



Green Tea: A Storehouse of Antioxidants

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Abstract: Tea is one of the most consumed and preferable beverages in the world. It is grown in about 30 countries worldwide but it is consumed by everyone in the world. The leaf and the leaf buds of *Camellia sinensis* – an evergreen shrub from the Theaceae flowering plant family – are used to produce tea. Of the different types of tea available in the market, green tea is one of the healthiest one as it has many types of antioxidants, catechins such as EGCG, ECG, EGC and EC, it has antiviral, anticancer properties, it helps in improving skin, helps in burning fat and has anti – inflammatory properties. Green tea is produced by withering and oxidizing the leaves of the *Camellia sinensis* plant. It is manufactured mainly in Asia. In this review we will have a look at the different types of tea produced, the production of green tea, the different types of antioxidants present in it and the various health benefits of consuming green tea.

Index Terms - Green tea, camellia sinensis, antioxidants, catechins.

I. INTRODUCTION

Tea is a hot, flavoured, aromatic and popular beverage made by pouring hot water on the fresh leaves of *Camellia sinensis*. The tea plant, *Camellia sinensis*, is grown in over 30 countries and is economically very important plant. It is grown in the various parts of east Asia and China. The plant best grows in the tropical and subtropical regions. The different types of tea produced are white tea, yellow tea, green tea, oolong tea, black tea and post fermented tea. The production of tea is based on the processing of the tea leaves. White tea is produced from young leaves and buds of the plant, green tea is produced from mature leaves, oolong tea is produced from partially fermented mature leaves and black tea is produced from completely fermented mature leaves of the *Camellia sinensis* plant. Green tea is mostly consumed in China, Korea, and Japan. It makes up to 20% of tea production in the world. Oolong tea is consumed mostly in China and Taiwan. Black tea makes up to 78% of tea production in the world. It is consumed mostly in the United States and the United Kingdom. Green tea contains one third the amount of caffeine present in black tea.

Green tea contains polyphenols and flavonoids. The most important flavonoids present in green tea are the catechins. They make up 80% - 90% of the flavonoids and around 40% of the water - soluble solids. The amount of catechins present depends on a variety of factors such as harvesting, processing of leaves, production of tea, geographical area and climatic condition where the plants are grown. The main catechins present in green tea are epicatechin (EC) around 6%, epigallocatechin (EGC) around 19%, epicatechin – 3 - gallate (ECG) around 14% and epigallocatechin - 3 - gallate (EGCG) around 59%. The health benefits of green tea depend whether it is absorbed in the body after consumption. Green tea has a number of health benefits which include anticarcinogenic, anti - inflammatory, antimicrobial, antioxidant properties, prevention from cardiovascular disease and good oral health [5, 11, 12, 14].



Figure 1 *Camellia sinensis* plant [17]

II. DIFFERENT TYPES OF TEAS

Camellia sinensis is cultivated in South and Southeast Asia, now it is cultivated in tropical and subtropical parts of the world as well. The leaves and leaf buds of the tea plant are used in producing all types of teas. *Camellia sinensis* var. *sinensis* and *Camellia sinensis* var. *assamica* are the two types of the tea plants. Tea is produced from both the varieties. On the basis of production, tea is divided into six categories. The six different categories are explained below.

White tea is produced from the buds and young tea leaves of the *Camellia sinensis* plant. These leaves are collected shortly before the buds have fully opened. The leaves are then steamed and dried with the low level of processing. Therefore, white tea has the highest level of antioxidants and the lowest level of caffeine. It is a lightly oxidized tea. It is mostly grown and harvested in China, now it is also grown in other parts of Asia. White tea gets its name from the fine silvery - white hair present on the unopened buds of the tea plant. They give a whitish appearance to the plant. The beverage is not white or colourless but it is pale yellow in colour.

Yellow tea leaves are yellow – green in colour. Sometimes the smell of yellow tea is mistaken for black tea as both have a typical strong smell. It is produced in a similar way as the green tea, but the drying process is a bit slower than green tea. The leaves of yellow tea are damp and are left to yellow.

The unfermented leaves of the *Camellia sinensis* plant are the source from which green tea is produced. It is rich in antioxidants and has a lot of health benefits to the human body. The tea plant leaves undergo minimum processing. Green tea originated in China and now is consumed all over the world. There are many different varieties of green tea which are grown in different parts of the world. The method and condition of production in other parts of the world might differ a little.

Oolong tea is a mixture of green tea and black tea. It is a partially fermented tea and has flavour and health characteristics of both green tea and black tea. Oolong tea has a high number of antioxidants which protects healthy skin cells and the slows down the aging process. It is a traditional Chinese tea produced through a unique process. Firstly, the tea leaves are withered under the sun and oxidized before curling and twisting. The degree of oxidation ranges from 8% to 85% depending on the variety and production style of the tea. It is mostly consumed in south China and in Southeast Asia.

Black tea is the most produced tea among the six categories. It is around 72% of the tea produced in the whole world. Black tea is high in antioxidant content. Flavonoids are present in high number. It is more oxidized than the other types of teas and has a very strong flavour. Its flavour is retained for years together. Black tea is processed in two ways, CTC (Crush, Tear, Curl) or Orthodox. In CTC method, medium to low quality leaves can produce a good quality product. It is an efficient and effective method as the tea leaves are dark in colour. In orthodox method, tea is processed by either machine or by hand. High quality of tea is produced by this method.

Post fermented tea is a type of tea that undergoes open air fermentation. The open - air fermentation varies from several months to several years. For further fermentation, the tea is exposed to micro flora, humidity and oxygen. The oxygen causes the tea to undergo further fermentation. This includes auto oxidation and sometimes reactivated oxidative enzymes. This process changes the smell of the tea and alters the taste. The bitter taste of tea is mellowed down and the tea tastes pleasant to the mouth and for aftertaste [2].



Figure 2 Different types of tea [<https://www.sciencelearn.org.nz/images/2041-six-types-of-tea>]

III. CHEMICAL COMPOSITION OF GREEN TEA PRODUCTION OF GREEN TEA

Green tea has a good amount of protein content of about 15% to 20%, which includes amino acids such as l-theanine, tyrosine, tryptophan, threonine, 5-*N*-ethylglutamine, glutamic acid, serine, glycine, valine, leucine, aspartic acid, lysine and arginine. It also has trace elements such as magnesium, chromium, manganese, calcium, copper, zinc, iron, selenium, sodium cobalt or nickel, and carbohydrates such as glucose, cellulose and sucrose. Moreover, green tea is rich in sterols and lipids such as linoleic and α -linolenic acid and vitamins such as B2, B3, C, E and some amount K. It also includes macro - elements such as fluorine, iodine and phosphorus. The diphenylpropanoid skeleton ($C_6C_3C_6$) is also present in green tea. Further, it is rich in xanthine bases, which are theophylline, caffeine and pigments which include carotenoids and chlorophyll. Phenolic acids such as gallic acid and volatile compounds such as alcohols, esters, hydrocarbons and aldehydes also make up the chemical contents of green tea. Catechins are the typical green tea flavonoids. Green tea contains higher amount of catechins than any other tea. The group of catechins present in green tea are (-)-epicatechin (EC) around 6%, (-)-epigallocatechin (EGC) is around 20%, (-)-epicatechin-3-gallate (ECG) around 14% and (-)-

epigallocatechin-3-gallate (EGCG) which is 60%. The antioxidant activity of catechins plays an important role in making green tea a health alternative to the other teas. Catechins which have pyrogallol group have higher antioxidant activity as compared to catechins which have catechol group. According to one of the researches, ascorbic acid, arginine, proline, lysine and EGCG have a positive effect on the reduction of tumor growth [1, 7, 10].

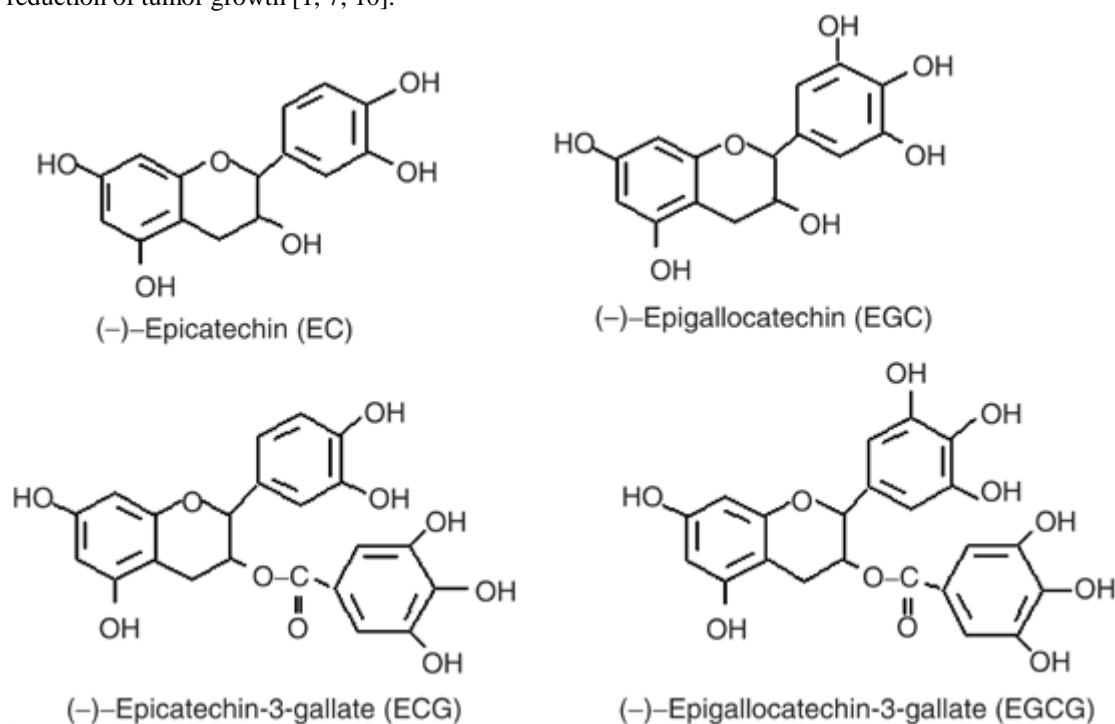


Figure 3 Chemical Structure of [6]

IV. PRODUCTION OF GREEN TEA

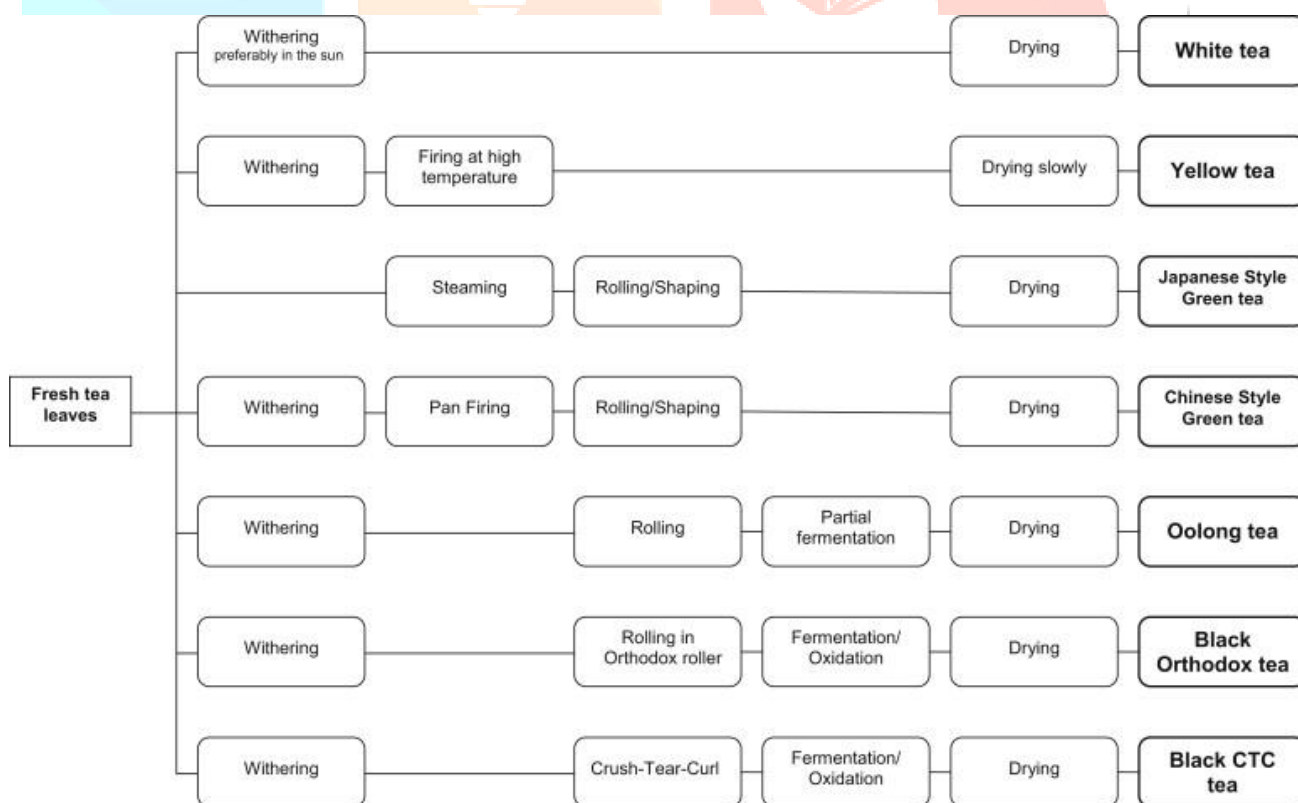


Figure 4 Production Steps of different types of Tea [20]

Green tea is produced from *Camellia sinensis* var. *sinensis* variety of the tea plant. The other variety of the tea plant, the *Camellia sinensis* var. *assamica* has a high concentration of polyphenols which can make the green tea bitter. The steps for processing green tea are plucking, withering, steaming, rolling, drying and sorting. Step one is plucking. Here the leaves are first plucked from the tea plant *Camellia sinensis* var. *sinensis* and send in the factory for the further processing. Step two is withering, which helps the leaves lose some of the moisture. The third step is steaming which stops the oxidation process and the tea leaves retain the green colour. The polyphenol oxidase enzyme is killed during this process. In the fourth step, the leaves are cooled, cut, twisted and rolled to let the remaining moisture evaporate. Later the tea leaves are air dried or hot air dried and then sorted according to grade and size [3, 14, 19].

V. ANTIOXIDANTS PRESENT IN GREEN TEA

The antioxidants present in green tea come under the category of non – enzymatic antioxidants. They are further classified into flavonoids under which catechins are seen. Generally, antioxidants have two types of mechanism in which they work. First is by breaking the chain mechanism, this way the primary antioxidant donates an electron to the free radical present in the product. In the second mechanism of antioxidants, the secondary antioxidants are removed by pulling out the chain initiating catalyst [15, 16].

Catechins are one of the antioxidants present in green tea which gives it more health benefits than the other teas. Catechins have numerous health benefits as they are anti – inflammatory, anti – microbial, anti – viral, anti – diabetic and can repair DNA which has been damaged by radiation. The amount of catechins present in green tea depends on various factors such as the plant variety, method of production, temperature. They are the most stable at pH range of 4 to 6 [1, 5].

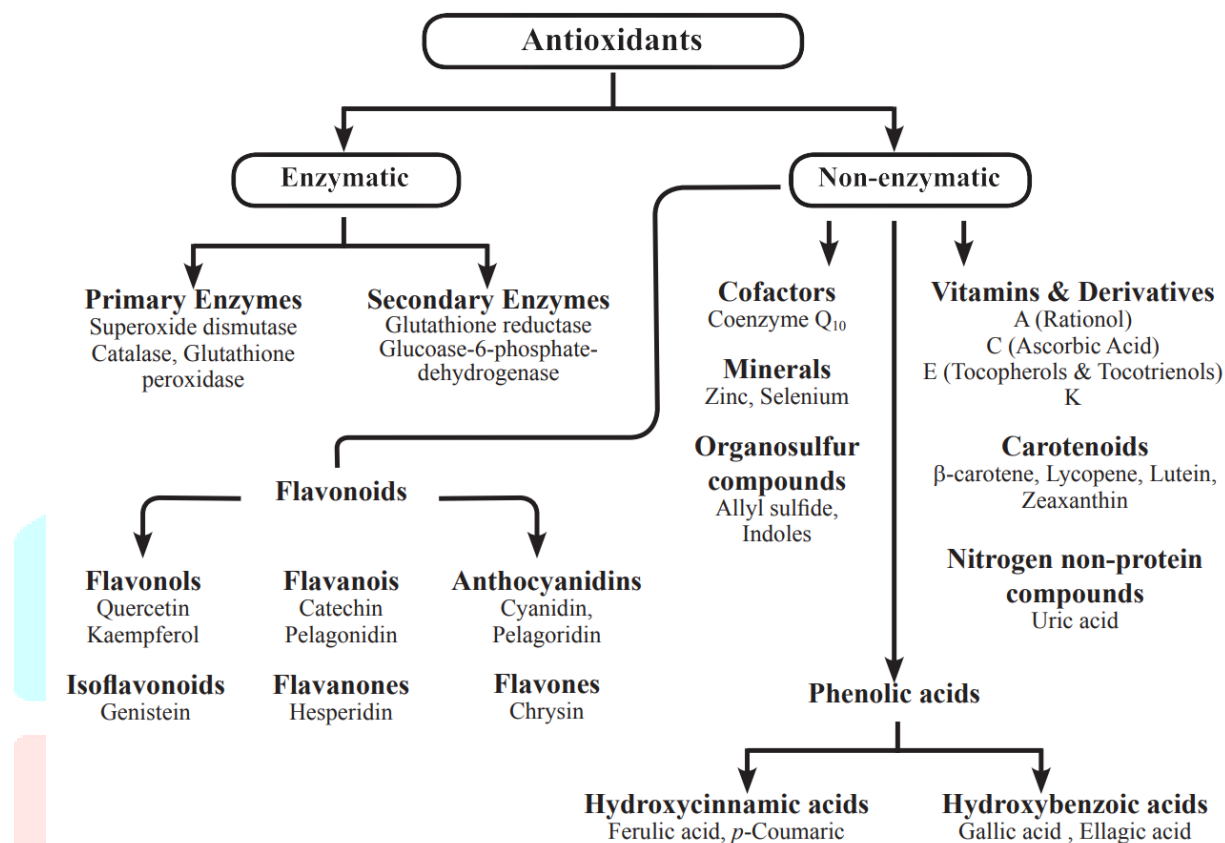


Figure 5 Classification of Antioxidants [22]

VI. HEALTH BENEFITS OF GREEN TEA

Green tea has enormous health benefits one can think of. It improves the lipid and glucose metabolism, hinders the sudden increase of blood sugar levels in the body and balances the metabolic rate. It is observed that the EGCG catechin has antidiabetic effect. Green tea polyphenols protect the neurotransmitter (dopamine) in the brain. Parkinson's disease is caused as the cell in the brain get damaged, but the antioxidants present in green tea help prevent cells getting damaged in the brain. Green tea also helps treat Alzheimer's disease, the main treatment for Alzheimer's disease is the inhibition of acetylcholinesterase enzyme and β - amyloidosis. The catechin ECGC reduces the production of β - amyloid. β - amyloid is a protein that clogs the brain of the Alzheimer patients by forming plaques. Green tea increases the energy expenditure and fat oxidation which leads to weight loss therefore, it has been observed to have anti - obesity effects. EGCG and ECG are seen to be potential inhibitors of influenza virus. They inhibit the neuraminidase activity; neuraminidase is an antigenic glycoprotein enzyme present on the surface of the influenza virus which helps release virus from the cells. Green tea also increases the antioxidants present in the blood protecting the LDL cholesterol from oxidation. Anti – thyroidal and goitrogenic activity is also seen in catechins present in green tea. One of the studies has also revealed that green tea drinkers have a higher mean bone mineral density (BMD) measurement than others who do not consume green tea. The antioxidant defence system of the body is preserved by the consumption of green tea which makes green tea an anti – cataract agent.

Green tea has should to affect gram – positive as well as gram – negative bacteria. It also has antimicrobial activity such as damaging the bacterial cell membrane, inhibition of bacterial fatty acid synthesis and inhibition of other enzymes. EGCG, the major polyphenol present in green tea has anti - inflammatory and anticancer properties that may prevent the onset and growth of skin tumours. However, late stages of cancer experience little or no improvement from consuming green tea. Green tea is effective in reducing the oral mal - odour due to its disinfectant and deodorant activities as it inhibits VSCs (volatile sulphur compounds) production in the body. Tannins and flavonoids of tea have antiseptic properties, they can be useful topically for skin regeneration, wound healing, treatment of certain epithelial conditions such as aphthous ulcers, psoriasis, rosacea and actinic keratosis. At particular concentrations, EGCG or a mixture of polyphenols present in green tea can stimulate aged keratinocytes to generate biological energy and to synthesize DNA for renewed cell division. Moreover, green tea naturally exfoliates the dry flakes of dandruff which are the

roots of dandruff without dehydrating the skin. It also normalizes the skin cell growth cycle by regulating a protein called Caspase-14, soothes the skin and reduces inflammation [4, 13, 18, 21].

VII. CONCLUSION

Green tea is one of the most consumed hot beverages in the world. The enormous health benefits have been proven to be a boon for a better lifestyle. Anything in excess is not good, therefore consumption of approximately one cup of green tea can make wonders to our body. EGCG is the only catechin which is widely studied and has seen so many health advantages, more research on the other catechins EC, ECG, EGC should be undertaken to discover many other interesting facts. Green tea is also reasonably inexpensive for common man and is available in every grocery store which makes it a good option for people for improving health all over the world [8, 9, 14].

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