



***Asparagus racemosus* - a multi-use medicinal miracle herb: a review**

Nida Rafiq^{1*}, J.D Parrah² and Sajad A. Gangoo¹

¹Faculty of Forestry, Benhama, Ganderbal; ²Division of Veterinary Clinical Complex, Faculty of Veterinary Sciences and Animal Husbandry, Shuhama, Alusteng; Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar Srinagar-190 025 Jammu and Kashmir (India)

*e-mail: bhatnida323@gmail.com

(Received September 19, 2022; accepted November 01, 2022)

ABSTRACT

Asparagus racemosus known as Shatavari or Satavar, belongs to family Asparagaceae. It can be found in tropical Africa, Java, Australia, Sri Lanka, southern China and India, although it is predominantly cultivated in India. A group of steroidal saponins, sarsasapogenins, flavonoids, kaempferol, quercetin, rutin, and polyphenols are the main bioactive ingredients that give the herb its medicinal significance. Because of its remarkable potential, the tuberous roots of this herbaceous plant are widely used in the pharmaceutical and biotechnological industries in the creation of numerous herbal remedies. The root extracts have been shown to have pharmacological properties such as rejuvenator, antioxidant, estrogenic, immunomodulator, antistress, antidiabetic, antibacterial, antiviral, antifungal, anti-amoebic, antitumor, gastroprotective. In Ayurveda it is known as 'Rasayana' due to its therapeutic properties. In animal health too, plant is widely used especially in the dairy animals to improve their productive and reproductive performance. The present review explores the phytochemical constituents and therapeutic properties of *A. racemosus* that provide the plant a medicinal significance.

Keywords: Allopathic, Antioxidants, *Asparagus racemosus*, pharmacological properties

The genus *Asparagus* (Asparagaceae), besides medicinally important species includes commercially important species of vegetable as well as some ornamental, which are exploited for manufacturing nutraceuticals (Ravindra *et al.*, 2012). *Asparagus* plant has about 300 species across the world, among which *Asparagus officinalis* is a popular vegetable (Goyal *et al.*, 2003). Out of 22 species of '*Asparagus*' grown in India, *Asparagus racemosus*, *Asparagus gonaclades* and *Asparagus adsendens* are most used in indigenous medicine (Hayes *et al.*, 2008). Two species of *Asparagus*, *Asparagus racemosus* and *Asparagus filicinus* are grown in Kashmir Himalaya (Polecnin and Stainton, 1984). *Asparagus racemosus* is an important medicinal plant that has been investigated since antiquity. The herb is now frequently employed in the production of allopathic, ayurveda, and homoeopathic medications. The usage of numerous chemical ingredients of this plant in various pharmaceutical compositions has increased its demand (Singh *et al.*, 2018). The most often used herb in traditional medicine (Ahmad *et al.*, 2017) is *Asparagus racemosus*, also known as "Shatavari" in Sanskrit and "Satmuli" in Hindi (Bopana and Saxena, 2007). The Shatavar rejuvenation effect in female reproductive organs is referred to as "who possesses hundred spouses" (Kushwah *et al.*, 2013). Shatavari is said to strengthen a woman to the point where she can produce hundreds of healthy oocytes, according to Ayurvedic scriptures (Sharma and Sharma, 2013). Muli signifies roots and shata means hundred (Kumar *et al.*, 2008). This magnificent herb is renowned as the "queen of herbs" in Ayurveda since it improves the potential for lovemaking by improving women's health and devotion (Simon, 1997). Apart from being a health tonic, its root paste or root juice is used to cure a variety of diseases (Goyal *et al.*, 2003). The demand for *Asparagus racemosus* is always increasing due to its many uses. The plant is classified as 'endangered' in its natural habitat due to destructive harvesting, habitat damage, and deforestation (Sahrawat *et al.*, 2014). According to the National Medicinal Plant Board, the demand for *A. racemosus* increased from 10, 924.7 tonnes in 2001-2002 to 16, 658.5 tonnes in 2004-2005, showing a 15% annual growth rate in demand (Singla and Jaitak, 2014).

Distribution and Morphology of *Asparagus racemosus*: *Asparagus racemosus* Wild (Asparagaceae) an important medicinal plant is a widely dispersed plant that can be found in tropical Africa, Java, Australia, Srilanka, China's southern regions, native to the Indian subcontinent (Chasndhay and Dantu, 2019) and is distributed throughout tropical and subtropical parts of India in the Himalayan and sub-Himalayan regions from mean sea level up to 1500 m from Kashmir eastwards (Sharma and Sharma, 2013; Geetha and Siril, 2019). The plant is a spinous under shrub with tuberous short root stock bearing numerous succulent tuberous roots (30-100 cm and 1-2 mm thick) that are slivery white or ash coloured externally and white internally (Bopana and Saxena, 2007; Gomase and Sherkhane, 2010). Roots are smooth when fresh and start to develop longitudinal wrinkles upon drying (Hussain *et al.*, 2011). The roots contain long needle shaped structure known as pith which is meant for the conduction of water (Kirtikar and Basu, 1975).

Phytochemical constituents of *Asparagus recemosus*

Source	Phytochemical constituents of <i>Asparagus recemosus</i>	References
Root	Isolated Kaepfrol- Kaepfrol along with Sarsapogenin from woody portions of tuberous roots of <i>Asparagus racemosus</i> .	Subramanian and Nair, 1968
Root	Roots of Shatavari are reported to contain 4 steroids saponin known as shatvarins. Shatvarin I to VI are present. Shatvarin I is the major glycoside with 3-glucose and rhamnose moieties attached to sarsapogenin, whereas in sahatvarin -IV two glucose & one rhamnose moieties attached.	Joshi <i>et al.</i> , 1988; Gaitonde <i>et al.</i> , 1969; Nair <i>et al.</i> , 1969
Root	Reported that Carbohydrates- Polysaccharides, mucilage are present in the roots. Isolated cyclic hydrocarbons such as racemosol, dihydrophenantherene from the roots of <i>Asparagus racemosus</i> .	Sharma, 1981; Borger <i>et al.</i> , 1985
Root	Made an attempt to isolate Miscellaneous-Essential fatty acids like Gamma linoleinic acids, vitamin A, diosgenin, quercetin 3-glucourbnides from the roots.	Tambvekar, 1985
Flower & fruit	Reported that flowers and fruits of <i>Asparagus racemosus</i> contain flavonoids, glycosides of quercitin, rutin and hyperoside.	Singh, 1991
Root	Reported that roots contain Sterols-sitosterol, 4, 6-dihydryxy-2-O (-2-hydroxy isobutyl) benzaldehyde and undecanyl cetanoate.	Choudhary and Kar, 1992
Root	Isolated polycyclic alkaloid-Aspargamine A, a cage type pyrrolizidine alkaloid from the roots.	Sekine, 1994
Root	Reported that roots also contain Furan compound- Racemofuran.	Kamat <i>et al.</i> , 2000
Root	Reported Isoflavones-8-methoxy-5, 6, 4-trihydroxy isoflavone-7- 0-beta-D-glucopyranoside are present in roots.	Saxena and Chourasia, 2001
Whole plant	Performed different biochemical analysis on various <i>A. racemosus</i> plant sections. According to their studies, Shatavari has more than 50 different types of organic chemical compounds.	Thomsen, 2002
Root	Reported that trace minerals found in roots-zinc (53.15), manganese (19.98 mg/g), copper (5.29 mg/g), cobalt (22.00 mg/g) along with calcium, magnesium, potassium, zinc and selenium.	Mohanta <i>et al.</i> , 2003
Root	Reported that immunside is the term referring to oligospirostanoside is also present in roots of <i>Asparagus racemosus</i> .	Handa <i>et al.</i> , 2003
Root	Reported Furan compound - Racemofuran present in the roots.	Wiboonpun <i>et al.</i> , 2004
Root	Reported shatvarins, which are steroidal saponins. Roots contain Shatvarin I to VI. There have also been reports of shatavarin V, asparinins, asparosides, curillins, and curillosides.	Patricia <i>et al.</i> , 2006
Root	The preliminary phytochemical analysis, <i>Asparagus racemosus</i> root powder extracts from ethanol, aqueous, and benzene contain steroidal saponins, glycosides, alkaloids, polysaccharides, mucilage, racemosol, and isoflavones that have a variety of therapeutic properties.	Sharma and Sharma, 2013
Root	Reported that twenty nine steroidal saponins are present in <i>A. racemosus</i> root.	Singla and Jaitak, 2014
Aerial parts	Reported 55 components of essential oils that can be extracted from aerial parts of <i>Asparagus racemosus</i> . These components belong to a wide range of chemical classes, including acids, alcohol, aldehydes, ester, hydrocarbons, ketone, and N-containing compounds.	Singla and Jaitak, 2014
Root	Reported Vitamins A, B1, B2, C, E, Mg, P, Ca, Fe, and folic acid are also present in <i>Asparagus racemosus</i> root.	Joshi, 2016

This climbing woody stem plant has pin- needle like leaves and small white flower (Joshi, 2016). Small pin needle like phylloclades (photosynthetic branches) are uniform and shiny green in appearance. *A. racemosus* almost dies or dries up in summers and it grows with new tender branches from underground root. Flowers begin to appear in September-December and fruits appear afterwards (Shirkande and Shirkande, 2019).

Distribution of therapeutic utility across *Asparagus racemosus* plant: Each part of *A. racemosus* plant has different medicinal properties (Singh, 2018). Roots are considered lactagogue, estrogenic, antioxytotoxin, immune modulators, antidyspepsia, antiallergic, anticancer, anti-inflammatory, antidiabetic, antioxidant, antitussive, hepatoprotective, antibacterial, antiulcer, anti-diarrhoeal, antilithiatic (Rakesh, 2016). The root extracts of *A. racemosus* are employed in two major forms as methanolic and aqueous extracts, the products of which include root powder in tablet form and root extract in syrup form (Nand and Saxena, 2007). Hydromethanol extract shows maximum protective effect to reduce uremia (Roy et al., 2013). Leaves have cholinesterase and antiparasitic activities; shoots - anti-inflammatory, antidiabetic, and diuretic, while as whole plant has antimicrobial, nephroprotective and hepatoprotective (Hojatollah et al., 2016). Aerial parts of *A. racemosus* plant have urolithiasis, hypolipidemic, antiasthmatic and antifertility activities, seeds-antiparasitic and flower-diuretic activity (Singh, 2018).

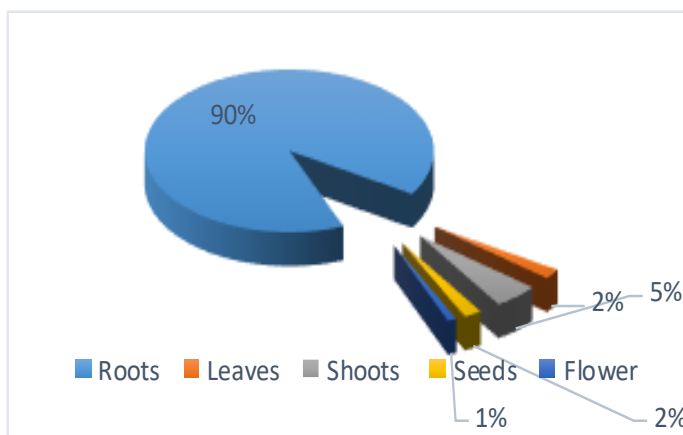


Fig. 1: Distribution of therapeutic utility across *Asparagus racemosus* plant

Different Ayurvedic names of *Asparagus racemosus* plant due to therapeutic utility

Different names of <i>A. racemosus</i> plant due to therapeutic utility	Ayurvedic	Meaning	References
Rasayana		Which means plant drugs promoting general well-being by increasing cellular vitality and resistance or rejuvenator herb which improves health by increasing immunity, vitality and resistance, imparting longevity as well as protection against stress	Goyal et al., 2003, Puri, 2003
Medhya		The plant which increase intelligence and promote learning and memory	Sharma, 1993
Balya		Means a strength promoter	Gogte, 2000
Stanya		A galactagogue i.e. increase production of breast milk	Gogte, 2000
Jeevaniya		An erythropoietin i.e. a hormone secreted by the kidneys that increases the rate of production of red blood cells in response to falling levels of oxygen in the tissues	Sharma and Bhatnagar, 2014

Different Ayurvedic names of *Asparagus racemosus* plant due to therapeutic utility

The pharmacological activities and clinical trials of *Asparagus racemosus* have been summarized in the tabulated form below:

Pharmacological activities and clinical trials of *Asparagus racemosus*

Pharmacological activity	Procedure of action	References
Antioxidant activity	- Aqueous root extract of <i>A. racemosus</i> was investigated for antioxidant activity in the rat liver mitochondria and hence the root extract exhibited antioxidant effect by inhibiting radiation-induced protein thiol loss and superoxide dismutase inactivation, as well as by minimizing oxidative stress and hepatotoxicity. - Methanolic extract of <i>Asparagus racemosus</i> root were reported to have moderate free radical scavenging (antioxidant) activity. - Ethanollic fraction of <i>Asparagus racemosus</i> root showed high radical scavenging (antioxidant) activity. - The antioxidant effects of crude extract and purified aqueous fraction of <i>A. racemosus</i> were examined in rat liver cell mitochondrial membrane damage spurred about by produced free radicals. By preventing lipid peroxidation, protein oxidation, and a reduction in the levels of protein thiols and the antioxidant enzyme superoxide dismutase, the crude extract demonstrated an antioxidant activity against oxidative damage. - Another study indicated that the significant radical-scavenging activity of <i>Asparagus racemosus</i> is due to the high flavonoid concentration of the ethanol fraction.	Kamat <i>et al.</i> (2000) Dohare <i>et al.</i> (2011) Roy <i>et al.</i> (2014a) Singla and Jaitak (2014)
Galactagogue properties	Root extract of <i>Asparagus racemosus</i> exhibited galactagogue properties.	Jatmalani <i>et al.</i> (1967) Joglekar <i>et al.</i> (1967)
Antioxytocin activity	The saponin rich fraction obtained from <i>Asparagus racemosus</i> was found to inhibit oxytocin induced uterine contractions <i>in vivo</i>.	Gaitonde & Jetmalani (1969)
Antidiabetic properties	<i>Asparagus racemosus</i> root in extract form found to have antidiabetic properties. - Ethanollic extract of <i>A. racemosus</i> indicated the glucose-lowering effects. The antihyperglycaemic actions of the active plant constituents were partially mediated by boosting the insulin secretory capacity of the b-cells or augmenting insulin action.	Akhtar & Shah (1993), Rana <i>et al.</i> (1994), Hannan <i>et al.</i> (2012)
Antidepressant activity	- In a study, it was observed that <i>A. racemosus</i> root extract in methanol increased avoidance behaviour in the learned helplessness test (LH) and decreased immobility in the forced swim test (FST) in rats, indicating antidepressant effect. - In a similar investigation, the tail suspension test (TST) and forced swim test (FST) were used to compare the methanolic extract of <i>A. racemosus</i> root to the reference medications fluoxetine and imipramine in mice (FST). Strong antidepressant activity was shown by the significant reduction in immobility intervals in the TST and FST.	Dhingra and Kumar (2007) Singh <i>et al.</i> (2009)
Anticancer activity	Human breast cancer, human colon adenocarcinoma, human kidney carcinoma cell lines, and an <i>in vivo</i> experimental model of Ehrlich ascites carcinoma (EAC) tumour bearing mice all showed significant anticancer activity when treated with the root extract of <i>Asparagus racemosus</i> containing shatavarin IV.	Mitra <i>et al.</i> (2012)
Cardio protective activity	The effects of <i>A. racemosus</i> root powder were mediated by lowering the content of total lipids and by reducing LDL and VLDL (two types of cholesterol) that contribute to peroxidation.	Choudhary & Sharma (2014)
Memory deficit reliever potential	A study using memory-impaired mice and rats revealed the plant's potential to treat memory problems. Scopolamine (0.4 mg/kg, i.p.) and sodium nitrite (75 mg/kg, i.p.)-induced memory deficits were treated for seven days with two dosages of methanolic extract of <i>Asparagus racemosus</i> roots, 75 and 150 mg/kg (amnesia). The parameters of the Morris water maze (MWM) and elevated plus maze (EPM) were greatly enhanced.	Dhwaj & Singh (2011)
Diuretic activity	The Ayurvedic diuretic property has been supported by an appropriate experimental model. At a dose rate of 3200 mg/kg, an aqueous extract of the <i>A. racemosus</i> root exhibited diuretic action without any acute toxicity comparable to that of the frequently prescribed drug furosemide.	Kumar <i>et al.</i> (2010)

Antihepatotoxic potential	Alcoholic extract of <i>A. racemosus</i> root was used in the study which showed significant antihepatotoxic potential.	Sholapurkar (1986)
Antipyretic effect	The presence of flavonoids and saponins in the ethanolic extract of <i>A. racemosus</i> root indicate that it has a stronger antipyretic effect.	Devi and Priya (2013)
Immunomodulant activity	- Aqueous root extract of <i>A. racemosus</i> exhibited immunomodulant activity. <i>A. racemosus</i> is a significant immunomodulator that activates neutrophils in macrophages. - After administering the diphtheria, tetanus, and pertussis (DTP) vaccination to experimental animals, the immuno-adjuvant ability of <i>Asparagus racemosus</i> aqueous root extract was examined. Comparing treated (test) animals to untreated (control) animals, oral administration of test material at a dose of 100 mg/kg per day for 15 days led to a significant boost ($P = 0.0052$) in antibody titers against <i>Bordetella pertussis</i>. - When mice with <i>E. coli</i>-induced peritonitis were pretreated with a root decoction of <i>A. racemosus</i> at a dose of 100 mg/kg/day for 15 days, the results showed 50% mortality after 16 hours compared to 100% in the control animals, indicating an immune-modulating effect. - In experimental rats, the immune-therapeutic regulation of intraperitoneal adhesions caused by caecal rubbing and by oral administration of 200 mg/kg of entire plant extract of <i>A. racemosus</i> for five days was investigated. When normal rats peritoneal macrophages were examined, they showed a phagocytic activity of 321.77%, whereas those exposed to the plant extract shown a considerable increase of 535.78%.	Gautum <i>et al.</i> (2004) Thatte & Dahanukar (1989) Thatte <i>et al.</i> (1987) Rege <i>et al.</i> (1989)
Antimicrobial activity	<i>Vibrio cholerae</i>, <i>Shigella dysenteriae</i>, <i>Pseudomonas putida</i>, <i>Staphylococcus aureus</i>, <i>Shigella flexneri</i>, <i>Escherichia coli</i>, <i>Salmonella typhi</i>, <i>Salmonella typhimurium</i>, <i>Shigella sonnei</i>, and <i>Bacillus subtilis</i> have all been demonstrated to be significantly inhibited by the methanolic root extract of <i>A. racemosus</i>. - In other <i>in vitro</i> experiments, methanolic root extract of <i>A. racemosus</i> has demonstrated significant antibacterial efficacy against a wide range of pathogens. - Chemical components extracted from <i>A. racemosus</i> have been demonstrated to antimicrobial activity against <i>S. aureus</i> and <i>E. coli</i>, but not against <i>S. typhi</i>. <i>Staphylococcus aureus</i> (74.40), <i>Escherichia coli</i> (89.73), <i>Klebsiella pneumonia</i> (91.93), and <i>Streptococcus mutans</i> (84.28) are the bacterias that are most significantly inhibited by the ethanol fraction of <i>Asparagus racemosus</i>.	Yue <i>et al.</i> (2004), Jagannath <i>et al.</i> (2012), Shah <i>et al.</i> (2014), Roy <i>et al.</i> (2014b)
Wormicidal activity	Preliminary studies using the earthworm (<i>Pheretima posthuma</i>) as a model organism demonstrated that root extract from <i>A. racemosus</i> has wormicidal effect.	Kiranmayi <i>et al.</i> (2012), Gupta <i>et al.</i> (2012)
Antithrombolytic activity	The extractives of whole plant <i>A. racemosus</i> in an experimental study exhibited antithrombolytic activity.	Karim <i>et al.</i> (2017)
Dyspepsia properties	- Dried root powder of <i>A. racemosus</i>. - Fresh root juice of <i>A. racemosus</i>.	Kishore <i>et al.</i> (1980), Dalvi <i>et al.</i> (1990)
Uterus properties	<i>A. racemosus</i> root extracts in ethyl acetate and acetone.	Muruganadan <i>et al.</i> (2000)
Respiratory action	Higher doses of Alcoholic extracts of <i>A. racemosus</i> root.	Roy <i>et al.</i> (1971)
Anti-inflammatory activity	On carrageenan and serotonin-induced rat hind paw oedema models, the anti-inflammatory efficacy of a methanolic extract of <i>A. racemosus</i> root was examined.	Mandal <i>et al.</i> (1998)
Neural disorder activity	The examined ability of <i>A. racemosus</i> root extract to prevent against kainic acid (KA)-induced damage to the striatal and hippocampus brain systems.	Parihar & Hemnani (2004)
Adaptogenic activity	<i>A. racemosus</i> extract found to have excellent adaptogenic properties.	Rege <i>et al.</i> (1999)

Therapeutic utility of *Asparagus racemosus* as a female tonic: Shatavari is the principal Ayurvedic rejuvenative tonic for women, whereas Withania is the main Ayurvedic rejuvenative tonic for men (Sharma and Bhatnagar, 2011). It is traditionally used for PMS and sexual debility and is classified as a uterine tonic because it cleanses, maintains, and strengthens the female reproductive system (Frawley, 1989). Amenorrhea, dysmenorrhea, abnormal uterine bleeding (Swarup and Umadevi, 1998; Chopra and Simon, 2000), menopause, and pelvic inflammatory disease such as endometriosis (Hemprabha *et al.*, 2001; Prasad *et al.*, 2002) and gonorrhoea (Hemprabha *et al.*, 2001; Prasad *et al.*, 2002) (Thomsen, 2002). It relieves infertility, prepares the womb for conception, reduces miscarriage (Naik, 1988; Dwivedi *et al.*, 1991). It acts as a postpartum tonic by stimulating lactation and restoring normalcy to the uterus (Chopra and Simon, 2000). (Naik, 1988; Dwivedi *et al.*, 1991). (Vihan and Panwar, 1988), as well as regulating reproductive hormones and preventing uterine prolapse (Tirtha, 1998). The galactagogue and mammogenic effects are achieved by increasing blood prolactin levels and encouraging mammary gland cellular division (Jetmalani *et al.*, 1967; Sabins *et al.*, 1968; Pandey *et al.*, 2005). It also boosts libido, moisturises dry sexual organ tissues (Frawley, 1997), and improves folliculogenesis and fertilization (Kalia *et al.*, 2003; Sharma and Bhatnagar, 2011).

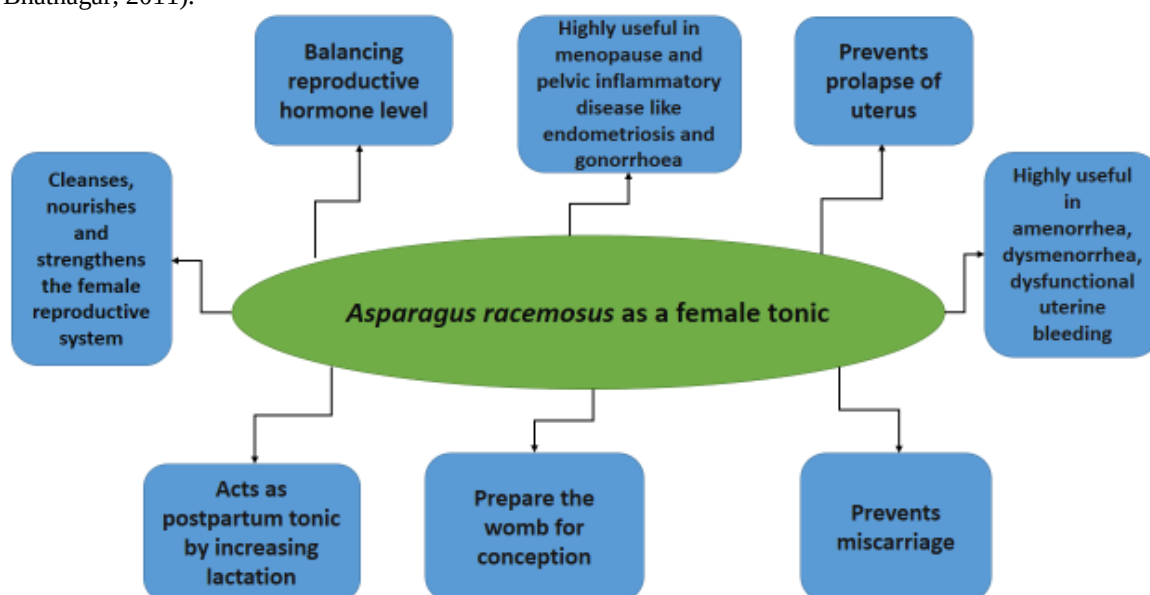


Fig. 2: Therapeutic utility of *Asparagus racemosus* as a female tonic

Other miscellaneous therapeutic utility of *Asparagus racemosus*: Other traditional indications of *A. racemosus* reported include: arthritis (Chaudhary and Singh, 1965), diarrhoea, dysentery (Roy *et al.*, 1971), edema, rheumatism, chronic and common fevers, aphrodisiac, cooling tonic, antispasmodic (Nadkarni, 1976; Singh and Ali, 1994), dyspepsia, indigestion (Dalvi *et al.*, 1990), thirst, sunstroke (Kapoor, 1990), rejuvenator, promoter of strength, breast milk and semen (Dash, 1991), long-term treatment of diabetes, cough (Mandal *et al.*, 2000b), and peptic ulcers (Sairam *et al.*, 2003; Dharmani and Gautam, 2006).

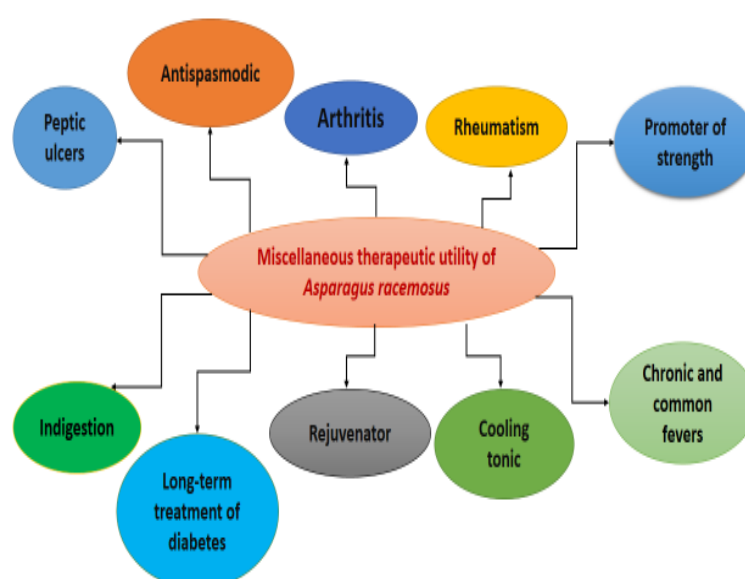
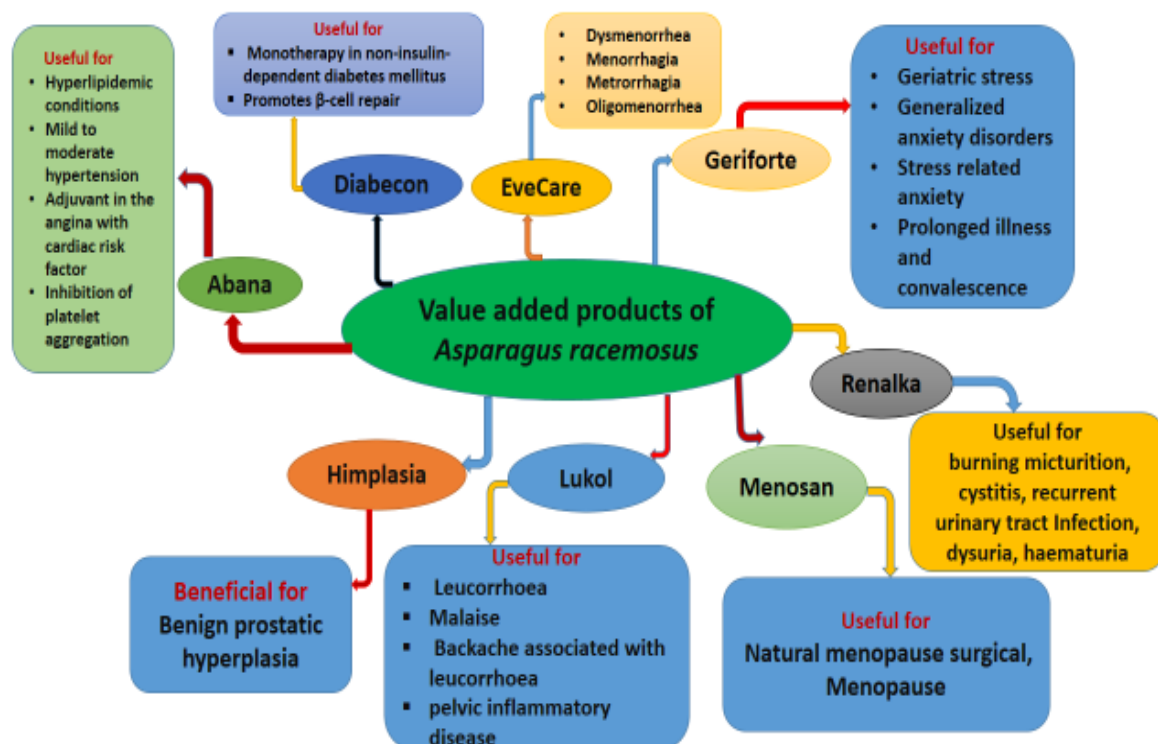


Fig. 3: Other miscellaneous therapeutic utility of *Asparagus racemosus*

Therapeutic utility of *Asparagus racemosus* plant to animal health

Therapeutic utility of <i>Asparagus racemosus</i>	Procedure of action	References
Galactagogue	- Supplementation of fresh root of shatavari at the rate of ½ kg per day with concentrate increases milk yield of buffaloes significantly - Supplementation of root powder of Shatavari @ 100 g per animal at alternate days improves milk production significantly in freshly calved crossbred cows.	Patel and Kantikar, 1969 Berhane and Singh, 2002
Anti-mastitis	Alcoholic extract of the root was found to possess in vitro antibacterial activity against mentioned mastitis causing bacteria such as streptococci, Coliform (<i>E. coli</i>), Klebsiella, Pseudomonas.	Bhatnagar <i>et al</i> , 1961 Ahmed <i>et al</i> , 1998
Anorectic & Rumenotoric	- Oral administration of powdered dried root of <i>A. racemosus</i> has been found to promote digestibility and dry matter intake in healthy as well as in problematic animals without disturbing rumen parameters. - Supplementation of <i>Asparagus racemosus</i> (100 g at alternate day) leads 100% estrus and 75% conception in crossbred cattle within 90 days of calving.	Pradhan, 1995 Barhane and Singh, 2002 Berhane, 2000
Feed supplement	<i>Asparagus racemosus</i> is considered a very important feed supplement component in the animal diets because of higher availability of nutrients in the form of crude protein, crude fiber (and nitrogen free extract and minerals like Ca, Mg, Fe, Cu and Zinc of their higher availability of nutrients.	Sharma and Sharma, 2013 Kumar <i>et al</i> , 2008
Broiler production	Effect of Shatavari root meal on the growth, immunity and carcass quality characteristics of broilers have been studied	Shukla <i>et al</i> , 2018
Anti-anaemic and Antithrombotic	- Potential effect of <i>Asparagus racemosus</i> extract on experimental anaemic and thrombocytopenic condition in rats <i>Asparagus racemosus</i> extract at 750 mg/kg increased significantly the number of RBC, Hb and significantly decreased MCH and WBC when compared with anaemic group. - Likewise in antithrombocytopenic study, extract at 750 mg/kg decreased significantly bleeding time and clotting time compared to heparin group.	Chaudhary <i>et al</i> , 2016

**Fig. 4: Value added products of *Asparagus racemosus***

Value added products of *Asparagus racemosus*

Value added products	Content of <i>A. racemosus</i>	Medicinal properties	References
Abana®	Contains 10mg Shatavari root extract per tablet	Considered useful for hyperlipidaemia conditions Mild to moderate hypertension Adjuvant in the angina with cardiac risk factor and inhibition of platelet aggregation	Venkataramaiah, 2002, verma and Bordia, 1992, Dubey <i>et al</i> , 1986, Verma and Bordia, 1991
Diabecon®	Contains 20 mg Shatavari root extract per tablet	Advised for use in monotherapy in non-insulin-dependent diabetes mellitus (adjuvant to other oral antidiabetic drugs NIDDM with hyperlipidemia early retinopathy microalbuminuria promotes β -cell repair/regeneration and increases the C-peptide level	Ganguly <i>et al</i> , 1995, Kohli <i>et al</i> , 2004, Mitra <i>et al</i> , 1996), Kant <i>et al</i> , 2002, Yajnik <i>et al</i> , 1995, Maji and Singh, 1996
EveCare®	Contains 32 mg Shatavari root extract per 5 ml syrup.	Indicated for dysmenorrheal, Menorrhagia, metrorrhagia, oligomenorrhea	Swarup and Umadevi, 1998, Sarda <i>et al</i> , 2007, Mitra <i>et al</i> , 1998, Venugopal, 1998
Geriforte®	Contains 20 mg Shatavari root powder per tablet.	Theraeuptically useful for geriatric stress Generalized anxiety disorders Stress related anxiety Prolonged illness and convalescence	Ghosh and Mitra, 1995, Shah <i>et al</i> , 1990 Boral <i>et al</i> , 1989, Vaidya, 1979
Himplasia®	Containing 80 mg Shatavari root powder per tablet	Considered beneficial for benign prostatic hyperplasia	Sahu M and Kulkarni KS, 2003
Lukol®	Concentration of 40 mg Satavari root extract per tablet	Prescribed for leucorrhea, malaise, backache associated with leukorrhea and pelvic inflammatory disease	Bhatnagar and Bhatnagar, 1984, Dabak <i>et al</i> , 1982, Tewiri <i>et al</i> , 2001
Menosan®	110 mg Satavari root extract per tablet	Useful for natural menopause, surgical menopause	Sarkar <i>et al</i> ., 2004, Singh S and Kulkarni, 2002
Renalka®	Contains 50mg shatavari root extract per 5mL of syrup	Mainly used for burning micturition, cystitis, recurrent urinary tract Infection, dysuria and hematuria.	Sahu <i>et al</i> , 2002, Prakash, 2001

Safety of *Asparagus racemosus*

Extracts	Safety	References
Root extract	Root extracts of <i>Asparagus racemosus</i> are considered safe for long term use even at very high doses and even during pregnancy and lactation No abnormality in the behaviour of rats and mice was observed following the administration of root extract of <i>Asparagus racemosus</i> plant for prolonged period of time	Sharma & Bhatnagar, 2011
All extracts	Systematic administration of higher doses of all extracts did not produce any abnormality in behavioural pattern of mice & rat	Jatmalani <i>et al</i> , 1967
Methanolic root extract	- Methanolic root extract was administered to Charles-foster strain albino rats @100mg/kg/day for 60 days. In prenatal study the extract treated group of rats suffered from increased resorption of fetuses, swelling of legs and slow growth of fetal body and placental parts - In the post-natal study the group of rats to which the extract was administered showed a decreased number of pups per litter, increased mortality of pups per litter and delayed the various developmental parameters when compared to control group, although, it does not show teratogenicity at clinical dose	Goel <i>et al</i> ., 2006
Shatavari at 1% level	Quite safe and viable for lucrative rearing of broilers for meat production	Kumar <i>et al</i> ., 2019

Biotechnological conservational approaches

The development of better conservation strategies can be ensured by identification of elite genotypes via molecular marker techniques and chemo profiling followed by their mass multiplication using both conventional and biotechnological approaches (Kumar *et al.*, 2016).

In vitro approaches for conservation of *Asparagus recemosus*

Name of propagation technique	Explant used & Results obtained	References
Callus culture	Shoot proliferation was induced from callus culture of <i>Asparagus recemosus</i> with 2,4 D and Kinetin using stem disc as explants	Kar & Sen, 1985
Indirect organogenesis via callus culture	- Stem disc as explant - Adventitious shoot bud regeneration and through callus culture using nodal portion as explant	Kar & Sen, 1985 Bopana & Saxena, 2008 Kumar & Vijay, 2008
Somatic embryogenesis	Ancymidol in combination with kinetin & NAA was found to be most efficient for somatic embryo maturation & germination	Chaudhary & Dantu, 2019

Important metabolite scaling-up techniques: The predominant phytoconstituents of *A. racemosus* are steroidal saponins, which have promising pharmacological effects (Pise *et al.*, 2011). The use of in vitro methods to extract saponin can help to reduce overexploitation of the plant. Suspension culture, for example, is a biotechnological plant technology that not only aids in conservation but also provides an alternate way of manufacturing huge amounts of active ingredient directly in the laboratory. Plant hormones are essential for callus formation. A systematic procedure for callus culture was created in order to establish the suspension culture technique. MS medium supplemented with 1.0mg/L ZEATIN + 0.1mg/L BAP yielded the greatest friable callus induction, maximum callus induction rate, and good callus growth. Following that, the same media was used to establish suspension culture. At 18 days after culture, the biomass of suspension culture starting from root explant produced the highest saponin production (0.580 mg/g) and the largest growth (7.7 g/l) in *A. racemosus* cell suspension culture (Sherathiy *et al.*, 2014).

CONCLUSION

Asparagus recemosus is a tropical and subtropical Indian medicinal plant that has been utilised for therapeutic and tonic purposes for thousands of years. Traditional techniques have been proven by phytochemical analysis and pharmacological research of *Asparagus recemosus* preparations. However, the Unani system of medicine mentions a slew of other indications that will require more scientific research to confirm their efficiency. The therapeutic efficacy of several components of *A. racemosus* have been widely explored. *A. racemosus* extracts have been shown to have a wide range of pharmacological activities and are effective medicinal agents. In order to develop the extract as a medicine in the near future, more research is required. Promoting traditional knowledge of the therapeutic herbal plant is vital and inevitable in the contemporary period, when there is an increasing problem with the use of synthetic medicines. Human uses of *Asparagus racemosus* are well established, indicating that it can be used as a multi-purpose medicinal agent. Its use in animal health is reported but very scanty, needs to be explored fully for animal health prospects too.

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