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(RESEARCH ARTICLE)

ASPARAGUS RACEMOSUS (LINN.): A REVIEW OF ITS PHYTOCHEMISTRY, BIOLOGICAL ACTIVITIES, AND THERAPEUTIC POTENTIAL

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ABSTRACT

Asparagus racemosus (Shatavari) is a medicinal plant that is valued for its diverse phytochemical composition and wide range of pharmacological properties. This plant contains various phytochemicals such as flavonoids, steroidal saponins (particularly shatavarins), phenolic compounds, tannins, alkaloids, and polysaccharides, which contribute to its biological activities. This review summarizes current knowledge on the phytochemical profile and major therapeutic effects of *A. racemosus*, with emphasis on its antibacterial, antioxidant, anti-ulcer, antiplasmodial, antidiarrheal, anticancer, and anti-abortifacient activities. The various experimental studies indicate that these phytochemical constituents help protect against oxidative stress, promote gastric mucosal defense, inhibit pathogenic microorganisms, suppress malaria parasites, regulate abnormal cell proliferation, reduce intestinal disorders, and support reproductive health. Despite encouraging preclinical findings, additional clinical investigations and standardized phytochemical studies are needed to confirm its efficacy and safety. Overall, *A. racemosus* remains a promising source of plant-derived bioactive compounds for the development of evidence-based therapeutic agents.

Keywords: *Asparagus racemosus;* Phytochemicals; Biological Properties; Therapeutic potential

1 INTRODUCTION

Asparagus racemosus(Linn.), the genus *Asparagus* has more than 250 species, which are found all over the world with 22 species also recorded in the Indian region [1]. *A. racemosus,* commonly known as "Shatavari" [2], is a perennial climbing medicinal herb widely distributed across India, Nepal, and Sri Lanka. This plant grows up to 1500 meters in altitude range and is found in tropical and subtropical parts of India. These plants have tubular and elongated brown-color roots. The main plant of *Asparagus* is a woody climber with a whitish or brown color and small protective spines [3-4]. This plant is frequently cultivated commercially in Uttar Pradesh, Uttarakhand, and Madhya Pradesh [5]. *A. racemosus* is commonly used in traditional medicine like Ayurveda, Unani system, and Sidda medicine [6-7]. This plant occupies a prominent position in Ayurvedic medicine, where its roots have traditionally been employed to promote general health and to support reproductive, gastroinstinal, nervous system, and immune functions [6]. It's also used in the treatment of gastric ulcers, dyspepsia, liver disease, nervous disorders, infectious diseases, and inflammation [5].

The different preparations of *A. racemosus* root powder show the anti-fungal, anti-bacterial, anti-cancerous, anti-oxytoxic, anti-abortifacient, anti-inflammatory, hypoglycemic, anti-ulcer, anti-coagulant, and anti-oxidant activities [8].

2 PHYTOCHEMICALS OF ASPARAGUS RACEMOSUS

Asparagus racemosus has a large number of phytochemicals like steroidal saponins, asparagamine, isoflavones, racemosol, polysaccharides, shatavaroside, secoisolariciresinol, ursolic acid, recemoside, stigmaterol, and Beta-sitosterol [8-9]. The root saps of *A. racemosus* have various Vitamins such as A, B_1, B_2, C, E, and minerals like Ca, Fe, Mg, and P [10]. However, the major active component of *A. racemosus* is shatavarins IV, which are steroidal saponins [11-12]. Some essential oils such asarginine, tannin,tyrosin, asparagine, flavonoids, and resin are found in the *A. racemosus* [10]. The phytochemicals asparagamine, racemosol [13], 8-Methoxy-5, 6, 4-Trihydroxyisoflavone 7-α-β-D-Glucopyranoside [14], tunin, quercitin, hyperoside flavonoids [15], sarsapogenin, kaepfrol, saponin [16], and sitosterol 4, 6-dihudroxy-2-O-2hydroxy benzaldehyde [17] are present in the root extract of *A. racemosus*. The various phytochemical studies have shown that *A. racemosus* is a rich source of steroidal saponins, particularly shatavarins, together with flavonoids, polyphenols, glycosides, alkaloids, and essential minerals. These phytochemicals are believed to contribute collectively to its broad spectrum of biological effects rather than acting as isolated compounds [18].

3 BIOLOGICAL ACTIVITIES

Asparagus racemosus has several biological properties, which are used in the treatment and prevention of liver diseases, intestinal ulcer, inflammation, galactogogues, and nervous disease [19]. In the Indian medicinal system *A. racemosus* medicinal plant and its root pests or root juice are frequently used as a health tonic [9, 20]. Some biological properties of *A. racemosus* are as fallow-

3.1 Anti-bacterial activity

The methanolic root extract of *A. racemosus* has anti-bacterial activity against *Salmonella typhimurium*, *S. typhi*, *Shigellasonnei*, *S. flexneri*, *S. dysenteriae*, *B. subtilis*, *E. coli*, *Pseudomonas putida,* and *Staphylococcus aureus* [21-23]. *In vitro* studies have demonstrated that methanolic root extracts inhibits the growth of *E. coli,Staphylococcus aureus*, *Salmonella typhi, S. typhimurium*, *Bacillus subtilis*, *Shigella flexneri, S. sonnei, Vibrio cholera, Pseudomonas putida*, although the degree of inhibition depends on extract concentration, solvent polarity, and bacterial species tested [24]. The root extract of *A. racemosus* inhibit the growth and development of *Pseudomonas putida*, *P. aeruginosa*, *Staphylococcus aureus*, *S. werneri*, *B. subtills*, and *Staphylococcus aurens* [25].

3.2 Anti-oxidant activity

Oxidative stress is a key factor in the development of various chronic disorders, such as diabetes, cardiovascular diseases, inflammatory disorders, and neurodegenerative conditions. Increasing evidence suggests that *A. racemosus* possesses considerable antioxidant potential because its roots contain a diverse array of phytochemicals, such as flavonoids, phenolic acids, steroidal saponins (shatavarins), and ascorbic acids, which collectively enhance the natural free radical scavenging capacity [12]. The root extracts of *A. racemosus* exhibit enhanced anti-oxidant activities in the mitochondrial membrane of the rat liver cells, which generate free radicals induced by gamma radiation [26-27]. However, the methanolic root extract of *A. racemosus* has a better scavenger for the nitric oxide radicals in comparison to superoxide or DPPH radicals at a higher concentration [28]. The various preparations of root extracts from *A. racemosus* have anti-oxidation properties [27, 29, 30]. In addition to direct radical scavenging, treatment with *A. racemosus* extracts has been reported to increase the activities of enzymatic antioxidants, including catalase, superoxide dismutase, and glutathione peroxidase, while simultaneously lowering malondialdehyde, a widely used marker of lipid peroxidation [31]. The anti-oxidation properties are due to the presence of asparagamine A, isoflavons specially, racemofuran, and recemosol [32].

3.3 Anti-ulcer activity

Asparagus racemosus has been extensively investigated for its gastroprotective capacity and is recognized as one of the important medicinal plants used in traditional medicine for the management of gastric disorders. The root extract of *A. racemosus* has anti-ulcer activity and a compatible decrease in the amount of gastric secretion, the number of ulcer patches, and free acidity [33]. The protective activity occurred by the increase in mucosal protective factors such as mucus secretion at the cellular level. Alok et al., [12] have reported that *A. racemosus* may decrease gastric acid output while simultaneously enhancing mucin production, creating a favorable environment for ulcer healing. Preparation of root powder of *A. racemosus* was used in Indian Ayurveda at two time's daily doses of 1.5 grams for the improvement of peptic ulcers [34]. However, in humans, the root powder of *A. racemosus* effectively reduces the chronic peptic ulcer [35].

3.4 Anti-plasmodial activity

The methanolic root extract of *A. racemosus* exhibited moderate suppression of both chloroquine-sensitive (D6) and chloroquine-resistant (W2) strains of Plasmodium falciparum, suggesting the presence of phytochemicals capable of interfering with parasite survival [36]. The root powder of *A. racemosus* in ethyl acetate extracts is commonly used as an anti-plasmodial component against *Plasmodium falciparum*, with a dose-dependent inhibition IC_{50} value is 29µg/ml [37].

3.5 Anti-diarrheal activity

Asparagus racemosus has long been employed in traditional medicine for the treatment of diarrhea and dysentery, and various experimental studies provide pharmacological support for this practice. Diarrheal infections are very common in developing countries, three-fourths of infants and children [38]. Therefore, the rate of mortality was observed very high in the infants. The whole plant and root of the *A. racemosus* are used in the treatment of diarrhea [39]. The ethanolic extract of *A. racemosus* has anti-diarrheal properties, which were observed in the *Albino* rats [40]. The aqueous and ethanolic extracts of *A. racemosus* have inhibitory properties against diarrheal infection [41]. The extracts also suppressed prostaglandin E_2-induced intestinal fluid secretion and slowed gastrointestinal transit in the charcoal meal test, indicating that the plant extracts have both antisecretory and antimotility effects, which together contribute to its antidiarrheal action.

3.6 Anti-cancerous activity

The steroidal components of the *A. racemosus* have anti-apoptotic properties, and it is inferred to have the capacity for various tumor cell deaths [42]. The root extract of *A. racemosus* has a protective capacity in carcinoma mammary cells [43]. The extracts of *A. racemosus* (Shatavarin IV) have anti-cancerous activity in human-like breast cancer (MCF-7), adenocarcinoma colon (HT-29), and kidney carcinoma (A-498) [44]. *In vitro* investigations have shown that ethanolic and aqueous extracts of *A. racemosus* exhibit concentration-dependent cytotoxic effects against human colorectal (HCT-116), lung (A5490, pancreatic (MIA PaCa-2) cancer cell lines, while producing comparatively lower toxicity toward normal cells, denoting their potential as sources of novel anticancer molecules [45, 46].

3.7 Anti-abortifacient activity

Several types of research have confirmed that the *in vivo* effect of *A. racemosus* (Shatvarin IV) causes an effect on the uterine muscles, just like estrogen [47]. Preparation of *A. racemosus* root is recommended in the case of threatened abortion [48]. However, these activities are due to shatavarin-I. This blocks even oxytocin, which induced contractions in rat, rabbit uteri, and guinea pig *in vivo* doses [49]. The active component polycyclic alkaloid asparagamine-A was observed in *A. racemosus*, which has an antioxytocic activity in antiabortifacients [13].

4 CONCLUSION

It is clear from the above literature that the common medicinal plant *Asparagus racemosus* is a pharmacologically important medicinal plant with a broad spectrum of bioactive phytochemicals, including flavonoids, steroidal saponins, phenolic compounds, alkaloids, tannins, and polysaccharides, which collectively contribute to its diverse therapeutic properties. Evidence from various experimental studies indicates that different plant extracts and their formulations exhibit antibacterial, antioxidant, anti-ulcer, antiplasmodial, antidiarrheal, anticancer, and anti-abortifacient activities through multiple mechanisms such as free radical scavenging, protection of gastric mucosa, modulation of inflammatory pathways, inhibition of microbial growth, and regulation of cellular signaling. Although the available research findings strongly support its traditional medicinal use, most studies remain limited to *in vitro* and animal models. Future investigations should prioritize standardized phytochemical profiling, identification of active constituents, detailed molecular mechanisms, well-designed toxicological evaluations, and multicenter clinical trials to establish its safety and therapeutic efficacy. Such efforts will facilitate the development of scientifically validated herbal formulations and improve the clinical utilization of *A. racemosus* in evidence-based medicine.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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