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REVIEW ARTICLE

Pharmacological efficacy and therapeutic properties of selected Ayurvedic medicinal plants: A scoping review

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Abstract

Ayurvedic medicinal plants have long been used for health promotion and disease management. This article explores the pharmacological efficacy and therapeutic properties of six widely used Ayurvedic herbs: *Withania somnifera* L. (Ashwagandha), *Mucuna pruriens* (Kapikachu), *Sida rhombifolia* (Atibala), *Cyanthillium cinereum* (Sahadevi), *Tinospora cordifolia* (Guduchi) and *Glycyrrhiza glabra* (Yashtimadhu). Each of these plants possesses unique bioactive compounds that contribute to their pharmacological effects. *Withania somnifera* (Ashwagandha) is well-known for its adaptogenic, neuroprotective and anti-inflammatory properties. *Mucuna pruriens* (Kapikachu) exhibits neuroprotective, aphrodisiac and anti-Parkinsonian activities due to its high L-DOPA content. *Sida rhombifolia* (Atibala) demonstrates anti-inflammatory, antimicrobial and hepatoprotective effects. *Cyanthillium cinereum* (Sahadevi) is valued for its anti-cancer, anti-inflammatory and detoxifying properties. *Tinospora cordifolia* (Guduchi) is a potent immunomodulator with anti-diabetic and hepatoprotective actions, while *Glycyrrhiza glabra* (Yashtimadhu) is widely used for its gastroprotective, anti-ulcer and anti-inflammatory effects. This review highlights their pharmacological mechanisms, therapeutic applications and potential integration into modern medicine. Further clinical research and pharmacological investigations are essential to establish their efficacy and safety in contemporary healthcare systems.

Keywords: adaptogen; Ayurveda; herbal medicine; immunomodulation; medicinal plants; neuroprotection; pharmacological properties

Introduction

Ayurveda has highlighted the importance of various herbal remedies due to their adaptogenic, immunomodulatory and antioxidant benefits. Notably, the roots, stems and whole plants of several medicinal herbs have shown promising chemoprotective properties against oxidative, genotoxic and organ-specific damage induced by chemotherapeutic agents and environmental toxins (1, 2). Medicinal plants have long been central to traditional systems such as Ayurveda, which promotes a holistic approach to healing. Among the numerous botanicals valued for their healing capabilities, *Withania somnifera* (Ashwagandha), *Mucuna pruriens* (Kapikachu), *Sida rhombifolia* (Atibala), *Cyanthillium cinereum* (Sahadevi), *Tinospora cordifolia* (Guduchi) and *Glycyrrhiza glabra* (Yashtimadhu) are particularly noteworthy due to their extensive pharmacological effects (3–5). These herbs display a range of actions, including adaptogenic, neuroprotective, immunomodulatory, anti-inflammatory and revitalizing effects, making them essential in both preventive and therapeutic healthcare (6–8).

Each of these plants is rich in bioactive compounds that enhance their effectiveness in managing diseases, for example *W. somnifera* contains withanolides, alkaloids and sitoindosides, which are known for their adaptogenic, antioxidant and neuroprotective activities. *Tinospora cordifolia* is abundant in diterpenoid lactones (such as tinosporaside and cordifolide), alkaloids, glycosides and polysaccharides, which exhibit immunomodulatory, anti-inflammatory and hepatoprotective effects. *Withania somnifera* (Ashwagandha), often called the "Indian Ginseng," is celebrated for its adaptogenic and cognitive-enhancing properties, aiding in the alleviation of stress, anxiety and neurodegeneration. *Mucuna pruriens* (Kapikachu), a natural L-Dopa source, is vital for neurological wellness, especially in treating Parkinson's disease. *Sida rhombifolia* (Atibala) is traditionally recognized for its pain-relieving, anti-inflammatory and tonic qualities, making it helpful for musculoskeletal issues. *Cyanthillium cinereum* (Sahadevi) is noted for its liver-protective, antimicrobial and detoxifying benefits, assisting in skin and liver conditions. *Tinospora cordifolia* (Guduchi), referred to, as "Amrita" in Ayurveda, is a strong immunomodulator known for its fever-reducing, anti-diabetic and antioxidant effects. *Glycyrrhiza glabra* (Yashtimadhu), commonly included in Ayurvedic mixtures, is valued for its soothing, anti-ulcer and expectorant properties, providing relief for digestive and respiratory ailments.

In recent years, contemporary pharmacological studies have confirmed many of the traditional benefits associated with these medicinal herbs, showcasing their promise for pharmaceutical development. Exploring their phytochemistry, pharmacodynamics and clinical uses can help connect traditional practices with modern medical science. This article examines the medicinal properties of these 6 influential herbs, focusing on their primary components,

mechanisms of action and therapeutic roles in current healthcare.

Methodology

This scoping review was conducted to evaluate the pharmacological efficacy and therapeutic properties of selected Ayurvedic medicinal plants. The review process followed a structured and transparent approach in accordance with the PRISMA Extension for Scoping Reviews (PRISMA-ScR) guidelines (Fig. 1).

Search strategy

A comprehensive literature search was performed using the PubMed database. Advanced search options were utilized with the following keywords and Boolean operators: ('Ayurveda' OR 'Ayurvedic medicine') AND ('Medicinal plants' OR 'Herbal medicine') AND ('Pharmacological efficacy' OR 'Pharmacological properties') AND ('Adaptogen' OR 'Immunomodulation' OR 'Neuroprotection'). The search was limited to English-language publications from January 2000 to January 2025. Reference lists of retrieved papers and related reviews were also screened manually to identify additional relevant studies.

Inclusion criteria

1. Original research studies evaluating the pharmacological efficacy of Ayurvedic medicinal plants.
2. Experimental designs involving *in vitro*, *in vivo* or clinical studies.
3. Studies published in peer-reviewed journals.

Exclusion criteria

The following were excluded:

1. Review articles, editorials, commentaries and conference abstracts.
2. Studies limited to phytochemical profiling or analytical standardization without pharmacological evaluation.
3. Articles involving polyherbal or non-Ayurvedic formulations without clear identification of Ayurvedic plant components.

Study selection

An initial search yielded 90 records. After removing duplicates and screening titles and abstracts for relevance, 70 articles were retained for full-text assessment. Following the application of inclusion and exclusion criteria, 50 studies were found eligible and included for data synthesis.

To provide contextual depth, an additional 34 sources (reviews, conceptual papers and methodological references) were consulted to support interpretation, discussion and background framework making a total of 84 references cited in this article.

Data extraction and synthesis

Data were extracted from the 50 included studies based on study design, plant species, pharmacological activities, bioactive compounds and therapeutic relevance. The findings were organized thematically according to major pharmacological domains such as adaptogenic, anti-inflammatory, antioxidant, neuroprotective, immunomodulatory, anti-diabetic and anti-cancer effects. Descriptive synthesis was employed to summarize the evidence and highlight the potential integration of these Ayurvedic medicinal plants into modern pharmacology.

Withania somnifera (Ashwagandha)

Withania somnifera (L.) Dunal, commonly known as Ashwagandha, is a medicinal plant belonging to the Solanaceae family (1). It has been widely used in Ayurveda, Unani and Siddha systems of medicine for its adaptogenic, anti-stress, anti-inflammatory and neuroprotective properties (2–4). The bioactive compounds, including withanolides, alkaloids, flavonoids and steroidal lactones, contribute to its pharmacological effects.

Pharmacological properties

Adaptogenic and anti-stress activity

Withania somnifera (Ashwagandha) is well known for its adaptogenic properties, which help the body combat stress. Studies have shown that it reduces cortisol levels, modulates the

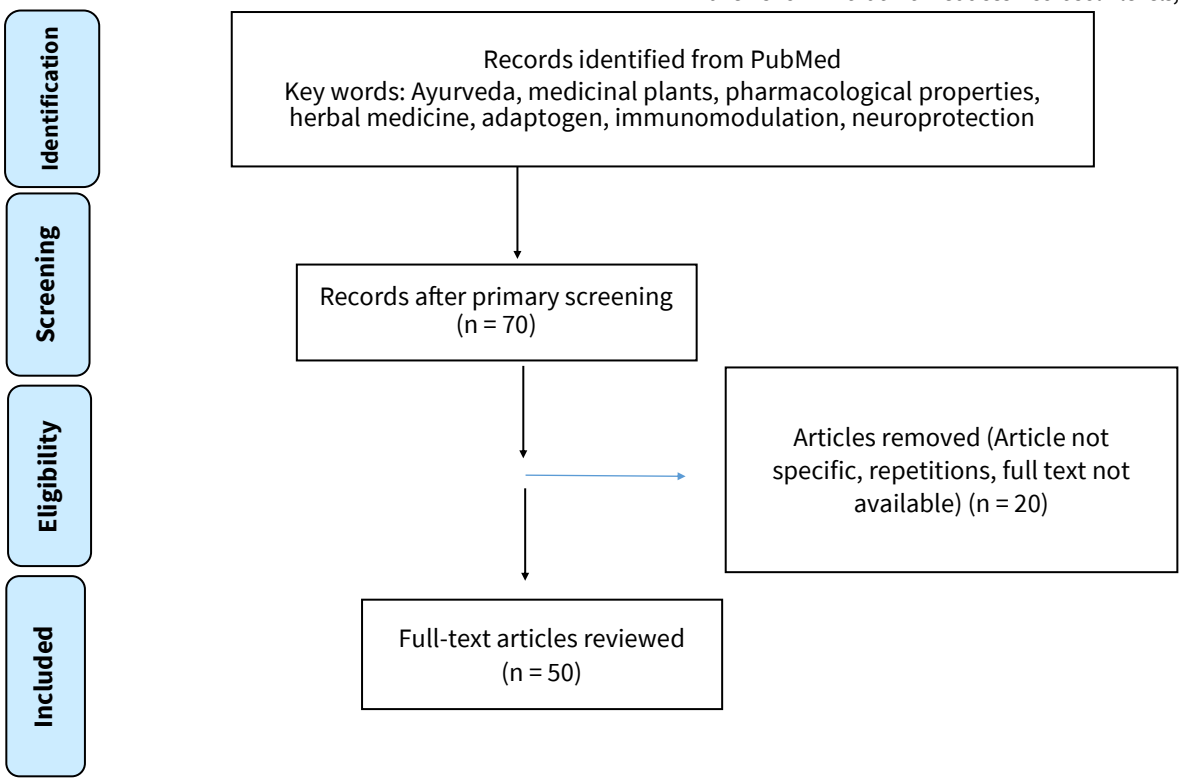

Fig. 1. Flow chart showing the review process.

hypothalamic-pituitary-adrenal (HPA) axis and enhances resilience to stress (5). It has been widely used in Ayurvedic formulations to improve mental stamina and reduce anxiety and depression.

Anti-inflammatory and analgesic effects

The root extract of *W. somnifera* (Ashwagandha) exhibits potent anti-inflammatory and analgesic properties. It inhibits pro-inflammatory cytokines (TNF-α, IL-6) and cyclooxygenase enzymes (COX-2), making it beneficial in arthritis, muscle pain and autoimmune conditions (6).

Neuroprotective and cognitive-enhancing properties

Withania somnifera (Ashwagandha) has been extensively studied for its neuroprotective effects. It promotes neurite outgrowth, reduces oxidative stress and enhances cholinergic function, making it beneficial in neurodegenerative disorders like Alzheimer's and Parkinson's disease (7). Additionally, it improves memory, focus and cognitive performance.

Immunomodulatory effects

Withania somnifera (Ashwagandha) enhances both innate and adaptive immune responses. Preclinical studies in animal models have shown that administration of *W. somnifera* root extract increases total white blood cell (WBC) count, stimulates macrophage activation and enhances antibody and delayed-type hypersensitivity responses (8, 9). In rodent models, it has also been shown to modulate cytokine production by reducing pro-inflammatory mediators such as TNF-α, IL-1β and IL-6, thereby exerting anti-inflammatory and immunoprotective effects (10, 3). Human studies, including randomized controlled and pilot trials, have reported that Ashwagandha supplementation enhances immune cell activity and increases levels of immunoglobulins and natural killer (NK) cell function, supporting its immunomodulatory role in humans (11, 12). Collectively, these findings suggest that *W. somnifera* strengthens the immune system against infections and inflammatory diseases through both cellular and humoral mechanisms.

Antioxidant and anti-aging effects

The bioactive compounds in *W. somnifera* (Ashwagandha) act as strong antioxidants, scavenging reactive oxygen species (ROS) and preventing oxidative damage. These properties help delay aging, reducing cellular damage and protecting against chronic diseases such as cardiovascular disorders and cancer (13).

Anti-diabetic and metabolic regulation

Withania somnifera (Ashwagandha) has been reported to regulate blood glucose levels and improve insulin sensitivity. Studies suggest that it enhances pancreatic β-cell function, reduces oxidative stress in diabetic patients and lowers fasting blood sugar levels (14).

Anti-cancer properties

Research has demonstrated that *W. somnifera* (Ashwagandha) exhibits anti-cancer properties through its ability to induce apoptosis, inhibit angiogenesis and suppress tumor proliferation. Withaferin A, one of its active compounds, has been shown to be effective against breast, lung, colon and prostate cancers (15).

Cardioprotective effects

Withania somnifera (Ashwagandha) has been found to lower cholesterol levels, reduce blood pressure and prevent atherosclerosis. It exerts a cardioprotective effect by reducing oxidative stress, improving endothelial function and preventing myocardial damage (16).

Withania somnifera (Ashwagandha) is a potent medicinal herb with a wide range of pharmacological properties, including adaptogenic, anti-inflammatory, neuroprotective, antioxidant, immunomodulatory, anti-diabetic, anti-cancer and cardioprotective effects. Traditional usage, combined with scientific validation, highlights its potential in modern medicine. Further clinical studies are required to explore its full therapeutic potential and mechanism of action.

Mucuna pruriens

Mucuna pruriens (Kapikachu), commonly known as velvet bean is a tropical leguminous plant extensively used in Ayurvedic medicine. It is well-known for its high L-Dopa (Levodopa) content, which makes it a valuable natural treatment for Parkinson's disease and other neurological disorders (17). Additionally, the plant possesses antioxidant, anti-inflammatory, aphrodisiac, neuroprotective, anti-diabetic and adaptogenic properties due to its diverse range of bioactive compounds such as flavonoids, alkaloids, tannins and saponins (18).

Pharmacological properties

Neuroprotective and anti-Parkinsonian effects: *Mucuna pruriens* (Kapikachu) is a rich source of Levodopa (L-Dopa), the precursor to dopamine, which plays a crucial role in treating Parkinson's disease (PD), a neurodegenerative disorder characterized by dopamine depletion in the brain (19). Studies show that *M. pruriens* (Kapikachu) has a faster onset and longer duration of action than synthetic levodopa, making it a potential alternative treatment (20). The plant also contains antioxidants that protect dopaminergic neurons, slowing down the progression of Parkinson's disease (3). Clinical trials suggests that *M. pruriens* (Kapikachu) causes fewer motor complications (dyskinesias) compared to synthetic levodopa (21).

Antioxidant and anti-inflammatory properties: Oxidative stress plays a major role in neurodegenerative diseases, diabetes and cardiovascular disorders. *Mucuna pruriens* (Kapikachu) exhibits strong antioxidant activity due to its high flavonoid and polyphenol content (22). Extracts of *M. pruriens* (Kapikachu) reduce lipid peroxidation, protecting cell membranes from oxidative damage (23). The plant suppresses pro-inflammatory cytokines (TNF-α, IL-6), beneficial in inflammatory conditions.

Aphrodisiac and fertility-enhancing effects: *Mucuna pruriens* (Kapikachu) has been traditionally used as an aphrodisiac and a male fertility enhancer. Research confirms its ability to increase sperm count, sperm motility and testosterone levels (24, 25). A clinical study in infertile men demonstrated that supplementation with *M. pruriens* seed powder (5 g/day for 3 months) significantly improved sperm quality, enhanced seminal plasma antioxidant levels and reduced oxidative stress markers (26). Another randomized clinical trial reported that *M. pruriens* restored spermatogenic function and improved hormonal balance by increasing testosterone and luteinizing hormone (LH) while reducing follicle-stimulating hormone (FSH) and prolactin levels (27). Additionally, *M. pruriens* has been shown to mitigate stress-induced infertility by lowering cortisol concentrations and enhancing dopamine synthesis, which plays a central role in regulating libido and sexual behaviour (28, 29). Collectively, these findings support the adaptogenic and aphrodisiac potential of *M. pruriens* through its neuroendocrine and antioxidant mechanisms.

Antidiabetic potential: *Mucuna pruriens* (L.) DC., commonly known as Kapikacchu, has demonstrated significant antidiabetic activity in

both animal models and human clinical studies. Preclinical investigations in streptozotocin and alloxan-induced diabetic rats have shown that *M. pruriens* seed extract and its bioactive constituents produce a marked reduction in blood glucose levels, improvement in glucose tolerance and enhancement of insulin secretion (30, 31). These effects are associated with increased activities of antioxidant enzymes, such as superoxide dismutase (SOD) and catalase (CAT), suggesting a protective role against oxidative stress linked to diabetes pathogenesis (32). Furthermore, clinical evidence supports its potential in type 2 diabetes mellitus (T2DM). A randomized controlled study involving diabetic patients reported that *M. pruriens* supplementation led to a significant decrease in fasting blood glucose, glycated hemoglobin (HbA1c) and total cholesterol levels, along with improvement in overall glycaemic control and lipid profile (33, 34). The combined antioxidant, insulin-sensitizing and β-cell protective actions of *M. pruriens* may underlie its efficacy in managing hyperglycaemia and diabetes-associated complications.

Adaptogenic and antidepressant effects: *Mucuna pruriens* (Kapikachu) exhibits adaptogenic properties that mitigate stress and anxiety. Studies indicate that *M. pruriens* (Kapikachu) reduces cortisol levels, improving resilience to stress and mental well-being. It enhances dopaminergic and serotonergic activity, making it useful for mood disorders like depression.

Glycyrrhiza glabra (Yastimadhu)

Licorice, scientifically known as *G. glabra* (Yastimadhu), is a member of the family Fabaceae. Licorice is a widely utilized plant with diverse applications across the tobacco, cosmetic, food and pharmaceutical industries (35). *Glycyrrhiza glabra* (Yashtimadhu) has important medical, pharmaceutical and industrial value. Since ancient times, the medicinal properties of its roots have been well recognized (36). It is one of the oldest known herbal remedies and possesses a diverse set of pharmacological actions, including expectorant, antitussive, emollient, anti-inflammatory, antipyretic, antiviral, antibacterial, antiprotozoal, hepatoprotective, antitumor, vasorelaxant, antiplatelet aggregation, immunomodulatory and endocrinological, antidepressant, memory-enhancing, sedative, muscle relaxant and antifungal actions (28). *Glycyrrhiza glabra* (Yashtimadhu) is a perennial shrub that can reach a height of up to 2.5 m. It is about 1 cm long tap root and about 3 cm long daughter root branch, giving rise to a horizontal wood table. *Glycyrrhiza glabra* (Yashtimadhu) is a plant that can grow up to 2.5 m and the dried plant itself and the taproot are cut to produce commercial licorice (37). Glycyrrhizin or glycyrrhizic acid proved the most relevant biological compound discovered in the outer roots with apoptotic activity. The anticancer effect of this plant on different cancers has been thoroughly investigated (38) (Table 1).

Pharmacological properties

Antioxidant activity: One of the important reasons for the applications of *Glycyrrhiza glabra* (Yashtimadhu) is its antioxidant activity. It is likely that the natural antioxidant activity exhibited by these plants is attributable to phenol content. This activity is based on active compounds, like Siefriedine, Lipaprolidine A, 30-hydroxy-4-methylglabridin and isoflavones (39).

Anti-inflammatory activity: Reports have shown that liquid extracts of Glycyrrhetinic acid exhibit anti-inflammatory effects similar to those of glucocorticoids and mineralocorticoids. The roots of licorice (Glycyrrhiza) have claimed to heal stomach ulcers and mouth sores for over 2000 years. Studies reveal that glycyrrhizic acid prevents all the inflammatory factors. It inhibits cyclooxygenase activity and prostaglandin synthesis and reduces platelet aggregation (40).

Antifungal activity: *Glycyrrhiza glabra* (Yashtimadhu) exhibits anti-fungal activity. Another study utilized an 80 % methanol extract of *Glycyrrhiza glabra* and screened it using *Chaetomium finicola* M002 to identify antifungal compounds in various plant materials. The active compound isolated was glabridin, which exhibited significant antifungal and preservative activity (41).

Anti-malarial activity: One compound of licorice, licochalcone A, a chalcone, is reported for antimalarial activity. In a follow-up study (including chemo prevention), it was reported that oral administration at a dose of 1000 mg kg^{-1} against *Plasmodium yoelii* resulted in complete elimination of malaria parasites.

Immuno-stimulant activity: *Glycyrrhiza glabra* (Yashtimadhu), at a concentration of 100 µg/mL, demonstrated immunomodulatory activity in an in-vitro study, enhancing macrophage function and cytokine production. This enhances the generation of TCD69 macrophages from human granulocytes. Previous studies showed increased immune complex levels associated with autoimmune diseases (42).

Antitumor activity: *In vivo* and *in vitro* studies of tumor cells in ascites demonstrated that the aqueous extract of *G. glabra* (Yastimadhu) inhibited tumor growth and suppressed neovascularization *in vitro*, peritoneal and chorioallantoic membrane assays. Ethanol extracts of *G. glabra* induce apoptosis and G1-phase cell cycle arrest in MCF-7 cells. Glycyrrhizic acids also activate pro-apoptotic signalling pathways and the mitochondrial permeability transition contributes to the apoptosis of tumor cells. Recent studies indicate that the most potent cytotoxic effect of G. glabra (Yastimadhu) is attributed to a newly discovered retrochalcone, licochalcone E, which exhibited greater activity than well-known antitumoral agents such as Ferber A and isoliquiritigenin.

Anticancer effect of Licorice: *Glycyrrhiza glabra* is a well-studied medicinal plant with significant pharmacological effects. Research has shown that these substances may help prevent the growth of various cancer cells, including stomach, breast and melanoma cells. One of the most abundant compounds is isoliquiritigenin (ISL), a direct inhibitor of cervical, liver, lung, breast and prostate cancer. At multiple developmental stages, ISL inhibits cancer formation via impacts on cell cycle, apoptosis, autophagy and anti-angiogenesis.

Table 1. Compounds present in *Glycyrrhiza glabra* and its properties

Class of compound	Representative examples	Major biological activities
Triterpenes	Glycyrrhizin, glycyrrhetinic acid	Anti-inflammatory, antiviral, hepatoprotective
Flavonoids	Liquiritin, liquiritigenin, glabridin	Antioxidant, antitumor, antimicrobial
Chalcones	Isoliquiritigenin	Antioxidant, anti-inflammatory
Phenolic acids	Ferulic acid, caffeic acid	Antioxidant, cardioprotective
Polysaccharides		Immunomodulatory, anti-inflammatory
Alkaloids		Antimicrobial, enzyme inhibitory
Polyamines	Spermidine, spermine	Cytoprotective, anti-aging

The other described flavonoid, licochalcone A (LA), shows anticancer activity through increasing autophagy and delaying cell cycle, both at G1/S and G2/M and lowering cyclin and cyclin-dependent kinase content. In animal models, cognitive function improved, accompanied by increased cerebral blood flow. Although licorice ethanol (EtOH) extracts were tested for anticancer effects on breast and liver cancer, no significant effects were observed against colon cancer. Lasers with LC-MS/MS analysis showing numerous bioactive compounds, indicating the pharmacological use of alcoholic beverages. Overall, licorice can aid in the prevention of diseases like cancer. Licorice also mitigates oxidative stress, contributing to its anticancer potential. Glabridin is another key flavonoid that helps to remove proteins from major signalling and provides antitumor activity.

Sida rhombifolia (Atibala)

Sida rhombifolia (Atibala), commonly known as Nithyakalyani, is a medicinal plant belonging to the Malvaceae family. It is widely distributed across tropical and subtropical regions and has been extensively used in Ayurveda, Siddha and folk medicine for treating various ailments. The root of *S. rhombifolia* (Atibala) is particularly valued for its diverse pharmacological properties, including anti-inflammatory, analgesic, antimicrobial, antioxidant, hepatoprotective and immunomodulatory effects. This article provides an overview of its pharmacological activities and therapeutic applications based on both traditional knowledge and scientific studies.

Pharmacological properties

Anti-inflammatory activity: Inflammation plays a crucial role in the pathogenesis of chronic diseases, including arthritis and autoimmune disorders. Studies have demonstrated that *S. rhombifolia* (Atibala) root extract inhibits pro-inflammatory cytokines, prostaglandins and cyclooxygenase-2 (COX-2), reducing inflammatory responses (43). Traditionally, the root is used to treat joint pain, muscle inflammation and inflammatory conditions.

Analgesic (pain-relieving) effect: Pain management is one of the key therapeutic applications of *S. rhombifolia* (Atibala) root. Research indicates that its extract acts on opioid receptors and central pain pathways, providing significant analgesic effects (44). It is used in traditional medicine to treat headaches, musculoskeletal pain and neuralgic disorders.

Antioxidant activity: Oxidative stress is associated with various chronic diseases such as cardiovascular disorders and neurodegenerative conditions. *Sida rhombifolia* (Atibala) root contains flavonoids, polyphenols and tannins, which have been found to scavenge free radicals and reduce oxidative stress (45). These properties make it useful for cellular protection and overall wellness.

Antimicrobial and antifungal properties: The root of *S. rhombifolia* (Atibala) has shown broad-spectrum antimicrobial activity against Gram-positive and Gram-negative bacteria, as well as fungi (46). Studies indicate its effectiveness against *Staphylococcus aureus*, *Escherichia coli* and *Candida* species, making it beneficial for wound healing, skin infections and gastrointestinal disorders.

Hepatoprotective (liver-protecting) activity: The liver plays a vital role in detoxification and *S. rhombifolia* (Atibala) root extract has been reported to protect liver cells from toxin-induced damage. Experimental studies suggest that it prevents oxidative damage in hepatocytes and promotes liver regeneration (47). In Ayurveda, it is traditionally used for jaundice, liver disorders and digestive complaints.

Immunomodulatory effects: The immune-boosting effects of *S. rhombifolia* (Atibala) root have been recognized in traditional medicine. Research indicates that the root extract stimulates white blood cell production, enhances cytokine activity and improves immune responses (48). These immunomodulatory effects may help prevent recurrent infections and support host defence.

Anti-diabetic activity: Diabetes mellitus is a growing global health concern and medicinal plants are being explored for their potential in managing blood sugar levels. Studies have shown that *S. rhombifolia* (Atibala) root extract reduces blood glucose levels, enhances insulin sensitivity and improves glucose metabolism (49). It is often used in herbal formulations for diabetes control.

Aphrodisiac and reproductive health benefits: *Sida rhombifolia* (Atibala) root is classified as an Aphrodisiac (Vrishya) in Ayurveda and is used to enhance male reproductive health and vitality. Research suggests that the root extract improves sperm quality, increases libido and aids in treating male infertility (50).

Sida rhombifolia (Nithyakalyani) root possesses diverse pharmacological properties that make it a valuable medicinal plant in traditional and modern medicine. Its anti-inflammatory, analgesic, antioxidant, antimicrobial, hepatoprotective, immunomodulatory, anti-diabetic and aphrodisiac properties highlight its therapeutic significance. While traditional applications strongly support its efficacy, further clinical trials and pharmacological research are required to establish its role in modern medical treatments.

Tinospora cordifolia (Guduchi)

Pharmacological properties

Anticancer potential: Studies show that different parts of *T. cordifolia* (Guduchi) have active components against cancer. Active compounds such as betulinic acid, palmatine and berberine contribute to these effects (51). Aqueous extracts of this plant have been reported to induce apoptosis in oral cancer cells. *Tinospora cordifolia* extract exhibited dose-dependent cytotoxic effects, with significant cell death observed even at a concentration of 5 µg/mL. After 24 hr of treatment, the extract selectively downregulated specific gene expressions associated with cancer proliferation while leaving others unaffected (52). Natural stuff like berberine seems to act somewhat like this plant, indicating its primary active role (53). A specific study found T1 to block growth, motion & invasiveness in certain cancer cells while boosting E-cadherin, a marker for evaluation (54). Studies on the hexane & methanol mixtures (T1 & T2) were further investigated. *Tinospora cordifolia* (Guduchi) also fights breast cancer. IC_{50} values are 59.85 µg/mL & 249 µg/mL in breast cancer cells, compared with 14.41 µM for the chemotherapy drug Vincristine. Some extraction methods may not be effective against certain cancers, but overall, they show promise in the prevention of breast cancer (55).

Anti-diabetic effects: Research in medicine has shown that the use of *T. cordifolia* (Guduchi) extracts can reduce the impact of diabetes. These benefits arise from various bioactive plant compounds such as alkaloids, flavonoids, & saponins (56). For example, Borapetoside C lowers high blood sugar in diabetic mice and enhances glucose utilization by activating specific liver pathways, like the IR-Akt-GLUT2 pathway (57). Extracts with alkaloids from plant stems imitate insulin and get insulin hormones going. Raw plant chunks reduce harmful substances such as malondialdehyde and ROS, which increase protective molecules like glutathione in the liver of diabetic mother rats, combating oxidative stress associated with diabetes.

Additionally, an isoquinoline alkaloid-rich fraction from the stem, including palmatine, jatrorrhizine and magnoflorine, demonstrates insulin-mimicking and insulin-releasing effects (58). Oral administration of these extracts in specific doses showed beneficial effects such as reduced liver damage and increased pancreatic insulin release over 14 days. It does this by reducing levels of malondialdehyde and ROS while increasing levels of glutathione and total thiols (59). This is achieved by alleviating oxidative stress, promoting insulin secretion and inhibiting gluconeogenesis and glycogenolysis (52).

Antioxidant role: In food and biological sciences, *T. cordifolia* (Guduchi) is widely recognised for its antioxidant properties. It helps to protect the kidneys from toxin-induced damage, largely due to choline and tinosporin alkaloids. The ethanol extract also helped rats fend off liver cancer induced by specific chemicals.

Immunomodulatory aspects: Compounds such as cordifolioside A and magnoflorine modulate cytokines production and boost immune cells. Administration of plant extracts in experimental animals resulted in increased footpad thickness and stimulation of white blood cells, making them ready to tackle threats such as *Candida* yeast. A successful trial showed the effectiveness of a plant lotion in reducing pro-inflammatory cytokines like IL-1, IL-6, IL-8, interleukins, helping with skin troubles from scabies.

Detoxifying potential: Various parts of the plant exhibit protective effects against nephrotoxicity induced by aflatoxins and demonstrate detoxifying activity against adverse effects associated with Parkinson's disease treatment in experimental models. They raise antioxidant elements in the kidneys to guard them.

Antimicrobial capabilities: *Tinospora cordifolia* (Guduchi) extracts have been evaluated against a wide range of bacterial strains, showing significant antimicrobial activity, particularly against pathogens associated with urinary tract infections. Silver bits from its stem tackled drug-resistant *Pseudomonas aeruginosa* strains effectively. Ethanol extract showed it stands tough against germs like *Enterococcus faecalis* and *Bacillus subtilis*, show casing great potential here.

Cyanthillium cinereum (Sahadevi)

*Cyanthillium cinereum (*Sahadevi*)* commonly known as little ironweed, purple fleabane (Poovankurunnal in Malayalam)] is a member of the Asteraceae family of medicinal plants. It is ubiquitous in tropical and subtropical regions, demonstrating various therapeutic activities and historically used in Ayurvedic, Siddha and folk medicine. The plant exhibits anti-inflammatory, anti-ulcer, antipyretic, antioxidant, anti-diabetic, hepatoprotective and anti-smoking activities (60).

Pharmacological properties

Anti-inflammatory and analgesic activities: These bioactive compounds, including flavonoids, tannins and phenolic acids, are largely responsible for the anti-inflammatory effects of the commonly studied *C. cinereum* (Sahadevi*)*. Experimental studies indicated that *C. cinereum* (Sahadevi) methanol and ethanol extracts significantly reduce inflammation and pain in rats in carrageenan-induced paw edema (61). It has an anti-inflammatory effect via inhibition of pro-inflammatory mediators like TNF-α, IL-6 and prostaglandins, which makes it functional against rheumatoid arthritis and other inflammatory disorders (62).

Antipyretic and anti-ulcer effects: In addition to its antipyretic activity, the plant exhibits significant anti-ulcer properties. It reduces body temperature in yeast-induced pyrexia, suggesting it has antipyretic potential (63). Gastroprotective activity of *C. cinereum* (Sahadevi) is also reported, reducing ulceration via increased mucus secretion and decreased output of gastric acid (64).

Antioxidant and hepatoprotective properties*:* Flavonoids and phenols found in *C. cinereum* (Sahadevi) exert their antioxidant activity by providing protection to cells against damage caused by ROS. The extract of the plant has been shown to increase the levels of antioxidant enzymes (SOD, CAT and glutathione peroxidase (GPx)) that reduce oxidative stress in hepatic tissues (65). The plant also exhibits hepatoprotective effects against liver injury by xenobiotics, such as carbon tetrachloride (CCl_4) and even toxicity induced by alcohol (66).

Anti-diabetic activity: *Cyanthillium cinereum* (Sahadevi) has been shown to have hypoglycemic properties and is helpful for type 2 diabetes mellitus. A study on diabetic animal models shows that the plant extract significantly reduces blood glucose levels with improvement of insulin sensitivity (67). The bioactive compounds are involved in regulating glucose metabolism and protecting pancreatic β-cells from oxidative damage.

Effects of anti-smoking and anti-addiction: Out of all the applications, one of the most common applications is that of anti-smoking therapy. As a traditional Thai medicine plant, it serves as a smoking cessation natural aid due to its ability to alleviate nicotine withdrawal symptoms (68). This extract is thought to alter dopaminergic pathways, decreasing cravings and dependence on nicotine.

Antimicrobial and antifungal activities: *Cyanthillium cinereum* (Sahadevi) shows antibacterial and antifungal activity. Its extracts have been identified to reduce the growth of *S. aureus*, *E. coli* and *Candida albicans*, suggesting its use in skin infections and wounds (69).

Discussion

Ayurvedic medicinal plants and their therapeutic applications are prominently described in traditional medicine but are also being progressively validated through modern scientific investigation. The article emphasizes the bioactive constituents and pharmacological actions of *W. somnifera* (Ashwagandha), *M. pruriens* (Kapikachu), *S. rhombifolia* (Atibala), *C. cinereum* (Sahadevi), *T. cordifolia* (Guduchi) and *G. glabra* (Yashtimadhu) as potential pharmacological agents in the alleviation of stress.

Effects of adaptogens and neuroprotection

Six medicinal plants discussed in this review, *W. somnifera* (Ashwagandha) and *M. pruriens* (Kapikachu), stand out due to their neuroprotective activity. *Withania somnifera* (Ashwagandha) is a well-defined adaptogen that influences the hypothalamic-pituitary-adrenal (HPA) axis, attenuating stress and improving cognition. It also shows neuroprotective effects in promoting nerve regeneration and reducing oxidative stress. *Mucuna pruriens* (Kapikachu), similarly, is extensively studied for its role in managing Parkinson's disease due to its high L-DOPA content, confirming its significant dopaminergic activity (70). Both plants possess these properties, which make them valuable for the treatment of neurodegenerative and psychiatric disorders.

Anti-inflammatory and immunomodulatory activities

Chronic inflammation is a key player in a plethora of diseases, such as autoimmune diseases, cardiovascular diseases and metabolic diseases. *Tinospora cordifolia* (Guduchi) and *S. rhombifolia* (Atibala) show strong anti-inflammatory and immunomodulatory effects. *Tinospora cordifolia* (Guduchi) boosts immune function by activating macrophages and cytokine production, hence it can be used in cases of infections and autoimmune disorders. *Sida rhombifolia* has anti-inflammatory, hepatoprotective and antimicrobial effects, making it beneficial for inflammatory disorders, etc.

Antioxidant and detoxifying

Oxidative stress is implicated in aging, cancer and chronic diseases. *Cyanthillium cinereum* (Sahadevi) and *W. somnifera* (Ashwagandha) have potent antioxidant action that protects the cells from oxidative damage. *Cyanthillium cinereum* (Sahadevi) has been especially studied with respect to its anti-cancer properties; bioactive compounds of *C. cinereum* (Sahadevi) inhibit tumor progression and induce apoptosis of cancer cells. The results provide a strong basis for the adoption of these plants in cancer prevention and as a complementary treatment modality.

Physiologic regulation of energy metabolism by endocrine and metabolic systems

The rising prevalence of metabolic disorders such as diabetes and obesity has increased interest in herbal interventions. Several studies have provided evidence for hypoglycemic and insulin sensitizing effects of *T. cordifolia* (Guduchi) and *G. glabra* (Yashtimadhu), which support their traditional use for diabetes (71, 72).

Another common herb, *G. glabra* (Yashtimadhu) has gastroprotective properties and a powerful action against ulcers, so it can be beneficial for conditions like acid reflux, gastritis and peptic ulcers.

Incorporation into present-day medicine

Although these plants have established therapeutic effects in Ayurveda, challenges remain regarding their scientific validation. Additional investigation is needed regarding standardization of active compounds in produced herbal extracts, bioavailability, clinical validation and potential interactions with pharmaceuticals. Clinical trials and pharmacokinetic studies will be critical to determine standardized dosages, safety profiles and mechanisms of action.

Future perspectives

These medicinal plants offer great potential for drug development and complementary therapy, with increasing interest in plant-based therapeutics. Hence, it has become essential to fill the gap between traditional knowledge and modern pharmacology, given the rising demand for natural, sustainable and holistic approaches to healthcare. It will be important to clinically validate, formulate and elucidate specific molecular pathways that facilitate the use of these plants as efficacious evidence-based medicines in the future.

Conclusion

The pharmacological properties of these Ayurvedic medicinal plants indicate potential applications in stress management, immune modulation, metabolic regulation, neuroprotection and anti-inflammatory therapies. Although considerable evidence supports traditional wisdom, scientific validation is essential to integrate these plants into modern medicine for therapeutic benefit. A synergistic approach that blends Ayurveda, pharmacology and clinical research will pave the path for their wider acceptance in global healthcare systems.

Authors' contributions

All participants have equal contributions. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

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