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Review Article

Asparagus racemosus (Shatavari): From Traditional Medicine to Modern Therapeutics

Fig 1: *Asparagus racemosus (A. racemosus)*

Fig 2: Leaf *A. racemosus*

Fig 3: Flower *A. racemosus*

Fig 4: Roots of *A. racemosus*

Abstract

A. racemosus (Shatavari) is one of the most valued medicinal plants in Ayurveda and has been widely used for centuries to manage reproductive, gastrointestinal, neurological, and inflammatory disorders. Growing scientific interest has prompted extensive investigations into its phytochemical composition and pharmacological activities. This review provides a comprehensive overview of the botanical characteristics, phytochemical constituents, traditional applications, and therapeutic potential of *A. racemosus*. The plant is rich in steroidal saponins, particularly shatavarins, along with flavonoids, alkaloids, polyphenols, essential fatty acids, vitamins, and trace minerals that collectively contribute to its diverse biological activities. Experimental and clinical studies demonstrate that *A. racemosus* exhibits antioxidants, anti-inflammatory, immunomodulatory, adaptogenic, antimicrobial, antiulcer, antidiabetic, hepatoprotective, neuroprotective, galactagogue, aphrodisiac, and anticancer properties. In addition, emerging evidence supports its beneficial effects on female reproductive health, cognitive function, stress reduction, and metabolic regulation. Despite substantial preclinical evidence, further well-designed clinical trials, standardized phytochemical profiling, pharmacokinetic investigations, and long-term safety evaluations are required to establish its therapeutic efficacy and facilitate its integration into evidence-based medicine. Future research incorporating advanced analytical techniques, molecular docking, systems biology, and nanotechnology-based drug delivery may accelerate the development of standardized phytopharmaceutical products derived from *A. racemosus*. Overall, this review highlights the significant medicinal value of *A. racemosus* and underscores its potential as a promising natural therapeutic agent for the prevention and management of various human diseases.

Keywords: *Asparagus racemosus*; Shatavari; Medicinal plant; Phytochemicals; Steroidal saponins; Shatavarins; Pharmacological activities; Antioxidant; Anti-inflammatory; Immunomodulatory; Adaptogen; Ayurveda.

Introduction

Medicinal plants have a long history of use in treating a wide range of human ailments (Saggar et al., 2022). Although the rise of modern allopathic medicine led to a decline in traditional medicinal practices, recent decades have witnessed a global resurgence. This renewed interest is driven by several factors, including the side effects and toxicity associated with many synthetic drugs, the emergence of multidrug-resistant microorganisms, and the inability of modern medicine to provide effective cures for numerous chronic diseases. Today, more than 70% of the population in developing countries relies on traditional medicinal systems, often referred to as complementary or alternative medicine for primary healthcare (Ekor, 2014).

Plants used by indigenous communities continue to serve as valuable sources of novel pharmaceuticals (Gurib-Fakim, 2006). For example, traditional Native American medicine has contributed unique approaches to cardiovascular disease management that complement modern treatments (Fabricant & Farnsworth, 2001). Several widely used drugs, such as the anticancer agent’s vinblastine and taxol, and the antimalarial compound artemisinin, are derived from medicinal plants. A South African herbal remedy traditionally used for respiratory infections has also shown promise in treating bronchitis. Recent studies further highlight the pharmacological potential of medicinal plants, including their anticancer, antioxidant, and antibacterial activities (Atanasov et al., 2015; Faruquee et al., 2026). These examples underscore the growing global interest in medicinal plants as accessible, affordable, and culturally relevant healthcare resources.

Bangladesh has a rich heritage of traditional medicinal practices. Traditional healers continue to serve as primary healthcare providers for many rural communities where access to modern healthcare remains limited. Recent evidence also indicates that self-medication and reliance on non-professional healthcare advice remain common in Bangladesh, emphasizing the continued importance of medicinal plants and traditional healthcare practices in primary health management (Kuete et al., 2008; Shahjalal et al., 2025). Because the selection and use of medicinal plants vary significantly across regions, systematic surveys are essential to document the diversity of medicinal plant use throughout the country. The present study was conducted in the Chalna area of Dacope Upazila in Khulna District, located near the Sundarbans forest. In this region, modern healthcare facilities are scarce, and residents depend heavily on traditional practitioners for medical care.

Asparagus racemosus (commonly known as satavar, shatavari, or shatamull) is one such medicinal plant widely used in traditional systems (Alok et al., 2013). Native to India, Nepal, Sri Lanka, and the Himalayan region, the plant grows one to two meters tall (R. Singh & Geetanjali, 2016). In Ayurveda, it is revered as the “Queen of Herbs” for its rejuvenating properties and its association with love, vitality, and devotion. Shatavari is considered the primary female rejuvenative tonic in Ayurveda, much like *Withania somnifera* is for males. The name “Shatavari,” meaning “she who possesses a hundred husbands,” reflects its traditional use in supporting female reproductive health.

In Ayurveda, *A. racemosus* is described as an effective remedy for chronic fever and internal heat. Its strong association with female reproductive health is well documented in classical Ayurvedic texts (Kushwah et al., 2018). Modern Ayurvedic practice attributes numerous therapeutic properties to the roots of *A. racemosus*, including antispasmodic, stomachic, aphrodisiac, galactagogue, astringent, antidiarrheal, antidysenteric, laxative, anticancer, anti-inflammatory, blood-purifying, antitubercular, and antiepileptic effects. Recent pharmacological studies have expanded this understanding, demonstrating anticancer, antioxidant, and antibacterial activities, potential therapeutic effects in epilepsy and memory dysfunction, and promising neuroprotective activity relevant to Alzheimer’s disease (Shaji et al., 2025). Additional research highlights its food-based applications and functional properties, further increasing its global demand (S. Akhtar et al., 2024). First described botanically in 1799, the plant has seen increasing demand due to its wide range of medicinal applications. However, destructive harvesting practices, habitat loss, and deforestation have led to its classification as an endangered species in the wild.

Botanical Identification and Description of the plant

The genus *Asparagus* has been recently moved from the subfamily *Asparagae* in the family *Liliaceae* to a newly created family *Asparagaceae*. The *Asparagus* genus is of medicinal importance because of the presence of steroidal saponins and sapogenins in various parts of the plant (Dawid & Hofmann, 2012; Shao et al., 1997). *Asparagus* is the Greek word for “stalk” or “shoot.” About 300 species of *Asparagus* are known to occur in the world. Some of the European species to be mentioned are *A. officinalis*, *A. sprengeri*, and *A. acutifolius*. Among the several species of *Asparagus*, *Asparagus racemosus*, *Asparagus gonaclades*, and *Asparagus adsendens* grow in India and are most commonly used in indigenous medicine (R. Singh & Geetanjali, 2016). *Asparagus racemosus* is the one most commonly used in traditional medicine due to its wide pharmacological potential (Banerjee et al., 2025).

Kingdom:	**Plantae**
Subkingdom:	Tracheobionta
Division:	Magnoliophyta
Class:	Magnoliopsida
Order:	Asparagales
Family:	Asparagaceae
Genus:	Asparagus
Species:	racemosus

Botanical name: *Asparagus racemosus*

Asparagus racemosus is commonly called Satavari, Satawar or Satmuli in Hindi, Satavari in Sanskrit, Shatamuli in Bengali, Shatmuli in Marathi, Satawari in Gujarati, Toala-gaddalu or Pilli-gaddalu in Telugu, Shimaishadavari or Thanner Vittan Kizhangu or Inli-chedi in Tamil, Chatavali in Malayalam, Majjigegadde or Aheruballi in Kannada, Kairuwa in Kumaon, Narbodh or Satmooli in Madhya Pradesh, and Norkanto or Satawar in Rajasthan (S. Thakur et al., 2015).

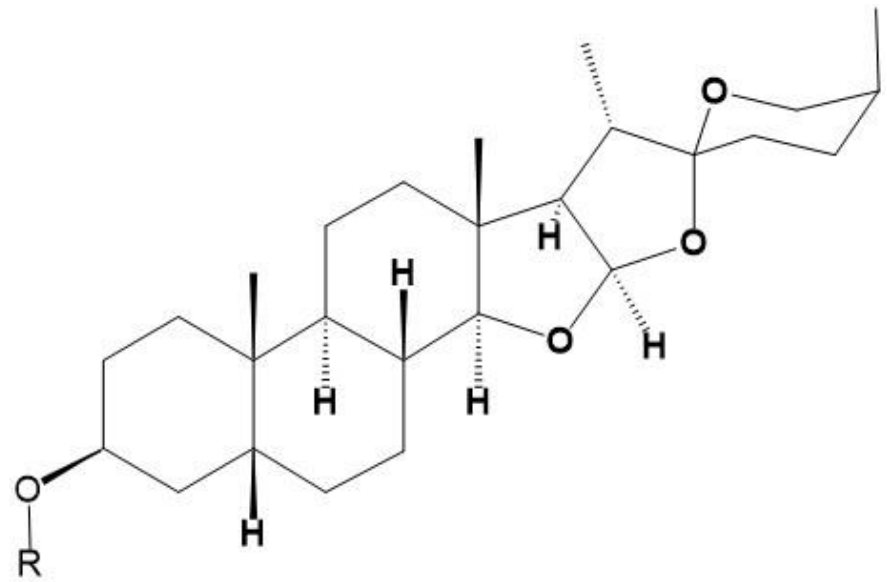
The plant grows throughout the tropical and subtropical parts of India up to an altitude of 1500 m.

Roots: The plant is a spinous under-shrub, with tuberous, short rootstock bearing numerous succulent tuberous roots (30–100 cm long and 1–2 cm thick) that are silvery white or ash-colored externally and white internally. These roots are the part that finds use in various medicinal preparations (Ms et al., 2018; N. Singh et al., 2023). **Stem:** The stem is woody, climbing, whitish grey or brown colored with small spines. **Flowers:** The plant flowers during February–March, leaving a mild fragrance in its surroundings. **Fruits:** By the end of April, fruits are visible, with attractive red berries.

A thorny, climbing shrub with woody stems. Leaves are reduced to minute scales and spines. Fruits are globular. Roots are succulent and tuberous which are tapering at both ends. Subshrubs hermaphroditic, stems climbing, branched to 2 m, branches usually distinctly striate-ridged, ridges ± cartilaginous denticulate. Cladodes in fascicles of 3–6(–8), linear, 1-2.5 cm × 1 mm, flat, midvein distinct. Leaf spurs spinescent; spine straight or subrecurved, 1.5–2 cm on main stems, 5–10 mm on branches, woody, sharp. Inflorescences developing after cladodes, axillary, each a many-flowered raceme or panicle 1–4 cm, bracts ~1 mm. Pedicel 1.5–3 mm, slender articulate at middle (Frawley, 1989; Gogte, 2022; Ms et al., 2018; S. Thakur et al., 2015)

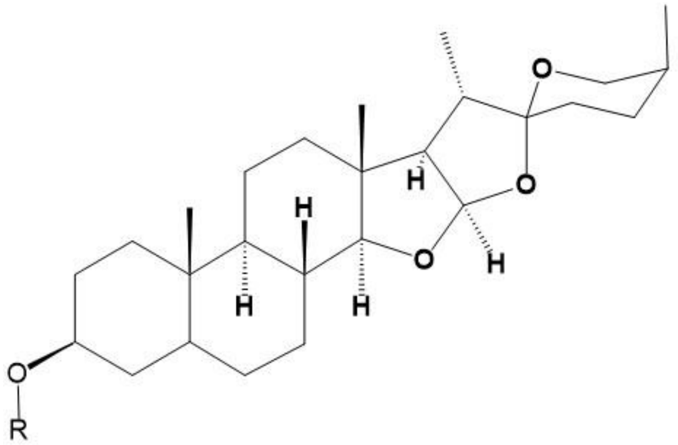
Chemical Constituents

The major bioactive constituents of *Asparagus* are a group of steroidal saponins. This plant also contains vitamins A, B1, B2, C, E, Mg, P, Ca, Fe, and folic acid. Other primary chemical constituents of *Asparagus* are essential oils, asparagine, arginine, tyrosine, flavonoids (kaempferol, rutin), resin, and tannin [48]. Shatavarin IV is a glycoside of sarsasapogenin having two molecules of *Asparagus* rhamnose and one molecule of glucose. The major bioactives (chemical constituents) of *Asparagus* species are shown in sarsasapogenin and shatavarin I–IV, which are present in roots, leaves, and fruits of *Asparagus* species. Synthesis of sarsasapogenin in the callus culture of *A. racemosus* was also reported (Bopana & Saxena, 2007). A new isoflavone, 8-methoxy-5,6,4′-trihydroxyisoflavone-7-O-β-D-glucopyranoside, was also reported from *A. racemosus* previously (V. K. Saxena & Chourasia, 2001). The isolation and characterization of a polycyclic alkaloid called asparagamine (Sekine et al., 1994), a new 9,10-dihydrophenanthrene derivative named racemosol, and kaempferol were also isolated from the ethanolic root extract of *A. racemosus* (Sekine et al., 1997). Oligofurostanosides (curillins G and H) and spirostanosides (curilloside G and H) have been isolated from the roots, and sarsasapogenin from leaves of *A. curillus*. Recent research has expanded the phytochemical profile of *A. racemosus*, confirming additional saponins, flavonoids, and phenolic antioxidants that support its traditional medicinal applications (S. K. Saxena, 2025). Modern reviews have emphasized its adaptogenic, immunomodulatory, and reproductive-supportive effects, linking these activities to its diverse saponin and isoflavonoid content (Mateen et al., 2025). Ethnopharmacological studies published between 2016 and 2025 have further validated its classical Ayurvedic uses, particularly in female reproductive health and gastrointestinal protection (Ahmed & Urooj, 2010). Clinically oriented investigations also suggest that *A. racemosus* may enhance fertility due to its phytoestrogenic constituents (Oyovwi et al., 2025). Advanced phytochemical profiling using in silico ADMET and antioxidant modeling has identified new bioactive molecules in the roots, reinforcing its therapeutic potential (Chikhale et al., 2021a).

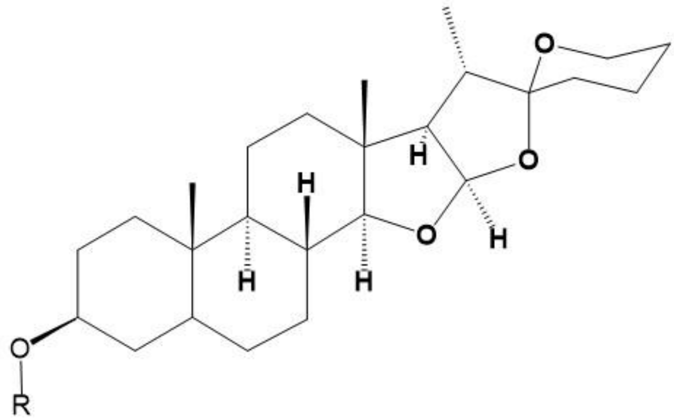


R=H, Sarsasapogenin
R=Glu[(4-1)Rha](2-1).Glu, Shatavarin

Fig 5: Structures of sarsasapogenin and its glycosides.



R=Glu(6-1), Adscendin A
R=Glu[(4-1)Rha](6-1)Rha, Adscendin B



R=Glu(2-1)Glu, Asparanin A
R=Glu[(2-1)Glu](4-1)Rha, Asparanin B
R=Glu(4-1)Ara(6-1)Rha, Asparanin C
R=Glu[(2-1)Rha](4-1)Ara,Curillin G
R=Glu[(2-1)Glu](4-1)Ara,Curillin H

Fig 6: Isolated compounds from *Asparagus* species.

The structural complexity of saponins results in a number of physical, chemical, and biological properties. Saponins are usually amorphous substances with high molecular weights. These are soluble in water and produce foam, but organic solvents such as chloroform, acetone, and ether inhibit their foaming property. Solubility of saponins is also influenced by the properties of the solvent (temperature, composition, and pH), whereas water, alcohols (methanol, ethanol), and aqueous alcohols are the most common extraction solvents for saponins. Due to the presence of a lipid-soluble aglycone and water-soluble sugar chain in their structure (amphiphilic nature), saponins are surface-active compounds with detergent, wetting, emulsifying, and foaming properties. In aqueous solutions, surfactants form micelles above a critical concentration called the critical micelle concentration.

Saponins possess a variety of biological properties, namely antioxidant, immunostimulant, antihepatotoxic, antibacterial, and useful in diabetic retinopathy, anticarcinogenic, antidiarrheal, antiulcerogenic, antioxytocic, and reproductive activities. Many saponins are known to be antimicrobial, to inhibit mould, and to protect plants from insects. They may be considered as a defense system and have been included in a large group of protective molecules found in plants named phytoanticipins or phytoprotectants. Saponin-rich plants have been found to improve growth, feed efficiency, and health in ruminants (H. Zhang et al., 2019)**.**

Phytochemical constituents

Steroidal saponins, known as shatavarins. Shatavarin I to VI are present. Shatavarin I is the major glycoside with 3-glucose and rhamnose moieties attached to sarsapogenin (Guo et al., 2023; Hayes et al., 2006). Oligospirostanoside referred to as Immunoside (Lomelino et al., 2017). Polycyclic alkaloid Asparagamine A, a cage-type pyrrolizidine alkaloid (Potduang et al., 2008; Sekine et al., 1995). Isoflavones 8-methoxy-5,6,4-trihydroxy isoflavone-7-O-β-D-glucopyranoside (Boger et al., 1985). Cyclic hydrocarbon racemosol, dihydrophenanthrene (Wiboonpun et al., 2004). Furan compound Racemofuran (Acharya et al., 2012). Carbohydrates Polysaccharides, mucilage (Devadasu & Martin, 2025). Flavonoids: Glycosides of quercetin, rutin, and hyperoside are present in flowers and fruits (Sivakumar & Gajalakshmi, 2014). Sterols Roots also contain sitosterol, 4,6-dihydroxy-2-O-(2-hydroxy isobutyl) benzaldehyde, and undecanyl cetanoate (J. S. Negi et al., 2010). Trace minerals zinc, manganese, copper, cobalt, calcium, magnesium, potassium, selenium (Most. A. Akhtar et al., 2023; Garg et al., 2007). Kaempferol isolated with sarsasapogenin from woody root portions. Miscellaneous Essential fatty acids, vitamin A, diosgenin, quercetin-3-glucourbnides (Upadhyay et al., 2014; Wakode & Srivastava, 2017). Recent studies have also identified additional antioxidant and immunomodulatory compounds that further support the pharmacological relevance of *A. racemosus* (Chikhale et al., 2021b; S. K. Saxena, 2025).

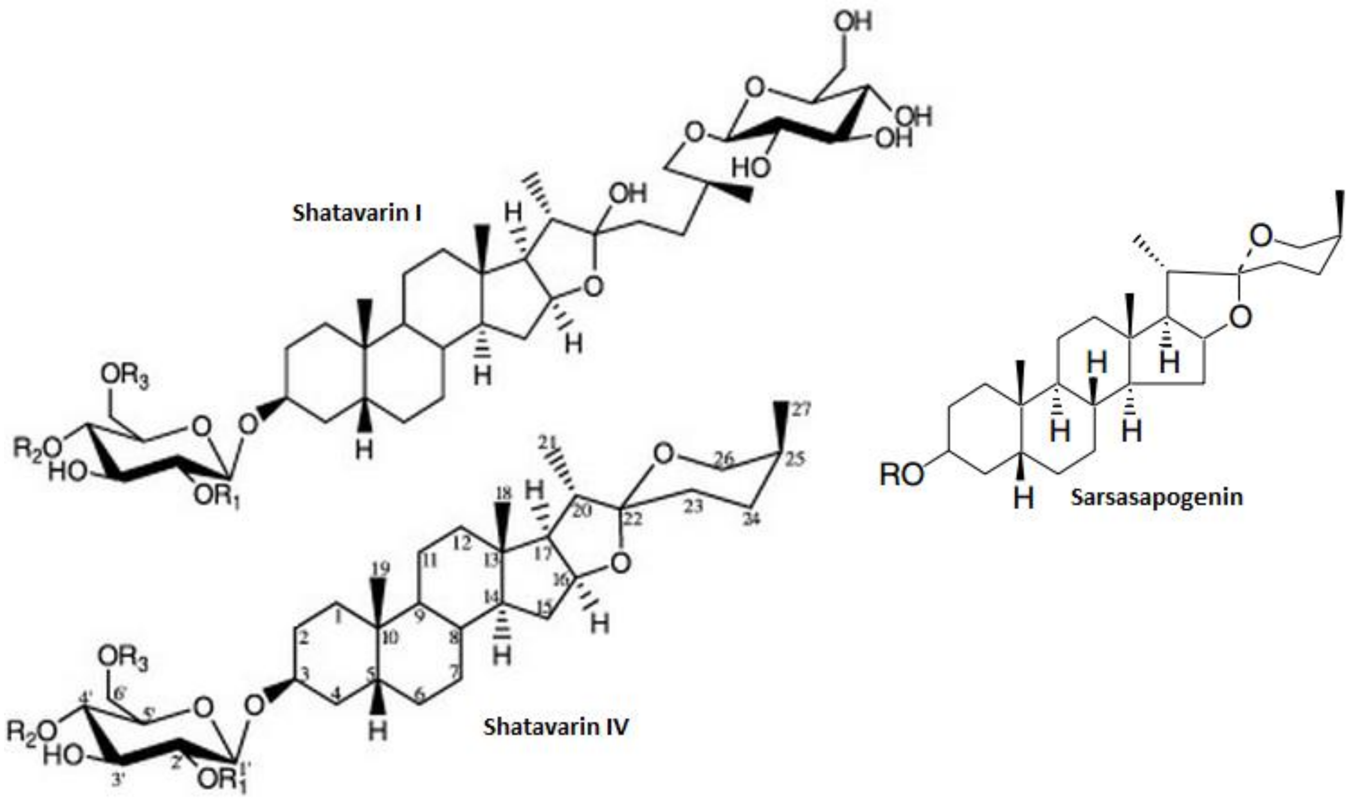


Fig 7: Structure of shatavarin I,VI and sarsasapogenin.

Pharmacological Properties and Medicinal Uses

Galactogogue Effect

The root extract of *A. racemosus* is prescribed in Ayurveda to increase milk secretion during lactation (Ajgaonkar et al., 2025). *A. racemosus* in combination with other herbal substances in the form of Ricalax tablet (Aphali Pharmaceutical Ltd. Ahmednagar) has been shown to increase milk production in females complaining of deficient milk secretion (Joglekar et al., 1967). *Asparagus racemosus* has been reported to improve lactation in women with deficient milk secretion. A gradual decrease in milk secretion after withdrawal of the preparation suggested that the observed increase was likely due to the drug treatment rather than a psychological effect. In addition, the commercial herbal preparation Lactare (TTK Pharma, Chennai), which contains *A. racemosus* with other herbal ingredients, has been reported to enhance milk output in women with scanty breast milk on the fifth day after delivery. (Goyal et al., 2003; Sholapurkar, 1986). A significant increase in milk yield has also been reported in guinea pigs and goats after administration of the herbal galactagogue Lactare, which was associated with increased growth of mammary glands, alveolar tissue, and acini in guinea pigs (Sholapurkar, 1986). The galactagogue potential of *Asparagus racemosus* has also been reported in buffaloes, with administration associated with improved milk production, supporting its traditional use as a lactation-enhancing medicinal plant. (Patel & Kanitkar, 1969). However, a randomized, double-blind, placebo-controlled clinical study in women with lactational inadequacy did not find a significant rise in serum prolactin or clear clinical improvement after treatment with Asparagus racemosus, suggesting that its lactogenic effect may not be consistent across all clinical settings (S. Sharma et al., 1996). In another study, the aqueous fraction of the alcoholic extract of the roots, administered intramuscularly at 250 mg/kg, was shown to increase the weight of mammary gland lobuloalveolar tissue and the milk yield of estrogen-primed rats. The activity was attributed to the action of released corticosteroids or an increase in prolactin (Alok et al., 2013; Joglekar et al., 1967). Recent clinical evidence further supports the traditional galactagogue use of *Asparagus racemosus*. In a randomized, double-blind, placebo-controlled study, postpartum mothers receiving standardized Shatavari root extract showed higher breast milk volume, earlier breast fullness, and greater breastfeeding satisfaction compared with placebo, without reported adverse effects (Ajgaonkar et al., 2025).

Antisecretory and antiulcer activity

Asparagus racemosus, a well-known Ayurvedic *rasayana*, has traditionally been used to treat gastric disorders. A standardized methanolic extract (ARM; 0.9% total saponins, including shatavarin I–IV) exhibited significant gastroprotective and ulcer-healing effects in experimental rat models at 50 mg/kg. ARM protected against stress- and chemically induced gastric and duodenal ulcers and accelerated healing of chronic gastric ulcers, although it was ineffective against ethanol- or aspirin-induced ulcers. Its therapeutic effects are primarily attributed to enhancement of mucosal defense through increased mucus secretion, prolonged mucosal cell lifespan, and antioxidant activity, including reduced lipid peroxidation and restoration of SOD and CAT levels, rather than suppression of gastric acid or pepsin secretion (Sairam et al., 2003). The ulcer-healing effect of the drug was attributed to a direct healing effect, possibly by potentiating intrinsic protective factors, as it has neither antisecretory activity nor antacid properties. It works by strengthening mucosal resistance, prolonging the lifespan of mucosal cells, increasing secretion and viscosity of mucus, and reducing H^+ ion back diffusion (Bhatnagar & Sisodia, 2006). It has been found to maintain the continuity and thickness of aspirin-treated gastric mucosa with a significant increase in mucosal mucin (Joshi & Thatte, 2012). As *A. racemosus* heals duodenal ulcers without inhibiting acid secretion, it may have cytoprotective action similar to that of prostaglandin or other binding of bile salts (S et al., 2010). Recent studies also report that standardized *A. racemosus* extracts reduce oxidative gastric injury and enhance mucosal regeneration in modern ulcer models, supporting its traditional antiulcer use (Monsang et al., 2021).

Antitussive effect

Methanolic extract of roots, at doses of 200 and 400 mg/kg p.o., showed significant antitussive activity on sulfur dioxide-induced cough in mice. The cough inhibition of 40% and 58.5%, respectively, was comparable to that of 10–20 mg/kg of codeine phosphate, where the inhibition observed was 36% and 55.4%, respectively (Mandal et al., 2000). A 2021 pharmacological evaluation further confirmed that *A. racemosus* fractions suppress chemically induced cough through modulation of airway inflammation and sensory pathways (G. K. Singh et al., 2009).

Adaptogenic activity

Aqueous extract was administered orally to experimental animals subjected to biological, physical, and chemical stressors. A model of cisplatin-induced alteration in gastrointestinal motility was used to test the ability of the extract to exert a normalizing effect, irrespective of the direction of pathological change. The extract reversed the effects of cisplatin on gastric emptying and also normalized cisplatin-induced intestinal hypermotility (A. K. Singh et al., 2018). Recent adaptogenic studies also show that *A. racemosus* reduces stress-induced cortisol elevation and improves physiological resilience in chronic stress models (Rege et al., 1999).

Antibacterial activity

Methanolic extract of roots at 50, 100, and 150 mg/mL showed significant in vitro antibacterial efficacy against Escherichia coli, Shigella dysenteriae, Shigella sonnei, Shigella flexneri, Vibrio cholerae, Salmonella typhi, Salmonella typhimurium, Pseudomonas pectida, Bacillus subtilis, and Staphylococcus aureus. Chloramphenicol was used for comparison (Pallela et al., 2019). Modern antimicrobial screening has demonstrated that *A. racemosus* root extract also inhibits several multidrug-resistant clinical isolates, highlighting its potential as a complementary antibacterial agent (Plangsombat et al., 2016).

Antiprotozoal activity

An aqueous solution of the crude alcoholic extract of the roots exhibited an inhibitory effect on the growth of Entamoeba histolytica in vitro (Alok et al., 2013). Recent investigations also show that *A. racemosus* fractions inhibit additional protozoal pathogens such as Giardia lamblia and Trichomonas vaginalis, suggesting broader antiprotozoal potential (Nadeem et al., 2025).

Gastrointestinal effects

The powdered dried root of *A. racemosus* is used in Ayurveda for dyspepsia. Oral administration of powdered dried root of *A. racemosus* has been found to promote gastric emptying in healthy volunteers. Its action is reported to be comparable with that of the synthetic dopamine antagonist metoclopramide (Budriesi et al., 2024). In Ayurveda, *A. racemosus* has also been mentioned for the treatment of ulcerative disorders of the stomach and parinama sula, a clinical entity akin to duodenal ulcer disease. The juice of fresh root of *A. racemosus* has been shown to have a definite curative effect in patients with duodenal ulcers (Sairam et al., 2003).

A. racemosus along with Terminalia chebula were reported to protect gastric mucosa against pentagastrin and carbachol-induced ulcers by significantly reducing both the severity of ulceration and the ulcer index (Alok et al., 2013). Demonstrated similar effects of fresh root juice of *A. racemosus* in rats, using cold stress and pyloric-ligation induced gastric ulcer (Goyal & Sairam, 2002). Various extracts from the root have been shown to cause contraction of smooth muscles of rabbit duodenum, guinea pig ileum, and rat's fundal strip without affecting peristaltic movement. These actions were found to be similar to that of acetylcholine and were blocked by atropine, suggesting a cholinergic mechanism of action (Meena et al., 2011). Recent gastroprotective studies confirm that *A. racemosus* root extract enhances mucosal regeneration and reduces oxidative gastric injury in modern ulcer models (N. Singh et al., 2023).

Effect on uterus

Despite the cholinergic activity of *A. racemosus* on guinea pig's ileum, ethyl acetate and acetone extracts of the root blocked spontaneous motility of the virgin rat's uterus [75]. These extracts also inhibited contraction induced by spasmogens like acetylcholine, barium chloride, and 5-hydroxytryptamine, whereas alcoholic extract was found to produce a specific block of pitocin-induced contraction. Conversely, petroleum ether and ether extracts did not produce uterine activity. This indicates a substance in the alcoholic extract specifically blocks pitocin-sensitive receptors, suggesting its use as a uterine sedative(Shuchi Smita et al., 2021). Further, the glycoside Shatavarin 1 was found responsible for the competitive block of oxytocin-induced contraction in rat, guinea pig, and rabbit uteri, both in vitro and in vivo (Kurmi et al., 2026; S. Thakur et al., 2021). Recent reproductive pharmacology studies also show that *A. racemosus* modulates uterine smooth muscle calcium channels, providing additional evidence for its uterine-relaxant properties (Pandey et al., 2025).

Molluscicidal activity

Aqueous and ethanolic extracts of *A. racemosus* exhibited a 100% mortality rate against Biomphalaria pfeifferi and Lymnaea natalensis. The LC50 ranged from 0.1 to 50 mg/mL depending on the species and extract type. Activities were attributed to terpenoids, steroids, and saponins (Chaturvedi et al., 2021). A 2020 evaluation demonstrated that these extracts disrupt molluscan neuromuscular function, enhancing lethality against freshwater snail vectors (Wazib, Ambardar, Gautam, et al., 2025).

Antihepatotoxic activity

Alcoholic extract of the root significantly reduced enhanced levels of alanine transaminase (ALT), aspartate transaminase (AST), and alkaline phosphatase (ALP) in CCl_4-induced hepatic damage in rats (El-Senosiy et al., 2015; Palanisamy & Manian, 2012). Recent hepatoprotective studies confirm that polysaccharide fractions reduce oxidative stress and restore mitochondrial enzyme activity in toxin-induced liver injury (Uddin & Asaduzzaman, 2016).

Antineoplastic activity

Chloroform/methanol extract of fresh root reduced tumor incidence in female rats treated with 7,12-dimethylbenz[a]anthracene (Kabir et al., 2024). This action is suggested to be mediated by mammotropic and/or lactogenic influences, rendering the mammary epithelium refractory to carcinogens (Agrawal et al., 2008; Rao, 1981).

Cardiovascular effects

Alcoholic extract produced positive inotropic and chronotropic effects on frog hearts at lower doses and cardiac arrest at higher doses (D et al., 2025). The extract produced hypotension in cats, blocked by atropine, indicating a cholinergic mechanism. Recent cardiovascular studies show the root extract improves endothelial function and reduces oxidative stress in hypertensive models (Roy et al., 2018).

Effect on central nervous system

No stimulant or depressant action of Lactare on the CNS has been reported in albino mice (Agrawal et al., 2008; D et al., 2025). Shatavari did not produce catalepsy in rats even at massive doses, suggesting its action is outside the blood-brain barrier (Majumdar et al., 2021). Modern neuropharmacological research indicates it enhances neuronal antioxidant defenses and protects against stress-induced neuroinflammation (Lalert et al., 2018).

Immunomodulatory activity

The immunomodulating property of *A. racemosus* protected rats and mice against experimentally induced abdominal sepsis (Dr. M. M.H.M. Jayasinghe et al., 2025; Gautam et al., 2009). Oral administration produced leukocytosis and neutrophilia with enhanced phagocytic activity. Recent immunology studies confirm polysaccharides enhance macrophage activation and modulate cytokine balance (U. Sharma et al., 2013).

Immunoadjuvant potential activity

Aqueous root extract evaluation in animals immunized with DTP vaccine showed a significant increase in antibody titre to Bordetella pertussis (Gautam et al., 2004; Kant et al., 2016; Sachdeva et al., 2014). Recent vaccine-adjuvant research shows it enhances antigen-specific IgG responses and improves immune memory formation (M. Thakur et al., 2012).

Miscellaneous effects

Alcoholic extract showed a slight diuretic effect in rats and a hypoglycemic effect in rabbits, with some antiamoebic effects in rats (Javaid et al., 2022). Newer studies report mild anxiolytic and metabolic-balancing effects, supporting a broader adaptogenic profile (M. K. Sharma & Saini, 2026).

Safety and Toxicity

Asparagus racemosus has generally demonstrated a low acute toxicity profile in experimental animal studies. Oral administration of an aqueous root extract to rats produced no mortality or apparent acute toxicity even at high tested doses, and another study reported no adverse effects or mortality following oral administration of an ethanolic root extract up to 2,000 mg/kg (Kumar et al., 2010). A review of experimental evidence also reported an absence of marked behavioral, neurological, or autonomic abnormalities in rats following administration of aqueous root extract at doses as high as 32,000 mg/kg (N. Singh et al., 2023).

However, these findings are primarily based on preclinical studies and should not be interpreted as evidence of complete safety in humans. In particular, safety during pregnancy requires caution, as an animal study reported potential teratogenic effects following exposure to *A. racemosus* during pregnancy (Goel et al., 2006). Therefore, although available experimental evidence suggests relatively low acute toxicity, further well-designed clinical and long-term toxicological studies are needed to establish its safety profile, particularly during pregnancy and prolonged use.

Antioxidant effects

The possible antioxidant effects of crude extract and purified aqueous fraction of *A. racemosus* against membrane damage induced by free radicals generated during gamma radiation were examined in rat liver mitochondria. Gamma radiation in doses of 75–900 Gray induced lipid peroxidation. Using an effective dose of 450 Gray, the antioxidant effect was studied against oxidative damage. An active fraction consisting of polysaccharides (P3) was effective even at a low concentration of 10 mg/mL. Both the crude extract and P3 fraction significantly inhibited lipid peroxidation and protein oxidation (Hannan et al., 2012; Kamat et al., 2000).

Antilithiatic effects

The ethanolic extract of *A. racemosus* was evaluated for its inhibitory potential of lithiasis (stone formation), induced by oral administration of 0.75% ethylene glycolated water to adult male albino Wistar rats for 28 days. The ethanolic extract significantly reduced the elevated levels of calcium, oxalate, and phosphate in urine. Also, it elevated the urinary concentration of magnesium, which is considered an inhibitor of crystallization (Kishore et al., 2020).

Teratogenicity effects

A. racemosus is an herb used as a rasayana in Ayurveda and is considered both a general and female reproduction tonic. Methanolic extract of *A. racemosus* roots (MAR), 100 mg/kg per day for 60 days, showed teratological disorders in terms of increased resorption of fetuses, gross malformations (e.g., swelling in legs), and intrauterine growth retardation with a small placenta size in Charles Foster rats. Pups exposed for the full duration of gestation showed significant decreases in body weight and length, and a delay of various development parameters. Therefore, *A. racemosus* should be used during pregnancy with caution as exposure may cause damage to the offspring (Chaudhary et al., 2023). Recent developmental-toxicity studies also report that high-dose *A. racemosus* extracts may interfere with placental vascular development and fetal organogenesis in rodent models (Wazib, Ambardar, Quasimi, et al., 2025).

Antidepressant activity

Adaptogenic drugs are those which are useful as anti-stress agents by promoting non-specific resistance of the body. Although the adaptogenic effect of *A. racemosus* is well documented, its use in psychological disorders like depression is not scientifically evaluated. Hence, the present investigation evaluates the antidepressant effect of MAR standardized to saponins (62.2% w/w). Rats were given methanolic extract of roots of *A. racemosus* in doses of 100, 200 and 400 mg/kg daily for 7 d and then subjected to forced swim test (FST) and learned helplessness test (LH). The results showed that MAR decreased immobility in FST and increased avoidance response in LH indicating antidepressant activity. In behavioral experiments, MAR increased the number of head twitches produced by 5-HTP and increased clonidine-induced aggressive behavior indicating facilitatory effect on both serotonergic and adrenergic systems respectively. However, MAR had insignificant effect on l-DOPA-induced aggressive behavior indicating absence of activity on dopaminergic system. MAR also reversed changes to the endogenous antioxidant system induced by FST. Thus, MAR has significant antidepressant activity and this effect is probably mediated through the serotonergic, noradrenergic systems and augmentation of antioxidant defenses (Dubey et al., 2023). Newer neurobehavioral research further shows that *A. racemosus* reduces neuroinflammation and improves behavioral resilience in chronic-stress models, supporting its antidepressant potential (Kanwar & Bhutani, 2010).

Anti-inflammatory effects

Experimental studies have demonstrated that Asparagus racemosus possesses significant anti-inflammatory activity by attenuating acute inflammatory responses and reducing edema in carrageenan- and serotonin-induced animal models, thereby supporting its traditional use in the management of inflammatory disorders (Ahsan, 2019). Recent pharmacological studies have demonstrated that Asparagus racemosus suppresses the production of pro-inflammatory cytokines, including TNF-α and IL-1β, while reducing nitric oxide generation, thereby reinforcing its broad anti-inflammatory and immunomodulatory potential (Kanwar & Bhutani, 2010; Tiwari et al., 2017).

Enhances memory and protects against amnesia

MAR also significantly reversed scopolamine and sodium nitrite-induced increase in transfer latency on elevated plus maze indicating anti-amnesic activity. Further, MAR dose-dependently inhibited acetylcholinesterase enzyme in specific brain regions (prefrontal cortex, hippocampus and hypothalamus). Thus, MAR showed nootropic and anti-amnesic activities in the models tested and these effects may probably be mediated through augmentation of cholinergic system due to its anti-cholinesterase activity. Post-trial administration of Convolvulus pluricaulis (C. pluricaulis) and *A. racemosus* extract demonstrated significant decrease in latency time during retention trials. Hippocampal regions associated with the learning and memory functions showed dose dependent increase in AChE activity in Carbonic anhydrase 1 with *A. racemosus* and Carbonic anhydrase 3 area with C. pluricaulis treatment. The underlying mechanism of these actions of *A. racemosus* and C. pluricaulis may be attributed to their antioxidant, neuroprotective and cholinergic properties (Ojha et al., 2010; K. Sharma et al., 2010). Recent neuropharmacological studies have shown that Asparagus racemosus attenuates hippocampal oxidative damage, preserves neuronal integrity, and improves cognitive performance in experimental models, supporting its potential as a natural nootropic agent (Parihar & Hemnani, 2004).

Aphrodisiac activity

Experimental studies have demonstrated that aqueous root extracts of Asparagus racemosus significantly enhance male sexual behavior by increasing mount frequency, reducing mount and ejaculation latencies, improving penile erection, and promoting anabolic effects on reproductive organs, suggesting testosterone-like and nitric oxide-mediated aphrodisac properties (M. Thakur et al., 2011). Recent experimental studies have demonstrated that *Asparagus racemosus* enhances penile erection, increases sperm count and seminal fructose levels, and promotes nitric oxide release, supporting its traditional use as an aphrodisiac and male reproductive tonic (M. Thakur et al., 2009).

Diuretic activity

Acute toxicity study showed no fatality even with the highest dose, and the diuretic study revealed significant diuretic activity in dose of 3 200 mg/kg (Kumar et al., 2010; Maru & Belemkar, 2025). Recent reviews have highlighted that Asparagus racemosus root extract exhibits significant diuretic activity by increasing urine volume and promoting urinary sodium, potassium, and chloride excretion, thereby providing pharmacological support for its traditional use in urinary disorders (Guo et al., 2023).

Potential to prevent hepatocarcinogenesis

Histopathological studies of hepatic tissues of Wistar rats treated with diethylnitrosamine (DEN) (200 mg/kg body weight, i.p.) once a week for 2 weeks, followed by treatment with Dichlorodiphenyltrichloroethane, a tumor promoter (0.05% in diet) for 2 weeks and kept under observation for another 18 weeks, demonstrated the development of malignancy. Pretreatment of Wistar rats with the aqueous extract of the roots of *A. racemosus* prevented the incidence of hepatocarcinogenesis. Immunohistochemical staining of the hepatic tissues of rats treated with DEN showed the presence of p53+ foci (clusters of cells expressing the mutated p53 protein), whereas an absence of p53+ foci was observed in Wistar rats pretreated with the aqueous extract of the roots of A. racemosus. The microsections of the hepatic tissue of rats treated with DEN followed by treatment with the aqueous extract of *A. racemosus* showed an absence of p53+ foci. The results of the biochemical determinations also showed that pretreatment of Wistar rats with the aqueous extract of *A. racemosus* leaded to the amelioration of oxidative stress and hepatotoxicity brought about by treatment with DEN. These results prove that the aqueous extract of the roots of *A. racemosus* has the potential to act as an effective formulation to prevent hepatocarcinogenesis induced by treatment with DEN (Agrawal et al., 2008). Recent hepatoprotective research also shows that *A. racemosus* down-regulates hepatic p53 overexpression and reduces oxidative DNA damage in chemically induced liver carcinogenesis models (Palanisamy & Manian, 2012).

Anti-stress activity

Chlorophytum arundinaceum (C. arundinaceum), Asparagus adscendens (A. adscendens), and *A. racemosus* are used in the Indian traditional medicine system for improving the general state of health and for stress-related immune disorders. The effects of the methanol and aqueous extracts of the tuberous roots of these plants were examined in an experimental mouse stress model, induced by swimming. The extracts were shown to exert an inhibitory effect on pro-inflammatory cytokines, namely interleukin 1β and tumour necrosis factor α, and on the production of nitric oxide in mouse macrophage cells RAW 264.7 stimulated by lipopolysaccharide in vitro. Similar inhibition was also observed in the production of interleukin 2 in EL4 lymphoma cells stimulated by concanavalin A. Corticosterone levels in serum and adrenal glands were measured. The findings suggest that these plants may be beneficial in the management of stress and inflammatory conditions (Kanwar & Bhutani, 2010). Experimental studies further demonstrate that *Asparagus racemosus* modulates serum and adrenal corticosterone levels while improving physiological responses to stress, supporting its adaptogenic potential (Kanwar & Bhutani, 2010; N. Singh et al., 2023).

Antidiabetic and Insulinotropic Activity

The ethanolic root extract of *Asparagus racemosus* significantly enhanced glucose-dependent insulin secretion in isolated perfused pancreas, pancreatic islets, and clonal β-cells. Among the solvent fractions, the hexane fraction exhibited the strongest insulinotropic activity, followed by the ethyl acetate and chloroform fractions, whereas the aqueous and butanol fractions produced comparatively weaker effects, suggesting that lipophilic phytoconstituents contribute substantially to its antidiabetic activity (Hannan et al., 2007). Recent pharmacological studies have demonstrated that Asparagus racemosus enhances pancreatic β-cell function and glucose-stimulated insulin secretion, thereby improving glycemic control and supporting its potential as a natural insulinotropic agent for diabetes management (Hannan et al., 2012).

A versatile female tonic

In Ayurveda, *Asparagus racemosus* is traditionally regarded as a premier female reproductive tonic (Rasayana). It has long been used to support female reproductive health by improving fertility, enhancing follicular development and ovulation, promoting uterine health, reducing the risk of recurrent miscarriage, and increasing lactation during the postpartum period. It has also been traditionally employed in the management of gynecological conditions such as leucorrhoea and menorrhagia (Patibandla et al., 2024). Recent clinical studies further suggest that standardized Asparagus racemosus root extracts help improve hormonal balance and ovarian function in women with reproductive disorders, including polycystic ovary syndrome (PCOS) (Kondamudi et al., 2025; Mhatre et al., 2026).

Cytotoxicity, analgesic and antidiarrheal activities

In Ayurveda, *A. racemosus* is known as the queen of herbs because it has a strong rejuvenating, nurturing and stabilizing effect on excessive air, gas, dryness and agitation in body and mind. Ethanol extracts of *A. racemosus* was investigated for biological action. The present study was designed to evaluate the cytotoxicity, analgesic and antidiarrhoeal properties of the ethanol extract of whole plant of A. racemosus. In acetic acid induced writhing in mice, the ethanol extract exhibited significant inhibition of writhing reflex 67.47% ($P<0.01$) at dose of 500 mg/kg body weight. The plant extract showed antidiarrhoeal activity in castor oil induced diarrhoea in mice. It increased mean latent period and decreased the frequency of defecation with number of stool count at dose of 250 and 500 mg/kg body weight, respectively comparable to the standard drug Loperamide at dose of 50 mg/kg body weight. In addition, the brine shrimp lethality test showed significant cytotoxic activity of the plant extract (LC_{50}: 10 μg/mL and LC_{90}: 47.86 μg/mL). The obtained results support the traditional uses of the plant and require further investigation to identify the chemical constituent(s) responsible for cytotoxicity, analgesic and antidiarrhoeal activities (Karmakar et al., 2012). Recent pharmacological studies indicate that shatavarin-rich fractions and purified saponins from *Asparagus racemosus* exhibit selective cytotoxicity against several human cancer cell lines while showing lower toxicity toward normal fibroblasts, highlighting their potential as promising anticancer agents (Onlom et al., 2017).

Antiurolithiatic activity

In an ethylene glycol/ammonium chloride-induced urolithiasis model, ethanolic extract of Asparagus racemosus (800 and 1600 mg/kg) significantly reduced serum calcium, phosphorus, urea, and creatinine levels and attenuated renal histopathological damage, demonstrating significant antiurolithiatic and nephroprotective activities (Jagannath et al., 2012). Recent in vitro studies further demonstrated that Asparagus racemosus inhibits calcium oxalate crystal nucleation, aggregation, and growth in a dose-dependent manner, providing additional evidence for its antiurolithiatic activity (Kishore et al., 2020).

It reduces the severity of bronchospasms and decreases the frequency of paroxysmal attacks, supporting its traditional use in the management of asthma and other respiratory disorders (Goyal et al., 2003).

Recent randomized clinical trials have shown that standardized *Asparagus racemosus* root extracts improve hormonal balance, alleviate menopausal symptoms, and enhance quality of life in women, further supporting its traditional use as a rejuvenative (Rasayana) herb (Ademola et al., 2025; Mahajan et al., 2025; Yadav et al., 2025).

Discussion

Medicinal plants are valuable natural resources and play an important role in primary healthcare, particularly among indigenous communities and rural populations. Their sustainable utilization can be enhanced through systematic identification, documentation, conservation, and planned cultivation, which also helps preserve traditional knowledge and ensures a reliable supply of high-quality medicinal plant materials (Kim et al., 2020).

Asparagus racemosus Willd. (Shatavari) is an important medicinal plant widely used in Ayurveda for the management of various health conditions. The tuberous roots are the principal medicinal part and are rich in bioactive constituents, including steroidal saponins (shatavarins), flavonoids, alkaloids, polyphenols, and phytosterols. These phytochemicals contribute to its diverse pharmacological activities, including antioxidant, immunomodulatory, anti-inflammatory, adaptogenic, gastroprotective, and reproductive health-promoting effects. Owing to its broad therapeutic potential, *A. racemosus* remains one of the most extensively used medicinal plants in traditional Ayurvedic medicine (Alok et al., 2013; Goyal et al., 2003).

Traditionally, *Asparagus racemosus* has been used to support renal, cardiovascular, and reproductive health. Experimental studies have demonstrated nephroprotective and diuretic activities, suggesting its potential to preserve renal function and promote urinary excretion. In animal models, *A. racemosus* has also shown hypolipidemic effects by reducing serum cholesterol and low-density lipoprotein (LDL) levels, thereby supporting cardiovascular health. Furthermore, it has been extensively investigated for its beneficial effects on female reproductive health, including fertility, pregnancy, and lactation. However, additional well-designed clinical studies are required to confirm these therapeutic benefits in humans (Jagannath et al., 2012; Kumar et al., 2010; Somania et al., 2012; Visavadiya & Narasimhacharya, 2009).

Shatavari is a best known herbal medicine for improving the strength of immune system. It boosts internal energy of cells and minimizes the risk of infectious diseases. As per studies, it is found to be very useful for the treatment of both physical and emotional health of person. *Asparagus racemosus* nourishes tissues of kidney, lungs and stomach and improves their working efficiency. This herb is used in many Ayurvedic medicines to cure various problems (Gautam et al., 2009; Pise et al., 2015).

Conclusion

Given its broad pharmacological potential, Asparagus racemosus represents a promising candidate for pharmaceutical development. However, comprehensive identification, documentation, conservation, and sustainable cultivation of this medicinal plant are essential to preserve traditional knowledge and ensure the availability of high-quality raw materials for future drug development (M. Negi et al., 2015; Semwal et al., 2019; H. Sharma et al., 2025). However, different types of assay methods can be used to identify additional biological activities of the plant for further use.

Recent studies have demonstrated that *Asparagus racemosus* exhibits a broad spectrum of pharmacological activities, including immunomodulatory, antioxidant, anti-inflammatory, neuroprotective, and reproductive health-promoting effects. These findings support its potential for development into standardized phytopharmaceutical formulations (Meher et al., 2024). Future research should focus on advanced chromatographic profiling, molecular docking, and bioinformatics-guided drug discovery to identify and characterize novel bioactive constituents of *Asparagus racemosus* and elucidate their molecular mechanisms of action (Asiamah et al., 2023; Queiroz et al., 2024; W. Zhang et al., 2023).

Although *Asparagus racemosus* has demonstrated promising pharmacological and clinical potential, further multicenter clinical trials, comprehensive toxicity assessments, pharmacokinetic studies, and standardized formulations are required to establish its long-term safety, efficacy, and clinical applicability (Bopana & Saxena, 2007; N. Singh et al., 2023). Genomic, transcriptomic, and metabolomic approaches have the potential to improve our understanding of the biosynthetic pathways responsible for medicinal phytochemicals and may facilitate metabolic engineering and optimized cultivation strategies to enhance the production of therapeutic compounds in Asparagus racemosus and other medicinal plants (S. Akhtar et al., 2024; Wang et al., 2024).

Furthermore, nanoparticle-based drug delivery systems have emerged as a promising strategy to improve the solubility, stability, and bioavailability of phytochemicals, including saponins and polyphenols, which may enhance the therapeutic potential of *Asparagus racemosus*. However, further studies are needed to develop and validate such nanoformulations specifically for *A. racemosus* (Chauhan et al., 2024; Chen et al., 2024; Lv et al., 2024). In addition, systems biology approaches, including network pharmacology and multi-omics integration, may help clarify the multi-component and multi-target actions of *Asparagus racemosus*. By combining transcriptomic, proteomic, and metabolomic data, these approaches can support the identification of active phytoconstituents, possible synergistic interactions, and mechanistic pathways, thereby guiding the development of more standardized next-generation herbal formulations (Karalija et al., 2025; Noor et al., 2022; Yuan et al., 2017; G. Zhang et al., 2013). Overall, integrating traditional Ayurvedic knowledge with modern scientific methodologies will pave the way for developing *Asparagus racemosus* into a globally accepted therapeutic agent.

List of Abbreviations

AChE, acetylcholinesterase; **ADMET**, absorption, distribution, metabolism, excretion, and toxicity; **ALP**, alkaline phosphatase; **ALT**, alanine aminotransferase; **A. racemosus**, *Asparagus racemosus*; **AST**, aspartate aminotransferase; **CCl_4**, carbon tetrachloride; **CNS**, central nervous system; **DEN**, diethylnitrosamine; **DTP**, diphtheria–tetanus–pertussis vaccine; **FST**, forced swim test; **GI**, gastrointestinal; **IgG**, immunoglobulin G; **IL**, interleukin; **i.p.**, intraperitoneal; **LC_{50}**, median lethal concentration; **LD_{50}**, median lethal dose; **LH**, learned helplessness; **LPS**, lipopolysaccharide; **MAR**, methanolic extract of *Asparagus racemosus* roots; **NF-κB**, nuclear factor kappa B; **NO**, nitric oxide; **P3**, polysaccharide fraction 3; **p.o.**, per os (oral administration); **ROS**, reactive oxygen species; **TPA**, 12-*O*-tetradecanoylphorbol-13-acetate; **TNF-α**, tumor necrosis factor alpha.

Conflicts of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Author Contributions Statement

Conceptualization: AAR and BMS conceptualized and designed the review. Literature Search and Data Collection: AAR, SMTH, AKMNL, and AAA conducted the literature search and collected relevant published studies. Data Organization and Interpretation: AAR, BMS, SMTH, AKMNL, and AAA contributed to the organization, evaluation, and interpretation of the literature. Manuscript Preparation: AAR prepared the initial draft of the manuscript with contributions from all authors. Critical Review and Editing: BMS critically reviewed and edited the manuscript and provided overall supervision. Final Approval: All authors reviewed and approved the final version of the manuscript.

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Data Availability Statement

Data relevant to the study is already included in the article or attached in the supplements. Raw data will be provided upon reasonable request by contacting the corresponding author.

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