Journal of Applied Pharmaceutical Research
Volume 12 Issue 4, Year of Publication 2024, Page 11 – 20
DOI: https://doi.org/10.69857/joapr.v12i4.588

Check for updates

Review Article

JOURNAL OF APPLIED PHARMACEUTICAL RESEARCH | JOAPR
www.japtronline.com ***ISSN: 2348 – 0335***

AN UPDATE ON PHYTOCONSTITUENTS AND PHARMACOLOGICAL IMPORTANCE OF ASPARAGUS RACEMOSUS

Deepak Meher[1]*, Mithilesh Singh[2], Bibekananda Meher[3]

Article Information
Received: 19th June 2024
Revised: 17th July 2024
Accepted: 30th July 2024
Published: 31st August 2024

Keywords
Shatavarins, antioxidant, immunomodulation, neuroprotective

ABSTRACT
Background: *Asparagus racemosus* (family: Liliaceae) is a well-researched traditional or ancient medicine in the Siddha, Ayurveda, and Unani systems. It is commonly known as Satawar, Satamuli, or Satavari and is found at low altitudes throughout India. It contains bioactive metabolites (substances that can be found in nature and can be beneficial to organisms) such as fructooligosaccharides, polysaccharides, asparosides, shatavarins, sapogenins, racemosols, isoflavones, glycosides, mucilage, and fatty acids, while saponin is one of the main active constituents of *Asparagus racemosus*. **Objective**: Across the globe, *Asparagus racemosus* gained importance for its ethano-pharmacological value in curing various ailments. This review will outline the medicinal properties, uses, and value addition of *Asparagus racemosus*. **Methods:** We have reviewed and retrieved the relevant information by probing the main keywords in online databases (PubMed, Scopus, Science Direct and Web of Science, *etc.*). Screening of relevant abstracts/titles and full papers was done to pick the suitable content based on the pharmacological profile of *Asparagus racemosus*. **Conclusion:** The whole plant possesses pleiotropic therapeutic activity (producing more than one effect), like antioxidant, anti-inflammatory, immunomodulatory, neuroprotective, nootropic, antidepressant, etc., without showing any remarkable side effects. It also treats stomach ulcers, diabetes, kidney disorders, Alzheimer's disease, etc.

INTRODUCTION

According to estimates from the World Health Organisation, 80% of people in low-income nations who cannot afford pharmaceutical medicines depend on traditional medicines, mainly plant-based remedies, to meet their basic medical requirements [1]. Among the nations with the most incredible diversity in medicine and culture is India, where medicinal plants are part of a long-standing custom still valued today. The primary traditional medical systems practiced here are Ayurveda, Unani, and Siddha [2]. It was observed that the public interest in the use of natural products in developed and developing countries has increased in the last few decades. These natural therapies/ remedies are readily available in the market (food stores, drug stores, and supermarkets) [3]. People are increasingly more concerned about their health and way of life. They are aware of the negative consequences associated

[1]*Department of Pharmaceutical Sciences, NIMS University, Jaipur, Rajasthan, India*
[2]*Department of Pharmaceutical Chemistry, NIMS Institute of Pharmacy, Nims University, Jaipur, Rajasthan, India*
[3]*RITEE College of Pharmacy, Raipur, Chhattisgarh, India*

For Correspondence: **dkmeher6@gmail.com**

with allopathic medicines. Using natural plant-based products that have fewer adverse effects on health has become increasingly popular over time [4]. *Asparagus racemosus* is a well-researched traditional or ancient medicine in the Siddha, Ayurveda, and Unani systems. Across the globe, *Asparagus racemosus* gained importance for its ethano-pharmacological value in curing various ailments/diseases [5]. Shatavari is another common name for *Asparagus racemosus* (Family-Asparagaceae). Indian and British Pharmacopoeias have already released information on their biological properties. There are over 300 species of asparagus in the genus Asparagus worldwide. Due to the presence of steroidal saponins and sapogenins in different plant sections, the genus is considered significant medicinally [2]. *Asparagus racemosus* is mainly known for its phytoestrogen properties. Its phytochemical constituents were reported to gain importance in hormone replacement therapy. Plant extract obtained from *Asparagus racemosus* also showed neuroprotective outcomes and was helpful in conditions like alcohol-mediated withdrawal symptoms [2]. *Asparagus racemosus* roots are bitter, sweet, oleaginous, cooling, and indigestible appetizer. They are helpful in Ayurveda for treating ailments like ulcers, inflammation, hepatic problems, bleeding, jaundice, tonic, and certain infectious conditions. Its hydro-alcoholic extracts also possess antihepatotoxic and immunomodulatory effects [6]. The Unani system uses roots as laxatives, tonics, aphrodisiacs, galactagogues, and kidney and liver-associated diseases [7].

Biodiversity and Botanical description of *Asparagus racemosus*

Morphology

The Greek word "shoot" or "stalk" is where the term "asparagus" originates. Asparagus species are perennial herbaceous, climbing shrubs with tuberous roots that belong to the family-Asparagaceae. About 300 types of asparagus are grown almost anywhere globally, primarily in arid climates [8]. Amongst all the varieties, *Asparagus racemosus*, popularly known as "Shatavari (meaning “curer of a hundred diseases)" is the most widely utilized traditional herbal remedy [6]. Some plant parts are given in ***Figure 1.***

Habitat/ Distribution

Asparagus racemosus is mainly found in tropical and subtropical regions of the Himalayas in India, Nepal, Sri Lanka, Australia, and Africa [6]. The districts of Nepal that produce the most *Asparagus racemosus* include Kavre, Bhaktapur, Lalitpur, Kathmandu, Dhading, Morang, Sunsari, and Kaski. The ideal pH range for the plants is between 6.0 and 7.0. They prefer well-drained, wet, sandy loam conditions and are sensitive to the densest clays [9].

Plants **Flowers** **Roots**

Figure 1: Botanical description (morphology) of *Asparagus racemosus*

Cultivation

It can grow about 1– 2 meters tall, and cultivation is feasible at 400–1450 m altitude, with an annual rainfall of 250 cm and a temperature range of 10–45°C [8]. From June through October, grouped, fragrant, and white florets appear. On the other hand, fruiting begins in October, and mature fruits are globose red berries with three to six seeds [10].

Taxonomy of *Asparagus racemosus*

Kingdom: Plantae
Clade: Angiosperms
Clade: Monocots
Order: Asparagales
Family: Asparagaceae
Subfamily: Asparagoideae
Genus: Asparagus
Species: Asparagus racemos

Phytochemicals of *Asparagus racemosus*

Asparagus racemosus phytochemicals screening in various solvents (methanol, ethanol, hydro-alcoholic) reported the presence of flavonoids (quercetin, and rutin, etc.), tannins, terpenes, and alkaloids [10]. A class of steroidal saponins (phytoestrogen-like) is the main bioactive component of *Asparagus racemosus*. Essential oils, asparagine (alkaloid), arginine, tyrosine, vitamins (A, B, C, E), and resin are some of the other bioactive constituents of *Asparagus racemosus* [7]. The harvest season, the type of fertilizer used, altitude, the amount of net shadow, and accessions all affect the plant's

biochemical production [8]. Compared to roots obtained during the wet seasons, those collected in the summer have a higher yield of shatavarin IV [11]. Sarsasapogenin and shatavarin I-IV are present in the roots, leaves, and fruits of Asparagus species. Sarsasapogenin also documented in the callus of *Asparagus racemosus* [12]. Other antioxidant compounds reported from the *Asparagus racemosus* root extracts include racemofuran and asparagamine A [8].

Table 1: Others Common Names of *Asparagus racemosus*

Vernacular names	
Hindi	Satavar, shatavir, satawari
Sanskrit	Abhiru, shatavari, hiranyasringi
English	Asparagus, wild asparagus
Assamese	Satmuli, shatmul, satomul
Bengali	Satamuli, satamul
Kannada	Aheruballi, ashadhi, halarru-makkal
Malayalam	Chathavalli, sathavali, satavali, thalicheria, thaliperiya etc.
Telugu	Challagadda, ethavaludutige, challa-gaddalu
Manipuri	Nunggarei
Marathi	Asvel, satavari-mul
Oriya	Vari
Urdu	Satawar, shaqaqul misri

Phytochemicals of *Asparagus racemosus*

Asparagus racemosus phytochemicals screening in various solvents (methanol, ethanol, hydro-alcoholic) reported the presence of flavonoids (quercetin, and rutin, etc.), tannins, terpenes, and alkaloids [10]. A class of steroidal saponins (phytoestrogen-like) is the main bioactive component of *Asparagus racemosus*. Essential oils, asparagine (alkaloid), arginine, tyrosine, vitamins (A, B, C, E), and resin are some of the other bioactive constituents of *Asparagus racemosus* [7]. The harvest season, the type of fertilizer used, altitude, the amount of net shadow, and accessions all affect the plant's biochemical production [8]. Compared to roots obtained during the wet seasons, those collected in the summer have a higher yield of shatavarin IV [11]. Sarsasapogenin and shatavarin I-IV are present in the roots, leaves, and fruits of Asparagus species. Sarsasapogenin also documented in the callus of *Asparagus racemosus* [12]. Other antioxidant compounds reported from the *Asparagus racemosus* root extracts include racemofuran and asparagamine A [8].

Table 2: Phytoconstituents of *Asparagus racemosus*

Part	**Phytoconstituents**	**Ref.**
Fruits	Rutin, Racemoside A, B, and C, Quercetin, Sarsasapogenin, the aglycone of Racemosides A	[13, 14]
Leaves	Diosgenin, vanillin, asparagusic acid, and methyl esters	[11]
Flower	Diosgenin, quercetin-3-glucuronide, rutin (2.5% dry basis) and hyperoside	[13]
Roots	Rutin, Asparagamine A, Quercetin, Racemofuron, ncoumertans, Shatavarin V. Shatavarin I, II, III, IV (steroid glycosides), diosgenin, Racemosol, sarsasapogenin, saponins, 4- trihydro isoflavine, Sterols, Alkaloid, shatavarol, racemofuran, Tannins, carbohydrates, Flavonoids, isoflavones, Lactones, Amino acids and rutin	[8]

Medicinal Importance of *Asparagus racemosus* associated plant parts

It has *Asparagus racemosus* extract have been reported to possess antioxidant activity, anti-abortifacient activity, antioxytoxic, spasmodic to uterus, hypoglycemic, hypertensive activity, anticoagulant activity, antiviral activity, anticancer. Studies have reported that sarsasapogenin and shatavarol in *Asparagus racemosus* possess neuroprotective properties in Alzheimer's, anxiolytic, and other neurodegenerative disorders. The plant extracts also contain the antioxidant compounds racemofuran and asparagine A, which offer neuroprotection through free radical scavenging [15]. Table 3 also includes some other parts of Asparagus racemosus with their medicinal importance.

DISCUSSION

Pharmacological activities of *Asparagus racemosus*

***Asparagus racemosus*: Anti-epileptic capacity**

Epilepsy is a serious and complex neurological condition, typified by short bursts of convulsions, unconsciousness, and/or distinctive motor motions due to discrepancies in the cerebral circulation of excitatory (glutamatergic) and inhibitory (GABAergic) neurotransmitters [21]. It's a significant cause of mortality and disability that impacts people of all ages, races, and geographical locations. This medical condition affects about 10 million individuals in India [22]. Currently, GABA mimetics

and sodium and calcium channel blockers are used to treat epilepsy. Additionally, the medication above has significant adverse effects when used repeatedly over an extended period, necessitating ongoing plasma drug concentration monitoring [8].

Table 3: Medicinal Importance of *Asparagus racemosus* associated Plant parts

Part	Medicinal value	Ref.
Roots	anti-inflammatory, Antiallergic, immunomodulator, anti-ulcer, hypoglycemic effects, Galactagogue, prevent diabetic nephropathy, antibacterial, reduced neuronal degeneration I brain disorders such as depression, anxiety, and epilepsy, etc.	[16-19]
Leaves	Cholinesterase, Antiparasitic	[13]
Shoots	Anti-inflammatory activity, hypoglycemic and diuretic.	[20]
Whole Plant	Antimicrobial & Cytotoxic, Nephroprotective, Hepatoprotective	[19]
Aerial Parts	Urolithiasis, Hypolipidemic, Antiasthmatic, and Antifertility	[13]
Seeds & Flower	Antiparasitic, Diuretic	[13]

This fosters the development of novel medications with fewer side effects that may be taken for extended periods. Consequently, research has been conducted on using the medicinal plants and herbal remedies specified in the Indian medical system to treat epilepsy [21]. Flavonoids in *Asparagus racemosus* and their effects on monoamines (NA, DA, and 5-HT) make it a viable nutraceutical for use as an anti-epileptic. *Asparagus racemosus* extract was reported to significantly reverse the alterations of monoamines due to pentylenetetrazol (PTZ) administration in rodents [23]. The earlier research on *Asparagus racemosus* reported decreased excitatory neurotransmitters in the brain, which was involved in epilepsy [10, 24]. According to research, the ethanolic root extract (500 mg/kg, p.o.) of *Asparagus racemosus significantly declined* the hind leg extensions in the mouse maximal electroshock-MES model, suggesting that it possessed anticonvulsant properties in comparison to the methanolic extract [25]. In comparable studies, the MES rodent model's back leg extension and stupor period diminished by the methanol, chloroform, and aqueous extracts of *Asparagus racemosus* roots [19]. Asparagus racemosus roots are used as traditional medicine for controlling epilepsy [26]. The beneficial action of Asparagus racemosus root extract (400, 800 mg/kg, p.o.) was also reported against depression and memory impairment brought on by PTZ-induced kindling [26]. Even so, the impact of *Asparagus racemosus* in these modalities has not been highlighted in the therapeutic and preclinical findings that are currently accessible. Therefore, more investigation is needed to identify the active ingredients and clarify the processes behind this plant's anticonvulsant action.

Neuroprotective potential in Alzheimer's

Traditionally, *Asparagus racemosus* has been employed in Ayurvedic preparations to improve cognitive ability in nervous disorders like Alzheimer's and Parkinson's [27, 28]. Cognitive decline and dementia are major public health challenges. Alzheimer's disease (AD) is an age-related neurological ailment that includes progressive cognitive deterioration with significant personal and social consequences [29, 30]. The buildup of insoluble extracellular β-amyloid (Aβ) material and hyper-phosphorylated and oxidized internal fibrillar clumps of tau peptide is the pathological hallmark of AD [31]. Aβ oligomers and Aβ plaques are two more significant, hazardous compounds formed when the Aβ aggregates. This is the primary cause of neuronal apoptosis and dementia through disrupting intercellular calcium signaling in the brain [31, 32]. *Asparagus racemosus* extract (aqueous) was reported to have many therapeutic qualities, which include a nootropic effect in traditional Ayurvedic literature [18]. Sarsasapogenin, a constituent of Asparagus racemosus, was demonstrated to obstruct key enzymes (acetylcholinesterase-AChE) involved in the pathogenesis of AD. It also exhibited anti-amyloidogenic, anti-oxidant, and neuroprotective effects in AD [18]. Nuro-nutraceuticals derived from Asparagus racemosus extract may be a neuroprotectant by postponing neuronal deterioration and treating associated clinical symptoms.

Adaptogenic potential of *Asparagus racemosus*

According to medical professionals, stress is a potentially deadly mental disorder that may strike anyone at any time of life and has severe, long-lasting symptoms [33]. The most frequent pathological reason for sadness is a change in monoamine (5-HT), dopamine-DA), and norepinephrine-NE) levels and malfunction of the hypothalamic-pituitary-adrenal (HPA) axis [34]. In depressive individuals, the disrupted HPA axis results in

an elevated amount of corticotropin-releasing hormone [35]. Tricyclic antidepressants, selective serotonin reuptake inhibitors (SSRIs), and monoamine oxidase inhibitors (MAOIs) [36] are included in the treatment plan, yet they come with several adverse effects. Given the information above, it is necessary to investigate safer treatment approaches with the fewest possible adverse effects. Adaptogens are stress-response adjusters with medicinal properties that preserve brain health by acting as neuroprotectants [37]. One of the well-researched plant adaptogens used in traditional medicine like Siddha, Ayurveda, and Unani is *A. racemosus* [38]. *A. racemosus* plant extract is well known to have adaptogenic potential by controlling the stress-induced alterations in 5-HT, DA, & NA neurotransmitters [39]. Additionally, the study revealed that *A. racemosus* extracts reduced the rise in tribulin (stress markers) brought on by stress [14]. Elevated lipid peroxidation and a rise in oxidative free radicals have also been linked to chronic depression. A study team has shown that *A. racemosus* provide benefits for depression through its anti-oxidant properties (raising SOD and catalase levels) and decreased lipid peroxidase activity [40].

Anti-ulcer potential of *Asparagus racemosus*

Gastrointestinal diseases are severe and common problems that cause maximum discomfort, morbidity, and mobility in human beings. It occurs in 10-15% of the population at a time [41]. Peptic ulcer is a common gastrointestinal disorder characterized by gastric and duodenal mucosal lesions, bleeding, ulcers, etc. [42]. An ulcer in the stomach is known as a gastric ulcer, while an ulcer in the first part of the intestine is also known as a duodenal ulcer [41]. Ancient Indian scriptures mention using the Ayurvedic rasayana asparagus racemosus to cure stomach ulcers [40]. *A. racemosus* has been reported to possess antisecretory and antiulcer properties against stomach ulcers in rats caused by pyloric ligation and indomethacin. *A. racemosus* methanolic extract (100 mg/kg BW/day p.o.) was reported to significantly decrease the ulcer index (UI) volume of gastric secretion, free acidity, and total acidity, which may be by enhancing antioxidant defense mechanism [43]. A very similar report also suggests that Asparagus racemosus (methanolic extract: 25-100 mg/kg p.o) of fresh root displayed protection against acute stomach ulcers (induced by cold restraint stress, pyloric structure, and duodenal ulcers provoked by cysteamine [40]. *A. racemosus* cures duodenal ulcers without preventing acid secretion and may have cytoprotective properties similar to prostaglandin or other bile salt binding [40, 44].

Cytotoxic potential of *Asparagus racemosus*

Cancer is the second largest killer in the world. Despite significant advancements in detection and treatment, cancer remains the most common cause of death and spread. The plant *Asparagus racemosus* has been used in traditional medicine to treat various conditions, including cancer, hematological dyscrasias, and Lymphoma [45]. Asparagus's primary class of secondary metabolites are called saponins. A. racemosus extract is tested against several malignant cell lines [13]. The primary steroidal glucosides (saponins), namely shatavarins-IV, were extracted from *Asparagus racemosus* roots, which were reported to inhibit dimethylbenzanthracene-induced carcinogenesis in rats [46]. It has been observed that a fresh *Asparagus racemosus* root extract in a 1:1 methanol/chloroform ratio lowers the occurrence of tumors in female rats [47]. Previous findings suggest that the anticancer effects may be due to increased antioxidant activity caused by Asparagus racemosus roots [45]. Much evidence has proven the anti-neoplastic ability of root extracts against colon, breast, hepatic, and lung cancer [46].

Cardioprotective potential of *Asparagus racemosus*

One of the most feared adverse effects of anticancer drugs, such as doxorubicin, is cardiotoxicity. *Asparagus racemosus* ethanolic extract has been demonstrated in several research to have cardioprotective effects. *Asparagus racemosus* aqueous extract can protect against the cardiotoxic effects of doxorubicin [48]. Traditionally, the hypolipidemic, anti-inflammatory, and antioxidant qualities of asparagus racemosus help to prevent atherogenesis and other cardiovascular problems [49]. Root powder (5% and 10% levels) *Asparagus racemosus* possesses anti-hyperlipidemic/hypercholesteremia impact by decreasing bad cholesterol, enhancing boosts antioxidant activity, and increasing bile acid synthesis due to the presence of phytosterol, ascorbic acid, flavonoids, saponins, and polyphenols [10].

***Asparagus racemosus:* Antioxidant and hepatoprotective**

In Ayurvedic preparations, *A. racemosus* is traditionally used to protect against hepatic dysfunctions [44]. Hydro-alcoholic extract of *A. racemosus* roots and its various constituents were reported to exert antioxidant properties by enhancing the activity of many enzymes, viz. superoxide dismutase (SOD), reduced glutathione, and catalase. The root extract of *A. racemosus* offers hepatoprotection in CCl_4-mediated hepatotoxicity in rats via raising glutamate oxaloacetate transaminase, glutamate pyruvate transaminase, alkaline phosphatase, and serum oxidant enzymes

[50]. In rats, hepatoprotective effects of *A. racemosus* were also reported against paracetamol-induced hepatotoxicity [51]. In a different investigation, male albino rats were used to test *A. racemosus* hepatoprotective potential against isoniazid-induced hepatotoxicity. The change in serum enzyme concentration suggests that isoniazid produced a considerable amount of liver toxicity. Rats' body weight and the levels of several different enzymes, including aspartate aminotransferase, g-glutamyl transferase, alanine aminotransferase, alkaline phosphatase, albumin, total protein, and hepatic malondialdehyde content, were examined to determine the hepatoprotective activity of *A. racemosus*. The hepatoprotective potential of *A. racemosus* extract was due to free radical inhibition and the induction of antioxidant enzymes [52].

Table 4: Phytoconstituents obtained from *Asparagus racemosus* with their therapeutic value

Plant Part	Extract	Phytoconstituents	Pharmacological value	Ref.
Root	Extract	Racemofuran, racemosol asparagamine A	Antioxidant and neuroprotective via declining free radicals' generation.	[62]
Root	alcoholic extract	Saponins, flavonoids	Galactogogue effect: increases milk secretion during lactation and increase prolactin release	[44]
Root	alcoholic extract	Flavonoids	Inhibits Eintamoeba histolytica	[63]
Plant	Hydro-alcoholic extract	Saponins, asparagamine	Increased antioxidant effects (enhanced GSH level and reduced lipid peroxidation) by declining free radicle production in rat liver.	[13]
Root (*A. racemosus* extract)	alcoholic extract	Racemofuran, asparagamine A, racemosol	Prevented isoniazid-induced hepatotoxicity by attenuated oxidative stress	[64]
Root	Methanolic Extract	Saponins	Antifungal activity against all the Candida strains, and anti-inflammatory activity,	[65]
Root, plant	Aqueous and ethanolic extract	Oligosaccharides	Exert immunomodulatory effect via potentiating humoral as well as cellular immunity.	[57]
Plant	*Asparagus racemosus* ethanolic extract	phytosterol, ascorbic acid, flavonoids, saponins	Provide cardioprotection and anti-hyperlipidemic effects by decreasing bad cholesterol and enhancing and boosting antioxidant activity.	[49]
Plant and root	Methanolic	Saponins, shatavarins	Plant extracts can treat colon, breast, hepatic, and lung cancer.	[47]
Leaves	Ethanol, & chloroform extracts	Steroidal saponin	Antimicrobial property	[66, 67]

Antidiabetic potential of *Asparagus racemosus*

Diabetes mellitus (DM) is a complex metabolic disorder and the leading cause of hospitalization and disability that places a significant financial burden on businesses globally [53]. It is characterized by hyperglycemia or an increased glucose level in the blood plasma. In type 2 diabetes mellitus, α-glucosidase and α-amylase inhibitors are utilized to manage hyperglycemia better [16]. There have been several reports of traditional Indian herbs being used to treat diabetes, but very few of them have undergone scientific and medical assessment to determine their effectiveness. *Asparagus racemosus* has been used traditionally for diabetes management [54]. *Asparagus racemosus* leaf extracts exhibit hypoglycemic or antidiabetic potential through declining the activity of α-amylase and α-glucosidase, which might be the presence of high concentrations of flavonoids and triterpenoids in their extract [16]. It has previously been documented that constituents of *Asparagus racemosus* root extracts have shown a stimulatory impact on the physiological insulinotropic cascade, which may decline blood sugar levels in rats and rabbits [54].

Antidiarrhoeal potential of *Asparagus racemosus*

With an estimated 2.2 million deaths from diarrhea worldwide, mostly in poor nations, diarrhea might be considered one of the most significant issues faced by these nations. The majority of

the fatal cases occur in youngsters under the age of five [2]. In Ayurveda, A. racemosus root is historically used to cure dysentery and diarrhea. Its ethanolic and aqueous extracts exhibit antidiarrhoeal effects against several experimental models of diarrhea in rats [55].

Immunomodulatory potential of *Asparagus racemosus*

Indian traditional medicine uses asparagus racemosus to treat immunological abnormalities brought on by stress as well as general health issues [56]. In Ayurveda, the roots of *Asparagus racemosus* are frequently used as a rasayana to stimulate immune responses [57]. Multiple studies have documented the immunomodulatory properties of *Asparagus racemosus* root extract. It is said to increase neutrophil and lymphocyte numbers [58]. Additionally, in experimental animals, it delays the formation of tumors and modifies macrophage activation. The level of CD_3(+) and CD_4/CD_8(+) is significantly increased by the aqueous extract of the roots of Asparagus racemosus (100 mg/kg; p.o.), suggesting that the extract affects T cell activation [57]. Animal studies confirm that the steroidal saponins (shatavaroside A and shatavaroside B) found in Asparagus racemosus are essential for producing immunomodulatory effects [56]. It has been demonstrated that *Asparagus racemosus* immunomodulating ability shields rats and mice contrary to experimentally produced gut septic [59].

Anti-inflammatory potential of *Asparagus racemosus*

The body uses inflammation as its primary defense mechanism to fend off infections, allergies, poisonous chemicals, and other hazards. The uncontrollable inflammation process gives rise to chronic diseases under various pathophysiological conditions. Inflammation is a defensive reaction to eliminate harmful substances like poisonous chemicals or microorganisms [60]. In animal studies, an aqueous methanolic extract of the root of Asparagus racemosus lessened pain and inflammation. Paw edema in rodents was significantly decreased when the aqueous methanolic extract (250 and 500 mg/kg; p.o) was used. The extract also dramatically reduced the writhing and paw licking caused by formalin and acetic acid in pain models [61].

CONCLUSION

People are concerned about their lifestyle and health. They are conscious of the drawbacks of using allopathic medications. Adopting ecological products from plants has grown in popularity since they are less harmful to health. Phytochemical constituents of *Asparagus racemosus* gained popularity for the treatment of various ailments. The whole plant possesses pleiotropic (more than one) therapeutic activity, antioxidant, anti-inflammatory, immunomodulatory, neuroprotective, nootropic, antidiarrhoeal, antidepressant, antiulcer, antidiabetic, etc., without showing any remarkable side effects. Many investigations have been carried out on various components of A. racemosus; the pharmaceutical industry has developed this plant as a medication. Plant identification, cataloging, and documenting involve a thorough and systematic investigation that could significantly advance traditional knowledge about medicinal herbs.

Strengths and limitations of the study

This is a review paper on the benefits of *Asparagus racemosus* as an adjunct therapy for various illnesses. Citations from research employing this Ayurvedic plant have been included to provide a detailed explanation of the pharmacological effects displayed by this plant. Most Ayurvedic practitioners could use this plant in their pharmaceutical regimens to treat patients with various ailments, and it is an excellent source of literature reviews for researchers planning to conduct studies in this area. This manuscript is a review paper; hence, it does not involve any lab experiments. However, the author referenced studies conducted in this area, introducing readers to the most current analytical method for this plant's pharmacological potential.

FINANCIAL ASSISTANCE

NIL

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTION

Deepak Meher, Mithlesh Singh, and Bibekananda Meher contributed to the idea and design, data collection, analysis, and interpretation of the findings. All the authors also made substantial contributions to drafting and reviewing the article.

REFERENCES

[1] Ekor M. The growing use of herbal medicines: issues relating to adverse reactions and challenges in monitoring safety. *Frontiers in pharmacology,* **4**, 66193 (2014).

[2] Bopana N, Saxena S. Asparagus racemosus-Ethnopharmacological evaluation and conservation needs. *Journal of Ethnopharmacology*, **110**, 1-5 (2007).

[3] Anquez-Traxler C. The legal and regulatory framework of herbal medicinal products in the European Union: a focus on the traditional herbal medicines category. *Drug Information Journal*, **45**, 15–23 (2011).

[4] Islam Z, Islam SM, Hossen F, Mahtab-ul-Islam K, Hasan MR, Karim R. Moringa oleifera is a prominent source of nutrients with potential health benefits. *International Journal of Food Science*, **1**, 6627265 (2021).

[5] Pandey AK, Gupta A, Tiwari M, Prasad S, Pandey AN, Yadav PK, Sharma A, Sahu K, Asrafuzzaman S, Vengayil DT, Shrivastav TG. Impact of stress on female reproductive health disorders: Possible beneficial effects of shatavari (*Asparagus racemosus*). *Biomedicine & Pharmacotherapy*, **103**, 46-9 (2018).

[6] Chaudhary D, Giri S, Lamichhane G. Concise review on Asparagus racemosus and its role as nutraceuticals and functional foods. *Herbs, Spices and their Roles in Nutraceuticals and Functional Foods*, 245-55 (2023).

[7] Negi JS, Singh P, Joshi GP, Rawat MS, Bisht VK. Chemical constituents of Asparagus. *Pharmacognosy Reviews*, **4(8**), 215 (2010).

[8] Majumdar S, Gupta S, Prajapati SK, Krishnamurthy S. Neuro-nutraceutical potential of Asparagus racemosus: A review. *Neurochemistry international*, **145**, 105013 (2021).

[9] Thapa S, Rawal S, Bist S. Highlighting the nutritional and medicinal value of Asparagus along with its cultivation practices. *Matrix Science Pharma*, **4(1**), 18-21 (2020).

[10] Singh N, Garg M, Prajapati P, Singh PK, Chopra R, Kumari A, Mittal A. Adaptogenic property of Asparagus racemosus: Future trends and prospects. *Heliyon*, **9(14)**, (2023).

[11] Saran PL, Singh S, Solanki VH, Kalariya KA, Meena RP, Patel RB. Impact of shade-net intensities on root yield and quality of Asparagus racemosus: A viable option as an intercrop. *Industrial Crops and Products*, **141**, 111740 (2019).

[12] Kar DK. Sarsasapagenin in callus culture of Asparagus racemosus. *Current science (Bangalore)*, **54**, 12 (1985).

[13] Singh L, Choudhary A, Singh G. Asparagus racemosus: The plant with immense medicinal potential. *Journal of Pharmacognosy and Phytochemistry*, **7(3),** 2199-203 (2018).

[14] Bhattacharya SK, Bhattacharya A, Chakrabarti A. Adaptogenic activity of Siotone, a polyherbal formulation of Ayurvedic rasayanas. *Ind J Exp Biol*, **38**, 119-28 (2000).

[15] Bagchi P, Anuradha M, Kar A. Ayur-Informatics: establishing an Ayurvedic medication for Parkinson's disorder. *Int J Adv Chem Eng Biol Sci*, **4**, 21-5 (2017).

[16] Vadivelan R, Krishnan RG, Kannan R. Antidiabetic potential of Asparagus racemosus Willd leaf extracts through inhibition of α-amylase and α-glucosidase. *Journal of traditional and complementary medicine*, **9(1)**, 1-4 (2019).

[17] Bhatnagar M, Meena P, Barbar S, Joshi C. Neuroprotective response of the hippocampus region of the brain to Withania somnifera and Asparagus racemosus root extract: An in vitro study. *J Med Plants Res*, **7(13)**, 2259-64 (2013).

[18] Kashyap P, Muthusamy K, Niranjan M, Trikha S, Kumar S. Sarsasapogenin: A steroidal saponin from Asparagus racemosus as multi target directed ligand in Alzheimer's disease. *Steroids*, **153,** 108529 (2020).

[19] Amberkar MV, Christopher R, Chandrashekar BR, Pradeepa HD, Kumari KM. An experimental evaluation of anticonvulsant activity of Asparagus racemosus. *International Journal of Pharmaceutical Sciences Review and Research*, **11(1)**, 64-8 (2011).

[20] Sachan AK, Das DR, Dohare SL, Shuaib M. Asparagus racemosus (Shatavari): an overview. *Int J Pharm Chem Sci*, **1(3)**, 588-92 (2012).

[21] Dhar A, Maurya SK, Mishra A, Singh GK, Singh MK, Seth A. Preliminary screening of a classical ayurvedic formulation for anticonvulsant activity. *Ancient science of life*, **36(1)**, 28 (2016).

[22] Santhosh NS, Sinha S, Satishchandra P. Epilepsy: indian perspective. *Annals of Indian Academy of Neurology*, **7**, S3 (2014).

[23] Anovadiya AP, Sanmukhani JJ, Tripathi CB. Epilepsy: Novel therapeutic targets. *Journal of Pharmacology and Pharmacotherapeutics*, **3(2),** 112-7 (2012).

[24] Singh GK, Garabadu D, Muruganandam AV, Joshi VK, Krishnamurthy S. Antidepressant activity of Asparagus racemosus in rodent models. *Pharmacology Biochemistry and Behavior*. **91(3)**, 283-90 (2009).

[25] Shastry RA, Madagundi SD, Habbu PV, Patil BS, Joshi SD, Kulkarni VH. Phytochemical investigation and antiepileptic activity of Asparagus racemosus (Wild) root extracts in rodents. *RGUHS J Pharm Sci*, **5(3),** 97-103 (2015).

[26] Pahwa P, Goel RK. Ameliorative effect of Asparagus racemosus root extract against pentylenetetrazol-induced

kindling and associated depression and memory deficit. *Epilepsy & Behavior*, **57**, 196-201 (2016).

[27] de Rus Jacquet A, Subedi R, Ghimire SK, Rochet JC. Nepalese traditional medicine and symptoms related to Parkinson′ s disease and other disorders: Patterns of the usage of plant resources along the Himalayan altitudinal range. *Journal of ethnopharmacology*, **153(1)**, 178-89 (2014).

[28] Uddin MS, Asaduzzaman M, Mamun AA, Iqbal MA, Wahid F, Rony RK. Neuroprotective activity of Asparagus racemosus Linn. against ethanol-induced cognitive impairment and oxidative stress in rats brain: auspicious for controlling the risk of Alzheimer's disease. *J Alzheimers Dis Parkinsonism*, **6(4)**, 1-0 (2016).

[29] Singh P, Sharma B. Agonism of Histaminergic-H1 Receptors in Ischemic Postconditioning During Cerebral Ischemia-Reperfusion Injury is Protective. *Current Neurovascular Research*, **17(5)**, 686-99 (2020).

[30] Singh P, Sharma B. Pharmacological connection of Histamine-1 (H1) Receptor Mediated Neuroprotective mechanism of Ischemic preconditioning in rat. *Research Journal of Pharmacy and Technology*, **14(5**), 2717-22 (2021).

[31] Jayant S, Sharma BM, Sharma B. Protective effect of transient receptor potential vanilloid subtype 1 (TRPV1) modulator, against behavioral, biochemical and structural damage in experimental models of Alzheimer's disease. *Brain research*, **1642**, 397-408 (2016).

[32] Lee YJ, Han SB, Nam SY, Oh KW, Hong JT. Inflammation and Alzheimer's disease. *Archives of pharmacal research*, **33**, 1539-56 (2010).

[33] Veeraiah P, Noronha JM, Maitra S, Bagga P, Khandelwal N, Chakravarty S, Kumar A, Patel AB. Dysfunctional glutamatergic and γ-aminobutyric acidergic activities in prefrontal cortex of mice in social defeat model of depression. *Biological psychiatry*, **76(3)**, 231-8 (2014).

[34] Iob E, Kirschbaum C, Steptoe A. Persistent depressive symptoms, HPA-axis hyperactivity, and inflammation: the role of cognitive-affective and somatic symptoms. *Molecular psychiatry*, **25(5)**, 1130-40 (2020).

[35] Kasckow JW, Baker D, Geracioti Jr TD. Corticotropin-releasing hormone in depression and post-traumatic stress disorder. *Peptides*, **22(5)**, 845-51 (2001).

[36] Arroll B, Macgillivray S, Ogston S, Reid I, Sullivan F, Williams B, Crombie I. Efficacy and tolerability of tricyclic antidepressants and SSRIs compared with placebo for treatment of depression in primary care: a meta-analysis. *The Annals of Family Medicine*, **3(5)**, 449-56 (2005).

[37] Sulaiman MK, Lakshmanan J. Systemic and Anticancer Potential of Adaptogenic Constituents Isolated from Traditional Herbs-A Mini-Review. *Anti-Cancer Agents in Medicinal Chemistry (Formerly Current Medicinal Chemistry-Anti-Cancer Agents)*, **22(16)**, 2811-21 (2022).

[38] Singh R, Geetanjali. Asparagus racemosus: a review on its phytochemical and therapeutic potential. *Natural Product Research*, **30(17),** 1896-1908 (2016).

[39] Mishra JN, Verma NK. Asparagus racemosus: chemical constituents and pharmacological activities-a review. *Eur. J. Biomed. Pharm. Sci*, **4**, 207-13 (20178).

[40] Sairam K, Priyambada S, Aryya NC, Goel RK. Gastroduodenal ulcer protective activity of Asparagus racemosus: an experimental, biochemical and histological study. *Journal of ethnopharmacology*, **86(1)**, 1-10 (2003).

[41] Mishra AP, Bajpai A, Chandra S. A comprehensive review on the screening models for the pharmacological assessment of antiulcer drugs. *Current clinical pharmacology*, **14(3)**, 175-96 (2019).

[42] Li X, He F, Tuo X, Qiu Y, Guo J, Wu Y, Meng X, Yang Z. Electroacupuncture ameliorates peptic ulcer disease in association with gastroduodenal microbiota modulation in mice. *Frontiers in Cellular and Infection Microbiology*, **12**, 935681 (2022).

[43] Bhatnagar M, Sisodia SS. Antisecretory and antiulcer activity of Asparagus racemosus Willd. against indomethacin plus pyloric ligation-induced gastric ulcer in rats. *Journal of herbal pharmacotherapy*, **6(1)**, 13-20 (2006).

[44] Alok S, Jain SK, Verma A, Kumar M, Mahor A, Sabharwal M. Plant profile, phytochemistry and pharmacology of Asparagus racemosus (Shatavari): A review. *Asian Pacific journal of tropical disease*, **3(3)**, 242-51 (2013).

[45] Benil PB, Nimisha P, Arokiyaraj S, Rajakrishnan R, Alfarhan A, AlAnsari A. Antitumour and anti-haematotoxic activity of Asparagus racemosus L total dissolved solids in co-administration with cyclophosphamide in mice. *Journal of King Saud University-Science*, **32(5)**, 2582-9 (2020).

[46] Mitra SK, Prakash NS, Sundaram R. Shatavarins (containing Shatavarin IV) with anticancer activity from the roots of Asparagus racemosus. *Indian journal of pharmacology*, **44(6)**, 732 (2012).

[47] Biswas D, Mathur M, Bhargava S, Malhotra H. Anticancer activity of root extracts in nonsmall cell lung cancer Asparagus racemosus A549 cells. *Asian J Pharm Pharmacol*, **4**, 764-70 (2018).

[48] Vishwakarma P, Chatterjee M, Sharma M, Saini M, Goel R, Saxena KK. Evaluation of Cardioprotective activity of Asparagus racemosus against Doxorubicin induced cardiotoxicity in albino rats: an experimental study. *International Journal of Basic & Clinical Pharmacology*, **8(7)**, 1693 (2019).

[49] Prabhu AN, Shivashankara AR, Haniadka R, Palatty PL, Prabhu D, Baliga MS. Antiatherogenic effects of ginger (Zingiber officinale Roscoe): Scientific observations and ethnomedicinal validation. *In Bioactive Food as Dietary Interventions for Cardiovascular Disease*, 693-704) (2013).

[50] Acharya SR, Acharya NS, Bhangale JO, Shah SK, Pandya SS. Antioxidant and hepatoprotective action of Asparagus racemosus Willd. root extracts. *Indian Journal of Experimental Biology*, **50,** 795-801 (2012).

[51] El-Senosiy YA, Ahmad SA, Farid AS. Hepatoprotective effect of asparagus racemosus in paracetamol induced hepatotoxicity in rats. *Benha Veterinary Medical Journal*, **28(1),** 133-7 (2015).

[52] Alavian SM, Nabavi SM, Nabavi SF, Silva AS, editors. Influence of Nutrients, Bioactive Compounds, and Plant Extracts in Liver Diseases. *Academic Press*, 2020.

[53] Alosaimi ME, Alotaibi BS, Abduljabbar MH, Alnemari RM, Almalki AH, Serag A. Therapeutic Implications of Dapagliflozin on the Metabolomics Profile of Diabetic Rats: A GC-MS Investigation Coupled with Multivariate Analysis. *Journal of Pharmaceutical and Biomedical Analysis*, 116018 (2024).

[54] Hannan JM, Marenah L, Ali L, Rokeya B, Flatt PR, Abdel-Wahab YH. Insulin secretory actions of extracts of Asparagus racemosus root in perfused pancreas, isolated islets and clonal pancreatic β-cells. *Journal of Endocrinology*, **192**, 159-68 (2007).

[55] Venkatesan N, Thiyagarajan V, Narayanan S, Arul A, Raja S, Kumar SV, Rajarajan T, Perianayagam JB. Anti-diarrhoeal potential of Asparagus racemosus wild root extracts in laboratory animals. *J Pharm Pharm Sci*, **8(1)**, 39-46 (2005).

[56] Sharma U, Kumar N, Singh B, Munshi RK, Bhalerao S. Immunomodulatory active steroidal saponins from Asparagus racemosus. *Medicinal Chemistry Research*, **22**, 573-579 (2013).

[57] Gautam M, Saha S, Bani S, Kaul A, Mishra S, Patil D, Satti NK, Suri KA, Gairola S, Suresh K, Jadhav S. Immunomodulatory activity of Asparagus racemosus on systemic Th1/Th2 immunity: implications for immunoadjuvant potential. *Journal of ethnopharmacology*, **121(2)**, 241-7 (2009).

[58] Thatte U, Chhabria S, Karandikar SM, Dahanukar S. Immunotherapeutic modification of E. coli induced abdominal sepsis and mortality in mice by Indian medicinal plants. *Indian drugs*, **25(3)**, 95-97 (1987).

[59] Dahanukar S, Thatte U, Pai N, Mose PB, Karandikar SM. Protective effect of Asparagus racemosus against induced abdominal sepsis. *Indian Drugs*, **24**, 125–128 (1986).

[60] Allam R, Anders HJ. The role of innate immunity in autoimmune tissue injury. *Current opinion in rheumatology*, **20(5)**, 538-544 (2008).

[61] Ahsan H, Haider I, Mushtaq MN, Anjum I. Evaluation of anti-inflammatory and analgesic activity of the aqueous methanolic extract of *Aspraragus racemosus* in experimental models. *Farmacia*, **67(2)**, 354-359 (2019).

[62] Wiboonpun N, Phuwapraisirisan P, Tip-pyang S. Identification of antioxidant compound from Asparagus racemosus. *Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives*, **18(9)**, 771-3 (2004).

[63] Roy RN, Bhagwager S, Chavan SR, Dutta NK. Preliminary pharmacological studies on extracts of root of Asparagus racemosus (Satavari), Willd, Lilliaceae. *J Res Indian Med*, **6**, 132-8 (1971).

[64] Palanisamy N, Manian S. Protective effects of Asparagus racemosus on oxidative damage in isoniazid-induced hepatotoxic rats: an in vivo study. *Toxicology and industrial health*, **28(3)**, 238-44 (2012).

[65] Uma B, Prabhakar K, Rajendran S. Anticandidal activity of Asparagus racemosus. *Indian Journal of Pharmaceutical Sciences*, **71(3)**, 342-343 (2009).

[66] Battu GR, Kumar BM. Phytochemical and antimicrobial activity of leaf extract of Asparagus racemosus Willd. *Pharmacognosy Journal*, **2(12)**, 456-63 (2010).