peters et al Am J Epidemiol 2001;154:495-503*)
7. Additionally, TEA consumption has been inversely associated with the development and progression of atherosclerosis. (*Geleijnse JM, Launer LJ,*

Hofman A, Pols HAP, Witteman JCM. Tea flavonoids may protect against atherosclerosis: the Rotterdam Study. *Arch Intern Med* 1999;159:2170-4). In this context, endothelial dysfunction is a key step in the development of atherosclerosis, thus playing a pivotal role in the pathogenesis of cardiovascular disease. Endothelial function is the ability of the inner lining of blood vessels to dilate in response to increased blood flow .

Improved endothelial function might also contribute to lower blood pressure. Investigations of the longer-term effects of TEA flavonoids on blood pressure in cross-sectional studies reported an inverse relationship between TEA intake with blood pressure, and the prevalence of hypertension (Fig. 9)



Fig. 9: Influence Of Black TEA Consumption On Hypertension, Prof. Claudio Ferri, MD, Professor of Internal Medicine, University of L'Aquila – San Salvatore Hospital

8. Research by Professor Claudio Ferri, University of L'Aquila in Italy provided additional insights into how TEA flavonoids provide support for vascular health by promoting healthy endothelial function. In his studies, subjects were given

either low, intermediate or high doses of TEA flavonoids and then the researchers measured endothelial dysfunction via flow-mediated dilation of the brachial artery and arterial stiffness (Fig. 10)



Fig.10: Effect Of Black TEA Consumption On Endothelium-Dependent Vasodilation, Prof. Claudio Ferri, MD, Professor of Internal Medicine, University of L'Aquila – San Salvatore Hospital

The study found that TEA flavonoids improved endothelium-dependent vasorelaxation and decreased arterial stiffness in study participants, thereby suggesting

that TEA consumption may have favorable effects on cardiovascular functions (Fig. 11).

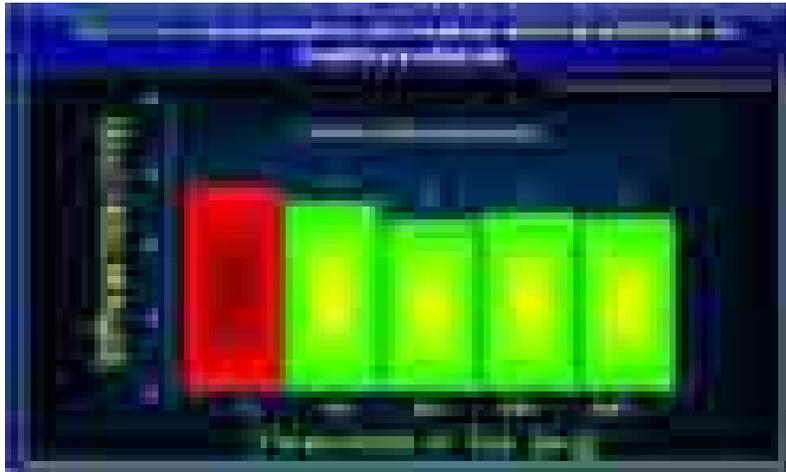


Fig. 11: Effect Of Black TEA Consumption On Arterial Stiffness, Prof. Claudio Ferri, MD, Professor of Internal Medicine, University of L'Aquila – San Salvatore Hospital

These new developments in artery endothelium research add to the growing body of evidence suggesting that drinking as little as two to four cups of TEA daily can promote cardiovascular health in several different ways.



Fig. 12: Effect of TEA Consumption on FMD, Prof. Claudio Ferri, MD, Professor of Internal Medicine, University of L'Aquila – San Salvatore Hospital

C. Stroke Risk Reduction

Research studies have shown that drinking at least 3 cups of TEA (Green or Black) daily decreases the risk of strokes.

1. A meta-analysis rigorously examined the human clinical and epidemiological data available to determine the impact of hot TEA consumption upon the relative risk of stroke. The meta-analysis took in data from studies conducted in Finland, Japan, United States, Netherlands, Australia and China and, regardless of country of origin, individuals consuming three or more cups of TEA per day had a 21% lower risk of developing, or dying, from a stroke than those individuals consuming less than one cup per day (*Arab et al, 2009*).
2. Another meta analysis of prospective cohort studies from Netherlands, Finland and the United States to assess the strength of the association between flavonol (a subdivision of flavonoids) intake and stroke showed that a high intake of flavonols compared with a low intake was inversely associated with nonfatal and fatal stroke incidence with a pooled relative risk of 0.80 (95% CI: 0.65, 0.98). (*J. Nutr. 140: 600–604*).

Major sources of flavonols included TEA, apples and onions with TEA being the primary contributor in TEA drinking countries.

A high intake of flavonols compared to a low intake of flavonols was inversely associated with reduced risk of stroke (i.e. 16-47mg per day; (*Hollman et al. 2010*).

3. A meta-analysis by Ras et al. (2011) took data from 9 short term intervention studies showing effects of TEA consumption on endothelial dependant vasodilation, a measure of the ability of blood vessels to dilate. This meta.-analysis concluded that moderate consumption (500 ml or 2-3 cups) of TEA substantially enhances endothelial-dependant vasodilation.
4. A study was conducted at Vivekananda Institute of Medical Science at Kolkata, India, within the Ramakrishna Mission Seva Pratisthan Hospital. The study focused on the impact of Black TEA on preventing hypertension, cardiovascular diseases, diabetes and stroke. The study revealed that chances of a repeat stroke among TEA drinkers was 19.08% while the same for non-TEA drinkers was twice as much at 38.77%. Those who consumed 5 or more cups of TEA daily were at a much lesser risk of suffering another attack.

Observations from the study reveal that daily consumption of 450 ml (around 3 cups) of TEA may reduce the incidence of recurrent ischemic stroke and may give rise to better control of fasting hyperglycemia. Besides, it may be helpful in decreasing the level of total cholesterol as well as LDL cholesterol in subjects with hypercholesterolemia.

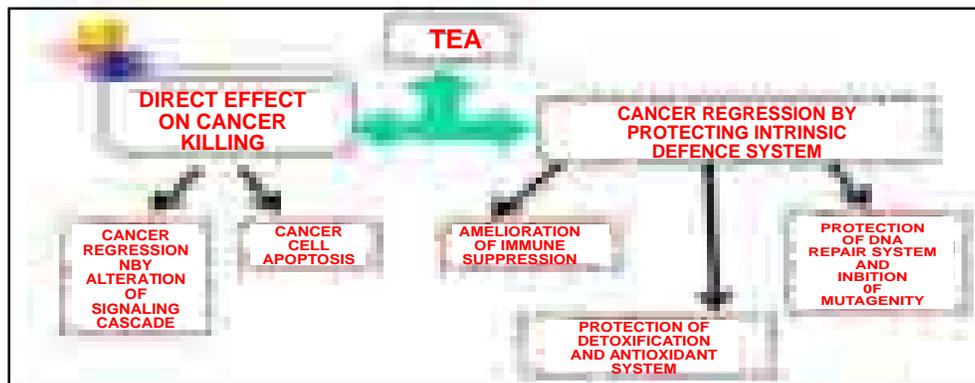
D. Cancer

Among their many biological activities, the predominant polyphenols in Green TEA EGCG, EGC, ECG, and EC⁻and the theaflavins and

thearubigins in Black TEAS may protect cells from DNA damage caused by reactive oxygen species.

1 TEA polyphenols have also been shown to inhibit tumor cell proliferation and induce apoptosis(programmed cell death) in laboratory and animal studies. In other laboratory and animal studies, TEA catechins have been shown to inhibit angiogenesis and tumor cell

invasiveness. In addition, TEA polyphenols may protect against damage caused by ultraviolet (UV) B radiation, and they may modulate immune system function . Furthermore, green TEAS have been shown to activate detoxification enzymes, such as glutathione S-transferase and quinine reductase that may help protect against tumor development (Fig. 13)



*Fig.13 Effect of TEA on Tumor Development
Prof. Sandip K Bandopadhyay, Advisor, National Tea Research Foundation*

2 A recent study found that smokers who drank four cups of decaffeinated Green TEA per day demonstrated a 31 percent decrease in biomarkers of oxidative DNA damage in white blood cells as compared to those who drank four cups of water. Oxidative DNA damage is implicated in the development of various forms of cancer. (Hakim IA et al."Effect of increased tea consumption on oxidative damage among smokers: a randomized controlled study. J Nutr.2003 Oct;133(10):330).

3 Epigallocatechin gallate (EGCG) may protect normal cells from cancer-causing hazards as well as eliminate cancer cells though apoptosis. Researchers tested the potential anti-cancer benefits of Green TEA polyphenol, EGCG, in hamster cells

and discovered that EGCG suppressed DNA changes and damage from carcinogens. EGCG also protected from further damage from the carcinogens and inhibited growth and multiplication of cancer cells . (Roy M, et al,"Anticlastogenic, antigenotoxic and apoptotic activity of epigallocatechin gallate :a green tea polyphenol. Mutat Res 2003;523-524:33-41).

4 According to a study conducted by Dr. Koustubh Panda, from Calcutta University's department of biotechnology, Black TEA can be a preventive measure for smokers who are at the risk of contracting emphysema, the fourth major killer disease around the world. Ninety percent of emphysema victims have been cigarette smokers.

The antioxidants in Black TEA prevent cigarette smoke induced oxidants of lung protein and thereby

protect against emphysema (Fig. 14).

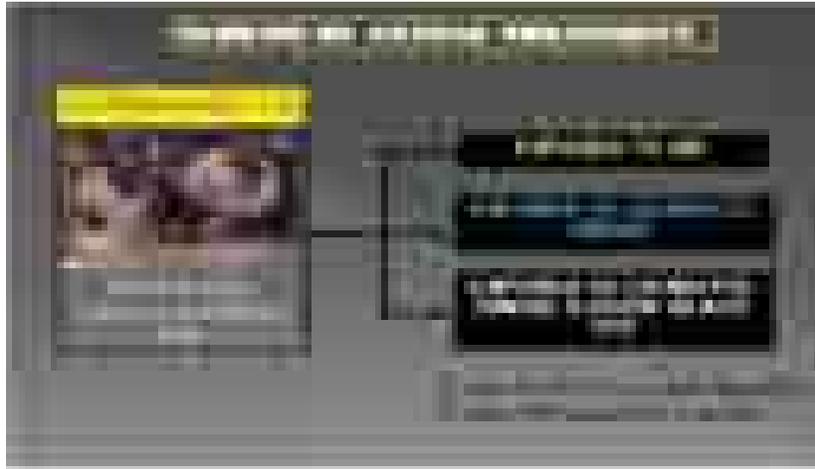


Fig 14. Scheme Of Animal Treatment To Study Effect Of Black TEA On Cigarette Smoking, Dr Koustubh Panda, Head & Coordinator, Dept. of Biotechnology & Dr. B.C. Guha Centre For Genetic Engineering & Biotechnology, University of Calcutta, Director, West Bengal Biotech Development Corporation, Adviser, Science & Technology, Govt. of West Bengal

After treatment of the animals for 45 days with and without black TEA supplementation, lung proteins were subjected to oxyblot assay against untreated control. The

results show prominent oxidative damage due to cigarette exposure and significant prevention of the same by Black TEA (Fig 15)

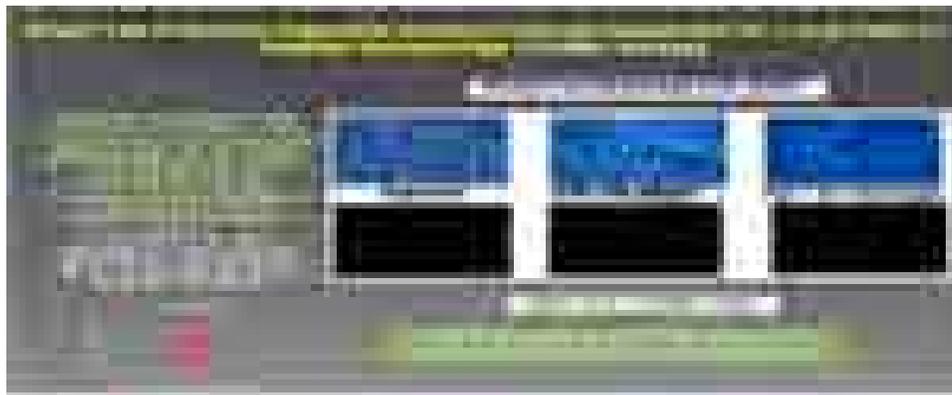


Fig 15: Effect Of Black TEA In Prevention Of Cigarette Smoke Induced Apoptosis Of Lung Cells In Treated Guinea Pigs, Dr Koustubh Panda, Head & Coordinator, Dept. of Biotechnology & Dr. B.C. Guha Centre For Genetic Engineering & Biotechnology, University of Calcutta, Director, West Bengal Biotech Development Corporation, Adviser, Science & Technology, Govt. of West Bengal

4 An animal study identified beneficial changes in immune function after Black TEA ingestion in cancer-bearing animals. Black TEA beneficially altered immune responses that helped protect

immune cells against harmful cancerous cells. The study found Black TEA acted like anti-cancer drugs that help boost the immune system without promoting the proliferation of cancerous cells (Fig 16).



Fig 16: Suppression Of Tumor Growth By Consumption Of Green TEA Catechins, Dr Yukihiro Hara President, Tea Solutions & Visiting Professor of School of Food and Nutritional Science, Univ. of Shizuoka

According to Dr. Hara, if “crude extract” of TEA is approved as a cancer preventive/ curative agent a great number of consumers will become heavy TEA drinkers or buy TEA capsules and that may reduce the incidence of cancer to a certain extent.

E Mental Performance

TEA contains biologically-active substances, such as flavonoids, caffeine and theanine. Theanine and Caffeine alter the neurophysiology of attention.

The ability to deploy attention effectively is a key human cognitive function, and when it goes awry, as in Attention Deficit Disorder (ADD) for example, the consequences can be quite severe. Ingestion of the non-protein amino acid Theanine (L-N-ethylglutamine), found exclusively in TEA, has been shown to increase oscillatory brain activity in the so-called alpha-band (8-14 Hz) during

resting EEG recordings in humans. Independently, alpha-band activity has been shown to be a key component in selective attention processes.

1. Two surveys, studying Norwegian (Nurk et al., 2009) and Chinese (Ng et al., 2008) elderly populations, observed a lower rate of decline in aspects of cognition such as memory and attention with higher flavonoids intakes and/or regular black TEA consumption respectively.

These studies suggest there may be long term benefits to regular flavonoid and/or TEA consumption, However, long term randomized intervention studies are limited. The most compelling data for benefits of TEA to an individual’s mental performance come from short term intervention studies in healthy adults.

2. Earlier studies have looked at the immediate effects of drinking a few cups of TEA during the day. Studies found that TEA drinking helped to sustain alertness (*Durlach 1998, Hindmarch 1998, Hindmarch 2000*).
3. More recent studies have linked regular TEA drinking, at around 4 servings daily, with reduced stress and increased relaxation (*Steptoe et al, 2007*), or an enhanced ability to focus attention (*de Bruin et al, 2011*).
4. Most effects on mental performance have been attributed to theanine and caffeine. Theanine is an amino acid almost unique to TEA. Studies show that it has effect on alpha brain activity, a pattern associated with relaxed yet alert mental state (*Nobre et al, 2008*). Through its effects on alpha brain activity, theanine may also improve the ability to focus attention when people perform a cognitive task (*Gomez-Ramirez et al, 2007*). Fig 17 depicts beneficial effects of L- Theanine.
5. John Foxe and his team used electrophysiological messages to monitor brain activity after individuals drank solutions containing 250 mgs of the aminoacid theanine. Theanine is present almost exclusively in the TEA plant. After a person consumes TEA, theanine is absorbed by the small intestine and crosses the blood brain barrier where it influences neurotransmitters and increases alpha brain wave activity. This alpha brain rhythm is known to induce a calmer, yet more alert, state of minds.
6. A recent review (*Ruxton, 2008*) has suggested that moderate caffeine intakes, as found in few cups of TEA, may actually improve mood and mental performance.

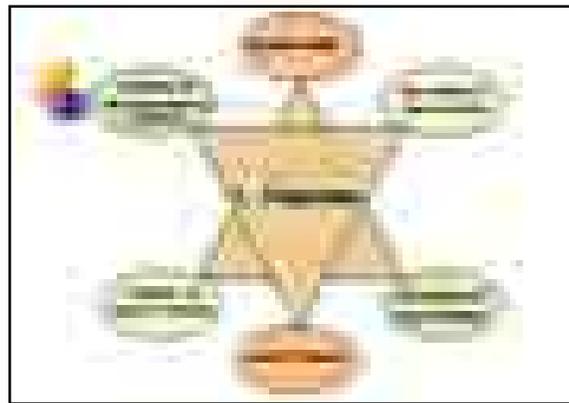


Fig 17: Beneficial Effects Of L-Theanine
Prof. Sandip K Bandopadhyay, Advisor, National Tea Research Foundation

F. Weight Management

Green (and Oolong) TEA contain high quantities of catechin polyphenols and modest amounts caffeine, ingredients that have been proposed to increase and/or prolong the stimulatory effects of norepinephrine on energy and lipid metabolism.

There is increasing evidence from medium- and long-term studies (> 8 weeks) that Green TEAS rich in catechins may improve body composition by reducing body fat and in particular visceral fat. Most of this evidence has been generated from studies that investigated the effects of catechin-rich Green (or

Oolong) TEA beverages in Asian populations. Some of these studies have also investigated the effects of regular consumption of catechin-rich Green TEAS on energy

expenditure and/or fat oxidation, which seem to have increased. (Westerterp-Plantega, 2010).

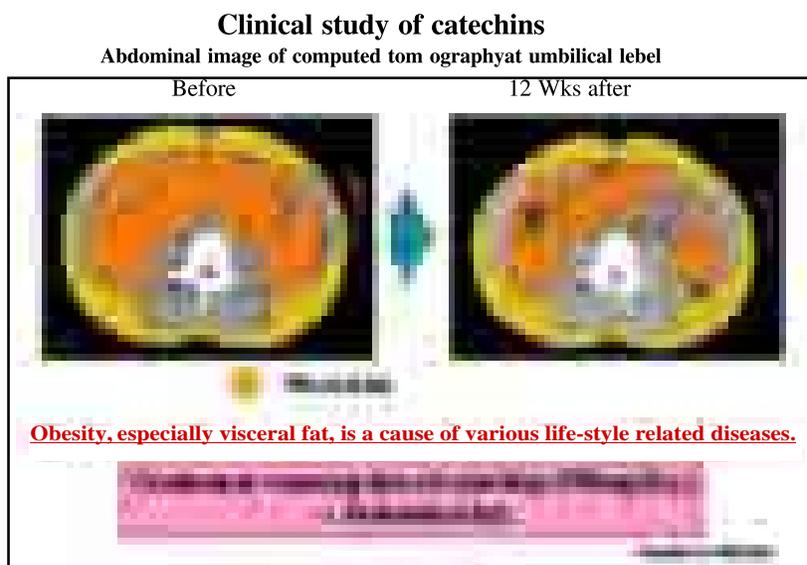


Fig 18: Reduction Of Abdominal Fat By Consumption Of Catechins, Dr Yukihiro Hara President, Tea Solutions & Visiting Professor of School of Food and Nutritional Science, Univ. of Shizuoka

Although Green TEA has shown positive effects with respect to weight control, especially with respect to long-term improvement of body composition and fat distribution, a number of questions related to Green TEA efficacy still need to be addressed and answered, e.g. long-term efficacy in a Western population, exact mechanism of action, optimal dosing level and schedule as well as formulation (caffeine:catechins ratio, catechins profile).

G. Bone Health

Nutrients found in TEA, such as flavonoids, may positively influence bone mineral density (BMD) and that TEA drinking may protect against osteoporosis in older women.

1. Research suggests that TEA may play a role in bone health. A study published in the American Journal of Clinical Nutrition (October 2007) found that older women who drank TEA had higher BMD measurements than those who did not drink TEA. The researchers concluded that the flavonoids in TEA might influence bone mass and that TEA drinking may reduce the risk of osteoporosis.
2. Another recent study found that habitual TEA-drinking was seen to have a significant beneficial effect on the BMD of adults (30 years and older), especially in those who had been habitual TEA-drinkers for six or more years. (*Archives of Internal Medicine, May 2002*)

H. Oral Health

TEA may also contribute to oral health. The flavonoids in TEA may inhibit the plaque-forming ability of oral bacteria and the fluoride in TEA may support healthy tooth enamel.

A study conducted at the New York University Dental Center examined the effects of Black TEA extract on

dental caries formation in hamsters. Compared to those who were fed water with their food, hamsters which were fed water with Black TEA extract developed up to 63.7 percent fewer dental caries (Fig 19). (Linke HA, LeGeros RZ. *Black tea extract and dental caries formation in hamsters. Int J Food Sci Nutr* 2003;54(1):89-95.

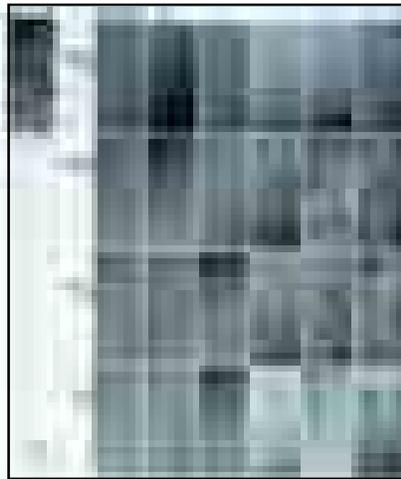


Fig19: Antidental Plaque Effect of Tea Beverages Dr Yukihiko Hara President, Tea Solutions & Visiting Professor of School of Food and Nutritional Science, Univ. of Shizuoka

I. Immune Function

Recently published novel new data indicates that TEA contains a component that can help the body ward off infection and disease and that drinking TEA may strengthen the immune system.

Researchers from Brigham and Women's Hospital and Harvard University have identified substance in TEA, L-theanine, which primes the immune system in fighting infection, bacteria, viruses and fungi. A subsequent human clinical trial showed that certain immune cells of participants who drank five cups of Black TEA a day for two to four weeks secreted up

to four times more interferon, an important part of the body's immune defense, than at baseline.

This study suggests that drinking Black TEA provides the body's immune system with natural resistance to microbial infection. (Kamath AB, Wang L, Das H, Li L, Reinhold VN, Bukowski JF. *Antigens in tea-beverage prime human Vgamma 2Vdelta 2 T cells in vitro and in vivo for memory and nonmemory antibacterial cytokine responses. Proc Natl Acad Sci U S A.* 2003 May 13;100(10):6009-14. Epub 2003 Apr 28).

SECTION THREE

DISPELLING THE MYTHS

Tea Loses Its Benefits After Adding Milk And Sugar!

The current weight of evidence shows that the effect of adding up to 25% milk to tea has an insignificant impact on flavonoid or theanine bioavailability. Though milk may delay the time taken to raise their levels in the blood, significant levels, comparable to TEA without milk, are still achieved. The addition of sugar to TEA is not expected to have any impact either.

TEA Doesn't Count Towards Daily Fluid Requirements!

Tea does indeed count towards daily fluid requirements. Tea contains approximately 99% water. The Food Standards Agency and the British Dietetic Association advise that tea can help to meeting daily fluid requirements.

Drinking TEA Can Reduce Iron Absorption!

TEA naturally contains polyphenols that can bind to iron from plant foods. This effect may be somewhat countered by consuming foods rich in vitamin C which help enhance iron absorption. In contrast, the more bioavailable iron from animal foods is not affected. Allowing a minimum of one hour to elapse between the end of the meal and consumption of TEA will minimize any effect of TEA on iron absorption. TEA consumption

has not been shown to result in iron deficiency in healthy consumers who eat a varied and balanced diet. However, those at risk from iron deficiency, including pregnant women, and especially those consuming a predominantly vegetarian diet, are encouraged to drink TEA away from mealtimes to ensure maximum iron absorption.

TEA Causes Acidity!

TEA does not cause acidity by itself; it is not an acidic beverage. In fact research has shown that the hot water extract of black tea possesses antiulcer activity (*S.Maity et al,1995*).

TEA Is Bad For Bones!

No. In the past it was thought that certain constituents found in TEA, such as caffeine and fluoride, may weaken the bones. However, recent research is now suggesting that drinking TEA can actually improve bone density. (*Archives of Internal Medicine, May 2002; American Journal of Clinical Nutrition, October 2007*).

TEA Drinking Causes Dark Complexion!

It is a common misconception. The pigmentation in the skin determines the color of the complexion, and TEA or Coffee, has no effect on it.

TEA Drinking Causes Stones!

Like many plants, TEA leaves contain oxalate. Among the richest sources of oxalate are spinach and rhubarb.

urinary oxalate concentration, a well-known risk factor for the formation of kidney stones. Sufficiently high intake of water or other fluids reduces the risk of kidney stone formation. The fluid intake associated with TEA consumption sufficiently compensates for the moderate level of oxalate found in tea (levels of oxalate in tea vary depending on tea variety, brewing time, quantity of tea, etc.). Oxalates do not cause problems with healthy individuals following a balanced diet and consuming adequate fluids. Consuming TEA does not pose a risk of kidney stone formation in healthy people.

Increased intake of fluids is routinely recommended for people who have had kidney stones to reduce the likelihood of recurrence. A recent study that followed 81,093 women for eight years suggests that beverage choice may also affect kidney stones development. The study found that for each eight-ounce cup of tea consumed daily by female participants with no previous history of kidney stones, the risk of developing stones appeared to be lowered by eight percent. (*Curhan GC, Willett WC, Speizer FE, Stampfer MJ. Beverage use and risk of kidney stones in women. Ann Intern Med 1998;128:534-40.*)

An earlier study of 45,289 men reported a similar relationship, suggesting that for each eight-ounce serving of tea consumed daily, a 14 percent decrease in risk of stone development was observed. (*Curhan GC, Willett WC, Rimm EB, Spiegelman D, Stampfer MJ. Prospective study of beverage use and the risk of kidney stones. Am J Epidemiol 1996;143:240-7.*)

Safety Considerations Regarding TEA Consumption

Due to the substantial data documenting TEA's health benefits, recently published "Healthy Beverage Guidelines" by US researchers in *American Journal of Clinical Nutrition* in March 2006, suggest that next to water, unsweetened TEA and coffee can provide the majority of daily fluid intake. For optimal hydration, experts recommend between 4 to 6 cups of TEA per day. For people worried about excessive caffeine intake, up to 8 cups of TEA per day has been shown to be safe.

A typical cup of TEA contains approximately 50 mg of caffeine. The caffeine contained in TEA is too little to cause any adverse effects. A review by Health Canada concluded that moderate caffeine intakes of up to 400 mg per day (less than 10 cups of TEA a day) were not associated with adverse effects.

Aluminum, a neurotoxic element, is found in varying quantities in TEA plants depending on soil conditions. Studies have found concentrations of aluminum in infusions of Green and Black TEAS that range from 14 to 27 micrograms per liter ($\mu\text{g/L}$) to 431 to 2239 $\mu\text{g/L}$. However, there is no evidence of any aluminum toxicity associated with drinking TEA.

As regards the view that Black and Green TEA may inhibit iron bioavailability from the diet, as explained earlier this effect may be important for individuals who suffer from iron-deficiency anemia. There is insufficient evidence to conclude that this would have an effect on blood measures (i.e., hemoglobin and ferritin concentrations) of overall iron status in adults. It is better, however, to maintain a gap of about an hour between a regular meal and TEA.

[Disclaimer -ILSI/ILSI-India are not responsible for veracity of any statement or findings]

SECTION FOUR

KEY MESSAGES

Tea is not only a natural drink but it is safe drink as national regulations based on international norms have been laid down for providing safe tea. Animals Studies and in vitro studies have shown conclusively that Tea polyphenols do prevent chronic diseases including cancer and cardiovascular diseases. Further research at National Tea Research Foundation has also pointed towards additional health benefits in respect of gastrointestinal diseases, stress, hypertension and dementia in aging population.Four to Six cups of TEA should be consumed daily for optimum health benefits.

Mrs. Roshini Sen

*Deputy Chairman, Tea Board, Department of Commerce,
Ministry of Commerce and Industry, GOI*

All varieties of TEA have sufficient antioxidant. Rather than focusing on actual content of antioxidant in different varieties of tea it is more important to focus on how much of antioxidant is converted into plasma antioxidant from the point of view of its impact on health. The health benefits depend on how Tea is processed and consumed.

Dr. B Sesikeran

Director, National Institute of Nutrition

- Considering the chemical composition of TEA with benefits of each constituent, there is immense potential of tea as a beverage. The polyphenols in TEA (catechins) have high antioxidant properties. Caffeine stimulates the brain and nervous system. Black TEA and Green TEA are both good for health.

Prof. Sandip K. Bandyopadhyay

Advisor, National Tea Research Foundation

The association between Flavonoids, TEA consumption and reduced CVD risk is evident. Studies have shown that Black TEA (having Flavonoids) consumption reduces blood vessel reactivity, decreases the arterial stiffness and blood pressure and thereby improves the elastic capacity (dilation) of the blood vessels. Further, TEA has positive effects on reducing blood cholesterol levels. Black TEA can thus exert a notably better CVD health profile in common tea drinkers.

Prof. Caudio Ferri MD

*Professor of Internal Medicine
University of L'Aquila – San Salvatore Hospital*

Agriculture research in TEA should focus on introducing new varieties of Tea plants with added nutraceutical benefits, disease resistance and long life.

Dr. V Prakash FRSC
*Distinguished Scientist of CSIR ,
President, Nutrition Society of India &
Chairperson, Panel on Nutraceuticals and Functional Foods*

Research has proved that TEA consumption of 450 ml or more(>3 cups)/day was associated with reduction of the incidence of recurrent ischemic stroke, significant decrement of diastolic blood pressure, better control of fasting hyperglycemia, and lowering down of the level of LDL in subjects with hypercholesterolemia.

Dr. Amar Kumar Mishra
Stroke Unit, Stroke unit, Ramakrishna Mission Seva Pratishthan

Data from studies indicate that regular consumption of TEA fortified with ayurvedic herbs enhances NK cell activity, which is an important aspect of the (early) innate immune response to infections.

Dr. Gautam Banerjee
Hindustan Unilever Research Center

Black TEA can be preventive measure for smokers who are at risk of contracting emphysema, the 4th major killer disease around the world. Studies on guinea pigs have provided substantial evidence of the protective effect of Black TEA (due to its antioxidants) against cigarette smoke induced oxidative damage and the consequent lung injury. TEA is a potential palliative against oxidative damage induced by oxygen toxicity as well as xenobiotic exposure and the diseases implicated with such damage. However, this research does not encourage people to take up smoking.

Dr K. Panda
*Head & Coordinator, Dept. of Biotechnology &
Dr. B.C. Guha Centre For Genetic Engineering & Biotechnology,
University of Calcutta,, & Adviser, Science & Technology, Govt. of West Bengal*

Health benefits of TEA are derived from TEA Catechins. The functions, range from anti-oxidative, anti-bacterial, anti-viral to bowel modulating, hypo-lipidemic, hypo-tensive, hypo-glycemic, anti-tumor and so on and so forth.

Dr. Yukihiro Hara
*President, Tea Solutions and Visiting Professor of
School of Food and Nutritional Science, University of Shizuoka*

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