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A Phytopharmacological Review on *Asparagus racemosus*

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Abstract: ***Nowadays it is a wide spread belief on the part of the general public that natural substances are inherently superior to synthetic substances and have played a mainstream role in the health care system for the prevention of diseases. A study of ancient ayurvedic literature has claimed that Asparagus racemosus have numerous medicinal and therapeutic properties like phytoestrogenic, antidepressant, antidiarrhoeal, anticancer etc. A. racemosus has been specially recommended in case of threatended abortion, galactogogue as well as restorative action as it is beneficial in women's complaints. It is used in almost 67 ayurvedic preparations and commonly mentioned as 'Rasayana' in Ayurveda due to its medicinal uses. This review summarizes the pharmacological, pharmacognostic and phytochemical aspects of A. racemosus.***

Keywords: Asparagus racemosus, Pharmacognosy, Pharmacology, Phytochemistry, Shatavarins

1. Introduction

Asparagus racemosus have numerous medicinal usages which have been reported in the Indian and British Pharmacopoeias and in indigenous systems of medicine. The plant is also known as Shatavari which means "she who has hundred husbands" which indicates to the rejuvenative effect of the herb on the female reproductive organs [1]. It is used in 67 ayurvedic preparations like anuthalia, brahmarasyana, dhanwanthari shtakashaya, narayanathaila, rasnadikashaya, sahacharadithaila, saraswatharishra, shatavaripanaka, shatavarighritha, shatamulyadilehya, vasishtharasayana and vidaryadighritha.

The plant belongs to the genus Asparagus which has been recently moved from the subfamily *Asparagaceae* in the family *Liliaceae* to a newly created family *Asparagaceae*.[2] The name "Asparagus" was given by Theophrastus. It includes about 300 species out of which 22 species are native of India and most commonly used in indigenous medicine. In Ayurveda and Siddha medicine system the plant is used for treating *madhura rasam, madhura vipakam, seeta-veeryam*, polyuria, chronic fevers, *soma rogam*, white discharge, internal heat and as tonic [2].

2. Pharmacognostic Features

The roots of plant are tuberous, short rootstock bearing numerous succulent tuberous (30-100cm long and 1-2cm thick) that are silvery white or ash coloured externally and white internally as shown in fig 1. The leaves resemble to pine needles, and grow to up to 2m in height. Stem of plant is woody, whitish grey or brown coloured with small spines. The plant flowers during February–March leaving a mild fragrance in its surrounding. By the end of April, fruits can be seen with attractive red berries [3]. Plant is a spinous under-shrub grows throughout the tropical and subtropical parts of India up to an altitude of 1500m [4].

Figure 1: *Asparagus racemosus* plant and its parts

2.2 Taxonomic Profile

Table 1: Taxonomy of *Asparagus racemosus*

Kingdom	Plantae
Phylum	Anthophyta
Class	Monocotyledons
Order	Liliales
Family	Liliaceae /Asparagaceae
Genus	*Asparagus*
Species	*racemosus*

2.3 Synonyms

Table: 2 Synonyms of *Asparagus racemosus*

Classical Names	Asparagus, Satavari, Satawar, Shtavari
Vernacular Names:	
Hindi	Satmuli
Sanskrit	Satavari
Bengali	Shatamuli
Marathi	Shatavari or Shatmuli
Gujarati	Satawari
Telegu	Toala-gaddalu or Pilli-gaddalu
Tamil	Shimaishadavari or Inlichedi
Malayalam	Chatavali
Kannada	Majjigegadde or Aheruballi
Madhya Pradesh	Narbodh or atmooli
Rajasthan	Norkanto or Satawar

3. Phytochemical Review

The major active constituents of *A. racemosus* are steroidal saponins named as shatavarin I and shatavarin IV as shown in fig 2 which are present in the roots. Shatavarins are the glycoside of sarsasapogenin which are generally occurring in two types of skeletons furostanols and spirostanols rhamnose. 8-methoxy-5,6,4'-trihydroxyisoflavone a new isoflavone was isolated by roots of *A. racemosus* by Saxena *et al.* in year 2000 [5]. A noval oligospirostanosid 1,3-*O*-[*α*-L-3-rhamnopyronosyl-(1→2)-*α*-L-rhamnopyronosyl(1→4)-*O*-β-D-glycopyranosyl]25(*S*)-5β-Spirostan-3β-ol also known as immunoside was isolated in (2003) by Handa *et al.* and it was biologically evaluated as an immunomodulatory agent [6].

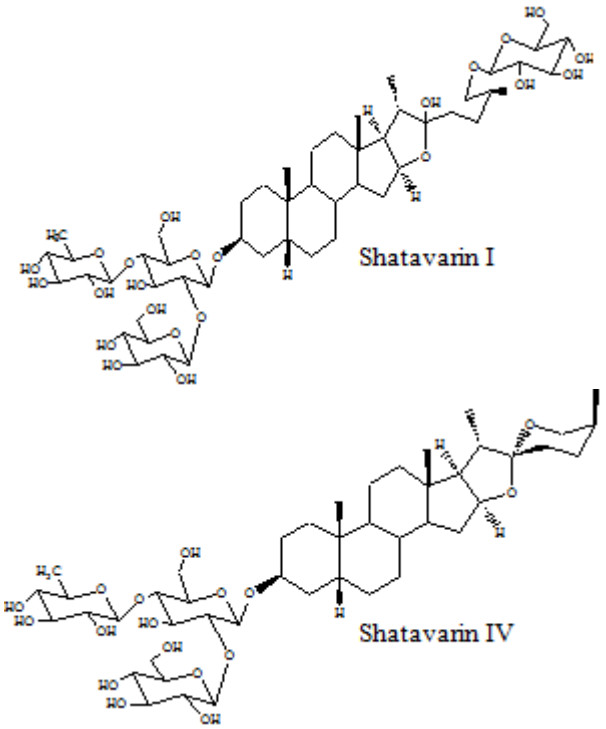

Figure 2: Chemical structure of steroidal saponines of *A. racemosus*

Wiboonpun *et al.* isolated a new antioxidant compound named Racemofuran, together with known compounds asparagamine A, and racemosol [7]. Three steroidal saponin namely Racemosides A, B and C were isolated from the methanolic extract of fruit of *A. racemosus*, earlier reported isoflavones, steroidal glycosides, polycyclic alkaloids and a dihydrophenanthrene derivative were isolated from roots of plant but there has been no report on the chemistry of the constituents of its fruit [8]. Isolation and structural clarification of Asparinins, Asparosides, Curillins, Curillorides and shavatarins was performed by Hayes *et al.* along with isolation of a new steroidal saponin shatavarin V, from *A. racemosus* powdered roots. Five steroidal saponins VI-X together with five known saponins. Shatavarin I, Shatavarin IV, Shatavarin V, Schidegerasaponin D_5 Immunside were isolated by Hayes *et al.* from *A. racemosus* roots [9].

4. Pharmacological Studies

4.1 Phytoestrogenic activity

Hormone replacement therapy is unsafe and not so effective so plant derived oestrogens are in demand now-a-days [10]. Phytoestrogens are compounds of any plant that are structurally or functionally similar to ovarian and placental oestrogens and their active metabolites [11]. *A. racemosus* root encompasses sound lactogenic effect [12]. Root extract of *A. racemosus* are considered as very effective in enhancing milk secretion during lactation in Ayurveda system of medicine [13]. The saponin-rich fraction of plant was found to inhibit Oxytocin induced uterine contractions *in vi*vo [14]. Aqueous extract of *A. racemosus* roots increases the weight of mammary glands in post-partum and oestrogen-primed rats and the uterine weight in the oestrogen-primed group due to action of released corticoids or prolactin [15]. Whereas alcoholic extract of *A. racemosus* reveals oestrogenic effect not only on female mammary glands but also on genital organs. Formulation of *Asparagus racemosus* such as Ricalex® tablets (Aphali Pharmaceuticals; 40 mg concentrated root extract per tablet) is effective to women suffering from deficient milk secretion [16]. 'U-3107' or EveCare® is a herbal preparation formulated by the Himalaya Drug Co., Bangalore, containing 32 mg *Asparagus racemosus* extract per 5ml syrup it is used to treat various menstrual disorders and threatened abortion [17]. 'EveCare' capsules were also proved to be effective in the treatment of dysfunctional uterine bleeding (DUB). It also regularized menstrual cycle this action can be attributed that to the local healing of the endometrium stimulated by endometrial microvascular thrombosis caused by high doses of phytoestrogens [18]. A drug of *Asparagus racemosus* (about 85 parts), patented has been shown to be effective in the treatment of pre-menstrual syndrome (PMS) in human females [19]. 'EveCare' was also found to be effective for in patients suffering from dysmenorrhoea [20]. Menosan® (containing 110 mg *Asparagus racemosus* extract per tablet) is another polyherbal formulation that increases in uterine weight and uterine glycogen [21]. Phytoestrogen performs its function by binding directly to the oestrogen receptor without enhancing the endogenous oestrogen levels. 'Menosan' has also been studied for the treatment of post-menopausal symptoms [22]. Satavari has also been known for its influence on the male reproductive system. Significantly high testes weights were found in rats treated with *A. racemosus* [23].

4.2 Effect in neurodegenerative disorders

Various formulations of *A. racemosus* have efficient neurodegenerative potential such as 'Mentat', is a psychotropic preparation is very effective in the treatment of alcohol abstinence induced withdrawal symptoms such as tremors, convulsions, hallucinations and anxiety in ethanol administered rats [24]. Whereas, 'EuMil' treatment normalized the perturbed nor-adrenalin, dopamine and 5-hydroxytryptamine concentrations in brain of animals [25]. Evaluation of the potential antidepressant activity rodent models of depression such as forced swimming test (FST) shows that the methanolic extract of *A. racemosus* (100, 200 and 400 mg/kg) and Imipramine an antidepressant drug

treated groups were significantly decreased the duration of immobility time indicating antidepressant effect. In learned helplessness test (LH) methanolic extract of plant (100, 200 and 400 mg/kg) pretreatment for 7 days significantly decreased escape failures and increased avoidance responses in contrast to control rats [26]. Methanolic extract of *A. racemosus* involve the adrenergic system and enhances the serotonergic mediated behaviour indicating the involvement of serotonergic pathway in the antidepressant activity.

4.3. Anti-oxidant activity

A study to investigate the potential of methanolic extract of *Asparagus racemosus* roots against kainic acid (KA) - induced hippocampal and striatal neuronal damage in mice. Excitotoxic lesions were produced in the brain by Intra-hippocampal and intra-striatal injections of KA to anesthetized mice. Decreased glutathione peroxidase (GPx) activity and reduced glutathione (GSH) content was observed after KA injection, GSH acts as a nucleophilic scavenger of toxic compounds and also as a substrate in the GPx-mediated destruction of hydroperoxides to stop the accumulation of toxic levels in brain tissues so GSH is considered to have a good antioxidant property. The mice treated with *Asparagus racemosus* extract showed an enhancement in GPx activity and GSH content, and reduction in membranal lipid peroxidation and protein carbonyl. From the study it was concluded that the plant extract plays the role of an antioxidant by attenuating free radical induced oxidative damage [27].

4.4 Anti-diarrhoeal activity

Diarrhoea is one of the most important health problems. Diarrhoea kill about 2.2 million people globally in one year; majority of infants and children below the age of 5 years are estimated to affected by it [28]. Satavari is found to be effective in the treatment of *Atisar* (diarrhoea), *Pravahika* (dysentery) and *Pittajshool* (gastritis) as described in Ayurvedic texts such as *Sushruta Samhita* and *Sharangdhar Samhita* [29]. Evaluation of the ethanol and aqueous extracts of *A. racemosus* roots against castor oil induced diarrhoea in rats was based on the property of liberation of ricinoleic acid from castor oil which results in irritation and inflammation of the intestinal mucosa and hence lead to release of prostaglandins, which stimulate motility and secretion and resulted in diarrhoea. Very significant anti-diarrhoeal activity was found out, and result shown were similar to loperamide an anti-diarrhoeal drug the action of this extract can be attributed to the inhibition of prostaglandin biosynthesis which in turn inhibits gastrointestinal motility and secretion.

4.5 Anti-inflammatory activity

NO plays an important role as an important molecule in the immune system, elevated levels of NO are found in infectious and inflammatory diseases, autoimmune processes, during tumour growth and in various immunopathological situations. The methanolic extracts significantly inhibited production of TNF-α and IL-1β production in mouse macrophage cells, Elevated tumour necrosis factor-α (TNF-α) synthesis has been associated with the development of diabetes, septic shock, tumorigenesis, rheumatoid arthritis, psoriatic arthritis and inflammatory bowel disease. Inhibition of NO production was statistically significant for methanolic and aqueous extracts at 100µg/mL and are presented in production is associated with acute and chronic inflammation. In this study, significant inhibitory effects by the methanol and aqueous extracts of the three root extracts on NO production were observed. Macrophages play an important role in inflammation [30].

4.6 Anti-dyspepsia activity

A. racemosus also has been used in Ayurveda against the treatment of dyspepsia. The plant was found to have an effect comparable to dopamine antagonist metoclopramide which is an allopathic drug used to reduce gastric emptying time in dyspepsia. In this study, 2g powdered root of *A. racemosus* was compared to a standard treatment of metoclopramide (10 mg tablet) in eight normal healthy male volunteers, and the gastric emptying halftime was observed. There was no statistically significant difference between the actions of *A. racemosus* and metoclopramide. This study hypothesized that Satavari might having mild dopamine agonist action [31].

4.7 Adaptogenic activity

'Rasayana' is a group of plant drugs which besides improving defence mechanisms of the body also promote physical and mental health as well as provide strength and long life. The objectives of 'rasayanas' include *vayasthapana* (retarding ageing), *ayukaram* (enhancing life span), *medhabalakaram* (promoting intellect and physical strength) and *rogapaharanasamartha* (increasing resistance to diseases) [32]. These are similar to 'adaptogens' which are the agents that increase the non-specific resistance of organisms against a variety of stresses. *A. racemosus* is studied against the side effects induced by cisplatin such as gastric emptying and normalise intestinal hypermotility. *A. racemosus* reversed the effects of cisplatin on gastric emptying, and also normalized cisplatin induced intestinal hypermotility [33]. 'Satavari mandur'(SM) is an ayurvedic herbo-mineral formulation main ingredient of Satavari mandur is the root extract of *A. racemosus*, having effective antiulcerogenic agent. 'Siotone' is herbal formulation which has significant adaptogenic activity and it reverse chronic stress-induced biochemical, physiological and behavioural perturbations [34]. 'EuMil' also like 'Siotone', exhibited significant adaptogenic and antistress activity. Acute and subacute toxicity studies on 'Siotone' and 'EuMil' showed that both were devoid of any toxic effects. Studied were also carried out on effect of *Asparagus racemosus* on *Amlapitta* (hyperacidity), *Grahani* (ulcerative colitis), *Parinam shool* (septic ulcer) and *Vataj shool* (spastic colon) and observed an amelioration of symptoms. Methanolic extract of fresh roots of *Asparagus racemosus* showed significant protection against acute gastric ulcers induced by cold restraint stress, acetic acid, pylorus ligation, aspirin plus pylorus ligation, and cysteamine induced duodenal ulcers [35].

4.8 Anticancer activity

Aqueous extract of the roots of *Asparagus racemosus* has the potential to act as an effective formulation to prevent

hepatocarcinogenesis induced by treatment with DEN Immunohistochemical staining of the hepatic tissues of rats treated with DEN showed the presence of clusters of cells expressing the mutated p53 protein, whereas an absence of mutated p53 foci was observed in Wistar rats pretreated with the aqueous extract of the roots of *Asparagus racemosus*. So, Wistar rats which were pretreated with the aqueous extract of the roots of *Asparagus racemosus* prevented the incidence of hepatocarcinogenesis [36]. *Asparagus racemosus* shows the inhibitory action on DMBA-induced mammary carcinogenesis in rats. As rats fed on a 2% *Asparagus racemosus* diet showed a decline in both tumour incidence and mean number of tumours per tumour bearing animal [37].

4.9 Teratogenic Effects

Teratogenic effects such as swelling of legs, slow growth of fetal body and placental part, an increase in resorption of fetus whereas in post-natal study a smaller litter of pups with increased mortality and delayed development was exhibited by administrating methanolic extract of *A. racemosus* [38].

4.10 Cardio protective activity

Coronary artery disease and atherosclerosis are due to increase in serum lipid levels such as cholesterol and due to the generation of reactive oxygen species. Abana', is a herbo-mineral formulation was found to have significant hypocholesterolaemic effect in rats and therefore demonstrated a potential for use as a cardio-protective agent [39]. *A. racemosus* root powder supplements decreased lipid peroxidation and caused a dose-dependent reduction in lipid profiles. The total lipids, total cholesterol and triglycerides in plasma and liver as well as plasma LDL (low-density lipoprotein) and VLDL (very low-density lipoprotein)-cholesterol decreased by more than 30% [40].

4.11 Anti-bacterial activity

The methanol extract of the roots of *A. racemosus* have also shown considerable antibacterial efficacy under *in vitro* conditions against *Escherichia coli*, *Shigella dysenteriae*, *Shigella sonnei*, *Shigella flexneri*, *Vibrio cholerae*, *Salmonella typhi*, *Salmonella typhimurium*, *Pseudomonas putida*, *Bacillus subtilis* and *Staphylococcus aureus* [41].

4.12 Immunoadjuvant Effects

A. racemosus was studied in experimental animals as an immunoadjuvant, as the animals treated daily with *A. racemosus* aqueous root extract showed a significant increase in antibody titres to *Bordetella pertussis* as against the untreated animals. High immunoadjuvant potential less mortality as well as overall improvement in health of animals was seen in animals which proved the development of a strong immunity [42]. Cyclophosphamide (CP) is used to treat immunopathological disorders and has several side effects such as leucopenia, anaemia, etc. *A. racemosus* reduces these adverse effects and maintain haemolytic antibody titres in (CP)-treated mouse. So, extracts and formulations prepared from *A. racemosus* aids in increases in white cell counts, absolute neutrophil counts, haemagglutinating. Increase in macrophages by *A. racemosus* helps in prevention and management of post-operative adhesions as macrophages aids in development of intraperitoneal adhesions. It was demonstrated that *A. racemosus*, being an immunomodulator and immunostimulant, along with *Withania somnifera*, *Tinospora cordifolia* and *Picrorhiza kurroa* significantly suppresses the chemotacticactivity and production of interleukin-1 and TNF-α by macrophages. AIDS is disease of decreased 'ojas', (essential energy of the body) defined in Ayurveda. Satavari is known as formation of 'ojas' in traditional system of medicines. Therefore, *A. racemosus* as immunoadjuvant can be scrutinized for use in adjuvant therapy in the management of HIV [43].

4.13 Antitussive activity

The methanol extract of *A. racemosus* roots showed significant antitussive activity on sulphur dioxide induced cough in mice with the cough inhibition being comparable to that of 10–20 mg/kg of codeine phosphate [44].

4.14 Anticandatial activity

The in vitro anticandidal activity of *Asparagus racemosus* roots and tubers extract was investigated against *Candida albicans, Candida tropicalis, Candida krusei, Candida guillermondii, Candida parapsilosis* and *Candida stellatoida,* which are isolated from vaginal thrush patients. The extract of *Asparagus racemosus* showed high degree of activity against all the *Candida* strains. The inhibitory effect of the extract against all the Candida tested was found comparable with that of standard antibiotics used [45].

5. Conclusion

Asparagus racemosus is a species with tremendous potential. A huge literature is available regarding its biological activities. But based on the present findings there are still some gaps in the existing literature with regard to the mode of action of various constituents of *Asparagus racemosus* and its relation with other plant constituents in polyherbal formulations. Therefore countless possibilities and scope for investigation are still remaining in relatively newer areas of its functions.

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