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Green tea - A short review

Rishi Raj Shrivastava, Pradeep Pateriya*, Mahendra Singh

*VNS Group of Institutions, Faculty of Pharmacy, Vidhya Vihar, Neelbud, Bhopal-462044, MP (India)

Daksh Institute of Pharmaceutical Science, Chhatarpur-471001 MP (India)

Abstract

Green tea, which is produced from the leaves of the *Camellia sinensis* plant and belongs to the family Theaceae, is one of the most popular beverages worldwide. Over the past 30 years or more, scientists have studied this plant in respect to potential health benefits. The health benefits of green tea for a wide variety of ailments, including different types of cancer, heart disease, and liver disease, were reported. Many of these beneficial effects of green tea are related to its catechin, particularly (-)-epigallocatechin-3-gallate, content. There is evidence from in vitro and animal studies on the underlying mechanisms of green tea catechins and their biological actions. There are also human studies on using green tea catechins to treat metabolic syndrome, such as obesity, type II diabetes, and cardiovascular risk factors. Long-term consumption of tea catechins could be beneficial against high-fat diet-induced obesity and type II diabetes and could reduce the risk of coronary disease. This review is done to spread awareness among general population about the benefits of green tea.

Keywords: Medicinal plants, Phytoconstituents, Pharmacology, Anti-inflammatory activity

Introduction

Tea or *Camellia sinensis* (L.) O. Kuntze is an important commercial crop generating employment for a large number of people. Green tea is one of the oldest beverages in the world [1]. It is a popular beverage crop having medicinal, anti-oxidative and anti-microbial properties. The tea plant has been cultivated in asia for thousands of years. The consumption of green tea has a history that spans back to over 5000 yrs. Traditionally, it was prescribed for a number of ailments while also being consumed for its refreshing qualities and the prevention of future health problems. This increase in popularity is in part due to the increasing awareness of green tea's many health benefits.Tea is an aromatic beverage commonly prepared by pouring hot or boiling water over cured leaves of the tea plant *Camellia sinensis* [2]. Currently, more than two thirds of the world population consumes this popular beverage [3]. The first green tea was exported from India to Japan during the 17th century [4]. Green tea originates from china [5]. Starting in China, the green tea craze has expanded worldwide to become the second most consumed drink after water. Two primary varieties of *C. sinensis* are *Camellia sinensis* sinensis and *Camellia sinensis* assamica. The sinensis plant strain is originated from China. The assamica plant strain primarily is inhabitant to the Assam region in Northern India [6]. According to legend, tea was discovered accidentally by either a man named Shien Non Shei or the Emperor Shen Nung. Either way, green tea soon became popular among wealthy Chinese nobles [7]. Green tea is made from the fresh leaves of *Camellia sinensis*, which are processed rapidly by means of steam to prevent fermentation [8]. Several *in vitro* studies have suggested that green tea catechins, such as (-)-epigallocatechingallate, inhibit periodontal pathogens and the destruction of periodontal tissue [9]. The traditional chinese medicine has recommended this plant for headaches, body aches, general pain, digestion, depression, as an energizer and in general to prolong life. Green tea has many oral health benefits. It has cognitive function and positive impact on bone density, caries, periodontal diseases and diabetes [10].

History

Camellia species spread in more than 90 species from Nepal to Taiwan and Japan in the East Asia. Among these species, "Tea" is the most widely distributed one. Green tea is widely popular in East Asia (particularly in China and Japan), whereas, black tea is the preferred tea in the West. The use of tea leaves probably first originated more than 3,000 years ago, in the southwest area of China and initially was used by people only for chewing and eating, in just the same way that coffee was first used [11]. The origin place of tea plant was estimated to be around Chinese Yunnan district by Sealy (1958), but it is not confirmed yet. A wild type of the variety Assamica in *C. sinenesis* was discovered in India at 1835 and thereafter also in Thailand and Burma.

Geographical distribution

Camellia sinensis var. sinensis is probably native to western Yunnan, while *C. sinensis* var. assamica is native to the

warmer parts of Assam, Burma, Thailand, Laos, Cambodia, Vietnam and southern China. 'Wild' tea plants can be found growing in forests, but these may be relics of past cultivation. It is also found in some country Africa, Asia, Australia, Bangladesh, Brazil, Burundi, Cambodia, Caucasus, China, Himalayas, India, Indonesia, Japan, Kenya, Korea, Malaysia, Myanmar, Nepal, SE Asia, Srilanka [12].

Description

In recent times, tea has been gaining a lot of attention in preventive medicine because of its high concentration of antioxidants. Tea was originally used as a medicine for various illnesses as a bitter concoction suggesting that the young leaves rich in catechins were used. It is thought that at first tea leaves were used by rolling them with a milk product into cheeselike balls that would temper their somewhat bitter taste. As the boiling of water became widespread, drinking tea became normal practice. Tea was drunk from wooden bowls and the water boiled in terracotta vessels. The tea was stored in the form of powder, leaves, and cakes. Small pieces would be broken off the cakes and steeped in water.Depending on the method used for manufacturing, tea can be of three types – black tea, green tea and oolong tea. Green tea is not fermented, oolong tea is semi-fermented and black tea is fully fermented [Table 1& 2] [13].

Botanical distribution

The *Camellia sinensis* L. is a plant of the Theaceae family and Camellia genus [Table 3], it is commonly known as "Tea" or "Cha" [Table 4 & 5], evergreen shrubs, 1-3 m tall; shoots, tender leaves pilose. 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 [16]. It has yellow-white flowers and long, serrated leaves. Flowers are axillary, solitary, or up to three in a cluster. They are 2.5-3.5 cm in diameter and have six to eight petals. The outer petals are sepaloid and the inner petals are obovate to broadly obovate. There are numerous stamens 0.8-1.3 cm in length. Young leaves have short white hairs on their underside and young branches are grayish yellow and glabrous. Current year branchlets are purplish red. Terminal buds are silvery gray and sericeous. Petioles are 4-7 mm in length, pubescent, and glabrescent. Leaf blades are elliptic, oblong-elliptic, or oblong. Seeds are brown, subglobose, and 1-1.4 cm in diameter. Flowering of *Camellia sinensis* occurs from October through February and fruiting occurs from August to October. Tea can be cultivated in regions with fair temperature, acidic soils and highly humid environmental conditions [17].

Table 1: Different types of Chinese green tea

S. No.	Type	Characteristics	References
1.	Gunpowder	This is one of the most popular types of Chinese green teas. This tea is still primarily grown in the Zhejian Province of China. One of the characteristics of this tea is that, once processed, the tea looks like tiny pellets. These pellets open up during the brewing process.	14
2.	Long Jing (Dragonwell)	This tea is most commonly known as Dragonwell Green Tea. Once processed, the leaves tend to be flat and have a jade colour. Dragonwell is one of the most popular green teas.	14
3.	Pi Lo Chun (Green Snail Spring)	Very unique and somewhat rare Chinese Green Tea. the tea leaves to pick up the fragrance of the fruit blossoms from these trees. As this tea is rolled, it has a “snail like” appearance.	14
4.	Snowy Mountain Jian	His tea is grown at high altitudes in the Yunnan Province of China. The leaves of this tea are quite long.	14
5.	Hyson Lucky Dragon	Lucky Dragon is a premium hyson green tea. The leaves have a greenish-yellow colour. The taste is more full-bodied than other green teas.	14
6.	Kai Hua Long Ding	This tea is grown in the Tiantai County region of China. A characteristic of this tea is that the leaves are rather thick (stocky) yet very short.	14
7.	Tian Mu Qing Ding	One of the more unique Chinese green teas. The leaves of this tea are fine and delicate. The tea produces a light and sweet taste, which is somewhat impervious to over-steeping.	14
8.	Xin Yang Mao Jian	This tea is grown in the Henan Province. The leaves are very fine. This green tea is popularly known as “green tip.”	14
9.	Hou Kui	This tea is grown in the Anhui Province and goes by the popular name of “Monkey Tea”. The leaves of this tea absorb the flavour of surrounding orchids, with the result being a slight orchid flavoured tea.	14

Pradeep Pateriya, E-mail:- pradeep.pateriya0106@gmail.com

Table 2: Different types of Japanese green tea

S. No.	Type	Characteristic	References
1.	Sencha	The flavors that distinguish sencha are a delicate sweetness and a mild astringency. Sencha is high in vitamin C and is especially popular with women as a teatime drink.	15
2.	Fukamushicha	The processing of fukamushicha is the same as for sencha, except that for fukamushicha the leaves are steamed two or three times longer. The taste remains just as "sweet" and moderate, and the fragrance is richer and deeper.	15
3.	Kukicha	Kukicha produced from the stalks of gyokuro is known as "karigane" and is highly prized. Kukicha made from either gyokuro or sencha. The clean taste and light fragrance are sure to help you wake up feeling refreshed.	15
4.	Konacha	Konacha (or "tea powder") is the tea served at sushi restaurants, where it is called "agari." It consists of the rejected buds and tea "dust" left over from the processing of sencha and gyokuro.	15
5.	Bancha	Bancha leaves are picked in June (nibancha), August (sanbancha), and October (yonbancha), with the leaves becoming tougher with each subsequent picking. High-grade bancha with less astringency and a pleasant fragrance is known as "senryu." Those tea leaves are also longer and thinner.	15
6.	Matcha	Matcha is the powdered tea used in Japan's formal tea ceremony. In its unpowdered form it is called "tencha." Matcha is a popular ingredient in savory dishes as well as desserts.	15
7.	Gyokuro	Rich green gyokuro is a top-grade tea. Gyokuro contains a lot of caffeine and chlorophyl. Caffeine stimulates the brain and the nervous system, while chlorophyl stimulates tissue growth, resulting in healthy skin.	15
8.	Hojicha	It contains relatively little caffeine and tannin, it is good for children, older people, and those recovering from illness. It can also be served cold in the summer.	15
9.	Genmaicha	It the ideal tea to drink after a meal that includes oily or deep-fried foods, such as tempura or Chinese cuisine.	15

Table 3: Botanical classification of green tea

Kingdom	Plantae–Plants	References
Subkingdom	Tracheobionta – Vascular plants	18
Super division	Spermatophyta – Seed plants	18
Division	Magnoliophyta – Flowering plants	18
Class	Magnoliopsida – Dicotyledons	18
Subclass	Dilleniide	18
Family	Theaceae – Tea family	18
Genus	Camellia L. – Camellia	18
Species	*Camellia sinensis* (L.) Kuntze – Tea	18

Table 4: International synonyms of green tea

S. No.	Country	Name	References
1.	India	Chha	19
2.	China	Cha	19
3.	Russia	Chai	19
4.	Africa	Itye	19
5.	Italy	Te	19
6.	England	Tea	19
7.	United States	Tea	19

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Table 5: Indian synonyms of green tea

S. No.	Language	Name	References
1.	Bengali	Cha	20
2.	Gujarati	Cha	20
3.	Hindi	Chai	20
4.	Kannada	Chaha	20
5.	Malayalam	Chaya	20
6.	Marathi	Chahaa	20
7.	Oriya	Cha	20
8.	Tamil	Theneer	20

Leaves

Leaves are alternate; petiole 3-7 mm long; leaf blade thinly leathery, elliptic or obovate-elliptic, 5-12 cm long, 1.8-4.5 cm wide, apex mucronate or blunt-pointed, base cuneate, margin serrate, glabrous or slightly hairy, lateral veins about 8 pairs, obviously. Bright green, shiny, often with a hairy underside [Figure 1] [21].

Flower

Flowers are bisexual, white, fragrant, often solitary or 2-borne on leaf axils; pedicels 6-10 mm long, curved downward; sepals 5-6, rounded, mucilaginous, margin membranous with lashes, persistent; petals 5-8, broadly obovate; stamens numerous, outer filaments fused to tube; ovary superior, tomentose, 3-locular, style 1, apical 3-lobed. Scented, occurring singly or in clusters of two to four [Figure 2] [21].

Fruits

Brownish-green, containing one to four spherical or flattened seeds [21].

Cultivation of green tea

Indigenous to East Asia, South East Asia and the Indian Subcontinent [Table 4 & 5], *Camellia sinensis* is cultivated today in tropical and subtropical regions throughout the world. The tea plant thrives in sunny climates where the temperatures are hot and rain is regular and plentiful, with a growing season that stretches for at least eight months of the year. Generally there are three growing spurts within the growing season. The spring shoots grow from the end of March to the beginning of May and this is the period when the plant is most bountiful. From early June to the start of July the second growing stage takes place and the season comes to an end with the final flux of growth occurring from mid July to October. *Camellia sinensis* is happiest in acidic conditions and grown in a range of soils. The perfect soil mix is “sandy loam” which consists of approximately 40 % sand, 40% silt and 20% clay, allowing the water to drain well out of the soil while still enabling it to trap all the essential nutrients the plant requires from the earth [22]. Tea is reported to tolerate an annual precipitation of 70 to 310 cm, an average annual temperature range of 14 to 27 °C and a pH in the range of 4.5 to 7.3 [Figure 3].

Propagation of tea

The three main types of tea, i.e. ‘Cambod’, ‘Chinary’ and ‘Assamica’ cultivars are distributed in widely-distanced regions of southern, northern and northeastern parts of India. Micro-propagation and artificial seed techniques ensure an efficient exchange of germplasm [23] among these regions and also among the tea-growing countries for successful storage, delivery and establishment of tea germplasm. ‘Artificial seed technology [24-28] provides a protective coating of essential nutrients to the encapsulated propagules [29], maintains high adaptability and vigour during their storage [23, 24,] removes the hurdles of delivery and establishment and has the added advantage of facilitating easy handling, storage and shipping [23].

Figure 1: Green tea leaves

Figure 2: Green tea flower

Figure 3: Cultivation of green tea

Pradeep Pateriya, E-mail:- pradeep.pateriya0106@gmail.com

Phytoconstituents

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 is present. Green tea contains polyphenols, which include flavanols, flavandiols, flavonoids, and phenolic acids [Table 6 & 7] [Figure 4] [30].

Table 6: Green tea component

S. No.	Component	Percentage	References
1.	Protein	15%	4
2.	Amino acids	4%	4
3.	Fiber	26%	4
4.	Others carbohydrates	7%	4
5.	Lipids	7%	4
6.	Pigments	2%	4
7.	Minerals	5%	4
8.	Phenolic compounds	30%	4
9.	Epigallocatechin (EGC)	19%	4
10.	Epicatechin–3–gallate (ECG)	13.6%	4
11.	Epicatechin (EC)	6.4%	4

Table 7: Chemical constituent of green tea leaves

S. No.	Constituent	Percentage (% of dried leaf)	References
1.	Polyphenols	37	31
2.	Carbohydrates	25	31
3.	Caffeine	3.5	31
4.	Protein	15	31
5.	Amino acids	4	31
6.	Lignin	6.5	31
7.	Organic acids	1.5	31
8.	Lipids	2	31
9.	Ash	5	31
10.	Chlorophyll	0.5	31

Medicinal value of green tea

The use of herbs is as old as mankind and people used them as medicine, cosmetic and for cooking for thousands of years. Archaeological researches also report that herbal concoctions had been used to indulgence bodily grievances many years before the writing of history. Throughout history, herbs have had their place in every civilization in the world, with their usage changing very little as the centuries passed. Ancient cultures wrote plentiful use of herbs, which included flowers, leaves, tree and bark, that were used for improving the taste of food, making medicines or preparing tea [32, 17]. One of the most popular and long-term use of herbs is the making of herbal tea. Herbal teas have a long history of helping people to stay healthy. Before the middle of the 18th century, when most people where living on farms, infusion of wintergreen, willow or birch were prepared from nearby growing herbs to calm down someone's pain. But when the old medicine men died much of our herbal heritage passed and this created an information gap for over hundred years. However, nowadays people are having knowledge with herbs and this tradition continues in 80% of the world and they are rediscovering the blessings of whole herbal medicines used throughout generations [32, 33].

Studies using animal models show that green tea catechins provide some protection against degenerative diseases. Some studies indicated that green tea has an antiproliferative activity on hepatoma cells and a hypolipidemic activity in hepatoma-treated rats, as well as the prevention of hepatoxicity and as a preventive agent against mammary cancer post-initiation [34]. Green tea catechins could also act as antitumorigenic agents [35] and as immune modulators in immunodysfunction caused by transplanted tumors or by carcinogen treatment [34]. Moreover, green tea, its extract, and its isolated constituents were also found to be effective in

Pradeep Pateriya, E-mail:- pradeep.pateriya0106@gmail.com

preventing oxidative stress [36] and neurological problems [37]. Green tea consumption has also been linked to the prevention of many types of cancer, including lung, colon, esophagus, mouth, stomach, small intestine, kidney, pancreas, and mammary glands [38]. Several epidemiological studies and clinical trials showed that green tea (and black and Oolong teas to a lesser extent) may reduce the risk of many chronic diseases [39]. This beneficial effect has been attributed to the presence of high amounts of polyphenols, which are potent antioxidants. In particular, green tea may lower blood pressure and thus reduce the risk of stroke and coronary heart disease. Some animal's studies suggested that green tea might protect against the development of coronary heart disease by reducing blood glucose levels and body weight [40]. However, all these data are based on middle-aged animals' populations, not the elderly populations, which nutritional status tends to be more adversely influenced by age-related biological and socioeconomic factors [41].

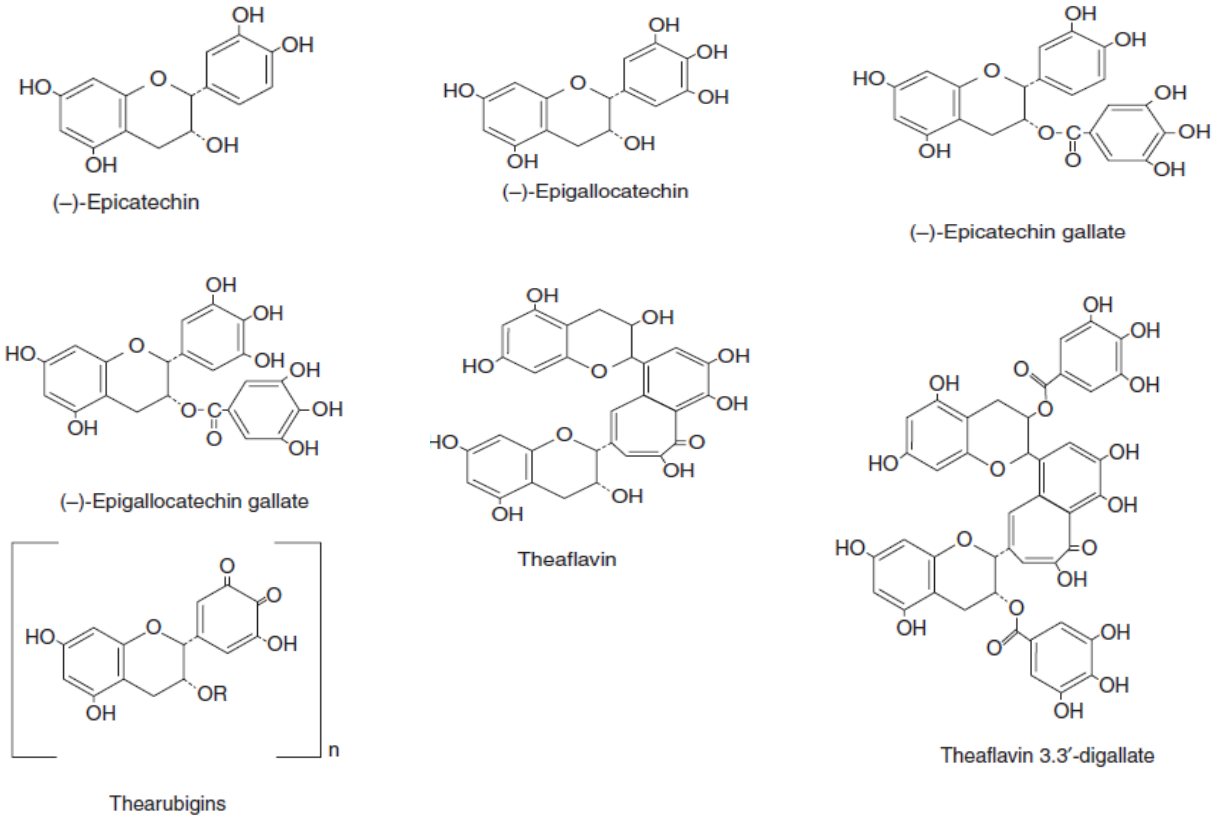

Figure 4: Chemical structure of tea constituents

Pharmacological activity

Antifungal activity of green tea leaves against a number of fungi (*Candida albicans*, *Candida glabrata, Candida kruseii*, *Candida parapsilosis* and *Candida dubliensis*) has been investigated. In addition, the catechin-based flavonoids in green tea leaves such as epigallocatechin-3-gallate (EGCG), epicatechin-3-gallate (ECG), epigallocatechin (EGC) and epicatechin (EC) were determined. Methanol extract of green tea samples showed a broad-spectrum antifungal activity against all Candida species in broth microdilution bioassays. However maximum activity of methanol extract (>17 mm inhibition zone) was observed against *Candida albicans* at 3rd harvest time [42].

Topical treatment or oral consumption of green tea polyphenols inhibits chemical carcinogen- or ultraviolet radiation induced skin tumorigenesis in different animal models. Studies have shown that green tea extract also possesses anti-inflammatory activity. These anti-inflammatory and anti-carcinogenic properties of green tea are due to their polyphenolic constituents present therein. The major and most chemopreventive constituent in green tea responsible for these biochemical or pharmacological effects is (-)-epigallocatechin-3-gallate (EGCG). 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 tumor promoters as well as ultraviolet (UV) light-induced inflammatory markers

Pradeep Pateriya, E-mail:- pradeep.pateriya0106@gmail.com

of skin inflammation. Topical treatment with EGCG on mouse skin also results in prevention of UVB-induced immune suppression, and oxidative stress. The protective effects of green tea treatment on human skin either topically or consumed orally against UV light induced inflammatory or carcinogenic responses are not well understood. Based on documented extensive beneficial effects of green tea on mouse skin models and very little in human skin, many pharmaceutical and cosmetic companies are supplementing their skin care products with green tea extracts. Therefore, the focus of this communication is to review and analyze the photoprotective effects of green tea polyphenols to skin [43].

Polyphenolic compound catechins (−)-epigallocatechin gallate (EGCG), (−)-epicatechin gallate (ECG) and (−)-epigallocatechin (EGC)) from green tea were evaluated for their ability to inhibit influenza virus replication in cell culture and for potentially direct virucidal effect. Among the test compounds, the EGCG and ECG were found to be potent inhibitors of influenza virus replication in MDCK cell culture (Madin-Darby canine kidney cell line) and this effect was observed in all influenza virus subtypes tested, including A/H1N1, A/H3N2 and B virus [44, 45].

An aqueous solution of green tea polyphenols (GTP) was found to inhibit lipid peroxidation (LP), scavenge hydroxyl and superoxide radicals in vitro. Administration of GTP (500 mg/kg b.wt.) to normal rats increased glucose tolerance significantly ($P< 0.05$) increased when compared to those values in control rats. The rats administrated with green tea extract and cadmium chloride showed a significantly ($p < 0.05$) decreased levels of serum SGOT, SGPT, LDH and GGT [46].

Extracts of leaves from the tea plant *C. sinensis* contain polyphenolic components with activity against a wide spectrum of microbes. Studies conducted over the last 20 years have shown that the green tea polyphenolic catechins, in particular (−)-epigallocatechin gallate (EGCG) and (−)-epicatechin gallate (ECG), can inhibit the growth of a wide range of gram-positive and gram-negative bacterial species with moderate potency. Evidence is emerging that these molecules may be useful in the control of common oral infections, such as dental caries and periodontal disease. Sub-inhibitory concentrations of EGCG and ECG can suppress the expression of bacterial virulence factors and can reverse the resistance of the opportunistic pathogen *Staphylococcus aureus* to β-lactam antibiotics. Catechin gallates such as ECG intercalate into phopsholipid bilayers and it is likely that they affect both virulence and antibiotic resistance by perturbing the function of key processes associated with the bacterial cytoplasmic membrane [47].

The antioxidant activity of the plant extracts and the standard was assessed on the basis of the radical scavenging effect of the stable 1, 1-diphenyl-2- picryl- hydrazyl (DPPH)-free radical activity by modified method [48, 49]. The diluted working solutions of the test extracts were prepared in methanol. Ascorbic acid was used as standard in 1-100 µg/ml solution 0.002% of DPPH was prepared in methanol and 1 ml of this solution was mixed with 1 ml of sample solution and standard solution separately. These solution mixtures were kept in dark for 30 min and optical density was measured at 517 nm using Cecil-Elect spectrophotometer. Methanol (1 ml) with DPPH solution (0.002%, 1 ml) was used as blank. The IC50 values of green tea was 6.7 ± 0.1 The results indicate that the antioxidant activity of the crude extract of green tea is higher than that of ascorbic acid .The antioxidant activity showed that the percentage inhibition of 10 µg/ml of green tea (*C. sinensis* Linn.) extract was 69.4%, which is comparable with the standard antioxidant activity of ascorbic acid (55.8%) [50, 51].

Green tea catechins (GTC) are polyphenolic compounds present in the unfermented dried leaves of the plant, *C. sinensis*. Results from a number of randomized, controlled intervention trials have shown that consumption of GTC (270 mg to 1200 mg/day) may reduce body weight and fat. There are several proposed mechanisms whereby GTC may influence body weight and composition. The predominating hypothesis is that GTC influences sympathetic nervous system (SNS) activity, increasing energy expenditure and promoting the oxidation of fat. Caffeine, naturally present in green tea, also influences SNS activity, and may act synergistically with GTC to increase energy expenditure and fat oxidation. Other potential mechanisms include modifications in appetite, up-regulation of enzymes involved in hepatic fat oxidation, and decreased nutrient absorption [52].

Evidence suggests that epigallocatechin gallate the major polyphenolic component of green tea is instrumental in suppressing the growth of cancer cells in various tumour models [53, 54]. Prostate cancer is the most recently diagnosed malignancy and second leading cause of cancer related deaths, but this cancer can also be cured by green tea [54, 55]. Tea polyphenols are known to exhibit cytotoxicity toward various tumour cell lines as well as growth inhibition that is accompanied by cell cycle arrest [56].

Hot water extract and tannin fraction of the dried entire plant were active on the rabbit and rat intestines vs. pilocarpine-induced spasms and barium induced contractions [57].

Tea, administered in culture to enucleated rat lens, reduced the incidence of selenite cataract *in-vivo*. The rat lenses were randomly divided into normal, control and treated groups and incubated for 24 h at 37 ºC. Oxidative stress was induced by sodium selenite in the culture medium of the two groups (except the normal group). The medium of the treated group was additionally supplemented with tea extract. After incubation, lenses were subjected to glutathione and

Pradeep Pateriya, E-mail:- pradeep.pateriya0106@gmail.com

malondialdehyde estimation. Enzyme activity of superoxide dismutase, catalase, and glutathione peroxidase were also measured indifferent sets of the experiment. *In vivo* cataract was induced in 9-day-old rat pups of both control and treated groups by a single subcutaneous injection of sodium selenite. The treated pups were injected with tea extract intraperitonally prior to selenite challenge and continued for 2 consecutive days thereafter. Cataract incidence was evaluated on 16 postnatal days by slit lamp examination. There was positive modulation of biochemical parameters in the organ culture study. The results indicated that tea act primarily by preserving the antioxidant defence system [58].

Using different animal model, many laboratories have shown that green tea extract, taken orally or applied to the skin, inhibits skin tumour formation induced by chemical carcinogens or ultra-violet radiation (UVB). The extracts also possess anti-inflammatory activity that similarly to the anticancer forming activity, is owed to the polyphenolic constituents present therein. The polyphenol mainly responsible for the prevention of cancer formation is epigallocatechin-3-gallate (EGCG). When applied to mouse skin, EGCG prevents UVB-induced oxidative stress and suppression of the immune system. Mouse skin models have illustrated extensive beneficial effects of green tea extracts and although only a few human skin studies have been conducted, many cosmetic and pharmaceutical companies are supplementing their skin care products with green tea extracts [43].

Several studies in animal and cell culture models suggest that EGCG from green tea may affect several potential targets associated with Alzheimer's disease progression. EGCG protects against beta-amyloid induced neurotoxicity in cultured hippocampal neurons, an effect attributed to its antioxidant properties [59].

Various studies have shown that green tea and EGCG significantly prevent these pathologies in animal models [60]. 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 [61].

Conclusion

Green tea has been consumed in China and other Asian countries since ancient times in order to maintain and improve health. As the human clinical evidence is still limited, future research needs to define the actual magnitude of health benefits, establishes the safe range of tea consumption associated with these benefits, and elucidates the mechanisms 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. Definitive conclusions concerning the protective effect of green tea have to come from well-designed observational epidemiological studies and intervention trials. The development of biomarkers for green tea consumption, as well as molecular markers for its biological effects, will facilitate future research in this area.

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Pradeep Pateriya, E-mail:- pradeep.pateriya0106@gmail.com

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Pradeep Pateriya, E-mail:- pradeep.pateriya0106@gmail.com

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Pradeep Pateriya, E-mail:- pradeep.pateriya0106@gmail.com