Review Article

Phytochemical Constituents and Pharmacological Profile of Green Tea: An Overview

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ABSTRACT

Tea is one of the most widely consumed beverages throughout the world. Tea is extracted from plant named *Camellia sinesis* .Among different variety of teas, green tea found to have a large number of health benefits. Green tea is prepared by special methods of preparation which greatly influences the disease treating properties of green tea. Earlier many invitro researches on animal models proves that the key component catechins , poly phenols and antioxidants present in green tea are responsible for producing beneficial affects against diseases. Being unadulterated and having very lilttle side effects the consumption of green tea is increasing worldwide. Various Epidemiological evidence shows that the components rich in antioxidants reduce the incidence of morbidities and mortalities. In ancient times Chinese used green tea to treat everything from headache to depression but the exact mode of action was not known to them. But as time passed on research revealed the exact mechanism of action of green .The major flavanoids in green tea are catechins, epicatechin(EC),epigallocatechin (EGC), ,epicatechingallate (ECG), epigallocatechingallate (EGCG).Among this EGCG is the most active component whose action is beneficial in treatment of diseases. The main interest in this review is on the amazing actions of green tea which provides variability in treating diseases which may be caused by a pathogen or to treat a fatal disease also like cancer, cardiovascular diseases, skin diseases, viral diseases, arthritis, obesity, neurodegenerative diseases, dental caries.

Keywords: Green tea, EGCG, Cancer, Antioxidants, Catechins.

1. INTRODUCTION

Green tea is the natures treasure to the mankind. It is the second oldest and largest most consumed beverage in the world.[1] The first green tea was exported from India to Japan during 17th century.Is is estimated that about 2.5 million tons of tea leaves are produced each year throughout the world with 20% produced as green tea in Asia, some parts of Northamerica, the united states and Europe.[2]Some higher quality of variants and traditional green tea include matcha and sencha. Matcha is primarily the uji plantations of Japan, the country`s famous tea growing area. Like matcha, sencha is primarily harvested in Japan, usually in the summer month. Sincha is produced from unground tea leaves and is valued for its texture.[3]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. These process preserve natural poly phenols with respect to 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 thea flavins, such that these teas may have different biological activities[4].

2. HISTORY

Initially used as an offering and as medicine, tea becomes the most commonly using beverage during western hang dynasty. Buddhist monks started growing it around monasteries. Later during the Ming dynasty, the tea trade took an upper share in the state economy and the “TEA AND HORSE BUREAU” was setup to supervise tea trade. The “KISSA YOJOKI OR BOOK OF TEA” was written by a Zen priest named Eisai in 1191 .The book describes how drinking green tea can have a positive effect on the five vital organs of the body especially the heart .Because of this book, we know that the Chinese and Asian people have long known that green tea can be used in many ways to promote healing and ward off health problems. When China was the sea power of the world (1405-1433) tea was among the indispensible supplies for the seamen. The amount of

vitamin C in the tea drink consumed by the seafarers at that time was enough to prevent scurvy which would kill many European sailors more than 100 years later, but was essentially unknown to the medical officers assigned to the fleet of more than 27,000 men on their round voyage from China to Africa.

In a famous painting titled “Drinking Tea” (a poor translation of the original elegant title in Chinese meaning “Tea Tending Event”), which is now on display in the Palace Museum, Beijing, the most admired envied painter of Ming dynasty, Tang Yin (1470-1523) recorded the traditional method for tea preparation at the time when China was the most prosperous nation on earth. As described in the poem written on the painting, an affluent intellect actually plucked fresh leaves from the teas trees growing on the southern hillside below his house to brew tea. This document recorded the fact that fresh or non-oxidized tea leaves, i.e., green tea, were used in the prosperous Chinese society at least until the latter part of Ming dynasty.[5]

3. NOMENCLATURE AND TAXONOMY

The name camellia is taken from the Latinized name of Rev. Georg Kamel, a Czech-born Jesuit lay brother, pharmacist and missionary to the Philippines.[6] Cart linnaneus chose his name in 1753 for the genes to honor Kamel`s contribution to botany.[7] Robert Sweet shifted all formerly Thea species to the Camellia genus in 1818.[8] The name sinensis means from China in latin.Four varieties of *Camellia Sinensis* are recognized of these *C,sinensis var, sinensis and C.sinensis var.assamica kitamura* are most commonly used for tea and *C.sinensis var pubiumba* Hung T. Chang and *C.sinensis va. Dehungensis* TL Mung are sometimes used locally.[9]

Table 1: Taxonomy

Classification	
Kingdom	Plantae – Plants
Sub kingdom	Tracheobionta – Vascular plants
Super division	Spermatophyta – Seed plants
Division	Magnoliophyta – Flowering plants
Class	Magnoliopsida – Dicotyledons
Sub class	Dilleniidae
Order	Theales
Family	Theaceae – Tea family
Genus	Camellia L. – camellia

4. CULTIVATION

The way the leaves are processed however is even more important in developing the individual characteristics on three predominant types of tea- GREEN TEA, BLACK TEA, OOLONG TEA.[11]

The difference between green tea and other teas are only partially or not fermented at all, allowing the finished tea to remain closer to the plants natural state .The ways in which fermentation of the leaves is stopped or prevented depends on culture and region, however because fermentation is stopped early on in the tea processing a significant amount of health benefits and healing properties are preserved with leaves. The freshly plucked tea leaf is steam blasted in perforated drums or cooked in iron pan, denaturing its oxidizing enzymes.[12]

5. CHEMICAL COMPONENTS OF GREEN TEA

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 theonine or 5-N-ethyl glutamine, 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, sucrose.[26] The other compounds in green tea with interest for human health like fluoride, caffeine, minerals, trace elements like chromium and manganese.[13-17] It contains trace amounts of lipids (linoleic acid, alpha linoleic acid), sterols (stigmasterol) , vitamins (B, C, E), xanthine bases (caffeine, theophylline), pigments (chlorophyll, carotenoids), volatile compounds (aldehyde, alcohol, esters, lactones, hydrocarbons) .[18] Green tea contains polyphenols which includes flavonols , flavonndiol, flavonoids , and phenolic acids.[19] It also contains catechins such as (-)-catechin, (-)-epicatechin, (-)-epigallocatechin, (-)-catechin-3-gallate, (-)-epicatechin-3-gallate , (-)-gallocatechin-3-gallate, (-)-epigallocatechin-3-gallate, theoflavin, theoflavin-3-gallate, theoflavin-3,3-bigallate are indicated as major part of biologically active substances. There are up to 30% of catechin in the tea sand up to 200 mg in one cup of tea.[20]

EGCG is the most common polyphenol found in green tea, making upto 10% of its dry weight, [21] comprising 60-70% of its total catechins.[34] .Many of green teas health promoting abilities are attributed to EGCG.[22]

EGCG and other catechins exhibit strong antioxidant activities due to their single electron reduction potential. Free radicals are harmful, and reactive molecules are made unstable by this unpaired electron. They are involved in diseases from blood clots to cancer.[23]

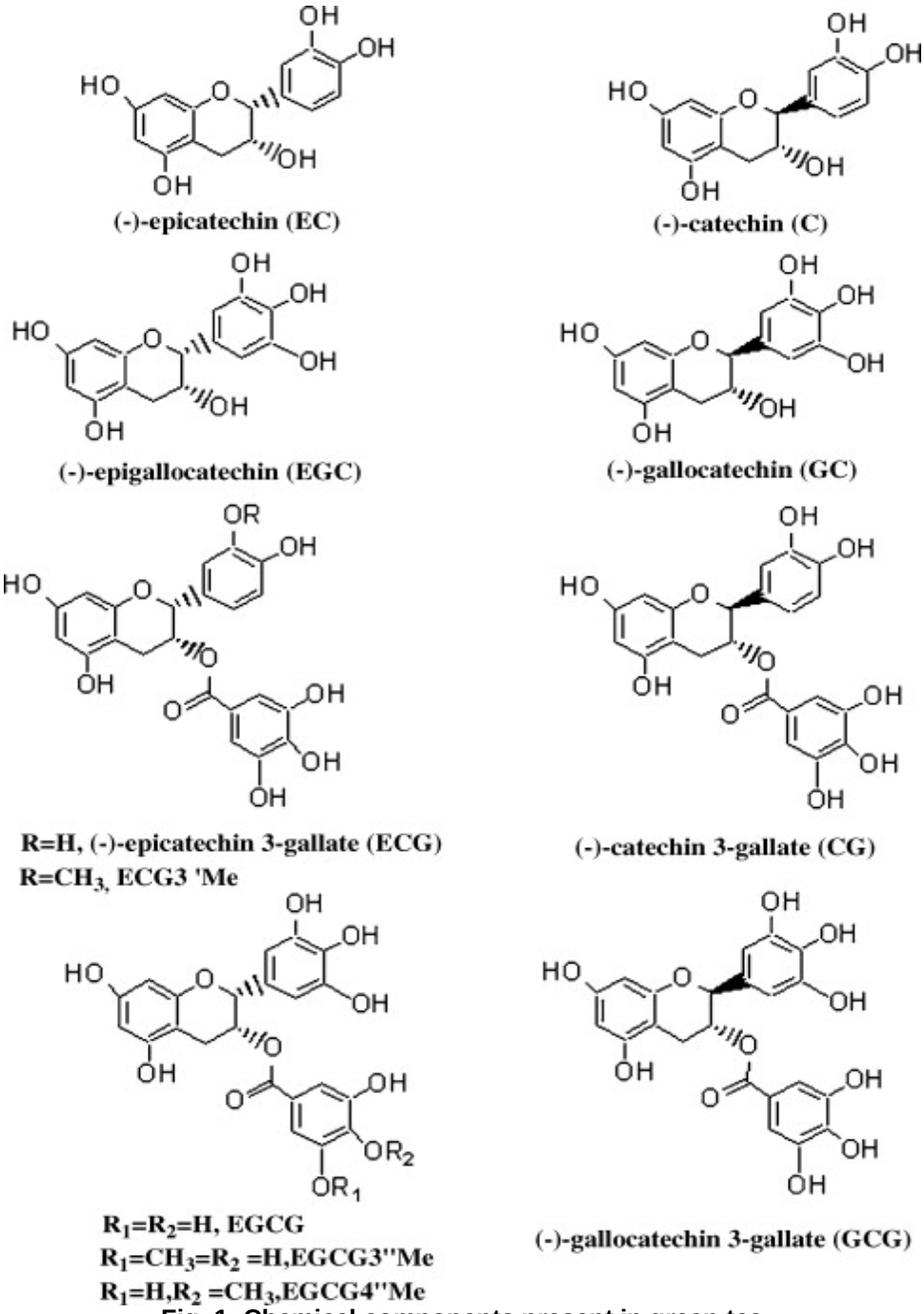

Fig. 1: Chemical components present in green tea

5. PHARMACOLOGICAL PROFILE

CANCER

Despite the demonstration of the inhibitory activities of green tea and its catechins against carcinogenesis in different organs in different animal model.[24] Green tea and EGCG have also been shown to inhibit the process of angiogenesis, tumor metastasis and invasion in animal models .The relevance of the various mechanismsm of antiproliferative, anti-angiogenic and anti-invasive activities of green tea and catechins, to the prevention of carcinogenesis in humans, represents a monumental challenge, yet to be addressed .[25]Several studies have demonstrated green tea polyphenols preventative and inhibitory effects against tumor formation and growth. While the studies are not conclusive, green tea polyphenols , particularly EGCG, may be effective in preventing cancer of the prostate, breast, esophagus, stomach, pancreas, and colon.[26,27]

CARDIOVASCULAR DISEASES

Green tea consumption has been associated with a lower incidence of coronary artery disease in Japanese populations.[28]The protective effect of green tea in cardiovascular diseases is also thought to stem from its antioxidant activity .[29] Green tea extract also attenuated blood pressure increases in spontaneously hypertensive rats, an effect attributed to its antioxidant properties.[30]Drinking tea may help lower the risk of developing heart disease by supporting the health of blood vessel cells surrounding the heart. Green tea may also protect arteries against atheroscelrosis, a buildup of fatty, plaque material on the inner layer of blood vessels. According to the university of Maryland Medical Centre, population based clinical studies indicate that the antioxidant properties of green tea may help prevent artherosclerosis, particularly coronary artery diseases by 11 percent with consumption of three cups of green tea per day.[31]In addition to reducing plaque buildup that can lead to heart attack, research presented by the university suggests that green tea might lower total cholesterol than those who do not drink green tea. In other small study of male smokers, researchers determined that green tea may significantly reduces blood levels of harmful LDL cholesterol.[32]Those who drink at least three cups of green tea every day, a 2% of lower risk of suffering a stroke is observed as compared with those who drink less than a cup a day.[33]Regular drinking of green tea seems to lower the chance of getting high blood pressure. The loss of arterial elasticity is one of the causes of high blood pressure. With age, this elasticity is lost and thromboxane is one cause of arterial constriction. Another cause of hypertension is an enzyme secreted by the kidneys called Angiotensin Converting Enzymes (ACE).Green tea seems to block thromboxane as well as ACE production and appears to be their natural inhibitor which significantly reduces blood pressure.[34]

SKIN TREATMENT

Green tea is effective in the area of skin care, particularly in the allevating the symptoms of acne and eczema. When they used as combination with sunscreen, green tea enhances sun protection.[35]Treatment of green tea polyphenols to skin has been shown to modulate the biochemical pathways involved in inflammatory responses, cell proliferation and responses of chemical tumour promoters as well as ultra violet light induced inflammatory markers of skin inflammation.86 Green tea has been found to reduce the release of pro inflammatory cytokines such as IC-beta, IL-6, IL-8, TNF-alpha and prostaglandins(E-2) in human white blood cells in culture.[36-38] Research using pooled human keratinocytes to study the normal growth of the skin cells alone and comparing it to the cells when exposed to EGCG revealed that EGCG reactivated drying cells. Cells that migrate toward the surface of the skin normally live about 28 days and, by day 20,they sit on the epidermis getting ready to die and slough off. Current research seems to show that EGCG reactivates epidermis cells.[39]

ANTI VIRAL EFFECTS

EGCG and ECG were found to be potent inhibitor of influenza virus replication in cell culture. This effect was observed in all influenza virus sub types tested, including A/H_1N_1, A/H_3N_2 and B virus. Similarly, EGCG and ECG inhibited the neuraminidase activity more effectively than ECG. Neuraminidase is an antigenic glycoprotein enzyme found on the surface of influenza virusand this aids in the efficiency of virus release from cells.[40]However, recently, EGCG has received significant attention for its effects on inhibition of HIV infection and multidrug –resistant *Staphylococcus aureus* infections.[41] EGCG has been shown to inhibit HIV-1 replication by inhibiting HIV reverse transcriptase and by interfering with the binding of the viral envelope.[42] EGCG's polyphenolic nature and its high affinity for protein may also confound the results of in vitro experiments that use pure EGCG. Interestingly, EGCG and other galloyl-containing catechins were also identified in a high throughput screening assay as inhibitors of scrapie-associated prion protein formation.[43]

NEURODEGENERATIVE DISORDERS

Green tea has revealed considerable health promoting qualities for nerve degeneration diseases such as parkinson's and alzheimer's disease. Interestingly, synergistic effects of green tea with anti parkinson's drug "rasagiline" were observed.[44]In well-established animal models of Parkinson's disease, neurotoxins 1-methyl-4-phenyl-1,2,3,4-tetrahydropyridine (MPTP) and 6-hydroxydopamine (6-OHDA) induce dopaminergic cell death and accumulation of Lewy bodies, mediated through several mechanisms involving oxidative stress. Various studies have shown that green tea and EGCG significantly prevent these pathologies in animal models.[45] EGCG, administered orally in doses as low as 25 mg/kg, prevented loss of dopaminergic

neurons in the substantia nigra and preserved striatal levels of dopamine.[46] Recently, also showed that EGCG prevented the accumulation of iron and alpha-synuclein in MPTP-treated mice. These effects have been attributed to the antioxidant activity and iron-chelating properties of EGCG, respectively. Epidemiological studies on the prevalence of Parkinson's disease and green tea consumption do show a 5- to 10-fold lower incidences of the disease in Asian populations.[44]

DIABETES

Insulin resistance and glucose intolerance, features of Type 2 diabetes, are also considered risk factors for cardiovascular disease and for metabolic syndrome X. In a small study in human volunteers,Found that drinking green tea substantially increased oral glucose tolerance but did not affect basal blood glucose levels. Long-term administration of green tea extract to normal rats increased insulin sensitivity. When administered to fructose-fed rats, green tea extract was also found to prevent development of insulin resistance, hyperglycemia and other metabolic defects.It has been demonstrated in vitro that these effects were due to increased insulin sensitivity and glucose uptake of adipocytes and that EGCG was the most active catechin component that showed these effects .[44]

DENTAL CARIES

Green tea effectively prevents dental caries.Both fermented and semi fermented *Camellia sinesis* extracts prevental the growth of oral Streptococci responsible for dental caries.[53] In vitro studies of simple catechin component of green tea have suggested anti carcinogenic properties such as a bactericidal effect against *Streptococcus mutans and S. sobrinus*, prevention of bacterial adherence to teeth and inhibition of bacterial and human enzymesfor production of plaque and acid that lead to dental caries.Tea contains substance, such as polyphenols that were shown to have antibacterial properties against cariogenic bacteria, especially *S. mutans*. The polyphenols in green tea were reported to have an inhibitory effect on the growth and cellular adherence of *Porphyomones gingiyalis* an oral bacterium that causes periodontal disease. Green tea also contains a significant amount of fluoride, which may support for strong teeth and bones. Some articles suggest that the tannic acid in green tea may help to provide relief to those suffering from gum infections by supporting the repair of damaged blood vessels and helping to prevent the development of dental plaque. Green tea has also been assiociated with preventing bad breath by potentially reducing bacteria found in mouth.[45]

ARTHRITIS

Extensive studies in the past two decade have verified the antioxidant, anti inflammatory, and cancer prevention properties of a polyphenolic mixture derived from green tea in many animal bioassay systems.[63] Severity of arthritis symptoms in rats was significantly reduced by green tea poly phenols at a dose of 8mg/L for nine days. A prospective cohort study of women aged 55-69 ,drinking three or more cups a day of tea had a reduced risk of developing rheumatoid arthritis compared with those who drank no tea.[46]

7. CONCLUSION

It is the largest consuming beverage around the world. The use of green tea is increasing day by day because of its wide variety of disease treating potential. All this benefits of green tea favors a growing interest in finding more and more properties of other chemical components present in green tea. Green tea as a herb is as old as human civilization and is itself a store house of remedies for treatment of various diseases. With the exploring potential of green tea, It has proved to be a nature's gift to mankind to rely on its beneficial effect on health. Currently many research are going on to identify and isolate the other components of green tea which are holding potent action of disease prevention and also to minimize and optimize side-effecs of those constituents. Green tea has also captured an important position in global market. To enhance the bioavailability of green tea it is now being formulated in the form of nano particles to ensure rapid action of drugs. Many invitro research on animal models are going on to find out more outcomes of constituent EGCG present in green tea which has proved to be avital and key component of green tea sharing a major importance in its disease preventing potential. Bsed on current findings and ongoing processes and many epidemiological and other in vivo and invitro tests should be performed to reveal a long term use of green tea after proper investigation of efficacy, pharmacology, safety and side-effects of different preparation of green tea which is an amazing gift to mankind with unbelievable outcomes. Clinical trials of green tea or green tea extract have shown potential prevention activities for disease. Emerging data from multiple ongoing trial will further define more facts and existing potential

and some other new facts and outcomes which is yet unknown or untouched and may prove to be beneficial in future.

Finding more about the beneficial effects of tea for health is of great importance around the world as it has a very little risk of toxicity and the ease of availability around the world, as it shares an advantage of its use in both raw or processed form.

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