

Review Paper:

Queen of all herbs (*Asparagus racemosus*): an assessment of its botany, conventional utilization, phytochemistry and pharmacology

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Abstract

Shatavari (Asparagus racemosus), a member of the *Asparagaceae* family, is vital in *Ayurveda* since it may prevent and treat hundreds of ailments. It is known as "herb's queen." Its bioactive constituents include steroidal glycosides, saponins (primarily *Shatavarins I, II, III and IV*), polyphenols, flavonoids, alkaloids (*racemosol*) and vitamins. *Shatavari* is a popular shrub in folk and *Ayurvedic* medicine due to its sapogenin content, which is the precursor to many pharmacologically active steroids. Most of its components are medicinal, but roots, stems and leaves are the most essential. *Shatavari "Rasayanas"* boost immunity and infection resistance. Due to its phytochemicals, it is used to cure several illnesses.

Due to its phytochemicals, it is used to cure several illnesses. *Shatavari* has many medicinal properties such as anti-spasmodic, anti-oxidant, anti-diabetic, anti-allergic, anti-malarial, protective, anti-neoplastic activities, immune response enhancement, anti-arthritis, anti-inflammatory, anti-periodic, anti-ulcerogenic action, immune modulatory antistress, anti-diarrheal, antidepressant infections, tuberculosis and so on. Commercial *Shatavari* extract medications are anti-leprotic, anti-abortion, antibacterial, antipyretic and analgesic. *Shatavari* root, leaf, flower and stem extracts treat dyspepsia, mental disorders, cough, bronchitis, throat and female reproductive system issues.

Keywords: *Asparagus racemosus*, *Asparagaceae*, Bioactive compounds, Phytochemistry, Pharmacological activities.

Introduction

To maintain and secure well-being and to treat, mitigate, identify and manage physical or mental illnesses, traditional medicine is a collection of information, acquaintances, skills (the ability to apply learned knowledge) and performances based on the theories, viewpoints and understanding of various ethnic groups, whether they are understandable or not. Most countries rely heavily on traditional medicine since it is reliable in terms of safety, cost and pharmacological efficacy⁴⁶. Since pre-Vedic times, *A. racemosus* has been used and is extensively discussed in our

natural herbal system (*Ayurvedic* literatures). The plant may reach heights of 1-2 metres and it prefers stony, gravelly soils at high altitudes in the piedmont³⁶.

Antitumorogenic action, immunomodulatory, antistress, anti-diarrheal, antidepressant, anti-leprotic, anti-abortion, antibacterial, antipyretic and analgesic are just some of the medicinal properties of *A. racemosus*. The majority of its saponin content, including compounds like *shatavarin I–IV* and *sarsasapogenin glycosides* is found in the plant's roots. Examples of its secondary metabolites are: steroids, alkaloids, dihydrophenanthrene derivatives, flavonoids, furan derivatives and essential oils³.

Table 1
Several local and common names¹⁷

Language	Vernacular Names of Satavari
Sanskrit	Satavari
Hindi	Satavari, Shatawar or Satmuli
Bengali	Shatamuli
Marathi	Shatavari or Shatmuli
Gujarati	Satawari
Telegu	Toala-gaddalu or Pilli-gaddalu
Tamil	Shimaishadavari or Inli-chedi
Malayalam	Chatavali
Kannada	Majjigegadde or Aheruballi
Madhya	Narbodh or atmooli
Kumaon	Kairuwa
Rajasthan	Norkanto or Satawar
Nepal	Nepal Kurilo

Plant profile:

History: Pre-Vedic texts and *Ayurvedic* writings both refer to the usage of *Asparagus racemosus*. The roots of *Ayurveda* may be traced back to India some five thousand years ago. The whole foundation of this method is natural herbs. While it was first confined to certain areas, alternative medicine has now gone global and has come to play a crucial role in healthcare systems everywhere. India has one of the longest and most extensive histories of using herbs for medical purposes. India provides an in-depth, all-encompassing view of a healthy lifestyle³⁵. In *Ayurveda*, the plant known as *shatavari (Asparagus racemosus)* is revered as a panacea due to its curative properties.

Traditional medical practices including *Ayurveda*, Unani and Siddha, as well as the Indian and British

Pharmacopoeias, attest to its therapeutic efficacy. The healing properties of this herb have been documented in ancient Ayurvedic writings including the Charak Samhita, Susruta Samhita and Astanga Samhita. About 22 of the roughly 300 species of asparagus found throughout the globe may be found in India. The most common species of *Asparagus* used in traditional medicine is *Asparagus racemosus*, also known as shatavari. In table 1, we provide the many common names for these plants^{41,49}.

Cultivation

Climate and Soil: Shatavari is endemic to the Indian subcontinent and grows in unusual places including Sri Lanka's wet tropical rainforests and the Himalayas' slopes. The plant climbs bushes and trees to get light and assist its development. Shatavari thrives in humid rainforests and severely dry environments. Its ability to catch and hold moisture in dry soils may replace bodily fluids and regulate a stressed system. Shatavari favours light, medium and heavy soils. Black, well-drained, rich soil is ideal for agriculture at 25–40°C^{3,21}.

Parts Used: All plant parts-mature fruits, leaves, seeds, flowers, roots, rhizomes, trunks and flora can be used to treat ailments^{16,42}.

Morphology: *A. racemosus* has a heavily branching, thorn-under-shrub morphology. It is a 1-2 m woody climber that climbs up documentation or other plants as in figure 1^{29,33,44,45}.

Roots: 5-15 cm long, 2 cm thick, silvery white (ash color) on the outside, white on the inside, longitudinal wrinkle upon drying, 18-24-layer cortex, 42-47 middle tuberous root, brown.

Seeds: Black, brittle seeds.

Fruit: Small, round, globular, 3-lobed, purplish-black, pulpy berries that ripen from green to blacksh purple.

Flower: A small, uniform, scented, unisexual, white flower with pink spikes pollinated by bees.

Identifications of phytochemicals constituents: Shatavari has several isoflavones, polysaccharides and steroidal saponins. Shatavarin I–IV dominates saponins. 8-methoxy-5,6,4'-trihydroxyisoflavone 7-O-beta-D-glucopyranoside is another phytoconstituent. Asparagamine, Racemosol, 9,10-dihydrophenanthrene, Shatavaroside and Secoisolariciresinol Shatavari Immunoside is a glycoside of Sarsasapogenin, Racemoside A Ursolic Acid, Beta-Sitosterol, Stigmasterol Genistein and Daidzein¹⁷⁻²⁰.



Figure 1: Morphological Characteristic of *A. racemosus*⁴⁵

Table 2
Taxonomic arrangement of *A. racemosus*³⁹

Kingdom	Plantae
Division	Angiosperms
Class	Monocots
Order	Asparagales
Family	Asparagaceae; Liliaceae
Genus	<i>Asparagus</i>
Species	<i>Racemosus</i>
Common Name	Shatavari

Bioactivity and pharmacological properties

Traditional uses: Galactagogue is one of its many uses. It is useful as an antioxidant, an aphrodisiac and for the health of the uterus; efficacy as an antidepressant, an analgesic and an antidiarrheal; Adoptogenicity, protection of the brain and liver and efficacy against ulcers, movements in the digestive system, as well as in fighting intestinal distress. Garlic has antimicrobial, antifungal and immunomodulatory properties. It has efficacy in lowering blood cholesterol and protecting heart health anticancer, anti-inflammatory, anti-anxiety, anti-convulsive, anti-amnesic, anticonvulsant and anti-tussive properties.

Antiparasitic, anti-tisecretory and nephroprotective effects benign prostatic hypertrophy treatment, antiepileptic properties and antiurolithiatic activity; efficacy against

diabetes, molluscan activity, "A" for "anti-oxytotic" effects against abortion, high blood pressure, clotting and enzyme deficiency, as well as anaemia and thrombocytopenia, antistress, adaptable revitalizer for women, multiple antiviral, phagocytic and other functions.^{6,11,18,22,23,27,47}

Galactagogue effect: In Ayurveda, *A. racemosus* increases milk production⁵². Intramuscularly injecting an aqueous fraction of an alcoholic extract of *A. racemosus* root increased mammary gland weight and milk supply. The extract boosted mammary gland weight in postpartum andestrogen-primed rats. On the fifth day after birth, a commercial preparation of *A. racemosus* and additional herbs increases breast milk production in women with low supply. In buffaloes, *Asparagus racemosus* roots contain galactagogue¹⁰.

Table 3
Phytochemical List of Shatavari^{1,4,37,56}

Name	Compound
Root extract and Stem extract of tuberous	
3-O-[α -L-rhamnopyranosyl-(1 $\rightarrow$ 2)- α -L-rhamnopyranosyl-(1 $\rightarrow$ 4)-O- β -D-glucopyranosyl]-25(S)-spirosta-3 β -ol(1)	Steroidal
Racemoside A, B, C	Steroidal
Shatavarins	Steroidal
Asparanin A	Steroidal
Immunoside	Steroidal
27 α -dimethyl-1 β ,2 β ,3 β -trihydroxy-25-spirost-4-en-19 β -oic	Steroidal
Sarsasapogenin	Steroidal
Diosgenin	Steroidal
Sitosterol	Steroidal
Anti-HIV compounds	Steroidal
Filiasparoside C	Steroidal
Shatavaroside A	Steroidal
Shatavaroside B	Steroidal
Asparagamine A	Alkaloid
Polycyclicalkaloid	Alkaloid
Racemosol(9,10-dihydro-1,5-dimethoxy-8-methyl-2,7-phenanthrenediol)	Dihydrophenanthrene derivative
Racemofuran	Furan derivatives
8-Methoxy-5,6,4-trihydroxyisoflavone-7-O- β -Dglucopyranoside	Flavonoid
Cyanidine-3-galatoside	Flavonoid
Kaempferol	Flavonoid
5-hydroxy-3,6,4'-trimethoxy-7-O- β -D-glucopyranosyl-[1 $\rightarrow$ 4]-O- α -D-xylopyranoside	Flavonoid
C. Flowers and fruits	
Quercetin-3-glucuronide	Flavonoid
Quercetin	Flavonoid
Rutin	Flavonoid
Hyperoside	Flavonoid
D. seeds	
Phytoecdysteroids	Steroids

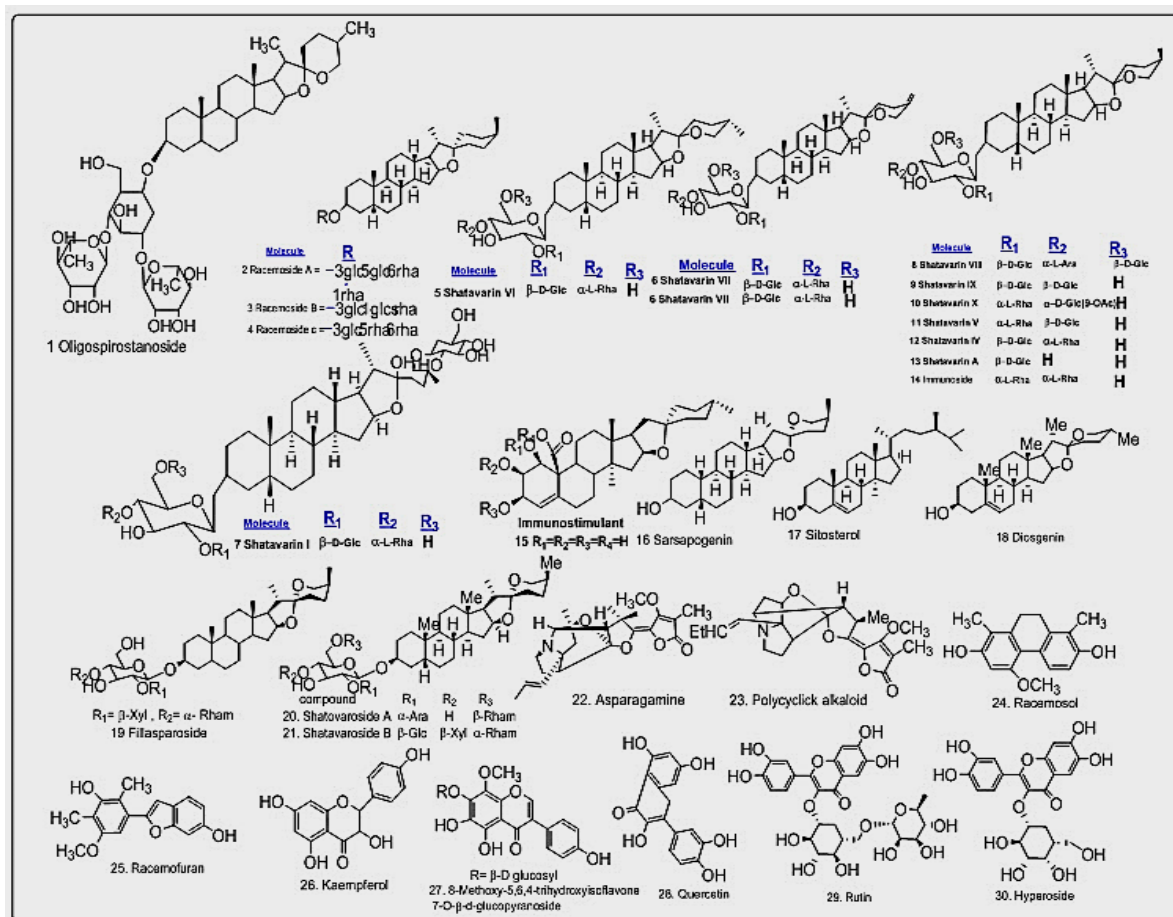


Figure 2: Structures of steroidal saponins, alkaloids, dihydrophenanthrene, furan derivative, flavonoids obtained from *A. Racemosu*²⁶

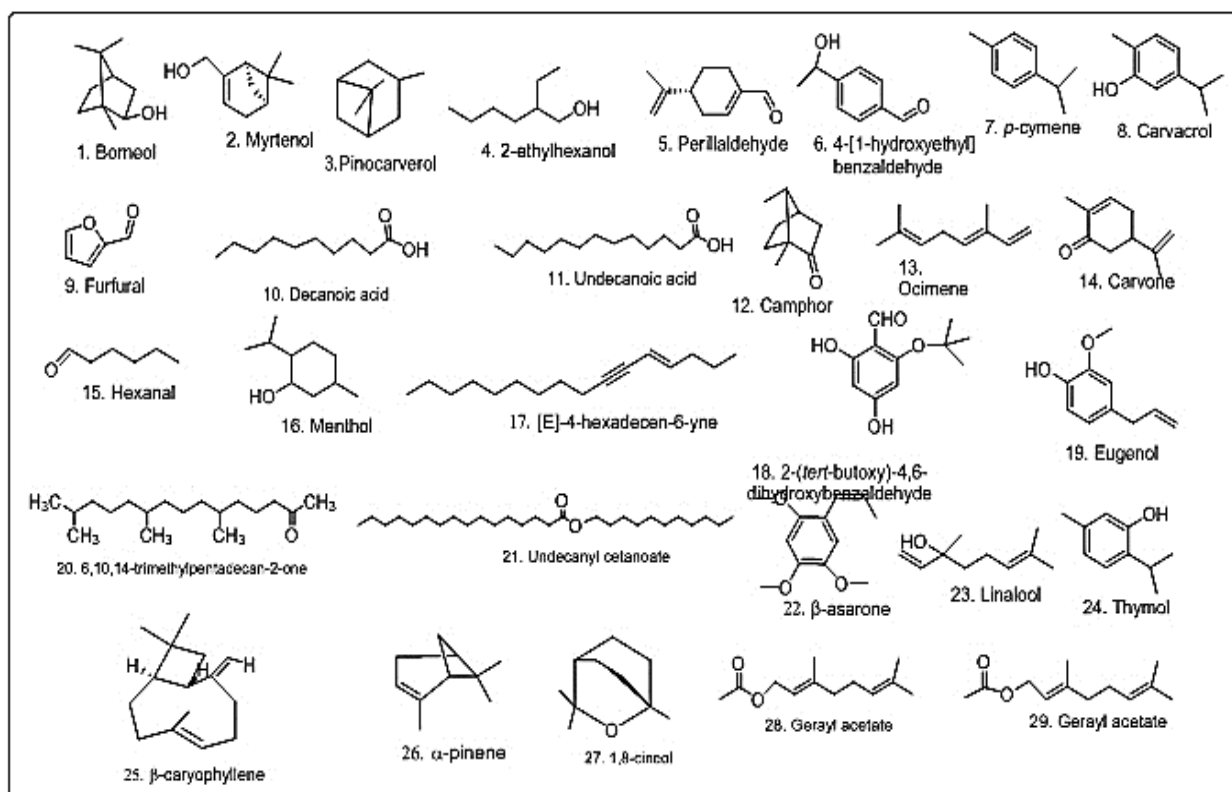


Figure 3: Structures of volatile components of *A. Racemosu*²⁵

Antioxidants effect: *In vitro*, *A. racemosus* plant extract enhances the antioxidant properties of rat liver mitochondrial membranes produced by gamma radiation-generated free radicals. It increases GPX and GSH enzyme activity and reduces protein and lipid peroxidation^{8,42,51}.

Aphrodisiac activity: Aphrodisiacs boost sexual desire, named after Aphrodite, the Greek Goddess of love and sexuality. Plant compounds that resemble ovarian and placental oestrogens and their active metabolites are known as phytoestrogens. Phytoestrogens regulate ovarian cycles and oestrous in female animals and promote growth, differentiation and physiological activities of the female genital tract, pituitary, breast and other organs and tissues in both sexes. Due to the understanding that hormone replacement treatment is neither safe nor effective, interest in phytoestrogens has surged. Dinan⁵ studied 16 asparagus species. Pandey et al³³ examined this herb's aphrodisiac property. In the treated group, the mammary glands were prominent, the vaginal entrance was dilated and the uterine horn was transverse.

Antidepressant activity: *A. racemosus* worked as adaptogenic agent means as an antidepressant agent. Adaptogenic drugs increase non-specific resistance. In rats, methanolic extracts of *A. racemosus* roots at 100, 200 and 400 mg/kg daily for 7 days were tested for antidepressant effects using the forced swim test (FST) and the learned helplessness test (LH). In behavioural trials, antidepressants caused FST immobility and LH avoidance. Shatavari may treat depression through the serotonergic and noradrenergic systems^{8,54}. Singh et al⁴⁸ subjected rats to biological, physical and chemical stressors after administering a methanol-based, standardised extract of *Asparagus racemosus* roots. *Asparagus racemosus* methanolic extract lowers immobility in forced swimming and enhances avoidance reactions in the helpless, suggesting antidepressant effects.

Cytotoxicity, analgesic and anti-diarrhoeal activities: *A. racemosus* root extracts were tested for their cytotoxicity, analgesic and antidiarrheal properties when extracted with ethanol. The acetic acid-induced writhing experiment in mice was used to assess the crude ethanolic extract for analgesic efficacy. Ethanol extracts of *A. racemosus* were tested for their ability to prevent diarrhoea using a mouse model of castor oil-induced diarrhoea and their cytotoxic action was evaluated using a bioassay involving the lethality of brine shrimp. The data collected lends credence to Shatavari's traditional use and calls for more research into the plant's chemical components, which are thought to be responsible for its cytotoxicity, analgesic and anti-diarrheal effects^{51,53}.

The plant extracts significantly reduced both castor oil- and PGE2-induced diarrhoea in rats. In a rat test using charcoal for food, both extracts significantly decreased gastrointestinal motility. Asparagus has been shown to speed

up digestion and reduce the time it takes for the stomach to empty. Asparagus root methanol extracts have been proven to decrease intestinal propulsive movement, diarrhoea caused by castor oil and fluid buildup in the intestines in other trials.

Neuroprotective effect: Among Ayurvedic practitioners, *A. racemosus* is revered for its nervine tonic properties. The protective effects of a root methanol extract from *A. racemosus* against kainic acid-induced neuronal injury in the mouse hippocampus and striatum were investigated³⁴. Brain lesions called excitotoxic lesions were induced by injecting kainic acid directly into the hippocampus or striatum of anaesthetized animals. Following injection, brain areas including the hippocampus and striatum showed impairment with increased lipid peroxidation, increased protein carbonyl content, decreased glutathione peroxidase (GPx) activity and reduced glutathione (GSH) content.

Important for preventing the accumulation of hydroperoxides to dangerous levels in brain tissues, GSH serves as a nucleophilic scavenger of these molecules and as a substrate in the GPx-mediated degradation of them³⁴. Mice given the extract had higher levels of glutathione (GSH) and GPx activity and lower levels of lipid peroxidation and protein carbonyls. According to findings, the plant extract acts as an antioxidant by reducing oxidative damage caused by free radicals³⁴.

Antihepatotoxic activity: Ethanolic extracts of *A. racemosus* root significantly reduced the increased levels of alanine transaminase, aspartate transaminase and alkaline phosphate in carbon tetra chloride CCl₄ induced hepatic damage in rat livers indicating *A. racemosus* antihepatotoxic potential⁵⁹.

Adaptogenic and anti-ulcer activity: The plant exhibits adaptogen properties (which increase the body's capacity to change according to the environment) and is a rasayana herb, both of which boost cellular immunity. An evaluation of *A. racemosus* extract in relation to the antacid ranitidine, reduced stomach acidity, free acidity and the number of ulcer patches was made⁵⁹.

Immunomodulatory activity: Rats and mice were protected from experimentally generated abdominal sepsis thanks to *A. racemosus*'s immunomodulating properties⁵. Animals infected with *A. racemosus* had a much lower percentage of deaths and their survival rate was on par with those infected with metronidazole and gentamicin. Since *A. racemosus* also operates as an antibacterial agent, the immunomodulatory feature of *A. racemosus* against sepsis is shown by its ability to affect the function of macrophages. Helper T cells (Th) are crucial to both cell-mediated immunity (Th1) and humoral immunity (Th2), but they are only created during infancy and a decline in their numbers beyond a certain age might be problematic. Albino mice were injected with sheep red blood cells as a particulate

antigen and the mice humoral and cell-mediated immune responses were shown to be improved after taking an alcoholic extract.

Anti-fungal and antibacterial activity: The antifungal effects of *Asparagus racemosus* Willd. were tested by Uma et al⁵² against six types of yeast (*Candida albicans*, *Candida tropicalis*, *Candida krusei*, *Candida guilliermondii*, *Candida parapsilosis* and *Candida stellatoidea*). A significant amount of inhibition against *Candida* was seen while using *Asparagus racemosus* extract in comparison to other antibiotics. Mandal et al^{23,24} looked at the effects of *Asparagus racemosus* on a wide variety of bacteria, including *E. coli*, *Shigella dysenteriae*, *Shigella sonnei*, *Shigella flexneri*, *Vibrio cholerae*, *Salmonella typhi*, *Salmonella typhimurium*, *Pseudomonas putida*, *Bacillus subtilis* and *Staphylococcus aureus*.

It has also been shown that an extract of *Asparagus racemosus* is effective against leishmania and plasmodium. *In vitro* antibacterial activity against *Staphylococcus aureus* and *Escherichia coli* was detected in an alcoholic extract of the root²².

Hypolipidemic and cardioprotective activity: It has been shown that root powder supplements can lower total lipid content and peroxidation by lowering LDL and VLDL cholesterol by more than 40%.

Effective in preventing coughing: Both 200 mg/kg and 400 mg/kg of a methanolic extract of *A. racemosus* roots were extremely efficient as an antitussive drug in mice. The research compared the experimental medication to the commonly used antitussive, codeine phosphate. When mice were given sulphur dioxide, which causes coughing, an extract of the root of the *Asparagus racemosus* was found to have a considerable antitussive effect⁹.

Anti-cancer activity: Cancer cell lines employ *A. racemosus* steroidal components such as shatavarin I–IV. Each line received various concentrations. Cell viability and death were observed at the same periods⁵². Cell viability and apoptosis in cancer cell lines are measured using the Sulforhodamine B cytotoxicity test and the M30 Cyto Death ELISA³⁶. Caspase-cleavage product accumulation and ccCK18 in cultured cells determine the cell death rate. All HCT116 cells have cytotoxic saponins from *A. racemosus*; however, the sugar aglycone in sarsasapogenin form does not. Shatavarin IV reduces cell viability and mortality rate.

Anti-inflammatory effects: It has been shown that a dosage of *A. racemosus* root extract at 200 mg/kg may decrease tissue weight, inflammatory cytokine production and neutrophil-mediated myeloperoxidase activity; hence, it has the potential to be used as an anti-inflammatory drug¹⁹.

Anti-stress activity: In Ayurveda, plants including *Chlorophytum arundinaceum*, *Asparagus adscendens* and *A.*

racemosus are used as preventative medicine and stress relievers. In an experimental mouse stress scenario generated by swimming, the effects of both methanol and an aqueous extract of the roots of these plants were studied. Evidence showed that the extracts suppressed nitric oxide generation in mouse macrophages and the production of the pro-inflammatory cytokines interleukin-1 and tumour necrosis factor. As a result, interleukin-2 production in EL4 lymphoma cells was similarly suppressed. Serum and adrenal corticosterone levels were analysed. The research results indicate that *A. racemosus* has potential as a stress-relieving medication⁴⁰.

Antidiabetic activity: The metabolic disorder diabetes high blood sugar (glucose) occurs when either the body does not create enough insulin or when cells do not react normally to insulin. In addition to its usage in conventional medicine, *Asparagus racemosus* has long been a staple therapy for diabetes in indigenous cultures. As shown above, the metformin treatment for diabetes raises Ca⁺⁺ levels in the mitochondria. According to research conducted by Hannan et al^{8,9}, components of *A. racemosus* root extracts show broad stimulatory actions on physiological insulinotropic pathways. Concentration-dependent stimulation of insulin secretion was seen in isolated perfused rat pancreas, isolated rat islet cells and clonal beta-cells by ethanol extract and each of the hexane, chloroform and ethyl acetate partition fractions.

The elimination of insulin secretory effects in the absence of Ca (2+) was also seen and this was accompanied by a rise in intracellular Ca (2+). A single-dose oral glucose tolerance test (GTT) in fasted albino rats showed hypoglycemic action with 250 milligrammes of ethanolic extract per kilogramme of body weight and 90 milligrammes of pure ash per kilogramme of body weight of the root.

Cognitive disorders: More people are permanently harmed by neurological and mental diseases than by any other medical condition. Neuronal cell death in Alzheimer's disease and Parkinson's disease is primarily mediated by excitotoxicity and oxidative stress. Therefore, a chemical that may slow or reverse this neuronal damage is needed to tackle neurodegenerative illnesses. Clinical studies for Alzheimer's disease (AD) now underway examine a wide variety of potential therapies including cardiovascular medications, antioxidants and vaccination therapy^{48,50}.

Conclusion

From what has been said, it is reasonable to infer that *Asparagus racemosus* Willd. is a beneficial natural plant that unlike allopathic medications, has no negative side effects and may be used to treat a wide range of potentially lethal diseases⁵⁸. Many of the relatively unexplored uses of this plant that have just recently come to light. Thus, the phytochemicals and minerals found in these plants will allow for their medicinal potential to be fully realised.

Toxicities and side effects of this medicine are unknown, making it safe for both short-term and long-term usage in humans. Since it is crucial to coordinate the quality of raw materials, in-process materials and finished products for top-notch medication, it is vital to establish dependable, specific and sensitive quality control procedures using both traditional and cutting-edge instrumental methods of analysis. These secondary metabolites are being induced *in vitro* by stress, employing a variety of abiotic and biotic elicitors.

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