

Book: Phytochemistry and Pharmacology of Medicinal Herbs

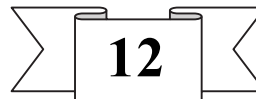
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## Multidimensional Efficacy of *Asparagus racemosus* Willd: A Medicinal Herb

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### ABSTRACT

Plants have been the basis of many traditional medicine systems throughout the world for thousands of years and continue to provide mankind with new remedies. *Asparagus racemosus* Willd is a medicine plant belongs to family Liliaceae and commonly known as Satawar, Satamuli, and Satavari found at low altitudes throughout India. Different species of *Asparagus* are present in India and all over the world. Every part of *A. racemosus* such as stem, root, leaves, are use to prevent disease in both humans and dairy animals. Its medicinal usage has been reported in the Indian and British Pharmacopoeias and in traditional systems of medicine such as Ayurveda, Unani and Siddha. *A. racemosus* is mainly known for its phytoestrogenic properties. With an increasing realization that hormone replacement therapy with synthetic oestrogens is neither as safe nor as effective as previously envisaged, the interest in plant-derived oestrogens has increased tremendously making *A. racemosus* particularly important. Mostly its sapogenin content the precursor of many pharmacologically active steroids. In spite of this it also contains minerals and vitamin. In Ayurveda, *A. racemosus* has been described as a rasayana herb and has been used extensively as an adaptogen to increase the non-specific resistance of organisms against a variety of stresses. The plant has been shown to aid in the treatment of neurodegenerative disorders and in alcohol abstinence-induced withdrawal symptoms. Besides use in the treatment of diarrhea and dysentery, the plant also has potent antioxidant, immune stimulant, anti-dyspepsia, antitussive effects Antiulcerogenic action, antibacterial, analgesic, galactagogue affects,

antihepatotoxic, immunomodulatory effect, Antioxidant etc. We will also discuss the *in silico* activity against dyspepsia of the active phytochemicals present in the herbal formulation.

**Keywords:** Herbal product, Phytochemicals, Pharmacology, *In silico* and *A. racemosus* Willd.

## INTRODUCTION

Plants, besides providing nutrition, have always formed an important source of chemical compounds, which can be used for medicinal purposes. Many species of plants synthesize and accumulate extractable organic substances in quantities sufficient to be economically useful as chemical feed stocks or as raw materials for various scientific, technological, and commercial applications. Plant based medicines initially dispensed in the form of crude drugs such as tinctures, teas, poultices, powders, and other herbal formulations, now serve as the basis of novel drug discovery (Samuelsson, 2004). The use of plants as medicines has involved the isolation of active compounds, beginning with the isolation of morphine from opium in the early 19th century (Kingham et al., 2001) and subsequently led to the isolation of early drugs such as cocaine, codeine, digitoxin and quinine, of which some are still in use (Butler, 2004). In many developing countries, there has been an increasing interest in use of herbal medicine for primary health care. About 80 % worldwide peoples mainly use herbal medicine (WHO, 2002). The herbal extracts have been a chief source of medicinal agents from long time ago. In worldwide, about thousands of plant species are known to have medicinal value and used to cure specific diseases (Parekh et al., 2005). Plant kingdom harbors an inexhaustible source of active ingredients invaluable in the management and treatment of many intractable diseases. However, these complementary components give the plant as a whole a safety and efficiency much superior to that of its isolated and pure active components (Shariff, 2001). *Asparagus racemosus* is also known as Shatavari, which belongs to family Liliaceae. Shatavari is the main Ayurvedic rejuvenative tonic for the female. Shatawari has different names in the different Indian languages, such as Shatuli, Vrishya and other terms. In Nepal, it is called Kurilo. The name Shatawari means "curer of a hundred diseases" (shat: "hundred"; variety: "curer"). Shatavari means "who possesses a hundred husbands or acceptable to many". It is considered both a general tonic and a female reproductive tonic. Shatavari may be translated as "100 spouses", implying its ability to increase fertility and vitality. In Ayurveda, this amazing herb is known as the "Queen of herbs", because it promotes love and devotion. In Indian system of medicine *A. racemosus* is an important medicinal plant and its root paste or root juice has been used in various ailments and as health tonic. The

stem is woody, climbing, whitish grey or brown colored with small spines. The plant flowers during February–March leaving a mild fragrance in its surrounding and by the end of April, fruits can be seen with attractive red berries. The roots are cylindrical, fleshy and tuberous. The roots are 30-100 cm in length, 1-2 cm in thickness and yellowish-cream in colour (Kirtikar and Basu, 1975). The plant enjoys considerable reputation in Indian system of medicine. Traditionally, the plant has been in use as a galactagogue which stimulates the secretion of breast milk. The other biological properties of plant are in aphrodisiacs, demulcent, rheumatism, diarrhoea, dysentery, tuberculosis, diabetes, antioxidant, antitussive, nervous disorders, hyperacidity, general debility, habitual abortion and safe delivery (Nadkarni, 1976). The reputed adaptogenic properties of the plant are attributed to the presence of high concentrations of saponins, known as Shatavarins. It is considered as very good energy provider to the weak body system. It is estimated that in India, more than 500 tonnes of shatavari roots are needed every year for various medicinal preparations. Aphrodisiacs are the substances which are used to increase sexual activity and help in fertility. Sexual feelings are an inevitable part of life. The basic and fundamental purpose of sex and sexuality is the “continuation of progeny” and the survival of human race (Kothari, 2001). Shatavari is, however, also used for sexual debility and infertility in both sexes. It is also used for menopausal symptoms and to increase lactation. In classical Ayurveda Shatavari is one of the best rejuvenative drugs. Its pharmacological applications, particularly from the root extracts, have recently been found to possess a phytoestrogenic effect, an effect on neurodegenerative disorders, as well as antidiarrhoeal (Venkatesan, 2005), antidyspepsia, adaptogenic, antiulcer, cardioprotective, antibacterial (Uddin et al., 2012), immunoadjuvant and antitussive effects. The root extracts of AR have been employed in two major forms as methanolic and aqueous extracts, the products of which include root extract in tablet form, root powder in tablet form and root extract in syrup form (Nand and Saxena, 2007). Goyal et al., (2003) reported that *A. racemosus* possess much more important biological properties such as immunostimulants, anti-inflammatory, anti-hepatotoxic, antimicrobial and reproductive agent. Hayes et al., (2006) investigated that, *A. racemosus* is also used in the treatments of various disorders including stomach ulcers, lung abscess, menopause, herpes and chronic fevers. In addition to this, roots of this plant can be used in nervous disorders, dyspepsia, diarrhoea, dysentery, tumors, inflammations, neuropathy, hyperdipsia, cough, bronchitis, hyperacidity and infectious diseases (Sharma et al., 2000). Generally, root of this plant is bitter in taste, emollients, cooling, nervine tonic, constipating, diuretic and rejuvenating.

**Classification of Herb**

*Asparagus racemosus* (shatavari)  
Kingdom: Plantae  
Division: Angiosperms  
Class: Monocots  
Order: Asparagales  
Family: Asparagaceae; Liliaceae  
Subfamily: Asparagoideae  
Genus: *Asparagus*  
Species: *racemosus*

**Cultivation*****Soils***

The plant prefers light (sandy), medium (loamy) and heavy (clay) soils and requires well-drained soil. Black, well drained and fertile soil is good for cultivation.

***Climate***

Crop responses well to tropical and hot climate. Temperature required 25-40°C.

***Irrigation***

The tamarind is adapted to semiarid regions of the tropics and can withstand drought conditions quite well. They require minimum irrigation so avoid over-watering..

***Fertilization***

One ploughing, three harrowings and then apply 20-25 tonnes of farm yard manure.

***Harvest***

Raised beds -1x3 m in the month of May or June Seed one kg for one hectare area. Apply 50 gram urea in the bed after 20-25 days. Seedlings become ready within 6-8 weeks for transplantation in the main field. Transplanting- Size of pit-45x45x45) spacing-row to row-1.5m and plant to plant-1.0m Fill the pits with 20-30 gram lindane or carbaryl and 5 kgs of FYM at the time of transplanting. Generally shatavari crop does not affect with pest and diseases.

### Harvesting

First harvesting 1.5-2 years after transplanting, which continues for 10-15 years. Male and female plants must be grown if seed is required.



Figure 1. Root, leaf, flowers and plants of *R. racemosus* Willd. Commercial ayurvedic products of *R. racemosus* Willd.

**Phytochemistry of herb**

Shatvari is known to possess a wide range of photochemical constituents which are mentioned below. Some of the structures have been shown in figure 2.

- a) Steroidal saponins, known as shatvarins. Shatvarin I to VI are present. Shatvarin I is the major glycoside with 3-glucose and rhamnose moieties attached to sarsapogenin
- b) Oligospirostanoside referred to as Immunoside
- c) Polycyclic alkaloid-Aspargamine A, a cage type pyrrolizidine alkaloid
- d) Isoflavones-8-methoxy-5, 6, 4-trihydroxy isoflavone-7-O-beta-D-glucopyranoside
- e) Cyclic hydrocarbon-racemosol, dihydrophenantherene
- f) Furan compound-Racemofuran
- g) Carbohydrates-Polysacharides, mucilage
- h) Flavanoids-Glycosides of quercitin, rutin and hyperoside are present in flower and fruits
- i) Sterols-Roots also contain sitosterol, 4, 6-dihydroxy-2-O (-2-hydroxy isobutyl) benzaldehyde and undecanyl cetanoate
- j) Trace minerals are 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
- k) Kaepfrol-Kaepfrol along with Sarsapogenin from woody portions of tuberous roots could be isolated
- l) Miscellaneous-Essential fatty acids-Gamma linoleinic acids, vitamin A, diosgenin, quercetin 3-glucourbnides

**Mineral contents**

In *A. racemosus* different mineral content are present as Ca, Mg, K, Fe, Cu, Mn, Zn, Cu in different parts as root, stems, leaves, flowers, seed, and twigs.

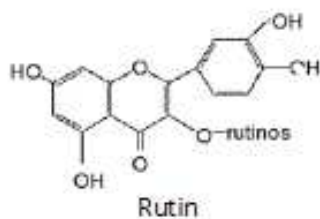
Table 1. Mineral contents in different part of *Asparagus racemosus* Willd (Dry plant material figures in g/100gms) are given below.

Element	Root	Stem	Leaves	Twigs	Flowers	Seeds
Ca	0.192	0.115	0.115	0.417	0.424	0.022
Mg	0.1	0.043	1.3	0.43	0.34	0.05
K	2.05	1.63	1.29	3.47	4.79	1.78
Fe	0.004	0.002	0.01	0.004	0.007	0.003
Figures in microgram/gm						
Cu	3.28	3.45	3.13	4.33	13.03	4.55
Zn	39.17	30.04	64.95	36.38	117.97	30.39
Mn	9.73	5.5	48.29	21.82	28.14	6.41
Co	12.41	18.4	29.46	17.91	43.46	10.41

Adapted from: Choudhary and Kar, (1992)

### Phytochemicals

The major active constituents of *Asparagus racemosus* are steroidal saponins (Shatavarins I-IV). Isoflavones, Asparagamine, Racemosol, Polysaccharides, mucilage, vitamins A, B1, B2, C, E, Mg, P, Ca, Fe, and folic acid present in roots. Other primary chemical constituents of *Asparagus* are essential oils, asparagine, arginine, tyrosine, flavonoids (kaempferol, quercetin, and rutin), resin and tannin. It is a well known Ayurvedic rasayana which prevent ageing, increase longevity, impart immunity, improve mental function, vigor and add vitality to the body. It is also used in nervous disorders, dyspepsia, tumors, inflammation, neuropathy and hepatopathy.



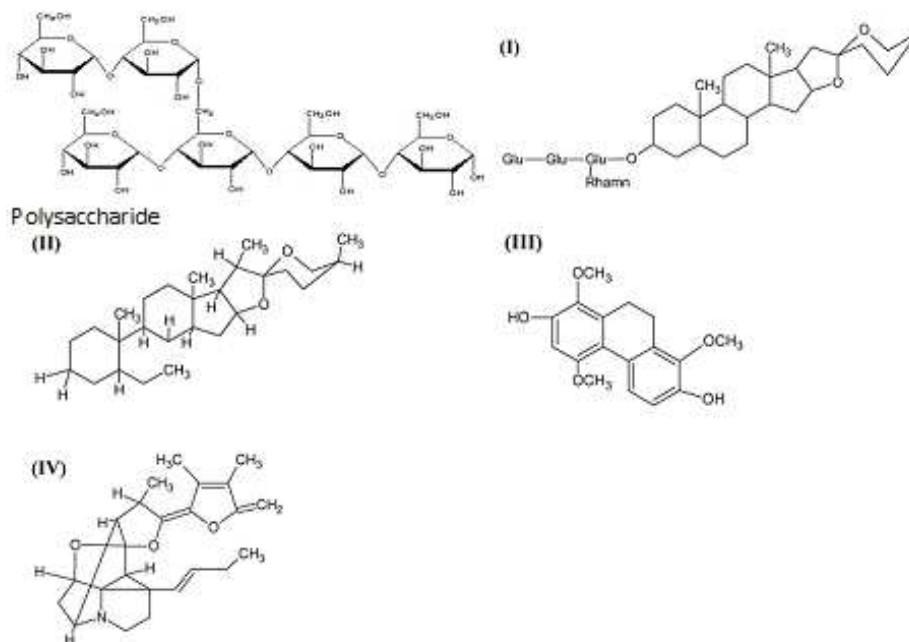


Figure 2. Active principles of *A. racemosus* Willd (I) Shatavarin, (II) Sarsasapogenin, (III) Racemosol and (IV) Asparagamine.

## Pharmacological activity

### *Galactagogue effect*

In Ayurveda to increase milk secretion during lactation the root extract of *A. racemosus* is prescribed (Nadkarni, 1954). In the form of Ricalax tablet (Aphali pharmaceutical Ltd. Ahmednagar) *A. racemosus* in combination with other herbal substances has been shown to increase milk production in females complaining of deficient milk secretion (Joglekar et al., 1967). Gradual decrease in milk secretion, on withdrawal of the drug suggested that the increase in milk secretion was due to drug therapy only and not due to any psychological effect. In the form of a commercial preparation, lactare (TTK Pharma, Chennai) is reported to enhance milk output in women complaining of scanty breast milk, on the 5th day after delivery (Sholapurkar., 1986).



Table 3. Phytoconstituents of *A. racemosus*.

Phytoconstituents	Obtained from	Function/Activity	References
Racemosol (9,10 dihydrophenanthene)	Roots	Antimicrobial and Cytotoxic	Sekine et al ., 1997, Wiboonpun et al., 2004, boger et al., 1985
Racemofuran	Roots	Antioxidative	Wiboonpun et al., 2004
Oligospirostanoside/ Immunoside	Roots	Immunomodulation,potent inducer of apoptosis	Handa et al., 2003, Bhutani et al., 2010
Aspargamine A	Roots	Anti-oxytotic	Sekine et al ., 1994, Sekine et al ., 1995, Wiboonpun et al., 2004
Isoflavones (8-methoxy-5,6, 4-trihydroxy isoflavone-7-0-beta-D-glucopyranoside)	Roots	Esterogenic	Saxena and Chourasia, 2001
Sarsasapogenin	Roots, in vitro cultures		Kar and Sen, 1985, Asmari et al.,2004, Ahmed et al ., 1991
Shatavarin I	Roots	Competitive block of oxytocin-induced contraction, Anticancerous	Hayes et al.,2006, Hayes et al.,2008, Dhuley, 1997, Rao Et al., 1981
Shatavarin IV	Roots	Cytotoxic and immunomodulatory effect	Hayes et al.,2008, Satti et al.,2006
Shatavarin V	Roots	Different Biological activites	Hayes et al.,2006b, Hayes et al.,2008
Shatavarin VI	Roots		Hayes et al.,2008
Shatavarin VII	Roots		Hayes et al.,2008
Shatavarin VIII	Roots		Hayes et al.,2008
Shatavarin IX	Roots		Hayes et al.,2008
Shatavarin X	Roots		Hayes et al.,2008
Kaempferol	Roots		Ahmed et al ., 1991
Shatavaroside A	Roots		Sharma et al., 2009
Shatavaroside B	Roots		Sharma et al., 2009
Shatavaroside C	Roots		Sharma et al., 2009
Sapogenin(21-nor-18â,27â-dimethyl-1 â, 2â,3â-trihydroxy-25-spirosat-4-en-19 â-oic acid.)	Roots	Immunostimulation	Sharma et al., 2011
Quercetin3-glucounides	Leaves		Rastogi and Mehrotra, 1969
Racemosides A	Fruits	Anti-leishmnia	Mandal et al., 2006, Dutta et al., 2002
Racemosides B	Fruits		Mandal et al., 2006
Racemosides C	Fruits		Mandal et al., 2006

A significant increase in milk yield has also increase growth of mammary glands, alveolar tissue and acini in guinea pigs (Narendranath et al., 1986). Patel et al. have shown galactogogue effect of *A. racemosus* in buffaloes (Patel and Kanitkar, 1986). However, Sharma et al. did not observed any increase in prolactin level in females complaining of secondary lactational failure with *A. racemosus*, suggesting that it has no lactogenic effect (Sharma et al., 1996). In other study, the aqueous fraction of the alcoholic extract of the roots at

250 mg/kg, administered intramuscularly, was shown to cause both an increase in the weight of mammary gland lobuloalveolar tissue and in the milk yield of oestrogen primed rats. The activity has been attributed to the action of released corticosteroids or an increase in prolactin (Joglekar et al., 1967).

#### ***Antisecretory and antiulcer Potential***

*A. racemosus* efficacy was evaluated in 32 patients, for an average duration of 6 weeks by administering the root powder 12 g/d in four doses. Shatavari was found to relieve most of the symptoms in majority of the patients. The ulcer healing effect of the drug was attributed to a direct healing effect, as it has neither antisecretory activity nor antacid properties, by strengthening mucosal resistance, prolonging the lifespan of mucosal cells, increasing secretion and viscosity of mucous and reducing H<sup>+</sup> ion back diffusion and had possible potentiating intrinsic protective factor. *A. racemosus* may have cytoprotective action similar to that of prostaglandin other than binding of bile salts with heals duodenal ulcers without inhibiting acid secretion. It has been found to maintain the continuity and thickness of aspirin treated gastric mucosa with a significant increase in mucosal mass (Singh and Singh, 1986; Bhatnagar and Sisodia, 2006; Sairam et al., 2003).

#### ***Adaptogenic activity***

Shatavari in aqueous extract was administered orally to experimental animals of biological, physical and chemical stressors. A model of cisplatin induced alteration in gastrointestinal motility was used to test the ability of extract to exert a normalizing effect, irrespective of direction of pathological change. This extract reversed the effects of cisplatin on gastric emptying and also normalized cisplatin-induced intestinal hyper motility (Regh et al., 1989).

#### ***Antitussive Action***

Shatavari roots of methanolic extract of, at dose of 200 and 400 mg/kg showed significant antitussive activity on sulphur dioxide induced cough in mice. The cough inhibition of 40% and 58.5%, respectively, was comparable to that of 10-20 mg/kg of codeine phosphate, where the inhibition observed 36% and 55.4% respectively (Mandal et al., 2000a)

#### ***Antibacterial action***

Significant results were shown in methanolic extract of Shatavari roots at 50, 100 and 150 mg/mL. *In vitro* antibacterial efficacy against *Escherichia coli*, *Shigella dysenteriae*, *Shigella sonnei*, *Shigella flexneri*, *Vibrio cholerae*, *Salmonella typhi*, *Salmonella typhimurium*, *Pseudomonas pectida*, *Bacillus subtilis* and

*Staphylococcus aureus*. Chloramphenicol was used for comparison (Mandal et al., 2000b).

#### ***Antiprotozoal action***

Shatavari roots in an aqueous solution with crude alcoholic extract exhibited an inhibitory effect of the growth of *Eintamoeba histolytica in vitro* (Roy et al.,1971).

#### ***Toxic effect***

In Ayurveda *A. racemosus* has been described as absolutely safe for long term use, even during pregnancy and lactation. Higher doses with systemic administration of all extracts did not produce any abnormality in behavior pattern of mice and rat (Jetmalani et al., 1967). LD50 of the product lactare has not been assessed since it did not produce mortality even up to oral dosage of 64 g/kg (Narendranath et al., 1986).

#### ***Antioxidant effects***

Purified aqueous fraction of *A. racemosus* have antioxidant effects of crude extract against membrane damage induced by the free radicals generated during gamma radiation were examined in rat liver mitochondria. Seventy five to nine hundred Gray Gamma radiation, induced lipid peroxidation as assessed by the formation of thiobarbituric acid reactive substances and lipid hydroperoxides. *A. racemosus* extract with using an effective dose of 450 Gray have antioxidant effect were studied against oxidative damage term of protection against lipid peroxidation, protein oxidation. An active fraction consisting of polysaccharides (P3) was effective even low concentration of 10 mg/mL. Both the crude extract as well as P3 fraction significantly inhibited lipid peroxidation and protein oxidation. The antioxidant effect of P3 fraction was more pronounced against lipid peroxidation, as assessed by thiobarbituric acid reactive substance formation, while that of crude extract was more effective in inhibiting proteins oxidation (Kamat et al ., 2000; Wiboonpun et al .,2004; Takeungwongtrakul et al ., 2012; Visavadiya et al., 2009).

#### ***Antilithiatic effects***

Ethanollic extract of *A. racemosus* was evaluated for its inhibitory potential of lithiasis (stone formation), induced by oral administration of 0.75% ethylene glycolated water to adult male albino wistar rats for 28 day. The ionic chemistry of urine was altered by ethylene glycol, which elevated the urinary concentration of crucial ions viz. calcium, oxalate and phosphate, there by contributing to renal stone formation. The ethanollic extract elevated the urinary concentration of magnesium, which is considered as one of the

inhibitor of crystallization however, significantly reduced the elevated level of these ions in urine (Christina et al., 2005).

#### *Teratogenicity effects*

In Ayurveda *A. racemosus* is an herb used as a rasayna and is considered both general and female reproduction tonic. Methanolic extract of *A. racemosus* roots (MAR), 100 mg/kg per day for 60 d, showed teratological disorders in terms of increase resorption of fetuses, gross malformation e.g. swelling in legs and intrauterine growth retardation with a small placenta size in charles foster rats. *A. racemosus* when exposed to Pups to mother to for full duration of gestation showed evidence of higher rate of resorption and therefore smaller litter size. The live pup showed significant decrease in body weight and length, and delay of various development parameters when compared to respective control group. Therefore, *A. racemosus* may cause damage to the offspring as it used in pregnancy continuously due to its exposure during that period (Goel et al., 2006).

#### *Antidepressant activity*

Antistress agents as Adaptogenic drugs are those which are useful as by promoting non-specific resistance of the body. *A. racemosus* is well documented, its use in psychological disorders like depression is not scientifically evaluated the adaptogenic effect. The antidepressant effect of MAR (Methanolic extract of *A. racemosus* roots) was standardized to saponins (62.2% w/w). Rats were given methanolic extract of roots of *A. racemosus* in doses of 100, 200 and 400 mg/kg daily for 7 d and then subjected to forced swim test (FST) and learned helplessness test (LH). The results showed that increased avoidance response in LH indicating antidepressant activity and MAR decreased immobility in FST. In behavioral experiments, MAR increased the number of head twitches produced by 5-HTP and increased clonidine-induced aggressive behavior indicating facilitator effect on both serotonergic and adrenergic systems respectively. However, MAR had insignificant effect on l-DOPA-induced aggressive behavior indicating absence of activity on dopaminergic system. Due to induced FST, MAR also reversed changes to the endogenous antioxidant system. Thus, MAR has significant antidepressant activity and this effect is probably mediated through the serotonergic, noradrenergic systems and augmentation of antioxidant defenses (Singh et al., 2009).

#### *Anti-inflammatory effects*

On administration at 200 mg/kg (i.p.), ACE inhibited topical edema in the mouse ear, following leading to substantial reductions in skin thickness

and tissue weight, inflammatory cytokine production, neutrophil-mediated myeloperoxidase activity, and various histopathological indicators. Furthermore, ACE was effective at reducing inflammatory damage induced by chronic TPA exposure and evoked a significant inhibition of vascular permeability induced by acetic acid in mice (Lee et al., 2009).

#### *Enhances memory and protects against amnesia*

Anti-amnesic activity of MAR (Methanolic extract of *A. racemosus* roots) also significantly reversed scopolamine and sodium nitrite-induced increase in transfer latency on elevated plus maze. Further, MAR dose-dependently inhibited acetylcholinesterase enzyme in specific brain regions (prefrontal cortex, hippocampus and hypothalamus). Thus, due to its anti-cholinesterase activity, MAR showed nootropic and anti-amnesic activities in the models tested and these effects may probably be mediated through augmentation of cholinergic system. Post-trial administration of *Convolvulus pluricaulis* and *A. racemosus* extract demonstrated significant decrease in latency time during retention trials. *A. racemosus* and carbonic anhydrase 3 area with *C. pluricaulis* treatment evaluates hippocampal regions associated with the learning and memory functions showed dose dependent increase in AChE activity in carbonic anhydrase 1. The antioxidant, neuroprotective and cholinergic properties may be attributed to their underlying mechanism of these actions of *A. racemosus* and *C. pluricaulis* (Ojha et al., 2010; Sharma et al., 2010).

#### *Aphrodisiac activity*

*A. racemosus*, *Chlorophytum borivilianum*, and rhizomes of *Curculigo orchioides* in form of lyophilized aqueous extracts obtained from the roots were studied for sexual behavior effects in male albino rats and compared with untreated control group animals. Administration of 200 mg/kg body weight of the aqueous extracts had pronounced anabolic effect in treated animals as evidenced by weight gains in body and reproductive organs then the rats were evaluated for effect of treatments on anabolic effect. Seven measures of sexual behaviors were evaluated. There was a significant variation in the sexual behavior of animals as reflected by reduction of mount latency, ejaculation latency, post ejaculatory latency, intromission latency, and an increase of mount frequency. Penile erection was also considerably enhanced. Reduced hesitation time (an indicator of attraction towards female in treated rats) also indicated an improvement in sexual behavior of extract treated animals. The observed effects appear to be attributable to the testosterone-like effects of the extracts. Nitric oxide based intervention may also be involved as observable from the improved penile erection. The usefulness of these herbs and provide a scientific basis for their purported the traditional usage, the present results, support the folklore claim (Thakur et al., 2009).

### *Diuretic activity*

With the highest dose, the diuretic study revealed significant diuretic activity in dose of 3 200 mg/kg as Acute toxicity study showed no fatality. (Kumar et al., 2010).

### *Potential to prevent hepatocarcinogenesis*

The development of malignancy was demonstrated by histopathological studies of hepatic tissues of Wistar rats treated with diethylnitrosamine (DEN) (200 mg/kg body weight, i.p.) once a week for 2 weeks, followed by treatment with Dichlorodiphenyltrichloro-ethane, a tumor promoter (0.05% in diet) for 2 weeks and kept under observation for another 18 weeks. *A. racemosus* prevented the incidence of hepatocarcinogenesis when pretreatment of Wistar rats with the aqueous extract of the roots were given. Immunohistochemical staining of the hepatic tissues of rats treated with DEN showed the presence of p53+ foci (clusters of cells expressing the mutated p53 protein), whereas an absence of p53+ foci was observed in Wistar rats pretreated with the aqueous extract of the roots of *A. racemosus*. The aqueous extract of *A. racemosus* showed an absence of p53+ foci. When microsections of the hepatic tissue of rats treated with DEN followed by treatment. The results of the biochemical determinations also showed that pretreatment of Wistar rats with the aqueous extract of *A. racemosus* led to the amelioration of oxidative stress and hepatotoxicity brought about by treatment with DEN. Therefore aqueous extract of the roots of *A. racemosus* has the potential to act as an effective formulation to prevent hepatocarcinogenesis induced by treatment with DEN, this experiment proves that (Agrawal et al., 2008).

### *Anti-stress potential*

In the Indian traditional medicine system *A. racemosus* and other plant *Chlorophytum arundinaceum*, *Asparagus adscendens* are used for improving the general state of health and for stress-related immune disorders. In an experimental mouse stress model, induced by swimming. Were examined the effects of the methanol and aqueous extracts of the tuberous roots of these plants. The extracts were shown to exert an inhibitory effect on pro-inflammatory cytokines, namely interleukin 1 $\alpha$  and tumour necrosis factor  $\alpha$ , and on the production of nitric oxide in mouse macrophage cells RAW 264.7 stimulated by lipopolysaccharide in vitro. Similar inhibition was also observed in the production of interleukin 2 in EL4 lymphoma cells stimulated by concanavalin A. Corticosterone levels in serum and adrenal glands were measured. In the management of stress and inflammatory conditions this findings suggest that these plants may be beneficial (Kanwar and Bhutani, 2010; Joshi et al., 2012).

### ***Reduce blood glucose***

A significant increase in insulin release were reported by its Ethanol extract, during 10 min perfusion ( $P < 0.001$ ), with a 21-fold increase above basal ( $0.06 \pm 0.01$ ) ng/mL at 2.8 mmol/L glucose vs. ( $1.27 \pm 0.09$ ) ng/mL with ethanol extract. Subsequent exposure for 5 min to 11.1 mmol/L glucose caused steep elevation in insulin release. When extract was reintroduced at 11.1 mmol/L glucose, there was a further enhancement of insulin release ( $P < 0.05$ ). Perfusion with hexane, chloroform and ethyl acetate fractions evokes a significant increase in insulin release in an almost similar pattern, with a peak increase above basal of 36-, 18- and 28-fold, respectively. Less prominent effects on insulin release showed by aqueous and butanol fractions showed, especially at lower glucose concentration (Hannan et al., 2007).

### ***A multipurpose female tonic***

In Ayurveda, it is considered a female tonic. it is a rejuvenating herb beneficial in female infertility, as it increases libido, cures inflammation of sexual organs and even moistens dry tissues of the sexual organs, enhances folliculogenesis and ovulation, prepares womb for conception, prevents miscarriages, acts as post partum tonic by increasing lactation, normalizing uterus and changing hormones in spite of being a. Its use is also advocated in leucorrhoea and menorrhagia (Sharma et al, 2011).

### ***Cytotoxicity, analgesic and antidiarrhoeal actions***

*A. racemosus* is known as the queen of herbs in Ayurveda because it has a strong rejuvenating, nurturing and stabilizing effect on excessive air, gas, dryness and agitation in body and mind. *A. racemosus* with ethanol extracts was investigated for biological action. The test for analgesic activity of the crude ethanol extract was performed using acetic acid induced writhing model in mice. Antidiarrhoeal test of the ethanol extracts of *A. racemosus* was done according to the model of castor oil induced diarrhea in mice and brine shrimp lethality bioassay was used to determine cytotoxic activity of ethanol extract of the plant. In acetic acid induced writhing in mice, the ethanol extract exhibited significant inhibition of writhing reflex 67.47% ( $P < 0.01$ ) at dose of 500 mg/kg body weight. Antidiarrhoeal activity was showed by the plant extract in castor oil induced diarrhoea in mice. It increased mean latent period and decreased the frequency of defecation with number of stool count at dose of 250 and 500 mg/kg body weight, respectively comparable to the standard drug loperamide at dose of 50 mg/kg body weight. In addition, cytotoxicity, analgesic and antidiarrhoeal activities were identified in the brine shrimp lethality test which showed significant cytotoxic activity of the plant extract (LC50 : 10  $\mu$ g/mL and LC90 : 47.86  $\mu$ g/mL). The obtained results

support the traditional uses of the plant and require further investigation to identify the chemical constituent ( Karmakar et al., 2012).

### Gastrointestinal effects

In Ayurveda for dyspepsia, the powdered dried root of *A. racemosus* was used. *A. racemosus* has been found to promote gastric emptying in healthy volunteers in oral administration of powdered dried root of it. Its action is reported to be comparable with that of the synthetic dopamine antagonist

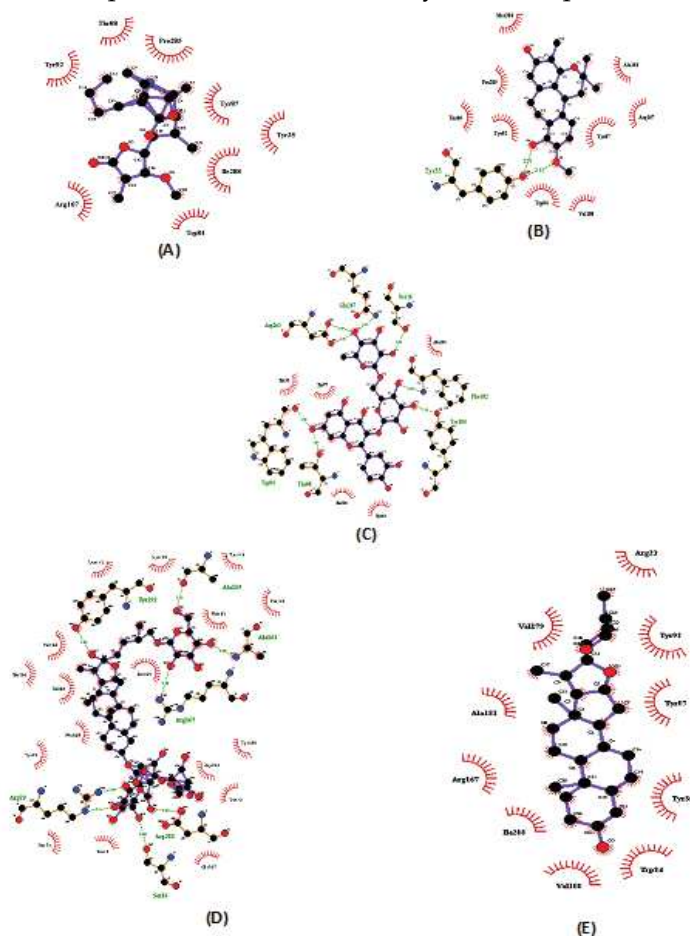
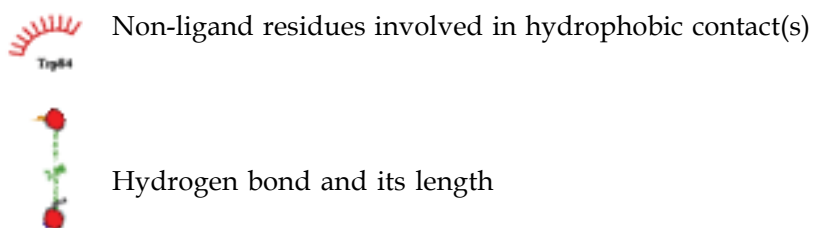


Figure 3. Visualization of the Angiotensin Receptor (AR) (PDB: 4ZUD)-ligand complex. (A) AR/Aspargamine A complex (B) AR/Recemosol complex (C) AR/Rutin complex (D) AR/Shatavarin I complex (E) AR/Diosgenin complex.



metoclopramide (Dalvi et al., 1990). In the treatment of ulcerative disorder of stomach and parinama sula, a clinical entity akin to the duodenal ulcer disease, *A. racemosus* are used which has also been mentioned in Ayurveda . Curative effect in patients of duodenal ulcers has been shown by the juice of fresh root of *A. racemosus* (Kishore et al., 1980).

Figure shows *in silico* study demonstrating the interaction of angiotensin receptor with different active phytochemicals in *Asparagus racemosus*. The present *in silico* study shows the angiotensin receptor antagonist present in *Asparagus racemosus*. The 3D structure of the target receptor (angiotensin receptor) was downloaded from RCSB-protein data bank in .pdb format. The *Asparagus racemosus* phytoconstituents structure was retrieved from NCBI PubChem compounds database in .sdf format. Offline docking tool such as Auto Dock Tools 1.5.6 (ADT) was used for to study the drug-protein interaction. LigPlot<sup>+</sup> (v.1.4.5) was used for visualization of the interaction pattern in the drug-protein complex. LigPlot<sup>+</sup> structures showing hydrophobic as well as hydrogen bonding pattern between the protein ligand complexes.



*A. racemosus* along with *Terminalia chebula* were reported to protect gastric mucosa against pentagastrin and carbachol induce ulcer by significantly reducing both severity of ulceration and ulcer index (Dahanukar et al., 1986). In addition to antiulcerogenic activity of *A. racemosus* are clinical trials demonstrated similar effects of fresh root juice of *A. racemosus* in rats, using cold stress and poloric-ligation induced gastric ulcer (De et al., 1997). *A. racemosus* of various extracts from the root of have been shown to cause contraction of smooth muscles of rabbit's duodenum, guinea pig ileum and rats's fundal strip without affecting peristaltic movement. These actions were found to be similar to that of acetylcholine and were blocked by atropine, suggesting a cholinergic mechanism of action (Jetmalani et al., 1967). However no effect was observed on isolate rectus abdomens.

Table 4. Showing amino acid residues of protein involved in the hydrophobic interaction and hydrogen bonding with ligand.

Protein-Ligand Complex	Hydrophobic Interaction	Hydrogen Bonding
AR/Aspargamine A	Thr88, Pro285, Tyr92, Tyr87, Tyr35, Ile288, Trp88 and Arg167	
AR/Recemosol	Met284, Pro285, Ala181, Arg167, Tyr87, Thr88, Tyr92, Trp84 and Val108	Tyr35
AR/Rutin	Ala181, Tyr35, Tyr87, Ile288 and Tyr92	Asp263, Gln267, Ser16, Phe182, Tyr184, Trp84 and Thr88
AR/Shatavarin I	Pro162, Tyr113, Lys199, Leu112, Phe182, Ser109, Val108, His256, Ile288, Met284, Tyr92, Tyr184, Asp263, Leu13, Gln267, Pro19, Ile172	Tyr292, Ala159, Ala163, Arg167, Arg23, Asp281, Ser16
AR/Diosgenin	Arg23, Tyr92, Val179, Tyr87, Ala181, Arg167, Tyr35, Ile288, Trp84, Val108	

### *Effect on uterus*

*A. racemosus* on guinea pigs ileum, ethyl acetate and acetone extract of the root of *A. racemosus* blocked spontaneous motility of the virgin rat's uterus, in spite of cholinergic activity (Jetmalani et al., 1967). These extract also inhibited contraction induced by spasmogens like acetylcholine, barium chloride and 5-hydroxytryptamine where as alcoholic extract was found to produce a specific block of pitocin induced contraction. On the other hand powdered roots with petroleum ether as well as ether extract did not produce any uterine activity. It indicates the presence of some particular substance in the alcoholic extract which specifically block pitocin sensitive receptor through not other in the uterus (Jetmalani et al., 1967). Confirming the Shatavari receptor can be used as uterin sedative. *A. racemosus* isolated from the roots which responsible for the competitive block of oxytocin induced contraction of rat, guinea pig and rabbits uteri, in vitro as well as in vivo (Joshi and Dev, 1988; Pandey et al., 2005).

### *Molluscicidal Potential*

Aqueous and ethanolic extract of *A. racemosus* exhibited a high mortality rate (100%) against *Biomphalaria pfeifferi* and *Lymnaea natalensis* of. The LC50 was found to be 0.1, 5, 10 and 50 mg/mL for *Biomphalaria pfeifferi* and 0.5, 5, 1, 10 mg/mL for *Lymnaea natalensis*. The activities were attributed to the presence of terpenoids, steroids and saponins in the extract (Chifundera et al., 1993).

***Antihepatotoxic or hepatoprotective action***

*A. racemosus* of alcoholic extract of root has been shown to significantly reduce the enhanced levels of alanine transaminase, aspartate transaminase and alkaline phosphate in CCl<sub>4</sub> induced hepatic damage in rats (Zhu et al., 2010; Muruganadan et al., 2000), indicating antihepatotoxic potential of *A. racemosus*.

***Antineoplastic action***

*A. racemosus* of chloroform/methanol (1:1) extract of fresh root has been reported to reduce the tumor incidence in female rats treated with 7, 12 dimethyl benza. This action is suggested to be mediated by virtue of mammatropic and/ or lactogenic (Rao, 1981), influence of *A. racemosus* on normal as well as estrogen primed animals, which renders the mammary epithelium refractory to the carcinogen (Sabins et al., 1968; Liu et al., 2009).

***Cardiovascular effects***

*A. racemosus*, alcoholic extract of the root has been reported to produce positive inotropic and chronotropic effect on frog heart with lower doses and cardiac arrest with higher doses. The extract was found to produce hypotension in cats, which was blocked by atropine, indicating cholinergic mechanism of action. The extract also produced congestion and complete stasis of blood flow in mesenteric vessels of mice and rat, slight increase in the bleeding time and no effect on clotting time was observed on i.v. administration of the extract in rabbits (Roy et al., 1971).

***Effect on central nervous system***

In albino mice neither stimulant nor depressant action of lactae on central nervous system has been reported (Narendranath et al., 1986; Parihar and Hemnani, 2004). Shatavari did not produce catalepsy in experimental rats, even with massive oral doses, suggesting that its action may be outside the blood-brain barrier, similar to that of metoclopramide.

***Immunomodulatory activity***

Intra-abdominal sepsis is major causes of mortality following trauma and bowel surgery. *A. racemosus* has been shown to protect the rat and mice against experimental induced abdominal sepsis as Immunomodulating property (Dahanukar et al., 1986; Thatte et al., 1987). *A. racemosus* has been reported to produce leucocytosis and predominant neutrophilia along with enhanced phagocytic activity of the macrophages and polymorphs on oral administration of decoction of powdered root. *A. racemosus* treated animals was found significantly reduced while survival rate was comparable to

that of the group treated with a combination of metronidazole and gentamicin in percentage of mortality. Since *A. racemosus* is reported to be devoid of antibacterial action, so protection offered by *A. racemosus* against sepsis by altering function of macrophages, indicating its possible immunomodulatory property (Dahanukar et al., 1986; Thatte et al., 1987).

#### ***Immunoadjuvant potential activity***

*A. racemosus* aqueous extract root extract was evaluated in experimental animals immunized with diphtheria, tetanus; pertussis vaccine has also immunoadjuvant potential. Immunostimulation was evaluated using serological and hematological parameters. For 15 days, a oral administration of test material at 100 mg/kg per day dose resulted significant increase in antibody titre to *Bordetella pertussis* as compared to untreated (control) animals. Results indicate that the treated animals did show significant increase in antibody titre as compared to untreated animals after change. Applications of test material as potential immunoadjuvant bring less morbidity and mortality to experimental animals (Gautam et al., 2009; Gautam et al.,).

#### ***Antiuro lithiatic Potential***

*A. racemosus* with ethanolic extract treated rats of at doses 800 and 1 600 mg/kg significantly ( $P < 0.05$ ) reduced the serum concentrations of calcium, phosphorus, urea and creatinine (Narumalla et al., 2012).

#### ***Adaptogenic activity***

In animal kingdom adoptability is probably the most distinct characteristics of the life. Perhaps adoptability is the single most important property of animals and it found naturally in all the animals more or less (Azmathulla and Hule, 2006). Dr. Hans Seyle defines stress as the sum of all non specific response of the body to any external stimuli acting up on it. Environmental stress suffer severely to the dairy animals and are directly more exposed to the environment and. Some time it increases beyond the limit and consequently reduction in productivity and reproductively in terms of quality and quantity both. In India or few places in world where the natural climate continuously remain optimum for dairy animals. Therefore, some herbal supplementary measure should be adopted with stress remover management practices to overcome the stress effect effectively. For dairy animal *Asparagus racemosus* one of the best adopathogenic herb, which can be easily used. As it proved that it normalized the perturbed regional noradrenaline, dopamine, and 5- hydroxytryptamine concentration, induced by chronic stress with supplementation of standardize extract of *Asparagus racemosus* along with some other herbs.

### *Miscellaneous effects*

Diuretic effect and hypoglycemic effect in rabbits, but no anticonvulsant and antifertility effect was observed in rats and rabbits, with alcoholic extract of root respectively. *A. racemosus* was found to have slight in rats however; it did show some antiamebic effect in rats (Roy et al., 1971).

### CONCLUSION WITH RECOMMENDATION

In recent years, ethnomedicinal studies received much attention as this brings to light the numerous little known and unknown medicinal virtues especially of plant origin. *A. racemosus*, a medicinally important herb has been used since ages by the rural people as a galactagogue. Economically also, it is a very significant plant because various parts of this plant contain different phytoconstituents such as steroidal saponins, sapogenins, flavonoids (kaempferol, quercetin, and rutin), and poly phenols. Pharmacological screenings of *A. racemosus* revealed its medicinal potential and represents as a valuable medicinal plant with several medicinal properties. A systemic research and development work should be undertaken for the conservation of *A. racemosus* and development of products for their better economic and therapeutic utilization. Since most drugs containing Satavari that are available in the market are in the form of polyherbal formulations, it is difficult to attribute a particular medicinal action as being solely due to the *Asparagus racemosus* component of the drug. *A. racemosus* remains a species with tremendous potential and although considerable work has been done to exploit the biological activity and medicinal applications of this plant, countless possibilities for investigation still remain in relatively newer areas of its function. As more uses of this plant are recognized, the pressure on existing natural populations would increase further. Since the importance of medicinal plants depends mainly on the active principle present in it; consistency in quality and quantity of planting material assumes paramount importance. This can be ensured by identifying elites through the application of molecular marker techniques and chemo profiling followed by mass multiplication using both conventional and biotechnological approaches. Furthermore, optimization of climatic conditions and development of appropriate agro techniques would enhance the quality and quantity of the overall produce thereby assuring a higher remuneration to the growers. This in turn would encourage farmers to undertake commercial cultivation of *A. racemosus* thus curbing the over exploitation of this plant in the wild and thereby complement the conservation process. Search of new compounds of plant origin having pharmacological activity still continues. Their isolation and characterization is need of hour.

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