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Review Article

Bioactive Compounds, Pharmacological study Health Benefits: A Review of Four Traditional Medicinal Plants

Deeksha Sharma*, Dr. Dev Prakash Dahiya, Anchal Sankhyani, Palak kumari, Manjula verma

School of pharmacy, Abhilashi university, chail-chowk, mandi (Himachal Pradesh)

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ABSTRACT

This review explores the phytochemical composition and pharmacological properties of four widely used medicinal plants: *Allium sativum* (Garlic), *Salvia rosmarinus* (Rosemary), *Camellia sinensis* (Green Tea), and *Cinnamomum verum* (Cinnamon). These plants are known for their traditional uses and are rich in bioactive compounds that contribute to their medicinal value. The aim of this review is to provide a comprehensive overview of their phytochemicals, highlighting their therapeutic potential and supporting evidence from pharmacological studies.

INTRODUCTION

The two guiding principles of Ayurvedic medication formulation are the use of a single drug and the use of many drugs, the latter of which is referred to as PHF. Known as polypharmacy or polyherbalism, this important traditional therapeutic herbal technique makes use of the combination of multiple medicinal herbs to obtain additional therapeutic effectiveness. It is important to remember that herbs are sometimes seen as incompatible (*viruddha*) and should not be consumed together while creating polyherbal mixtures. Functional incompatibility, energy incompatibility, or quantitative incompatibility could be the cause of this

incompatibility. For example, because ghee and honey have different tastes and temperatures, they shouldn't be consumed in the same weight proportions; yet, laxatives and astringents have antagonistic effects that counteract each other's activities (1). PHFs are more affordable, environmentally friendly, and easily accessible than allopathic medications because they are a natural substance. Demand is rising worldwide due to their improved accessibility and affordability, particularly in rural areas and some underdeveloped nations where expensive current therapies are unavailable. Furthermore, polyherbal treatments have long been accepted as traditional beliefs, customs, and practices in some tribes

***Corresponding Author:** Deeksha Sharma

Address: School of pharmacy, Abhilashi university, chail-chowk, mandi (Himachal Pradesh)

Email ✉: deekshasharma1111@gmail.com

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throughout history. These methods are rooted in centuries of trial and error. Put it simply, PHF are more readily acceptable culturally and socially (2, 3). All of the aforementioned factors—effectiveness, safety, affordability, accessibility, and improved acceptance—made PHF the preferred treatment, which increased patient compliance and guaranteed a superior therapeutic outcome.

Allium sativum

Scientific classification

According to taxonomy of this plant scientific classification was given below.

Botanical Name: - *Allium sativum*

Kingdom: - Plantae

Family: - Amaryllidaceae

Genus: - *Allium*

Species: - *A. sativum*

Botanical description

Growing from a bulb, *Allium sativum* is a perennial flowering plant. It can reach a height of 1 m (3 ft.) with its tall, upright blooming stalk. The leaf blade has an acute apex and is flat, linear, solid, and roughly 1.25–2.5 cm (0.5–1.0 in) wide. In the Northern Hemisphere, the plant may bear pink to purple blooms from July to September. The bulb usually contains 10 to 20 cloves and has a pungent smell. (4).

Traditional Use

Asthma, diabetes, high blood pressure, STIs, mental disorders, kidney and liver issues, and wound infections from the common cold, malaria, cough, and pulmonary tuberculosis can all be effectively treated with garlic (5).

Some of Phytochemical of *Allium sativum*

Numerous phytochemicals, including at least 33 sulfur compounds, multiple enzymes, more than 15 amino acids, and minerals like selenium, are found in garlic. Of all the allium species, garlic has the largest concentration of sulfur compounds. Sulfur gives garlic its strong, pungent smell, and sulfur components also give garlic its many therapeutic benefits. Garlic does not contain allicin (diallyl thiosulfinate or diallyl disulfide), one of the most physiologically active substances, unless it is crushed or sliced; damage to the garlic bulb triggers the enzyme allinase, which converts alliin to allicin. Vinylthiins are produced by further metabolizing allicin. At room temperature, this breakdown takes place in a matter of hours, and when cooked, it happens in a matter of minutes (6).

Pharmacological Activities

Antihypertensive Potential

An estimated 1 billion people worldwide suffer from hypertension, a recognized risk factor for cardiovascular illness and mortality. Throughout human history, garlic (*Allium sativum*) has been used both medicinally and as a food. Garlic has been demonstrated in research on both human and animal cells to have blood pressure-lowering qualities due to its hydrogen sulfide generation and allicin content, which is released from alliin and the enzyme allinase, which has angiotensin II-inhibiting and vasodilating effects (7, 8).

Wound Healing Potential

Angiogenesis is essential for wound healing, and chronic wounds associated with diabetes and venous or arterial insufficiency are characterized by decreased angiogenesis. Examining the impact of various natural treatments on wound healing is crucial in order to intervene and enhance wound closure. The effect of varying doses of old garlic solution (AGS) on wound healing was examined



using the chicken dorsum skin excision wound assay (9, 10).

Antidiabetic Potential

Garlic can be used to help manage hyperglycemia, according to a WHO report. A study by Ryan et al. (2001) found that one-third of diabetic patients take alternative drugs they believe to be effective, with garlic being the most often utilized. It has been demonstrated that garlic and garlic components made in different ways have antidiabetic effects. (11, 12).

Anticancer Potential

Using various garlic preparations, such as fresh garlic extract, aged garlic, garlic oil, and other organosulfur compounds produced from garlic, several studies have shown the chemopreventive potential of garlic. Garlic's organosulfur components have been identified as the cause of its chemopreventive action. Several ways of action have been hypothesized, however the precise mechanism of action was not fully understood. These include its impact on enzymes involved in medication metabolism, antioxidant qualities, and prevention of tumor growth (13, 14).

Antiatherosclerosis and Hypolipidemic Potential

The prevention and treatment of atherosclerosis have advanced significantly in recent years. High serum cholesterol, male gender, age, hypertension, cigarette smoking, and diabetes are all linked to atherosclerotic illnesses, which include peripheral artery disease, ischemic heart disease, and stroke. There are two types of garlic's direct effects: antiatherogenic or preventative and antiatherosclerotic or therapeutic. Garlic prevents the onset and progression of atherosclerotic lesions and causes the lesions to recede on the arterial wall (15).

Antimicrobial Potential

It has long been recognized that mashed garlic has antimicrobial qualities. A broad range of antibacterial efficacy against both Gram-positive and Gram-negative bacteria, including species of *Salmonella*, *Escherichia*, *Staphylococcus*, *Streptococcus*, *Klebsiella*, *Proteus*, *Bacillus*, and *Clostridium*, has been demonstrated for various garlic preparations (16, 17).

Antifungal Potential

The expanded use of immunosuppressive and cancer chemotherapeutic drugs, or the recent research and application of broader-spectrum antibiotics. It has been demonstrated that high dilutions of extracts of garlic, or *Allium sativum*, have fungistatic and fungicidal activity both in vitro and in vivo (18).

Immunomodulatory Potential

One significant medicinal plant with immunomodulatory properties is *Allium sativum*. Q-Sepharose chromatography of a 30 kD ultrafiltrate of raw garlic extract was used to separate three immunomodulatory proteins from garlic. When it comes to human peripheral blood lymphocytes, murine splenocytes, and thymocytes, all of these proteins have mitogenic action. These immunomodulatory proteins were extracted from raw garlic by P. Venkatesh et al., who then investigated how they affected the immune system (19).

Antioxidant Potential

Researchers examined the in vivo antioxidant effects of four test organosulfur compounds against lipid-associated oxidations and found that these effects were caused by the activation and modification of multiple enzymes, including glutathione-s-transferase, catalase, and 3-hydroxy-3 methylglutaryl-CoA reductase (20).

Antiinflammatory Potential



Whole blood and peripheral blood mononuclear cells (PBMCs) were stimulated with varying concentrations of garlic extract in order to examine the potential therapeutic benefits of garlic in the treatment of patients with IBD. Multiparameter flow cytometry was used to assess the effect on leukocyte cytokine production in vitro (21).

Antihelmentic Potential

According to reports, *A. sativum* works well as a vermifuge and to expose dysentery. Additionally, it has been observed that *A. sativum* oil contains anthelmintic properties and eliminates all harmful intestinal parasites (22).

Anticoagulant and Fibrinolytic Potential

Song et al (1960) have extracted blood anticoagulant material from garlic and examined its physical and chemical properties. A half milligram of garlic extract fully blocked one ml of blood from coagulating. Garlic extract had nearly the same blood clotting-inhibiting action as potassium oxalate (23).

Hepatoprotective Potential

When compared to rats treated with lead alone, post-lead therapy with *A. sativum* significantly decreased the activities of ALT and ALP and increased the activity of AST. The reversal impact of lead toxicity in rats is indicated by the lowered serum ALT and ALP activity, which are typically attributed to decreased synthesis of these enzymes from these sources (24).

Salvia Rosmarinus

Scientific classification

According to taxonomy of this plant scientific classification was given below.

Botanical Name: - *Salvia rosmarinus*

Kingdom: - Plantae

Family: - Lamiaceae

Genus: - *Salvia*

Species: - *S. rosmarinus*

Botanical description

The leaves of the fragrant evergreen shrub rosemary resemble the needles of hemlock. Although it is indigenous to the Mediterranean region, it can withstand chilly temperatures rather well. throughout temperate climates, the plant blooms throughout the spring and summer, although in warm climates, it can bloom continuously. The flowers can be deep blue, pink, purple, or white (25).

Traditional Use

Traditional uses for rosemary (*Salvia rosmarinus*) include:

- Pain relief: Rosemary has modest analgesic and pain-relieving properties.
- Infected wounds can heal more quickly thanks to rosemary's antimicrobial qualities.
- Memory enhancement: Rosemary has the ability to enhance memory.
- Hair growth: Rosemary can promote the growth of new hair.
- Relieving muscle pain: Rosemary can ease spasms and pain in the muscles.
- Treating colds, colic, and depression: Rosemary tea can help relieve headaches, colic, colds, and depression.
- Treating eczema and asthma: Rosemary was used in traditional European herbal remedies for treating eczema and asthma.
- Treating poor appetite: Rosemary was used in traditional European herbal remedies for treating poor appetite (26).

Some of Phytochemical of *Salvia Rosmarinus*



Numerous secondary metabolites, including carnosol and carnosic, rosmarinic, ursolic, oleanolic, and micromeric acids, are found in rosemary, a therapeutic shrub. Apart from the gross extracts, essential oil of rosemary can also be applied topically. β -pinene, 1, 8-cineole, borneol, camphor, limonene, and verbenone are the main components of the oil (27, 28).

Pharmacological Activities

Anti-inflammatory Activity

Ursolic, oleanolic, and micromeric acids, as well as carnosol and carnosic acid, are responsible for the inflammatory activity of *R. officinalis* extract. Nitric oxide (NO), a pro-inflammatory mediator that initiates or intensifies the inflammatory process, has been shown to be strongly inhibited by the bioactive molecule carnosic acid (29).

Skin Cancer

Human melanoma A375 cells were used to assess the effects of *R. officinalis* hydroalcoholic extract; the extract reduced the growth of human melanoma cells in a dose-dependent manner. The development of melanomas is caused by mutations in melanocytes, which are linked to excessive sun exposure (30).

Wound Healing

Another study found that both diabetic and nondiabetic rats' wounds healed more quickly after being topically treated with oil derived from *R. officinalis* (31).

Skin Flap Survival

According to the study, the oil's vasodilatory, anti-inflammatory, and antioxidant properties contributed to the enhanced tissue survival (32).

Transdermal Effects

According to the study, the essential oil contains a lot of monoterpenoids, particularly 1,8-cineole, which can facilitate cutaneous absorption (33).

Antifungal Treatment

According to the study, the essential oil contains a lot of monoterpenoids, particularly 1,8-cineole, which can facilitate cutaneous absorption (34).

Cinnamomum verum

Scientific classification

According to taxonomy of this plant scientific classification was given below.

Botanical Name: - *Cinnamomum verum*

Kingdom: - Plantae

Family: - Lauraceae

Genus: - *Cinnamomum*

Species: - *C. verum*

Botanical description

The height of a *Cinnamomum verum* tree is 10 to 15 meters (30 to 50 feet). The leaves are 7–18 cm (3–7 in) long and ovate-oblong in form. The panicles of flowers are greenish in color and have a characteristic smell. The fruit is a single-seeded, purple drupe that measures 1 cm (0.5 in) (35).

Traditional Use

Traditionally, cinnamon, or *Cinnamomum verum*, has been used as a spice and in medicine:

Spice

A common spice in a variety of dishes, such as baked products, curries, and sweets, is cinnamon. Creams, syrups, and mulled wines also contain it.

Medicine



For millennia, people have used cinnamon to treat a wide range of ailments, such as heart problems, inflammation, headaches, diarrhea, bronchitis, and asthma. Clinical studies have demonstrated that it can lower blood sugar levels and is also used to treat diabetes (36).

Some of Phytochemical of *Cinnamomum verum*

Cinnamon has various phytochemicals like:

- Aldehydes
- Alcohols
- Esters
- Phenols
- Acids
- Monoterpenes
- Diterpenes
- Sesquiterpenes
- Benzopyrones
- Flavonoids
- Hydrocarbons

Pharmacological Activities

Antimicrobial activity

P. aeruginosa cells were shown to have lower cellular membrane potential and selective membrane permeability, whilst *S. aureus* cells treated with the CEO showed decreased metabolic and replication rates. In addition to these changes, it causes membrane rupture and oxidative stress, as seen in *K. pneumonia* bacteria's KPC-KP cells (37).

Antioxidant activity

According to Gulcin et al. (2019), cinnamon and its active ingredients can provide free radicals a hydrogen atom. The free radicals stabilize after acquiring the hydrogen atom, protecting the cell from more oxidative stress (38).

Anti-inflammatory activity

According to the facts above, *C. verum* and its bioactives have an anti-inflammatory mechanism of action that may reduce NO generation, which is controlled by NF-kB overexpression (39).

Anticancer activity

Li et al. (2016) assessed how cinnamonaldehyde causes tumor cells to undergo apoptosis. According to their findings, the AKT/phosphoinositide-3-kinase (PI3K) signaling pathway is essential for several forms of carcinogenesis. Cinnamaldehyde inhibits the expression of apoptotic inhibitors including Bcl-2, matrix metalloproteinase-2 (MMP-2), MMP-9, mTOR, IGF-1, and the PI3K/AKT signaling pathway while upregulating the expression of pro-apoptotic proteins like E-cadherin and Bax (40).

Antidiabetic activity

According to Zare, Nadjarzadeh, Zarshenas, Shams, and Heydari (2019), cinnamon increases insulin sensitivity by blocking insulin receptor dephosphorylation and upregulating the expression of insulin receptor kinases. Additionally, by blocking the enzyme glycogen synthase kinase-3 and upregulating the expression of UCP3 genes involved in fatty acid metabolism, it decreases the absorption of glucose (41).

Wound healing

Angiogenesis is an essential stage in the healing of wounds. According to Yuan et al. (2018), angiogenesis supports cinnamon aldehyde's potential for wound healing. Cinnamaldehyde promoted angiogenesis and increased the expression of PI3K signaling and mitogen-activated protein kinases (MAPK), including Erk1/2, P38, and JNK/SAPK.

Anti-HIV activity

The anti-HIV activity of *C. verum* for the treatment of acquired immune deficiency



syndrome (AIDS) was reported by Semenya, Potgieter, and Erasmus (2013) (42).

Antianxiety and antidepressant

Sohrabi, Pazgoohan, Seresht, and Amin (2017) looked at the CEO's antidepressant and anti-anxiety effects. The antidepressant role was assessed using the forced swim test (FST) and tail suspension test (TST); the anti-anxiety activity of various dosages (0.5, 1, and 2 mg/kg) of CEO was assessed using the elevated plus-maze test (EPM) and elevated open field tests. The CEO considerably reduced the depressive and anxiety symptoms in the animals under study after 14 days of treatment (43).

Anti-Parkinson effects

Using MPTP-intoxicated mice, Khasnavis and Pahan (2014) assessed cinnamon's antiparkinson effects. 100 µl of cinnamon powder dissolved in 0.5% methylcellulose (MC) was added to the mice as a supplement. It was discovered that giving mice cinnamon boosted the formation of sodium benzoate in their brains and blood cells, which in turn enhanced the manufacture of the proteins Parkin and DJ-1 and prevented their subsequent loss (44).

Camellia Sinensis

Scientific classification

According to taxonomy of this plant scientific classification was given below.

Botanical Name: - *Camellia Sinensis*

Kingdom: - Plantae

Family: - Theaceae

Genus: - *Camellia*

Species: - *C. sinensis*

Botanical description

Using MPTP-intoxicated mice, Khasnavis and Pahan (2014) assessed cinnamon's antiparkinson effects. 100 µl of cinnamon powder dissolved in 0.5% methylcellulose (MC) was added to the mice as a supplement. It was discovered that giving mice cinnamon boosted the formation of sodium benzoate in their brains and blood cells, which in turn enhanced the manufacture of the proteins Parkin and DJ-1 and prevented their subsequent loss (45).

Traditional Use

For thousands of years, people have utilized the leaves, leaf buds, and stems of the *Camellia sinensis* plant—commonly referred to as the tea plant—in a number of ways.

- **Tea**

One of the most widely consumed beverages worldwide, tea, is typically made from the leaves.

- **Traditional Chinese medicine**

Tea has been used in traditional Chinese medicine for more than 4,000 years as a stimulant, to treat digestive problems, and to lessen sweating during fevers.

- **Cosmetics**

Skincare items contain *Camellia sinensis* extracts.

- **Kombucha**

The main substrate for fermenting kombucha, a well-liked beverage with potential health advantages, is the leaves of the *Camellia sinensis* plant.

- **Weight control**

Green tea leaf extract is used as a dietary supplement to help with weight control.



- **Hepatoprotective agent**

Tea has been shown to reduce liver injury caused by a number of substances (46).

Some of Phytochemical of *Camellia Sinensis*

A third of the 4000 bioactive components found in tea plants, which are used as medicinal herbs, are polyphenols. Alkaloids, amino acids, proteins, carbohydrates, chlorophyll, volatile organic compounds, fluoride, aluminum, minerals, and trace elements are additional substances (47, 48).

Pharmacological Activities

Anti-Aging Activity

Green tea as the only liquid supply, however, did not considerably lengthen mice's lifespans when compared to controls, according to Kitani et al. Green tea, however, did shield elderly animals from ethanol-induced oxidative stress and shielded serum lipids and protein from oxidative damage that ethanol and aging exacerbate (49).

Anti-Alzheimer Activity

Multiple research in animal and cell culture models indicate that EGCG from green tea may alter multiple possible targets related with the course of Alzheimer's disease, despite the lack of epidemiological data in human studies supporting the benefits of green tea for the condition (50).

Antiparkinson Activity

Green tea and EGCG have been demonstrated in numerous studies to greatly prevent various pathologies in animal models. When taken orally, EGCG at doses as low as 25 mg/kg preserved dopamine levels in the striatum and delayed the death of dopaminergic neurons in the substantia nigra (51).

Antistroke Activity

When given systemically at 50 mg/kg just after an excitotoxic ischemic insult, EGCG has been demonstrated to provide protection against neuronal damage following ischemia in gerbils. In rats, EGCG was also shown to have a strong antioxidant effect at this dosage, protecting against neurological impairment (52).

Cardiovascular Diseases

While tea catechism does inhibit the peroxidation of LDL (low density lipoprotein) cholesterol in vitro, the effect ex vivo is minimal. Consuming green tea has been shown to reduce the development of aortic atherosclerosis in rabbits, but it is more difficult to demonstrate in humans and the results are inconsistent. Several case studies demonstrate that tea does not lower blood pressure or plasma lipids (cholesterol) ex vivo (53, 54).

Anticancer Activity

The effectiveness of green tea as an anti-carcinogenic was investigated in a study involving 8552 inhabitants, who were representative of the Japanese population. According to the results, people who drink more than ten cups of green tea daily had a lower relative risk of developing cancer than people who drink less than three cups (55).

Other Activities

- Antidiabetic Activity
- Skin Disorders
- Obesity and Weight Loss
- Anticaries Activity

CONCLUSION

As a result of their rich phytochemical compositions, *Allium sativum*, *Salvia rosmarinus*, *Camellia sinensis*, and *Cinnamomum verum* constitute a diverse group of plants with strong



pharmacological qualities. Bioactive chemicals found in each of these plants have been demonstrated to provide a variety of therapeutic benefits, such as anti-inflammatory, anti-cancer, antibacterial, antioxidant, and metabolic advantages. They are effective in preventing and treating chronic diseases like cancer, diabetes, heart disease, and neurological disorders because of the compounds in garlic (allicin), rosemary (rosmarinic acid), green tea (EGCG and catechins), and cinnamon (cinnamaldehyde), which all play important roles in the modulation of various physiological processes.

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