Pharmacological and therapeutic application of *Asparagus racemosus* Willd

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S u m m a r y

Widespread acceptance of alternative medicine is the main reason for an increased demand for medicinal plants from South Asia, including India. Researchers are continuously searching for new anticancer drugs originating from plants. In particular, the attention is being paid to research on the properties of cytotoxic saponins. The results of experiments confirm the necessity of research on these compounds which occur in large quantities in wild asparagus - *Asparagus racemosus*. This species is known for its phytoestrogenic properties and used as a hormone modulator. In traditional Indian systems of medicine, the roots of *A. racemosus* are used in the treatment of neurodegenerative diseases, dyspepsia, inflammation, nephropathy, throat infections, tumours, hyperacidity, diarrhea, bronchitis and cough. *A. racemosus* is also used in the production of formulations of adaptogen characteristics.
There are many reasons for undertaking detailed research on the activity of compounds isolated from this plant.

Key words: *Asparagus racemosus, steroidal saponins, application, herbal medicine*

INTRODUCTION

There are about 450 000 species of higher plants existing on earth.Till now, the chemical composition and pharmacological properties of approximately 10-15% of them have been determined. They have been used therapeutically since time immemorial. In the mid-nineteenth century, with the appearance of synthetic drugs, medicinal plants began to lose their importance. In recent years, natural medicine is undergoing a renaissance. Chemical medicines do not fully meet all expectations. The

production is expensive. Furthermore, they may cause unwanted side effects. Studies of biological activity carried out in recent years have confirmed the presence of medicinal properties in plants which have long been known in traditional medicine for a long time. An interesting and both not well documented plant is *Asparagus racemosus* Willd, also known as Shatavari, Satavar or Shatamull.

Asparagus racemosus – the characteristics and the occurrence

A. racemosus is a medicinal plant native to tropical and subtropical India. Its medicinal use has been reported in the British and Indian pharmacopoeias as well as in the traditional Indian systems of medicine such as Ayurveda, Unani and Siddha. It is mainly used for medicinal purposes, but also ornamental.

A. racemosus belongs to the family *Asparagaceae*, genus *Asparagus*. The genus *Asparagus* includes about 350 species. Among 22 species of asparagus recorded in India *A. racemosus* is one of the most frequently used in traditional medicine. The plant occurs on the piedmont plains up to 1300-1500 meters and in the forests. It prefers gravely and rocky soils. Its climber's reach from 1 to 3 m in height. Green, glossy leaves of *A. racemosus* are reminiscent of pine needles. In July, the plants are covered with small, white flowers with a pink tint, mounted on short, thorny stems. Red berries appear in September. The plant also has a root system characteristic for genus *Asparagus*. The rhizome with roots is an appropriate therapeutic material.

Natural medicine in India is a tradition sanctified by centuries, respected to this day. The earliest mention regarding to the use of plants in medicine dates from 4500 to 1600 BC. For example, Ayurweda (knowledge or life art, specifically the art of a healthy life) has got eight chapters dealing with various aspects of the healing art. These include kaya cikitsa (internal medicine), salya tantra (surgery), salakya tantra (treatment of the head and neck diseases), agada tantra (toxicology), bhuta vidya (mental diseases), bala tantra (pediatrics), rasayana tantra (rejuvenation therapy and geriatrics), and vajikarana tantra (aphrodisiacs).

A. racemosus in the system of Ayurvedic medicine belongs to "rasayana" herbs - the medicinal plants which improve general well-being by increasing cellular vitality and resistance [1]. The tuberous roots of A. racemosus are used in traditional Indian medicine for the treatment of, inter alia: dysentery, cancer, inflammation, neuropathy, nervous disorders, bronchitis, hyperacidity and certain infectious diseases [1]. Pharmacological studies with animals have documented the following properties of *A. racemosus* extract: antioxidant [2, 3], adaptogenic [4, 5], anti-stress [6, 7], antiulcer [8, 9], antidiarrhoeal [10], antibacterial [11], antitussive [12] and its use as a substrate for inulinase production [13].

Active constituents of *Asparagus racemosus*

Steroidal saponins are main active constituents of *A. racemosus*. Saponins are a group of secondary metabolites widespread in the plant kingdom. Saponins are triterpens or sterols glycosides forming the so-called aglycone, in the case of saponin named sapogenin and a sugar component named glycone.

Due to the type and number of rings comprising the aglycone, saponins are divided into: steroidal saponins with steroidal grouping as sapogenin and triterpenoid saponins having triterpen aglycone.

27-carbon sterol skeleton with hexacyclic spirostanol conformation is the most frequent aglycone in steroidal saponins. In this subgroup there are only monodesmosides. Aglycone rarely has pentacyclic furastanol conformation. In addition to monodesmosides, bi- and tridesdesmosides may also occur in this subgroup [14].

Studies conducted by Hayes [15] on the roots of *A. racemosus* led to the isolation of ten saponins, five new and five already known ones. Sarsasapogenin was for the most part aglycone. It is commonly encountered in the family *Asparagaceae*. Using semi-preparative RP-HPLC, nuclear magnetic resonance spectroscopy (1D and 2D NMR) and mass spectrometry the separation and detailed determination of the structures of newly discovered saponins and the appropriate classification of previously detected saponins occurring in the root of *A. racemosus* were made. Due to structural similarities, they are divided into four types (I-IV) – fig. 1.

Asmari et al. [16] reported the presence of sarsasapogenin in natural plants of *A. racemosus* as well as in *in vitro* cultures.

Other active compounds, such as qercetin, rutin (2.5% of dry basis) and hyperoside are isolated in the flowers and fruits of *A. racemosus*, while the presence of diosgenin and qercetin-3 glucuronide are found in the leaves of this plant[17]. Seeds of *A. racemosus* contain trace amounts of phytoecdysteroids [18]. The effects of these compounds are similar to those of testosterone. Among others, they stimulate protein synthesis and block the cortisol receptors, so that they exhibit anticatabolic effect.

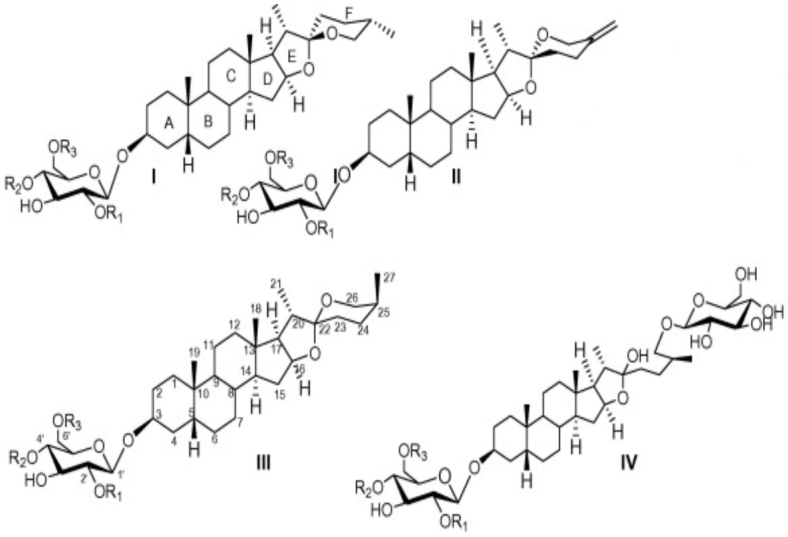
Challenges in the protection of *Asparagus racemosus*

The increasing global acceptance for complementary and alternative medicine has been the major reason for a rapid growth in demand for medicinal plants originating from the eastern parts of the world, including India. The prognosis concerning the role of medicinal plants in the world market show a significant increase in their consumption in the future. According to the World Bank report of 1998, the value of trade in medicinal plants and related products is estimated at $ 5 trillion by 2050 [19]. Medicinal plants are an important natural resource of India. They are a potential source of economic benefits and they provide health care to millions of residents, thanks to their continuous availability.

As the production base of *A. racemosus* is based mainly on material gathered in the wild, this species is increasingly threatened. Currently, harvesting practices are unsustainable and have led to depletion of the plant resource base. Pharmaceutical companies are also responsible for the inefficient turnover of formulations produced from this plant [20].

Due to its varied uses, the demand for *A. racemosus* is increasing, but the supply is insufficient. This is, among others, due to destruction of habitats of these plants by deforestation, in which it occurs. The plant is currently considered to be endangered in its natural environment and is on the National Medicinal Plants Board list of the 32 most

Figure 1. Structures of furostanol and spirostanol glycosides 1–10 isolated from *A. racemosus* roots, divided in four major structural types (I-IV) [15].



	Type	R_1	R_2	R_3	Name
1	I	β- D- Glc	α- L-Rha	H	shatavarin VI
2	II	β- D- Glc	α- L-Rha	H	shatavarin VI
3	III	β- D- Glc	α- L-Ara	β- D- Glc	shatavarin VIII
4	III	β- D- Glc	β- D- Glc	H	shatavarin IX
5	III	α- L-Rha	β- D- Glc(6-OAc)	H	shatavarin X
6	III	α- L-Rha	β- D- Glc	H	hatavarin V
7	III	β- D- Glc	α- L-Rha	H	shatavarin IV
8	III	β-D-Glc	H	H	asparinin A
9	III	α-L-Rha	α-L-Rha	H	immunoside
10	IV	β-D-Glc	α-L-Rha	H	shatavarin I

endangered species of medicinal plants [21]. In India, the main collectors of this plant are residents of the regions of its occurrence. They are often not aware how important the quality at harvest is to preserve the values of medicinal plants as well as the phase of their growth and the handling after harvest and during storage. All this contributes to drastic reduction of of *A. racemosus* population. In view of growing market requirements, continuity and consistency of material supply and growing depletion of natural resources of this plant, every effort should be taken to improve its cultivation, harvesting and marketing of medicinal formulations produced from this plant.

In nature, *A. racemosus* is propagated through seeds in March-April [19]. It is also possible to attempt a vegetative propagation of plants, although this method is slow and laborious.

Pharmacological applications of *Asparagus racemosus*

A. racemosus is used in about 65 ayuverdic formulations, among others are: Shatavari kalpa, Phalaghrita, Vishnu taila [22]. Distribution of products containing compounds of *A. racemosus* is dealt with by Himalaya Herbal Healthcare which offers following formulations as: Abana® (containing 10 mg of root extract of *A. racemosus* per tablet); Diabecon® (containing 20 mg of Satavari root extract per tablet); EveCare® (containing 32 mg of Satavari root extract per 5 ml of syrup); Himplasia® (containing 80 mg of Satavari root powdered per tablet);

Menosan® (containing 110 mg of Satvari Root extract per tablet) and others.

The existing literature relating to the pharmacological activities of *A. racemosus* is deficient. The gaps include an incomplete understanding of the interaction between *A. racemosus* and other components of polyherbal formulations in which it occurs. There is no information about the mode of action of the individual components of the formulations and the same active ingredients of *A. racemosus* [20].

Phytoestrogenic properties of *Asparagus racemosus*

Menopause is a difficult stage in a woman's life in which the gradual disappearance of the full capacity of gender as well as related somatic, hormonal and psychological symptoms take place. Disturbances in the production of female hormones are revealed by an irregularity of menstrual cycles until they cease, impacts of blood to the head causing a feeling of heat, dizziness and headaches, sweating, heart palpitations and emotional sensitivity. In addition, systemic change occur, including: an increase in blood pressure, joint pain and progressive osteoporosis. Modern medicine intervenes in the functioning of the endocrine system in pathological conditions as well as to assist the body's normal reaction. The example of such activities is estrogen supplementation in women during the peri- and postmenopausal stages, commonly known as hormone replacement therapy (HRT). It is used globally by millions of patients. Assessment of risk factors and long periods of therapy is still subject of dispute in the scientific literature and mass media.

Numerous clinical studies provide evidence that synthetic hormones increase the risk of endometrial cancer, breast cancer, venous thromboembolic events and gallbladder disease in women. Research on the relationship between HRT and the risk of endometrial cancer have been carried out in 1995, among others, by Grady et al. [23]. They confirmed a significant increase of risk associated with estrogens used for long periods, lasting several years after stopping of the use of them. The awareness that HRT is associated with undesirable effects has increased an interest in phytoestrogens, i.e. plant-derived estrogens. The studies show that they simulate the effects of estrogen in some tissues, while in others they act antagonistically. According to many experts, substances blocking the binding of estrogen in the tissues, i.e. compounds of the agonists or antagonist activity may act preventively, particularly in postmenopausal women, in whom endogenous estrogens are recognized as a potential carcinogen. Another type of medical intervention in the female sex hormone homeostasis involves the use of synthetic drugs on the function of the partial antagonists ER, known as

selective estrogen receptor modulators (SERM) such as raloxifene. Natural compounds classified as phytoestrogens have a similar physiological function and they have a safety advantage over synthetic drugs. As food ingredients are used for millennia.

The pharmaceutical industry produces many mono- and complex formulations containing phytoestrogens. The most frequently used raw materials are plants that contain the most of active hormonal compounds. They are: soybeans (Soyfem - contains extracts from soya), *Actaea racemosa* (Menofem - dry extract of the roots of Black Cohosh) and red clover.

A. racemosus is also a plant known for its phytoestrogenic properties and for use as a hormone modulator [24]. In studies on rats, Rao [25] showed the inhibitory action of *A. racemosus* on DMBA-induced mammary carcinogenesis. A diet containing 2% of root extract of this plant, obtained by extraction with chloroform and methanol (1:1) led to a significant decrease in the incidence of this cancer as well as the decrease in the average number of tumors.

In the system of Ayurvedic medicine, an extract from the root of *A. racemosus* has also been used to increase milk secretion during lactation. The test results confirming its ability to enhance lactation are not clear. Joglekar et al. [26] observed an increase in milk secretion after administration of *A. racemosus* in the form of Ricalex® tablets (Aphali Pharmaceticals, 40 mg of root extract per tablet). Sharma's et al. [27] controlled clinical trials performed on randomly selected women giving due birth, without complications, with an insufficient amount of milk secreted did not give a similar result. Four-week treatment with *A. racemosus* extract had no effect on the increase in lactation. Each 100g dose of the medicine contained 15g of *A. racemosus* root extract.

Research of EveCare capsules confirmed their efficacy in the treatment of dysfunctional uterine bleeding (DUB) [28]. DUB are regular or acyclic bleedings from the uterus with no organic cause such as neoplasia, inflammation of the endometrium, submucous fibroids or polyps. Dysfunctional uterine bleedings may occur throughout the reproductive period. 20% of them are observed in adolescents, 40% occur at the age of 18-45, the other 40% - in premenopausal stage. The study included 70 women with DUB in the age group of 20-45 years. In the study group, 63 women had achieved a regularized menstrual cycle. It can be attributed to the local healing of the endometrium stimulated by endometrial microvascular thrombosis caused by high doses of phytoestrogens. Other studies conducted on a group of 40 women confirmed the effectiveness of EveCare capsules in the treatment of dysmenorrhoea and pre-menstrual syndrome (PMS) [29].

The Menosan formulation that is recommended in the treatment of postmenopausal symptoms was also tested [30]. In the group of 27 women who used this preparation, a significant relief from post-menopusal symptoms such as depression (90% relief), insomnia (83.33% relief), irritability (50%), weight gain (50%), sweating (37.88%), and hot flashes (37.03%) were observed.

The study conducted by Goel et al. [31] indicated the opposite effect in the use of phytoestrogen. A certain teratogenic effect was noted in rats treated with methanolic extract of *A. racemosus*. In a prenatal testing, it was observed that treatment with methanolic extract of root of *A. racemosus* (ARM) caused leg swelling, a slow growth of the foetal body and placental parts and an increase in the resorption of fetuses.

In the post-natal studies, an ARM treated group of rats had a smaller litter of pups with delayed development and increased mortality. However, that study was not able to identify a particular component as a factor indicating teratogenicity, which may be the subject of further research.

It is also important that phytoestrogens from food are not equivalent to phytoestrogens of herbal origin. Foods rich in phytoestrogens such as soya, rye, barley contain small quantities of active substances and can be eaten regularly. Phytoestrogens in medicinal plants are highly condensed and are not recommended for prolonged use. A matched dose and time of application are very important in this case. More research is needed to determine the mechanism of action of active substances of this plant, the consequences of their actions, as well as standardizing characteristics of formulations containing them.

Adaptogenic properties of *Asparagus racemosus*

As mentioned above, *A. racemosus* in the Ayurvedic system of medicine belongs to the 'rasayana' herbs i.e. medicinal plants improving general well-being by increasing viability and cellular immunity. These properties are similar to the modern concept of 'adaptogens'. In general, adaptogens are defined as substances of natural origin, increasing the body's ability to adapt to changing environmental conditions. The definition by Israel Brekham [32] characterizes adaptogens as agents increasing resistance to hypoxia (low oxygen), supporting cardio-vascular system, eliminating fatigue, adjusting functions of the nervous system and a number of others. Some authors believe that this action is based on their impact on regulatory systems, found in various tissues and organs, by the immune, hormonal, cardiovascular and muscular systems. They also point to the fact that adaptogens correct stress disorders caused by different medium by activating the body's defense system, the effect on the hypothalamic-pituitary axis and also on the adrenergic system. Ginseng root (*Panax ginseng*) is the typical material with adaptogenic properties improving concentration and promoting physical fitness.

The prevention and treatment of disorders caused by stress is a major clinical challenge. Currently, the benzodiazepines are used for immediate treatment of increased anxiety, insomnia, relief of withdrawal symptoms in alcoholism, in the premedication for a diagnostic and surgical procedures and postoperative sedation. They are not applied in chronic treatment because they have no therapeutic action, but only reduce symptoms or alleviate pain. In addition, the prolonged use of benzodiazepines can lead to strong physical dependence and thus reduce their usefulness.

Rege et al. [5] administered orally the aqueous, standardized extract of *A. racemosus* to experimental animals and then exposed them to various biological, physical and chemical stimuli that cause stress. Using a model of cisplatin they induced alterations in gastrointestinal motility. They also tested the ability of *A. racemosus* extract to normalize them, irrespective of the direction of pathological change. The results of this experiment found that the extract reversed some of side effects of cisplatin such as gastric emptying and intestinal hypermotility.

Furthermore, research has been undertaken to investigate the adaptogenic activity of herbal formulation Siotone (including *Withania somnifera*, *Ocinum sanctum*, *A. racemosus*,

Tribulus terristris) against chronic, unpredictable but mild action stressors [4]. Chronic stress causes a number of physiological abnormalities, has a negative impact on glucose metabolism, cognitive, immune and behavioral function as well as sexual function in males. The following stress markers were used: the degree of gastric ulceration, adrenal gland and spleen weight, corticosterone concentrations of adrenal cortex and plasma corticosterone levels. Root powder of *Panax gingseng* was used a standard adaptogenic agent for comparison. The findings suggest that the preparation of Siotone has a significant ($p<0.05$) adaptogenic activity. It reversed chronic stress induced biochemical and physiological disorders. The quality was comparable to ginseng root.

A similar study to assess the antistress and adaptogenic activity of another herbal formulation EuMil was performed Murugandam et al. [7]. *Panax ginseng* has been also used for comparison. Similarly to Siotone, EuMil showed significant anti-stress and adaptogenic properties of reversing the chronic stress-induced biochemical, physiological and behavioral disorders. Studies on acute and subacute toxicity showed that 'Siotone' and 'EuMil' are devoid of any toxic effects. Both formulations contain *Withania somnifera*, *Ocinum sanctum*, *A. racemosus*. Therefore, it can be concluded that these three plants may perform the major functions in relation to this particular action.

Another study shows the impact of anti-ulcer properties of *A. racemosus* on the development of indomethacin-induced ulcers in rats [33]. The formation of gastric ulcers and the formation of intestinal ulcers are a serious side effect of indomethacin depending on the dose. Properties of *A. racemosus* extract were comparable to those of standard drug - ranitidine. A significant reduction in the ulcer index, free acidity, volume of gastric secretion and total acidity was observed.

Cardioprotective action of *Asparagus racemosus*

The increased concentration of serum lipids, especially cholesterol and the formation of reactive oxygen species are main causes for the development of coronary artery disease and atherosclerosis. Herbo-mineral formulation 'Abana' containing 10 mg of *A. racemosus* extract in each tablet showed a significant hypocholesterolaemic effect in rats, and thus has the potential of use in the cardiopreventive treatment [34]. A 37 to 45% decrease of total cholesterol, phospholipids and triglycerides has been reported compared to the control samples. Due to the multi-components of 'Abana' further research is needed to indicate the participation of *A. racemosus* in this hypolipidaemic action.

The effect of *A. racemosus* on the lowering of cholesterol in hypercholesterolemia in rats was also studied by Visavadiya and Narasimhacharya [35]. Supplementation with powder from the roots of *A. racemosus* resulted in a reduction of lipid peroxidation, and - depending on the dose - improved the lipid profile. Supplementation with *A. racemosus* root powder decreased lipid peroxidation and caused a reduction in lipid profiles - depending on the dose. The level of total lipids, total cholesterol and triglycerides in plasma and liver, as well as plasma LDL and VLDL-cholesterol decreased by more than 30%. There is a hypothesis that hypercholesterolemia in this case is tempered by decreased exogenous cholesterol absorption and an increased conversion of endogenous cholesterol into bile acids. Concrete conclusions will be drawn after carrying out tests aimed at understanding the mechanism responsible for this action.

Immunological activity of *Asparagus racemosus*

The immunoadjuvant potential of *A. racemosus* has been studied on experimental animals immunized with diphtheria, tetanus and pertussis vaccine (DTP). A significant increase ($p=0.005$) in antibody titers to *Bordetella pertussis* in animals has been shown when a daily aqueous root extract of *A. racemosus* was administered compared with animals which were not provided with this extract. These animals are characterized by a reduced mortality level combined with general improvement in their health status, which refers to the development of a protective immune response [36].

In another study, extracts and formulations prepared from *A. racemosus* showed immunopharmacological actions in cyclophosphamide (CP)-treated mouse ascetic sarcoma [37]. Cyclophosphamide is commonly used to treat various types of cancers and immunopathological disorders. However, it has many side effects, among others bone marrow suppression (leukopenia, thrombocytopenia), hemorrhagic cystitis and alopecia. An increase in white cell counts was observed as well as haemagglutinating and haemolytic antibody titres in animals which adopt a daily specified dose of extracts and preparations on the basis of *A. racemosus*.

The supporting resistance action of *A. racemosus* has been repeatedly investigated [38-40]. Some authors suggest its use as a supplementary measure in chemotherapy, among others, to avoid or reduce the toxic side effects of synthetic chemotherapeutic agents, without interference in their antitumor activity.

In the system of Ayurvedic medicine, AIDS is considered to be a disease of decreased 'ojas', defined as the essential energy of the body. *A. racemosus* - Satavari is used in the creation of this 'ojas' and it is used in immunotherapy [41]. Among other things, immunological properties of *A. racemosus* are subjected to thorough research, aiming at its implementation in the adjuvant treatment of HIV.

Antibacterial properties of *Asparagus racemosus*

The *in vitro* study [11] shows a very high antibacterial efficacy of methanol extracts of *A. racemosus* against: : *Escherichia coli, Shigella dysenteriae, Shigella sonnei, Shigella flexneri, Vibrio cholerae, Salmonella typhi, Salmonella typhimurium, Pseudomonas putida, Bacillus subtilis* and *Staphylococcus aureus*. The antibiotic properties of *A. racemosus* play a minor role in comparison with the other properties of plants, but are also noteworthy.

Other properties of *Asparagus racemosus*

Saponins are an important class of secondary metabolites whose cytotoxic activity is tested against various cancerous cell lines. Apoptosis is the desired endpoint of cancer therapy. The authors of several studies claim that compounds that induce apoptosis, ie programmed cell death, are a better "therapeutic window" (tumor/normal tissue) than those that induce necrosis.

The aim of the study of Bhutani et al. [42] was to investigate the antiproliferative activity of steroidal constituents isolated from *A. racemosus* and *Solanum xanthocarpum*

on human colon carcinoma cells. They were subjected to the action of previously isolated compounds from the above mentioned plants at different concentrations. The cell viability and the apoptosis were determined parallelly. Cell viability was determined using the Sulforhodamine B cytotoxicity assay. The ability of different compounds to induce apoptosis of the human colon carcinoma cell line HCT116 was assessed using the M30 CytoDeath ELISA. The assessment of apoptosis was based on the accumulation of a caspase-cleavage product of cytokeratin 18 (ccCK18) in cells and culture medium. All carbohydrate-containing saponins from *A. racemosus* showed cytotoxic activity on HCT116 cells. Only those which were unrelated to the rest of the sugar aglycone (in the form of sarsasapogenin) did not show such activity. From the tested compounds, Shatavarin IV showed the largest potency to reduce cell viability. However, in this study immunoside was the only component that induced apoptosis.

The extracts from *A. racemosus* showed strong antioxidant effects *in vitro* against membrane damage induced by free radicals produced by gamma radiation in rat liver mitochondria [2]. Both the crude extract and its aqueous fraction caused inhibition of lipid peroxidation and protein oxidation. This action was compared with the action of glutathione and ascorbic acid.

A. racemosus is also used to treat dyspepsia, diarrhea, neurodegenerative diseases and cough. On the basis of the results of their research Dalvi et al. [43] concluded that the effect of *A. racemosus* was comparable to an allopathic medicine - metoclopramide, similar to the dopamine receptor antagonist. No significant differences between the actions of *A. racemosus* and metoclopramide allowed them to hypothesis that *A. racemosus* can be used as a mild dopamine antagonist. This single study has enabled the use of the properties of this plant, in Ayurvedic traditional treatment as a medicine for indigestion. The mechanism of this action has not been known until now, which is another point for further research.

The anti-diarrheal activity of *A. racemosus* extract is attributed to its ability to inhibit the prostaglandin biosynthesis which in turn results in the reduction of gastrointestinal motility and secretion [10]. The aqueous and ethanol extracts of *A. racemosus* showed similar activity to loperamide.

In an isolated study, methanol extracts of *A. racemosus* showed significant antitussive activity on a sulphur dioxide induced cough in mice [12]. Inhibition of the cough was comparable with a dose of 10-20 mg/kg of codeine phosphate.

Numerous studies carried out for further use of *A. racemosus* extracts in the treatment of neurodegenerative diseases such as Alzheimer's and Parkinson's diseases, in which excitotoxicity and oxidative stress are the major mechanisms of neuronal cell death, confirmed their antioxidant properties and ability to scavenge free radicals [3, 6].

CONCLUSION

The dynamic development of the phytochemical, pharmacological and technological work shows that *A. racemosus* has gained a great popularity due to its wide spectrum of interesting therapeutic properties including antioxidant, strengthening, antibacterial, antidiarrhea and cytotoxic.

Test results available in the literature encourage the undertaking of detailed studies of active compounds isolated from this little acknowledged plant.

Saponins and their antitumor activity are especially interesting. Due to the fact that therapeutic methods used in cancer treatment are often ineffective, it is necessary to look for new solutions. Success based on substances of plant origin, including: vinblastine, vincristine and podophyllotoxin inspires scientists to search for new anticancer drugs from plants. Studies on the cytotoxic properties of saponins are of particular importance. In addition, some attempts have been made to combine the action of saponins with the anticancer agents widely used in therapy, for example ginsenoside RH_2 and cis-diamminedichloroplatinum (CDDP) against established human ovarian cancer cell lines [44]. The results of many experiments confirm the desirability of research on saponins, of which *A. racemosus* is also a rich source.

Pharmacological studies of formulations produced with participation of *A. racemosus* indicate the enormous potential of this plant in treating symptoms of menopause, neurodegenerative diseases, diarrhea and dyspepsia.

Most authors recommend caution in the use of raw materials in order to show the results of further studies confirming the efficiency as well as its safety.

A. racemosus is a promising topic for further research.

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ZASTOSOWANIE FARMAKOLOGICZNE I TERAPEUTYCZNE *ASPARAGUS RACEMOSUS* WILLD

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Streszczenie

Powszechna akceptacja medycyny alternatywnej to główny powód wzrostu popytu na rośliny lecznicze pochodzące z Azji Południowej i Południowo-Wschodniej, m.in. z Indii. Szczególną wagę przypisuje się badaniom nad właściwościami cytotoksycznymi saponin. Wyniki eksperymentów potwierdzają celowość badań nad tymi związkami, których bogatym źródłem jest także szparag dziki - *Asparagus racemosus*. To roślina znana z właściwości fitoestrogenicznych i stosowana jako modulator hormonalny. W tradycyjnych systemach medycyny indyjskiej korzenie *A. racemosus* używane są w leczeniu chorób neurodegeneracyjnych, niestrawności, stanów zapalnych, nefropatii, infekcji gardła, nowotworów, nadkwaśności, biegunkach, zapalenia oskrzeli czy kaszlu. *A. racemosus* używany jest również do wytwarzania preparatów o cechach adaptogenów. Jest wiele przesłanek zachęcających do podjęcia szczegółowych badań nad aktywnością związków izolowanych z tej wciąż mało poznanej rośliny.

Słowa kluczowe: Asparagus racemosus, saponiny steroidowe, zastosowanie, lek roślinny