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Full Length Research Paper

The morphology, characteristics, and medicinal properties of *Camellia sinensis*' tea

Tariq Mahmood*, Naveed Akhtar and Barkat Ali Khan

Department of Pharmacy, Faculty of Pharmacy and Alternative Medicine, The Islamia University of Bahawalpur, Pakistan.

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The aim of this literature review was to provide essential information about a plant which is known to everyone as a beverage. In this study we collected particular information about the tea, such as its history, botanical classification, types, extraction methodologies, plant morphology, its active constituents and uses as medicine. Every aspect was elaborated briefly with essence of easy understanding. Special consideration was given to antioxidant potential of the tea and mechanisms by which it acts as antioxidant. At the end, some suggestions for further expanding of the research were defined.

Key words: Tea, flavonoids, Epigallocatechin gallate (EGCG), antioxidant.

INTRODUCTİON

According to Chinese legend, tea was discovered in 2700 B.C. by an Emperor Shen Nong by a matter of chance when some tea leaves blew in kettle of boiling water. It was confined largely to Asia until the late sixteenth century and later on, European explorers established its trading trends as pioneers (Hoffmann and Manning, 2005). *Camellia sinensis* was first cultivated in South Asia but nowadays, it is widely grown throughout Asia, Africa and various parts of the Middle East (Chopade et al., 2008). Tea can be cultivated in regions with fair temperature, acidic soils and highly humid environmental conditions (Dufresne and Farnworth, 2001). Tea plant is an evergreen shrub with large number of branches. The leaves appear glossy dark green, elongate ovate, roughly serrate, coreacious, alternate and short-petiolate. While young leaves appear silver because they bear downy hairs on the surface (Gruenwald, 2007).

Tea contains a number of constituents like caffeine (1-5%), xanthines, theobromine and tannins including flavonoids, polyphenols, fats and vitamin C (Chevallier, 2000). Tea extract exhibits numerous properties such as antimutagenic, antitumour, antioxidant, anticoagulant, antiviral, blood pressure and cholesterol lowering activity (Jarald and Jarald, 2006).

*Corresponding author. E-mail: redgrape.u@gmail.com. Tel: 00923336375640.

PARTICULARS OF TEA

Common names of *C. sinensis*

The common names of *C. sinensis* are shown in Table 1.

Classification of *C. sinensis*

Its classifications are shown in Table 2.

PLANT MORPHOLOGY *C. SINENSIS*

C. sinensis, a member of theaceae family is an evergreen tree or shrub that attains a height of 10 - 15 m in the wild and 0.6 - 1.5 m when cultivated. The leaves are light green, short stalked, coriaceous, alternate, lanceolate, serrate margin, glabrous or pubescent beneath, varying in length from 5 - 30 cm and about 4 cm width. Mature leaves are bright green colored, smooth and leathery while young leaves are pubescent. Flowers are white fragrant, 2.5 - 4 cm in diameter, found in solitary or in clusters of two or four. Flowers bear numerous stamens with yellow anther and produce brownish red capsules (Ross, 2005). Fruit is a flattened, smooth, rounded trigonous three celled capsule, seed solitary in each, size of a small nut (Biswas, 2006).

Table 1. Common names of *C. sinensis*.

Common names of *C. sinensis*	
India	Chha
China	Cha
Russia	Chai
Africa	Itye
Italy	Te
England	Tea plant
United States	Tea

Table 2. Classification of *C. sinensis*.

Classification	
Genus	C. L- camellia
Family	Theaceae- Tea family
Order	Theales
Subclass	Dilleniidae
Class	Magnoliopsida- Dicotyledons
Division	Magnoliophyta- Flowering plants
Superdivision	Spermatophyta- Seed plants

TYPES OF TEA

Depending on fermentation process, tea is categorized into three types. Green tea is unfermented form; a partially fermented oolong tea and fermented teas. Fermented teas are black and red teas which undergo a post harvested fermentation stage before drying and streaming. Fermentation of black tea is carried out by an oxidation process which is catalyzed by an enzyme polyphenol oxidase. On the other hand, red or Pu-Erh tea is attained by fermentation using microorganisms (Cabrera et al., 2006). Another type of tea is roobios tea which comes from a shrub in South Africa. It contains high number of antioxidants and is safer to take by pregnant and breastfeeding women because this type of tea is naturally caffeine free (Sharangi, 2009).

METHODS OF EXTRACTİON

Green tea is receiving a lot of attention by researchers for its specific health promoting properties and catechins are major contributors to these properties. A suitable extraction methodology is of utmost importance for extracting these catechins to further investigate their health benefits (Yoshida et al., 1999). Two methods are discussed here. In method one, different solvent are used at constant temperature while the second method involves soxhlet apparatus for extraction. In the first method 20 g of green tea leaves were extracted with 400 ml of solvent using 20ml :1 g ratio of solvent and leaves in a round bottom flask fitted with a condenser. Solvents used were acetonitrile (50 and 100%), ethanol (25, 50, 80, 90, 96, and 100%), acetone (25, 50, 80, and 100%), methanol (25, 50, 80, and 100%) and water. Temperature for water soluble solvents was kept at boiling point temperature while for water 70, 85 and 100°C was used. The extraction mixture was constantly stirred with magnetic stirrer. After 2 h extraction the mixture was cooled, vacuum filtered (0.45 µm) and solvent evaporated at 40°C under vacuum (Perva-Uzunalic et al., 2006).

The second method involves the use of a novel packed column extractor coupled with an absorption system to improve the quality of green tea constituents extracted by using high pressure carbon dioxide. Effects of various solvents were examined but extraction with 95% ethanol produced largest amount of total polyphenols (Chang et al., 2000).

TEA COMPOSITION

Tea is reported to contain nearly 4000 bioactive compounds of which one third is contributed by polyphenols. Polyphenols are bonded benzene rings with multiple hydroxyl groups. Polyphenols are either flavonoids or non-flavonoids but chemicals found in tea are mostly flavonoids (Sumpio et al., 2006). They are secondary plant metabolites derived from the condensation reaction of cinnamic acid with three malonyl-CoA groups. A number of flavonoids are present but dietary flavonoids are usually categorized into six major groups (Yilmaz, 2006) (Table 3 and Figure 1).

Tea flavanols

These are called tea catechins which constitute up to 20-30% of dry weight of green tea. Major catechins are (−)-

Table 3. Classes of flavonoids.

Flavonoid	Examples
Flavanols	EGCG, EG, ECG and catechin
Flavonols	Kaempferol and Quercetin
Anthocyanidins	Malvidin, Cyanidin and Delphinidin
Flavones	Apigenin and Rutin
Flavonones	Myricetin
Isoflavonoids	Genistein and Biochanin A

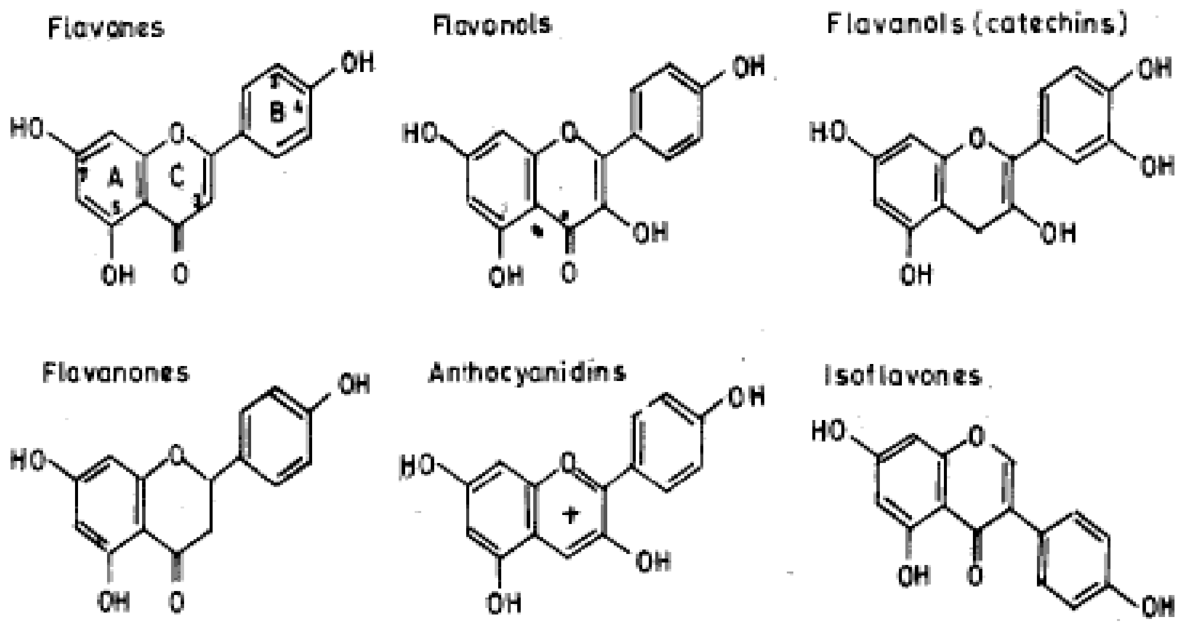

Figure 1. Basic ring structures of various flavonoids.

epicatechin gallate (ECG), (−)-epicatechin (EC), (−)-epigallocatechin (EGC) and (−)-epigallocatechin gallate (EGCG). These catechins are colorless, water soluble compounds imparting astringency and bitterness to tea infusion. Other characteristics like taste, color and aroma are associated directly or indirectly with modifications to these catechins. For example, a decrease in catechin content leads to improved aroma quality of tea (Wang et al., 2000) (Figure 2).

Tea flavonols

Quercetin, myricetin and kaempferol are major flavonols making up 2 - 3% of water soluble extractive in tea. Flavonols in tea are mainly in glycosidic form because non-glycosidic forms are water insoluble. Variable flavonols content are demonstrated possibly due to use of different analytical techniques. For example, 0.83-1.59, 1.79 - 4.05 and 1.56 - 3.31 g/kg are found respectively for myricetin, quercetin and kaempferol in green tea after acid hydrolysis, when these results are compared on dry weight bases (Wang et al., 2000).

ANTIOXIDANT POTENTİAL OF TEA

All living animals and plants are permanently prone to environmental oxidative damages. These damages originate from increase production of free radicals by endogenous source such as inflammation or from exogenous source such as radiation, pollution and cigarette smoking. Radicals are unstable oxygen compounds with an unpaired electron in atomic electron shell. They tend to react with other molecules to trap electron away from them. Thus these molecules become radicals and start a chain reaction. Various researchers showed that all types of organ and tissues are subjected to radical damages with varying intensity. That is why plant secondary metabolites have gained lot of attention

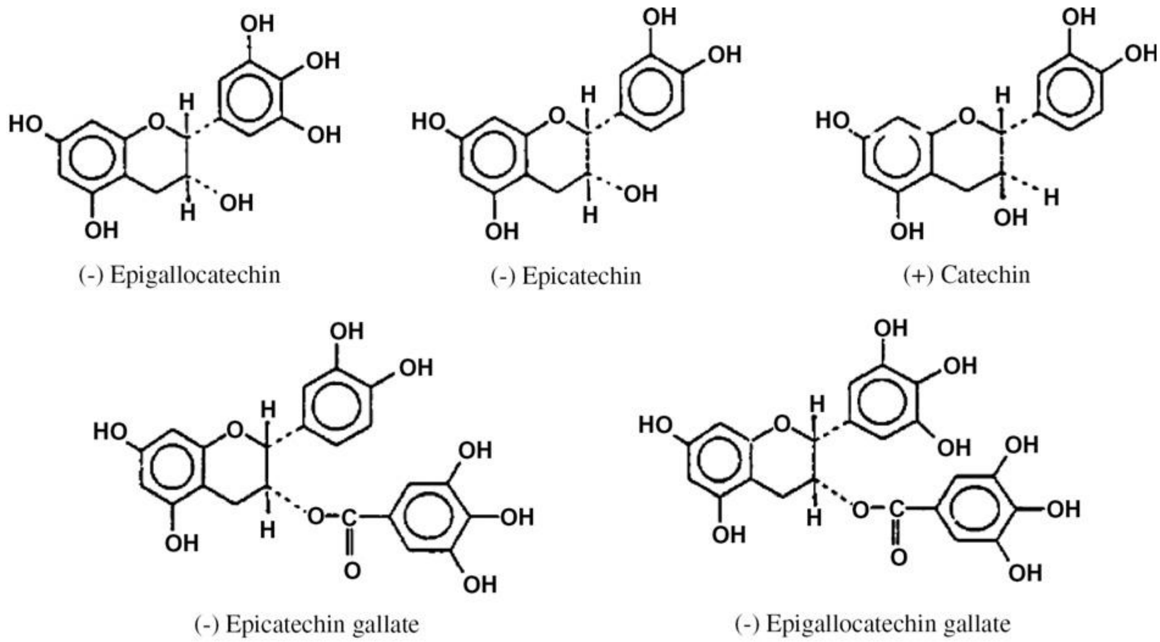

Figure 2. Ring structures of various flavanols.

to reduce the incidence of degenerative diseases (Grmza et al., 2005). Preparations of tea have shown to trap reactive oxygen species (ROS) such as singlet oxygen, superoxide radical, hydroxyl radical, nitric oxide, peroxynitrite and nitrogen dioxide, hence reducing damage to proteins, lipid membranes and nucleic acid in cell-free systems (Khan and Mukhtar, 2007).

Polyphenols show effective radical scavenging activity in three chemical ways:

• Presence of o-dihydroxy structure in the B ring participates in electron delocalization thus imparting higher stability to radical form.
• A 2, 3 double bonds in conjugation with 4-oxo function in the C ring contribute through participating in electron delocalization from B ring.
• A maximal radical scavenging potential is shown by 3- and 5-OH groups with 4-oxo function in A and C rings. That is why flavonols (quercetin) are more effective antioxidants than flavanols (catechins) as flavonols satisfy all these determinants while catechins lack some of the structural advantages of flavonols (Salah et al., 1995).

Polyphenols defense against offensive oxidants in following ways:

• Polyphenols exhibit beneficial modifying influence on protein phosphorylation by interacting with oxidative enzymes.
• They are able to prevent radical formation resulting from iron and copper metals by the process of chelation.
• They do not affect endogenous antioxidant protecting system of the body which is constituted by β-carotene, vitamin E and C.
• Interaction of nitrogen containing compounds with nitrosating agent to form offensive N-nitroso compounds is prevented by polyphenols.
• Flavonoids act as pro-oxidants like ascorbic acid and – tocopherol by inhibiting P-450 catalyzed activity (Ganguly, 2003).

APPLICATIONS OF TEA

Tea is the most popular beverage consumed all over the world. In recent years its consumption is much higher due to its preventive effects against certain human diseases. Tea and its polyphenols have evidence based role in number of diseases (Dalluge and Nelson, 2000).

Antiaging properties

Free radical theory of aging suggests that oxidative stress and increased free radical generation leads to functional deterioration and degeneration e.g. neurodegeneration which is solely due to phenotype changes. Parkinson's disease, cardiovascular problems and diabetes all are due to change in oxidant/antioxidant balance. However, green tea protects serum lipids and proteins from oxidative damage that is enhanced by aging. Furthermore, green tea also decreases the level of a marker for oxidative DNA damage, 8-oxodeoxyguanosine (8-oxodG) in liver kidney and cerebrum. Thus polyphenols from green tea are beneficial against damage from aging process (Zaveri, 2006).

Anticancer effects

Main chemopreventive agents in green tea are complex falconoid structures like EGCG, EGC, ECG and proanthocyanidins (Robbers and Tyler, 1999). Recently green tea catechins have gained significance in cancer prevention due to their structure similarity with chaperones and their interactions with target molecules. These properties suggest green tea prevent cancer due to their chaperone like activity (Kuzuhara et al., 2008).

Cardiovascular effects

Epidemiological studies show that a high flavonoid intake from tea may reduce incidences of coronary heart disease (CHD) as it improves vasomotion (Yaniv and Bachrach, 2005). Various animal studies have shown a hypolipidemic activity by the use of green tea constituents. In a study using 2.5% green tea, leaves feed to rats for number of weeks resulted in decreased serum cholesterol, triglycerides as well as no toxicity found to kidney and liver (Chansouria et al., 2006).

Anticaries effects

Green tea extract is effective in preventing dental caries because of its dual effect, that is, its flavor compounds are antibacterial while polyphenols possess a antiplaque activity. A synergistic effect of 128-folds to 256-folds was observed when combined with sesquiterpene hydrocarbons (delta cadinene and β–caryophyllene) and indole (Duke, 2000).

Antiparkinson’s property

Conversion of L-dopa into dopamine and serotonin is primarily mediated by an enzyme dopa decorboxylase which has key role in biosynthesis of biogenic amines. Enzyme is of high interest while developing drugs for hypertension and Parkinson’s disease. A potent and selective inhibitor of this enzyme is of high interest. Bertoldi et al., (2001) demonstrated green tea polyphenols EGCG and EGC both bind to the active site of enzyme and behave as irreversible inactivators of dopa decorboxylase following a pseudo first order kinetic at fixed concentration of EGCG (Bertoldi et al., 2001).

Antibacterial activity

Tea polyphenols show antibacterial activity, however, it is not determined precisely which species are inhibited by antioxidants. For example, polyphenols can inhibit *clostridia* and *Helicobacter pylori* but are ineffective against intestinal lactic bacteria. The use of natural antioxidants as preservative is of great demand but it depends upon the safety and efficacy to minimize food-borne microorganisms (Almajano et al., 2008). A number of bacteria like *staphylococcus aureus, vibrio cholerae, campylobacter jejuni, Stapylococcus epidermidis* and *Vibrio mimicus* are sensitive to polyphenols but it was shown that Gram positive bacteria are more sensitive than Gram negative and antibacterial activity was apparent after one hour of incubation (Ray et al., 2004).

Activity against HIV

The fact that green tea can be used as adjuvant therapy to AIDS is still hypothetical (Ernst et al., 2006).

Conclusion

Tea as a beverage is known to everyone all over the world. Now its therapeutic potentials are of great interest due to potent antioxidants present in it. A number of epidemiological studies and animal model studies have been investigated for cellular and subcellular targets of these antioxidants and sustained results have been observed. Still a lot of work have to be done to further investigate its actual potential for human use. For this purpose, clinical trials are mandatory for satisfactory safety data of its active constituents. Furthermore, development of best suited dosage forms and selecting administration routes for maximum bioavailbility (Pharmacokinetics studies) are of great importance. In all, there is need to explore miracle properties of tea, especially green tea which is a vast field and has a lot of things to learn about in the upcoming era of research.

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