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(REVIEW ARTICLE)

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A review on the phytochemical composition and medicinal uses of green tea (*Camellia sinensis*)

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Abstract

This review aimed to evaluate the phytochemical composition and medicinal uses of green tea (*Camellia sinensis*). A comprehensive literature search was conduction using ScienceDirect and Google scholar covering publications from 2016-2026. The study applied keywords such as phytochemistry, green tea and medicinal uses. Exclusion criteria were articles focusing on pharmacological properties, isolation methods and other unrelated experimental aspects.

Findings revealed that green tea is rich in bioactive compounds mainly catechins, polyphenols, alkaloids, amino acids and phenolic acids. Epigallocatechin gallate (EGCG) was also identified as a major compound contributing to its biological activity. The articles also demonstrated its antioxidant, anti-inflammatory, antimicrobial, cardioprotective, antidiabetic, neuroprotective and anticancer properties. The mechanisms were determined through the reduction of oxidative stress, modulation of metabolic and signaling pathways, inflammatory mediator inhibition and regulation of apoptosis and angiogenesis.

In conclusion, the phytochemical composition of *Camellia sinensis* is significant to the wide range applications of its medicinal uses. It demonstrated strong potential as a natural therapeutic and chemopreventive agent. However, further studies are necessary to establish appropriate and standardize dosing while also improving bioavailability and confirm its safety and efficacy in human populations.

Keywords: *Camellia Sinensis*; Green Tea; Phytochemical Composition; Medicinal Uses

1. Introduction

Green tea (*Camellia sinensis*) is known to be one of the most widely consumed herbal beverages in the world. Due to its diverse bioactive compounds and potential health benefits, it attracted scientific interest from researchers. It has been traditionally used for both nutritional and medicinal purposes. Extracts from the plant are abundant in biologically active compounds such as catechins, polyphenols, alkaloids, amino acids, and vitamins. [17]. The phytochemical constituents play significant roles in the pharmacological properties and biological processes. These include antioxidant effects, metabolic regulation, and protection and prevention of oxidative stress-related disorders [11].

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Over the years, scientific research has progressively focused on the therapeutic and pharmacological effects of green tea. Studies show that the compounds present in green tea may exert beneficial effects against chronic illnesses by modulating cellular signaling pathways, reducing inflammation, and regulating metabolic processes [17]. Additionally, polyphenol content has been shown to exert beneficial physiologic effects, particularly in cardiovascular health, metabolic regulation, and immune response.

As for these health benefits, green tea has encouraged considerable attention in pharmaceutical and nutraceutical research as a natural therapeutic agent. Due to the benefits its phytochemicals exert, researchers increasingly investigated the therapeutic potential of green tea in managing various conditions. Consequently, understanding the composition of the phytochemicals and the potential medical benefits of *Camellia sinensis* remains significant for the evaluation of its role as a natural supplement and herbal medicine.

2. Materials and Methods

This review article considered the literatures published between 2016-2026. The information was searched by referencing Science Direct and Google Scholar. The keywords phytochemistry, green tea, medicinal uses were used to gather the information. The articles related to pharmacologic properties, isolation methods, growing conditions, and other unrelated or experimental aspects outside the study focus were excluded. Chemical structures were drawn via Thermo Fisher Scientific. The chemical structures were verified from the official website of PubChem (https://pubchem.ncbi.nlm.nih.gov/compound/65064#section=2D-Structure).

2.1. Botanical Profile and Distribution

According to Bionity [23], green tea (*Camellia sinensis*) belongs to the family Theaceae. This tea plant was previously called *Thea bohea*, *Thea sinensis,* and *Thea viridis*. Other types of tea are also harvested from the same species, including white tea, oolong, and black tea with variations in the method of preparation and oxidation level. *"Sinensis"* is defined as *"Chinese"* in Latin. Chinese plant or *C. sinensis* var. *Sinensis* was native and confined to Eastern and Southern Asia including regions of China, India and Myanmar but is currently widely cultivated across the world, both in tropical and subtropical regions with fair temperature, acidic soils, and highly humid [24]. This variety is a small-leaved bush with multiple stems and reaches about 3 meters. The Cambodian variety, which is also called *C. sinensis* var. *parvifolia,* has a leaf size that is between the Assam and Chinese varieties and is considered a variety of both.

Based on the World Flora Online [19], green tea shrubs or small trees typically reach 1–5 m in height, occasionally up to 9m. Young branches are grayish-yellow and smooth, while branchlets are purplish-red with fine white hairs; terminal buds are covered with a silvery-gray silky texture. The petiole measures 4-7 mm and is initially pubescent, eventually hairless with age. Leaf blades vary from elliptic to oblong or oblong-elliptic, measuring 5–14 cm by 2–7.5 cm, and have a leathery texture. The lower surface is pale green and may be either smooth or slightly hairy, whereas the upper surface is dark green, glossy, and hairless. The midvein is somewhat raised on both sides, with 7–9 secondary veins on each side, also slightly raised; the network of smaller veins is visible on both surfaces. Leaf bases range from narrowly to broadly wedge-shaped; margins are finely toothed, and the apex is bluntly pointed to taper with a rounded tip.

Flowers are found in the leaf axils, either solitary or in clusters of up to three, measuring 2.5-3.5 cm in diameter. The pedicel, which is 5–10 mm long, is recurved and may be either hairy or smooth, becoming thicker toward the tip. Two small, ovate bracteoles (about 2 mm long) are present but fall off early. There are five persistent sepals, broadly ovate to nearly circular, 3-5 mm long, with outer surfaces either smooth or covered in white hairs and inner surfaces silky white, with finely ciliate margins. Petals number 6–8 and are white; the outer 1-3 resemble sepals, while the inner petals are obovate to broadly obovate, 1.5 - 2 cm long and 1.2 - 2 cm wide, fused at the base, and rounded at the tip. Stamens are numerous, 0.8–1.3 cm long, and hairless, with the outer filaments united at the base for about 2 mm.

The ovary is spherical, densely covered with white hairs or nearly smooth, and divided into three chambers. The style is approximately 1 cm long, either smooth or slightly hairy at the base, and splits into three lobes at the tip. The fruit is typically an oblate capsule, occasionally nearly spherical, measuring 1-1.5 cm by 1.5-3 cm, with one or two compartments, each containing a single seed; the fruit wall is about 1 mm thick. Seeds are brown, nearly spherical, and 1–1.4 cm in diameter. Flowering occurs from October to February, while fruiting is observed from August to October.

Table 1 Classification of Green Tea [21]

Kingdom	**Plantae**
Phylum	Streptophyta
Class	Magnoliopsida
Order	Theales
Family	Theaceae
Genus	Camellia L.
Species	Camellia *sinensis*
Binomial name	Camellia *sinensis* (L.) Kuntze
Synonyms	Thea *bohea* Thea *viridis*

2.2. Traditional/Medicinal Use

For centuries, green tea (*Camellia sinensis*) has been recognized as an aid to support digestion, detoxification, cardiovascular health, and overall health in traditional Asian medicine (8). In the past, it was known for its traditional role as a universal remedy, which is used for fever reduction, blood circulation improvement, and general wellness [9]. In present times, modern studies confirm these effects due to its rich phytochemical content that includes catechins, polyphenols, and flavonoids [11].

2.3. Cardiovascular Health

Due to its abundant content of catechins and polyphenols, green tea has been widely associated with cardiovascular health for the improvement of vascular function and lipid metabolism [12]. Musial [2020] reported that daily consumption of green tea may lower the risk of diseases associated with cardiovascular health, as it can lower cholesterol levels while also preventing oxidation of low-density lipoproteins [8]. Green tea intake has also been linked with improvement in circulation and reduced morbidity of coronary heart disease [9]. Lou et al. [2024] explained how polyphenols exert antioxidant and anti-inflammatory actions, leading to the reduction of oxidative stress and inflammation in relation to cardiovascular disorders [12]. Umesh [2023] further discussed that green tea exerts antihypertensive and cardioprotective properties, which contribute to the improvement of endothelial function and regulation of blood pressure [11]. These properties collectively support green tea's potential as a functional herbal beverage for cardiovascular health.

2.4. Weight Management and Metabolic Health

Green tea has been popular for weight control and metabolic regulation due to its catechin and caffeine contents with thermogenic effects [10]. Musial [2020] explained that these bioactive components increase fat oxidation and energy expenditure, which leads to weight control [8]. Lou et al. (2024) reported that polyphenols influence metabolic signaling pathways related to lipid metabolism and energy [12]. Kochman [2020] also stated that due to the plant's antioxidant and metabolism-stimulating properties, green tea might help control body weight and overall metabolic health when consumed regularly [9]. Similarly, Umesh [2023] discussed that green tea has probable pharmacological activity in metabolic regulation and preventing obesity [11]. The findings concerning green tea show its potential as a valuable natural supplement for metabolic health within a balanced diet.

2.5. Antidiabetic Effects

Green tea is associated with antidiabetic activity, as it influences glucose metabolism and responds well to insulin. According to Tolmie et al. [2023], polyphenols in Camellia *sinensis* are involved in regulating pathways of glucose absorption and glycemic control [14]. Correspondingly, Lawal et al. [2021] reported that green tea extracts inhibit α-glucosidase activity, thus slowing carbohydrate digestion and reducing postprandial blood glucose spikes. Similarly, adding green tea extracts can reduce the glycemic index of carbohydrate-rich foods and promote better glucose homeostasis. Indeed, Lou et al. [2024] discussed the interaction of bioactive compounds with metabolic pathways involved in insulin signaling and glucose homeostasis [14]. Therefore, this supports the potential use of green tea for diabetes mellitus management.

2.6. Anti-Inflammatory and Antimicrobial Effects

Due to its catechins and other polyphenolic compounds, *Camellia sinensis* exhibits strong anti-inflammatory properties [11]. Lou et al. [2024] reported that these compounds suppress inflammatory mediators and regulate signaling pathways associated with inflammation. Musial [2020] also noted its traditional use in treating infections and inflammatory conditions [8]. Umesh et al. [2023] demonstrated the antimicrobial effects of green tea against various bacterial and microbial pathogens [11]. Kochman [2020] further discussed that the antioxidant and antibacterial properties contribute to the role of green tea in protecting the host from infections [9]. The combined effects highlight the potential anti-inflammatory and antimicrobial effects of green tea as a natural medicine.

2.7. Neuroprotective and Cognitive Support

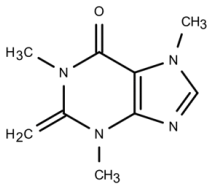
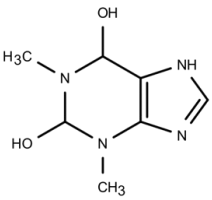
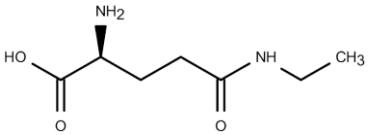
Bioactive compounds found in green tea have been investigated for activities that can influence brain function and neurological health, which include neuroprotective effects. Lou et al. [2024] discussed that the polyphenol contents of green tea reduce oxidative stress and neural tissue inflammation. These are important factors in neurodegenerative diseases [12]. Kochman [2020] reported that consumption of green tea can support cognitive function and mental alertness [9]. Musial [2020] also proposed that the antioxidant effects of the plant can aid in brain cell protection from oxidative damage [8]. It was further discussed by Umesh [2023] that the neuroprotective effects of green tea may play a supporting role in cognitive health and neurological function [11]. The findings suggest that green tea plays a role in cognitive health protection and neurological function.

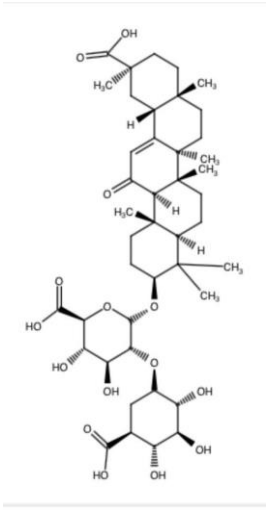
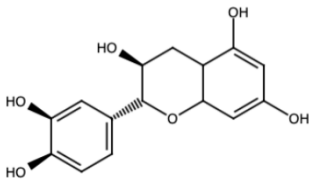
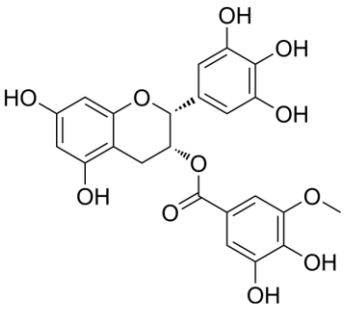
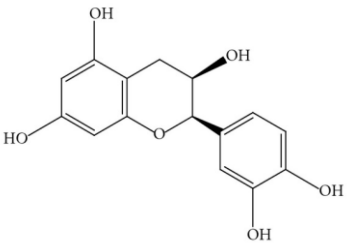
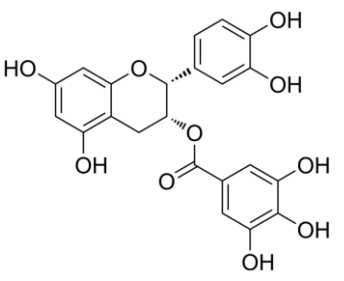
2.8. Anticancer Potential

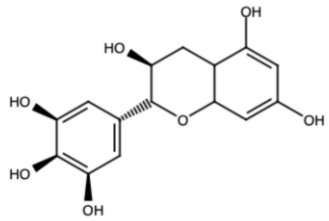
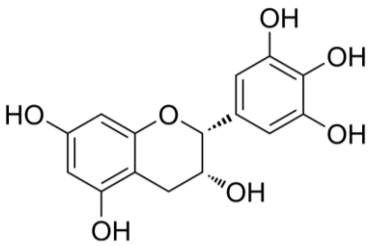
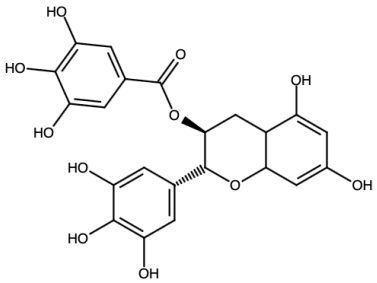
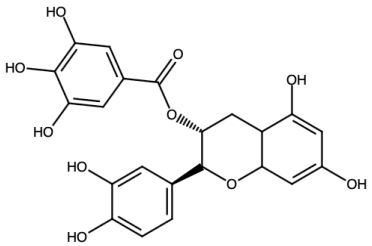
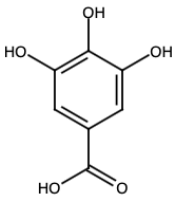
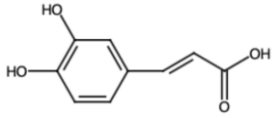
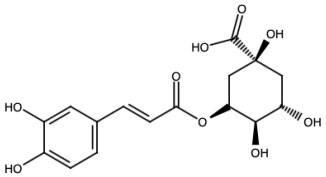
In recent studies, green tea gained notable attention for its anticancer potential. Singh et al. [2024] explained that the major catechin content in green tea, epigallocatechin gallate (EGCG), has the possibility to inhibit cancer cell proliferation and further promote apoptosis [13]. Lou et al. [2024] described the capabilities of green tea bioactive compounds in modulating molecular pathways involved in inflammation, oxidative stress, and tumor growth [12]. Umesh et al. [2023] also described how green tea exhibits anticarcinogenic activity through the process of angiogenesis inhibition and cell cycle progression regulation [11]. Antioxidant properties were further emphasized by Khan [2018] to support cell protection and oxidative damage that can further develop into cancer [9]. The mentioned mechanisms collectively support the anticancer potential of green tea as a natural chemopreventive agent.

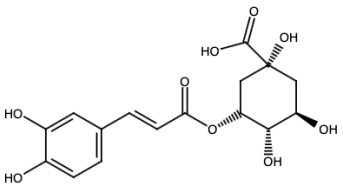
2.9. Phytochemistry

Table 2 List of Chemical constituents isolated from the various parts of Green tea

Class of phytochemical	Isolated compounds	Structure of compound	References
Alkaloids	Caffeine		3, 4,6
	Theophylline		3
Amino Acids	L- Theanine		3

Terpenoids (Saponins)	Glycirrizhin		1
Polyphenols	Flavonoids		
	Catechins		1,3, 4
	Epigallocatechin gallate (EGCG)		1,3,4
	Epicatechin		3,4
	Epicatechin gallate		3,4

	Gallocatechin		4
	Epigallocatechin		4
	Gallocatechin gallate		4
	Catechin gallate		4
	Phenolic acids		
	Gallic acids		1,3
	Caffeic acid		1
	oxyaromatic acid-caffeoylquinic(o-CQA)		3

	Neochlorogenic acid (NCA)		3

3. Conclusion

According to recent studies, Camellia *sinensis* has potent anticancer effects that are mainly caused by its high polyphenol content, particularly Epigallocatechin-3-gallate (EGCG). These bioactives exhibit a multi-targeted therapeutic strategy, successfully triggering apoptosis, stopping the advancement of the cell cycle, and preventing angiogenesis in a variety of malignancies, including colorectal, lung, breast, and prostate cancers. The production of endoplasmic reticulum (ER) stress, the regulation of glucose metabolism, and the modification of important signaling pathways such the PI3K/AKT and JAK2/STAT1 pathways are often the underlying causes. Even though green tea's traditional use for overall health is well-established, current pharmacological research provides a scientific basis for its potential application as a potent, plant-derived chemopreventive and adjuvant therapeutic agent.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that there are no conflicts of interest

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