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CODEN: IAASCA **REVIEW ARTICLE**

Fabulous Green Tea: Its Constituents & Therapeutic Applications

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ABSTRACT
Green tea, native to China and India, which is produced from the leaves of the Camellia sinensis plant, has been consumed and hailed for its health benefits for centuries globally, but has only recently gained popularity in the United States. Over the past 30 years or more, scientists have studied this plant in respect to potential health benefits. Research has shown that the main components of green tea that are associated with health benefits are the catechins. The four main catechins found in green tea are: (−)-epicatechin (EC), (−)-epicatechin-3-gallate (ECG), (−)-epigallocatechin (EGC), and (−)-epigallocatechin-3-gallate (EGCG). Of these four, EGCG is present in the largest quantity, and so has been used in much of the research. Among the health benefits of green tea are: anticarcinogenic, anti-inflammatory, antimicrobial, and antioxidant properties, and benefits in cardiovascular disease and oral health. Research has been carried out using various animal models and cells lines, and is now more and more being carried out in humans. This type of research will help us to better understand the direct benefits of green tea. The main objective of this review is to enlighten some recent facts with relevance to the current status and advance in green tea benefits.
Keywords: EC, ECG, EGC, EGCG, anticarcinogenic, anti-inflammatory, antimicrobial, antioxidant

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INTRODUCTION

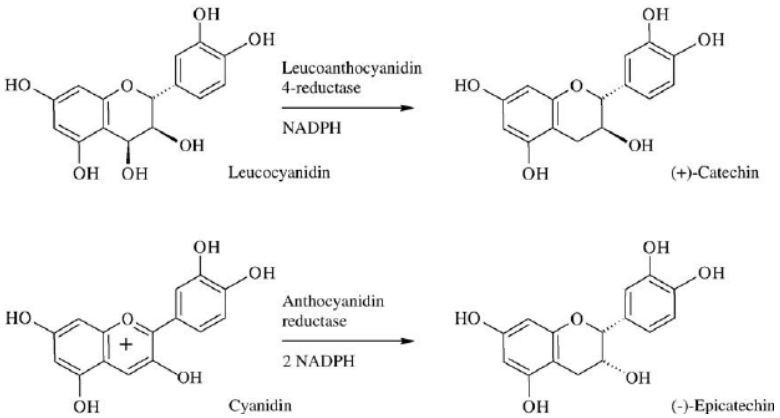
Tea is the most consumed beverage in the world behind water. However, 78 percent of the tea consumed worldwide is black and only about 20 percent is green. All types of tea, except herbal tea, are brewed from the dried leaves of the Camellia sinensis bush. The level of oxidation of the leaves determines the type of tea. Green tea is made from unoxidized leaves and is one of the less processed types of tea[1]. It therefore contains the most antioxidants and beneficial polyphenols. Green tea was used in traditional Chinese and Indian medicine to control bleeding and heal wounds, aid digestion, improve heart and mental health, and regulate body temperature.

Recent studies have shown green tea can potentially have positive effects on everything from weight loss to liver disorders, type 2 diabetes, and Alzheimer's disease[2]. The first green tea was exported from India to Japan during the 17th century. It is estimated that about 2.5 million tons of tea leaves are produced each year throughout the world, with 20% produced as green tea, which is mainly consumed in Asia, some parts of North Africa, the United States, and Europe. The association between tea consumption, especially green tea, and human health has long been appreciated. Green tea is emerging as the natural remedy to almost all the health related issues. With the latest advancement in the technologies, various potentials of green tea have been explored. This has succeeded in fetching the consistent interest of people toward the health benefits associated with this herbal gift of nature to the mankind[3].

Preparation of Green Tea

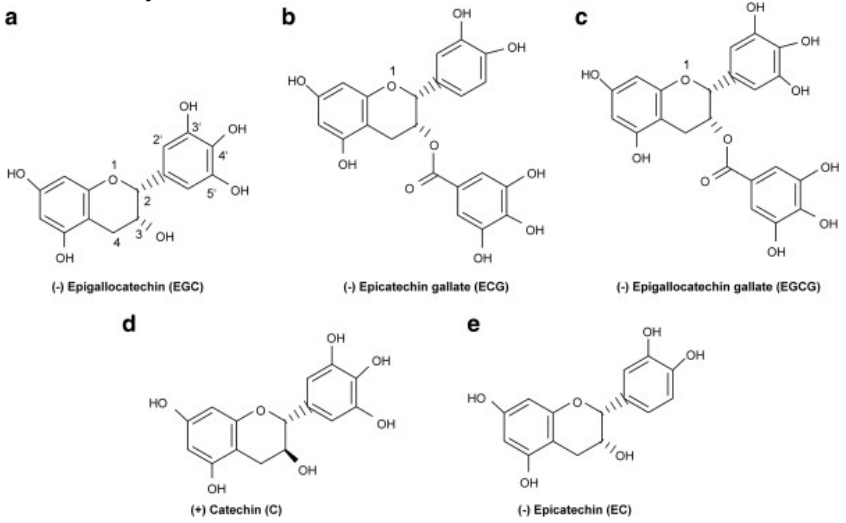
Green tea and black tea are processed differently during manufacturing. To produce green tea, freshly harvested leaves are immediately steamed to prevent fermentation, yielding a dry, stable product. This steaming process destroys the enzymes responsible for breaking down the color pigments in the leaves and allows the tea to maintain its green color during the subsequent rolling and drying processes[4]. These processes preserve natural polyphenols with respect to the health-promoting properties. As green tea is fermented to Oolong and then to black tea, polyphenol compounds (catechins) in green tea are dimerized to form a variety of theaflavins, such that these teas may have different biological activities[5].

Green tea composition

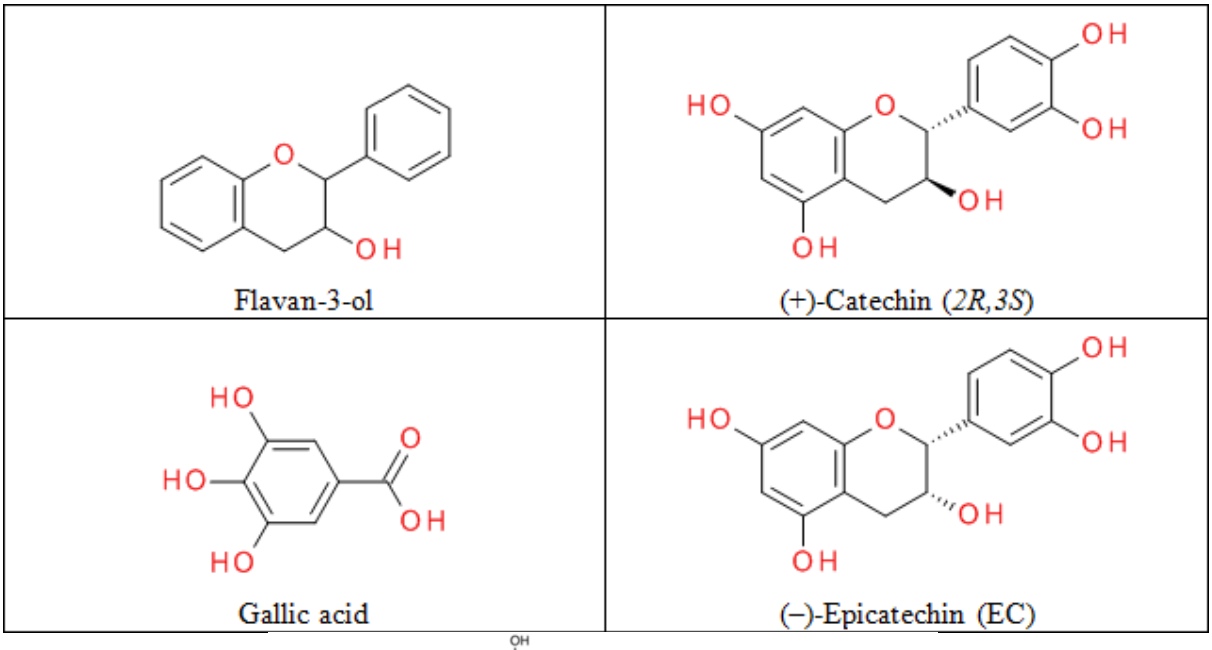


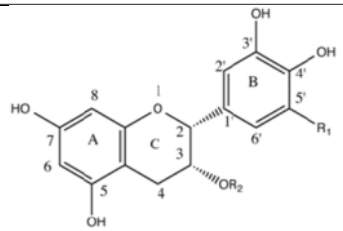
The astringency of the beverage is due to phenolic constituents known as catechins, which make up a group of compounds that are closely related to tannins. Broadly speaking, a tannin is a gallic acid ester of a carbohydrate or phenolic compound, and includes compounds derived from wood that are unrelated to tea. Tannins are acidic due to the phenolic hydroxyl groups on the gallic acid moiety. They also act as antioxidants, and form complexes or chelates with metals. All of the tannins in tea are catechins, which as a group are hydroxylated flavanols and their gallic acid esters. These compounds make up roughly half of the hot water-soluble material in tea beverages. Some types of catechins are also contained in other plants, but the "tea catechins" are unique to the tea plant. During fermentation process, these catechins undergo phenolic oxidative coupling reactions that yield red-colored catechin dimers such as thearubigins (proanthocyanidins). These latter account for the darker color of the beverages produced from oolong and black tea, and also have physiological activity similar to that of the catechins including antibiotic and immunomodulatory effects. Green tea does not contain appreciable amounts of these catechin dimers. The chemical structures of the most important constituents and their building blocks are shown below.

The chemical composition of green tea is complex: proteins (15-20% dry weight), whose enzymes constitute an important fraction; amino acids (1-4% dry weight) such as theanine or 5-*N*-ethylglutamine, glutamic acid, tryptophan, glycine, serine, aspartic acid, tyrosine, valine, leucine, threonine, arginine, and lysine; carbohydrates (5-7% dry weight) such as cellulose, pectins, glucose, fructose, and sucrose; minerals and trace elements (5% dry weight) such as calcium, magnesium, chromium, manganese, iron, copper, zinc, molybdenum, selenium, sodium, phosphorus, cobalt, strontium, nickel, potassium, fluorine, and aluminum; and trace amounts of lipids (linoleic and α-linolenic acids), sterols (stigmasterol), vitamins (B, C, E), xanthic bases (caffeine, theophylline), pigments (chlorophyll, carotenoids), and volatile compounds (aldehydes, alcohols, esters, lactones, hydrocarbons). Due to the great importance of the mineral presence in tea, many studies have determined their levels in tea leaves and their infusions [6-8].

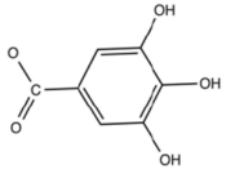


Chemical Structures of catechins. Structures of (−)-epigallocatechin (EGC) (a), (−)-epicatechin gallate (ECG) (b), (−)-epigallocatechin gallate (EGCG) (c), (+)-catechin(C) (d), and (−)-epicatechin (EC) (e).
Fresh leaves contain, on average, 3-4% of alkaloids known as methylxanthines, such as caffeine, theobromine, and theophylline. In addition, there are phenolic acids such as gallic acids and characteristic amino acid such as theanine present.





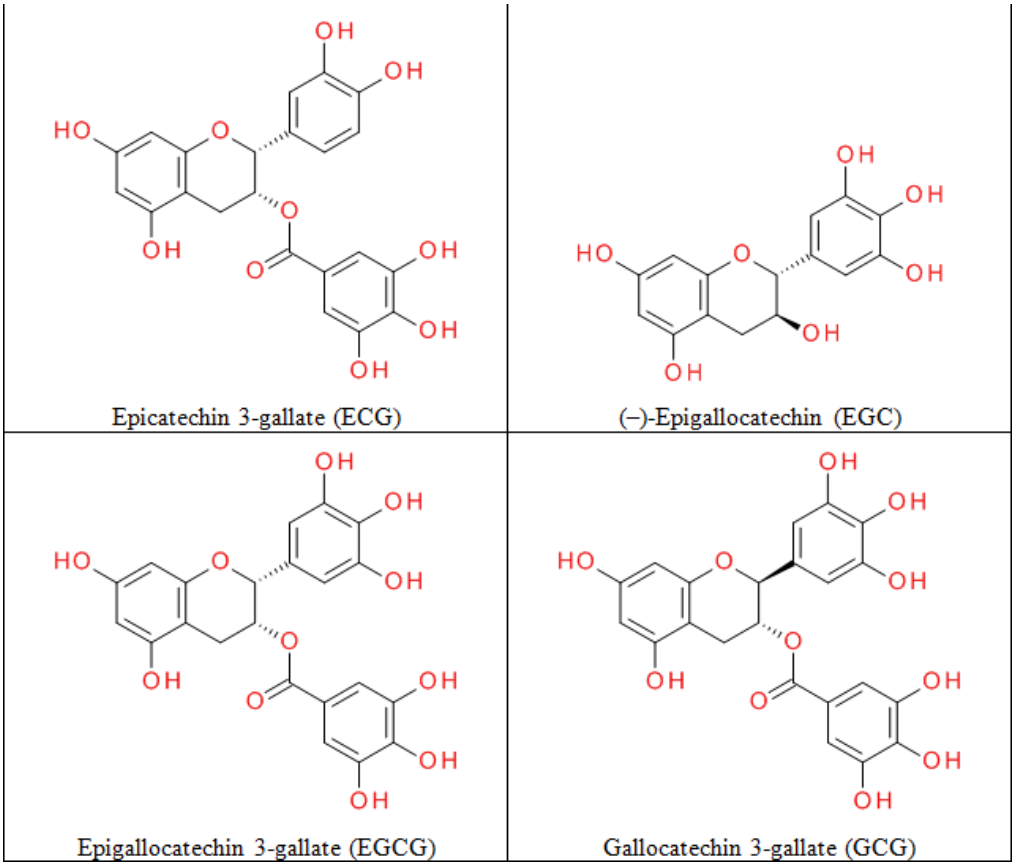
Main catechin structure



Gallate group

	R1	R2
EC	H	H
EGC	OH	H
ECG	H	Gallate group
EGCG	OH	Gallate group

Green tea contains polyphenols, which include flavanols, flavandiols, flavonoids, and phenolic acids; these compounds may account for up to 30% of the dry weight. Most of the green tea polyphenols (GTPs) are flavonols, commonly known as catechins. Products derived from green tea are mainly extracts of green tea in liquid or powder form that vary in the proportion of polyphenols (45-90%) and caffeine content (0.4-10%) [9-11].
The major flavonoids of green tea are various catechins, which are found in greater amounts in green tea than in black or Oolong tea. There are four kinds of catechins mainly find in green tea: epicatechin, epigallocatechin, epicatechin-3-gallate, and EGCG. Catechins are believed to have a range of beneficial health effects such as neuroprotective activity, and anti-inflammatory, antiulcer, antiviral, antibacterial, and antiparasitic effects.



The most studied catechin in relation to health contributing potential is epigallocatechin 3-gallate (EGCG), which constitutes 50-75% of the total flavonoid content in green tea. EGCG is a potent antioxidant, and acts to inhibit a number of physiologically important enzymes. There is some evidence that it might have therapeutic applications in the treatment of some types of cancer, chronic fatigue syndrome, endometriosis, neurodegeneration, periapical lesions, regulating the HIV viral load, Sjögren's syndrome, and spinal muscular atrophy, to name a few.

Benefits of Green Tea

Green tea in its purest and most unadulterated form has always influenced human health from generations and day by day scientific evidences throughout the world are making people aware of health benefits associated with this herbal drink. Though Green Tea is not officially recognized as a medical agent, it is one of the most researched plant-based remedies whose possible benefits include promotion of cardio-vascular health, cancer prevention, skin protection, and antioxidant activity, to fight high cholesterol levels, infection, impaired immune function, diarrhoea, fatigue and many more. Laboratory findings have revealed that notable health benefit of green tea is its powerful antioxidants potential which at the molecular level, helps prevent cellular damage from certain oxidation reactions in the body. The credit for their useful antioxidant property lies with their huge collection of chemical substances called polyphenols and catechins make the major contribution of them. Though catechins have been found in other plants derivatives such as grapes, pomegranates, those found in tea have proven to be the most effective antioxidants known. The catechins epigallocatechin gallate (EGCG) is found in the greatest concentration and most studied for its health benefits[12].

FURTHER RESEARCH

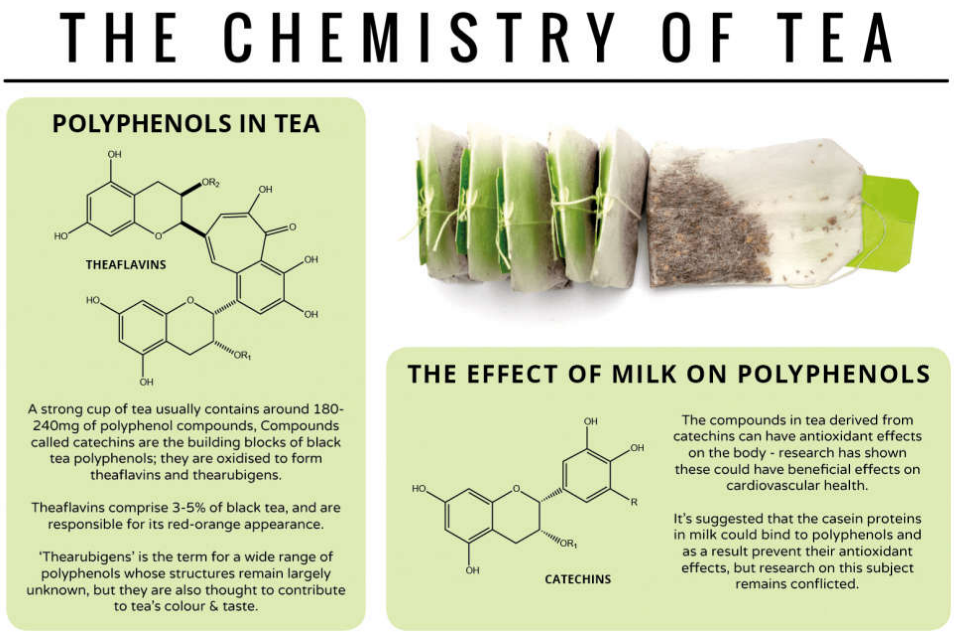
Recent application of green tea in nanotechnology has suggested promising evidences in its bioavailability by delivering EGCG using lipid nanocapsules and liposome encapsulation. Further study in this regard can be useful in availing the healthy benefits of green tea. With successful outcomes of in vivo- studies of green tea as a potent anti rheumatic and anti – HIV agent, human trials of green tea for the same can be done in future to provide a novel pathway for the therapy. Definitely, these findings are promising, but many of these properties of green tea have been revealed through several animal trials and still human clinical evidences are lacking on their behalf. It is very important to have future research with frequent epidemiological studies and to conduct human

trials which can further explore the hidden credentials of green tea and confirm their actual magnitude of potential for humans. Also, random experiments worldwide have explored varied outcomes, it is essential to study the safe dose of green tea consumption to acquire their health benefits and to have better understanding of their mode of action.

Development of more specific and sensitive methods with more representative models along with the development of good predictive biomarkers will give a better understanding of how green tea interacts with endogenous systems and other exogenous factors. The development of biomarkers for green tea consumption, as well as molecular markers for its biological effects, will facilitate future research in this area. Thus, there is an urgent need to check the efficacy, safety and translational guidelines for a green tea to be used as safe, effective drug. Current IHC Harmonised Tripartite Guidelines (current step 2 version, 2008) may be followed to study parameters like Cytotoxicity test, Comet assay, Biochemical analysis, Cytotoxicity assay (MTT test), Genotoxicity assay, carcinogenicity assay, percent protection test in challenged animal models. Identification of active principal, screening of bio medicinal properties by appropriate in vitro assays, investigation of toxicological effects as per the regulatory guidelines will make green tea a magical herb with miraculous outcomes[13].

CONCLUSION

Green tea has been consumed in China and other Asian countries since ancient times. Nowadays, green tea is considered to be one of the most promising dietary agents for the prevention and treatment of many diseases and is consequently being studied extensively worldwide. Numerous studies in humans and a variety of experimental animal models have demonstrated that green tea possess antioxidant, antidiabetic, anti-inflammatory, antibacterial, and anticarcinogenic effects. Furthermore, green tea consumption has been reported to act positively against cardiovascular diseases, obesity, insulin sensitivity, oral infections, and arthritis. Currently there has been an increased interest globally to identify antioxidant potentials of green tea which is pharmacologically potent and have low or no side effects for use in protective medicine and the food Industry. Increasing knowledge in antioxidant phytoconstituents and include them in daily uses and diet can give sufficient support to human body to fight those diseases. It is not surprising that day by day green tea and its products are capturing the global market and its use has also increased incredibly. The credit for this remarkable achievement is linked with the high antioxidant components of green tea. From antibacterial to antifungal, antiviral potentials, from skin, vision, hair loss, over weight issues, diabetes, kidney disorders, to Parkinson's and Alzheimer's disease, cancer and many more, green tea has proved its potentials and still many parameters are still need to be explored.



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