

Review on Therapeutic and Pharmaceutically Important Medicinal Plant *Asparagus officinalis* L

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Abstract

The use of medicinal plants is as old as human civilization. About 600-700 plants species in Pakistan are used for preparation of ayurvedic, unani and homeopathic drugs. *Asparagus officinalis* a sub-erect prickly shrub with white tuberous root usually is of prime importance in this regard. It naturally occurs in areas of southern Africa, Europe, Australia and Asia. Nutritive tonics are prepared from its roots and it is also a source of a nutritious starch, low in calories and is very low in sodium and good source of vitamins. This plant offers multiple health benefits because of presence of ingredients like proteins, alkaloids, saponins and tannins that help in improving fertility and vitality in women and men. Pharmacological activities of *Asparagus* include anticancer, antioxidant, antifungal, antibacterial, anti-dysenteric, anti-inflammatory, and anti-abortifacient, anti-oxtyotoxic, antiulcer, hypertensive and anticoagulant effects. Moreover, it is reported to reduce the risk of constipation, diarrhea, osteoporosis, obesity, cardiovascular disease, rheumatism and diabetes. Now days, the demand of such medicinally important plants has increased all over the world. However, indiscriminate use of such vital natural resources overtime and fragmentation of habitats may pose serious threat to their survival. Therefore, keeping in view the significance of *Asparagus*, efforts must be made to it protect it in its natural population.

Keywords: Medicinal plant; Pharmacological; Therapeutic; Conservation; Pakistan

Introduction

Plants are considered as an essential component of global sustainability due to their different ecosystem services like provision of fuel, food, medicine, shelter, condiments, aromas and perfumes [1]. Healthy ecosystems with plant diversity are vital for the livelihoods and well-being of all humankind. Plants, animals and human beings are inter-dependent upon one another. Therefore, human beings take care of both animals and plants by raring them in friendly environment ensuring their continuity and conservation. In return the food, forage, shelter and protection and other requirements are met by both the flora and fauna inhabiting the same ecological niches [2]. Therefore, it is essential to keep the plant diversity intact for the smooth running of the environment because local plants are important representatives of world biological diversity [3].

Plants constitute the major life sustaining system by forming the earth as a soft green protection layer. They control the atmosphere, preserve hydrological cycle, feed the animals and provide raw materials for pharmaceutical and scientific purposes. Globally important biological diversity territories are called hot spot territories. One half of all plant species of the planet grow in 34 hot spots, but destroyed vegetation of these territories occupies only 2.3% of the Earth's biodiversity [4]. The total species diversity of vascular plants on the earth is estimated between 310,000 to 420,000 [5].

Plants are sources of life saving drugs and have been used for medical treatment in human history. Man has traditionally needed these plants to cure diseases and knowledge of the medicinal plants and practice for regular uses extended to several parts of the world. Thus, mixture of magic, necessity, error and culture has created knowledge of medicinal plants; which has formed the base of modern medicine. These are used for primary health care in rural areas in developing countries and also in developed countries where modern medicines are predominantly used. The herbal drugs are prepared from medicinal plants only; while the traditional medicines are derived from medicinal plants, minerals, and organic matter. Pakistan being the most medico-culturally diverse

country in the world where the use of medicinal plants is part of a time-honored tradition that is respected even today by various indigenous healthcare systems of medicine including ayurveda and unani system.

Pakistan with an area of 80,943 Km², situated between 60° 55' to 75° 30' E longitude and 23° 45' to 36° 50' N latitude, with an altitude ranging from 0 to 8611 m has a diverse range of climatic and phytogeographic conditions that ultimately lead to diversification of plants including medicinal plants in maximum proportion. Approximately 6000 plant species has been found in Pakistan [6,7]. Among these, more than 4000 plant species have been reported from hilly areas of Pakistan such as KPK and Hindukush-Himalayas regions [8]. Various medicinal plants are used by local people for treating several diseases [9-11]. Majority of plants have never been examined for food and medicine, which may have the potential to provide raw materials to pharmaceutical companies. However, between 35,000 and 70,000 medicinal plants provide a real alternative for primary health care system worldwide [12].

Preserved monuments, written documents, and even unique plant medicines practiced now a day's also indicate link between man and his look for plant derived drugs from nature to the far-off past. The development of ideas and evolution of awareness related to the usage of medicinal plants in traditional healthcare systems is an outcome of long time efforts done against diseases which rendered man to learn to use plant mediated drugs from roots, leaves, barks, seeds, fruit bodies and other parts of the plants. It amplified the capacity of pharmacists

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Figure 1: Distribution of *Asparagus officinalis* (Yellow dots shows plant distribution).

and medical industry to face up the issues hindering in execution of professional services, to help the society [13].

Pakistan has been identified as one of the top mega diversity centers in the world having 6,000 species of floral diversity; out of these approximately 600-700 species are used for medicinal purpose [11]. Among these estimated species, 70% are uni-regional and other 30% are bi or pluri regional. *Asparagus* plants native to the western coasts of Europe (from northern Spain north to Ireland, Great Britain, and northwest Germany), Europe, northern Africa and western Asia, is widely cultivated as a vegetable crop. About 300 species of *Asparagus* are known throughout the world. Out of several species of *Asparagus* grown in Pakistan, *Asparagus racemosus*, *Asparagus gonacledes*, *Asparagus adsendens* and *Asparagus officinalis* are most commonly used in indigenous medicine [14].

Occurrence and habitat

Asparagus officinalis is a sub-erect prickly shrub with white tuberous root that grows well in tropical and sub-tropical climates. It grows and prefers to take root in gravelly, rocky soils high up in piedmont plains. It has a preference to grow in variety of medium like light sandy, medium loamy and heavy clay soils and need well-drained but moist soil. Its growth is much better in soil having acidic, neutral and basic (alkaline) pH. It has ability to grow in light shady places or where no shade is present and can easily bear maritime disclosure.

Distribution of *Asparagus officinalis*

The *Asparagus officinalis* is an herbaceous, perennial plant belongs to family Asparagaceae which has 150 species broadly dispersed in tropical and sub-tropical regions up to 1500 m elevation [15] and very dominant in regions of southern Africa, Europe, Australia and Asia (Figure 1). There are about 14 diverse species of *Asparagus* are present in Pakistan [16]. This specie is extraordinarily valuable as because of its use for ornamental, vegetable and medicinal purpose from prehistoric time.

It is commonly known as asparagus, crop asparagus, garden asparagus and edible asparagus in different areas of the world. It can be found in the parks in the steppes, steppe meadows and forest edges. *Asparagus officinalis* is categorized as very prominent daily routine vegetable in various localities of world [15]. It was used as a vegetable food and medicinal source near Aswan in Egypt about 20,000 years ago due to its flavor and diuretic properties. It was portrayed as a gift on an Egyptian frieze about 3000 BC and was also recognized previously in Syria and Spain [17].

Morphological description of *Asparagus officinalis*

The word *Asparagus* has derived from the Greek word *Asparagos*, which mean sprout or shoot, and it was first time published in English print about 1000 A.D. It is an herbaceous plant grows up to height of 2 m, and with a rhizome (underground stem) from which it re-grows in each spring. It has true but reduced scaly leaves also known as spines on stem at branching point. It has green color fine, flattened cladodes present in clusters and about 1-10 cladodes present per cluster. It has bell shaped flowers of both sexes (male and female) with six petals appeared on separate plants. The male flowers are 5-6 mm long and female flowers are about 4 mm long but the color of male flower is yellow and female flower is of yellow-green in color. The flower stalk is of about 25 mm long. It has fruits of red color known as berries (7-9 mm in diameter). Fruit usually contain 6 black seeds with a wrinkled and brittle seed coat.

Taxonomic classification and status of *Asparagus officinalis*

The status of *Asparagus* was described botanically in 1799. There are about 14 diverse species of *Asparagus* are present in Pakistan [16]. *Asparagus* has been placed in family Asparagaceae instead in Liliaceae by modern taxonomists [18]. This family includes 370 species with two important genera *Myrsiphyllum* and *Protasparagus* (Table 1). Most of the species are local to region Africa and cultivated for ornamentals (*A. officinallis*) and culinary purpose. In Pakistan, *Asparagus officinalis* is spread over in plains of Punjab and foothill regions of Kashmir [19]. Long time ago *Asparagus* was classified with *Allium*, onions and garlic as their cousins in Liliaceae family but later on onion-like plants are classified in family Amaryllidaceae and asparagus in the Asparagaceae family [20].

Chemical constituents

Asparagus officinalis is a very important medicinal plant and its roots, shoots, leaves, flower and mature fruits have very novel chemicals (Tables 2 and 3). The major bioactive constituents of

Kingdom	Plantae
Class	Angiosperms
Sub-class	Monocots
Order	Asparagales
Family	Asparagaceae
Sub-family	Asparagoideae
Genus	<i>Asparagus</i>
Species	<i>officinalis</i>

Table 1: Taxonomic Hierarchy of *Asparagus officinalis*.

Plant Part	Name of Compounds
Root	Steroidal saponins, sarsasapogenin, shatavarin I-IV, galactogogue, quercetin and rutin
Shoot	Thiophene, thiazole, aldehyde, ketone vanillin, asparagusic acid, and methyl/ethyl esters
Leaves	Diosgenin and quercetin-3-glucuronide
Flower	Quercetin, rutin (2.5% dry basis), and hyperoside
Mature Fruits	Quercetin, rutin (2.5% dry basis), and hyperoside
Other important compounds (Present in root, shoot, leaves, flower and mature fruits)	Vitamins (A,B,C,E), inorganic compounds (Mg, P, Ca, Fe, and folic acid), essential oils, amino acids (asparagine, arginine, tyrosine), secondary metabolites (flavonoids, kaempferol, resin and tannins)

Table 2: Chemical constituents of *Asparagus officinalis* (L.).

Compound Name	Quantity (%age/gm)
Water	91.70%
Carbohydrate	5 g
Fiber	0.7 g
Minerals	Ca (22 mg), P (62 gm), Fe (1 mg), Na (2 mg), K (278 mg)
Protein	2.5 g
Fat	0.2 g
Ash	0.6 g
Vitamins	A (540 mg), B1: Thiamin (0.18 mg), B2: Riboflavin (0.2 mg), Niacin (1.5 mg), C (33 mg)

Note: There is net of 26 Kilo Calories of energy is obtained per 100 g

Table 3: Chemical composition of fresh weight of stem (100 g of food) of *Asparagus officinalis* L.

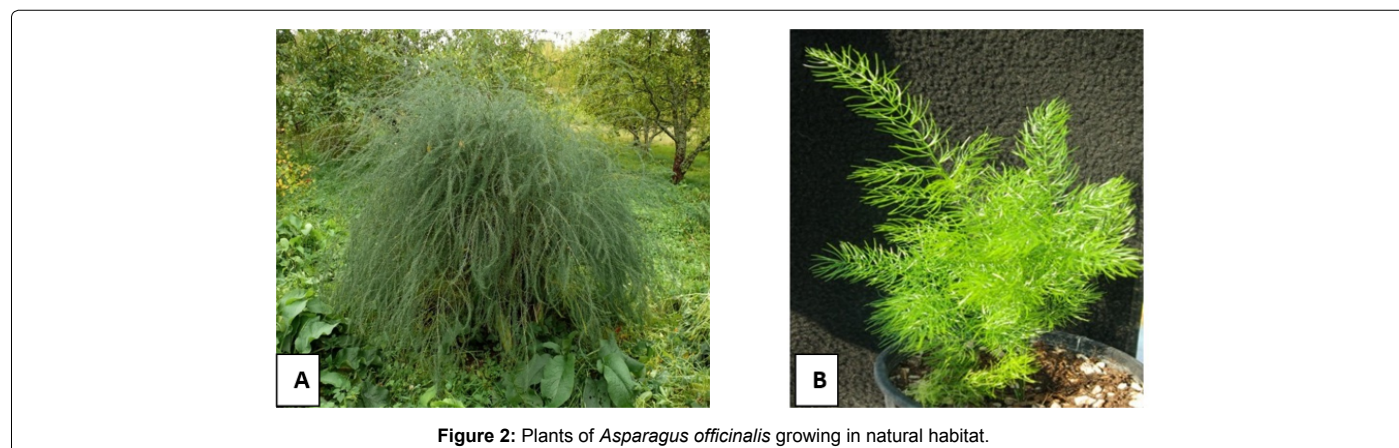


Figure 2: Plants of *Asparagus officinalis* growing in natural habitat.

Asparagus officinalis are a group of steroidal glycosides, saponins, inulin, asparagusic acid, and eight fructo-oligosaccharides [21]. Root contains sarsasapogenin, shatavarin I-IV, galactogogue, quercetin and rutin. Shoots contain thiophene, thiazole, aldehyde, ketone vanillin, asparagusic acid, and its methyl and ethyl esters which used as flavors. Leaves contain diosgenin and quercetin-3-glucuronide. Flowers and mature fruits contain quercetin, rutin (2.5% dry basis), and hyperoside. The other important bioactive chemical constituents are vitamins (A, B1, B2, C, E) inorganic compounds (Mg, P, Ca, Fe, and folic acid) essential oils, amino acids (asparagine, arginine, tyrosine) secondary metabolites (flavonoids (kaempferol, quercetin, rutin, resin, and tannin [22]. Mamta and Shukla [23] also reported different phytochemicals like steroids, triterpenoids, glycosides, saponins, phenolic compounds, aliphatic compounds and nitrogenous constituents in *A. adscendens*.

Edible and medicinal uses/Importance

The uses of the medicinal plants are found from ancient times with the origin of human beings. There are two basic uses of medicinal plants: direct use as dietary supplement or as chemical factories for the production of plants derived drugs.

Edible uses

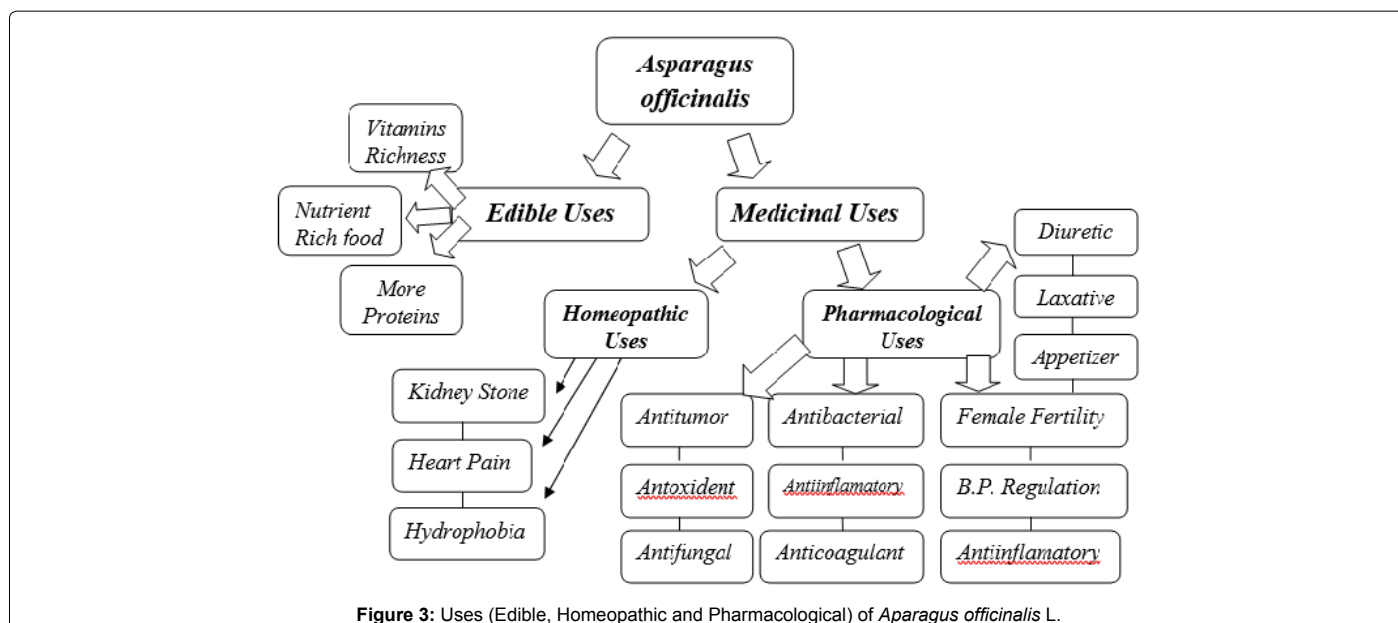
The history of cultivation of *Asparagus officinalis* as a vegetable

herb dates back to 2,000 years owing to the vital characteristics of low calories, high protein, zero fat, low sodium contents, superb source of folic acid, potassium, vitamins (such as C, Thiamin, B6) and fiber contents [24]. The young shoots of the plant harvested during spring season are not only used as delicious food item but also as vegetable and as an effective appetizer after boiling and steaming (Figures 2 and 3). Additionally, the shoots are served as salad because of having onion flavor. The shoots are a good source of carbohydrate, protein, vitamins and dietary fiber. Stem is also used in traditional dishes [25]. The prominent feature of *A. officinalis* among all vegetables is that it is major source of folic acid which is essential for blood cell formation, growth, and prevention of liver diseases. The roasted seeds of *A. officinalis* are used as a coffee substitute.

Medicinal Uses

Homeopathic uses

A. officinalis has been used in homeopathy for cure of heart pain, violent palpitation, dyspnoea due to hydrothorax, deglutition in hydrophobia, and passage of stones in urine with severe toothache (Figure 3). The fruits and seeds had strongest effect in reliefment of above problems.



Pharmacological, therapeutical and nutraceutical uses

Asparagus officinalis (L.) is considered as a high value plant because of its therapeutic and nutraceutical characteristics [26]. Its constituent saponins and fructans play pivotal role in anti-tumor activity and reduction of the risk of disorders such as constipation, diarrhea as well as diseases like osteoporosis, obesity, cardiovascular disease, rheumatism and diabetes [27]. Tendon et al. [28] also derived saponin mixture from *A. adscendens*. The roots also exhibit medicinal value as they are used as laxatives, tonic, aphrodisiac, galactagogue, and in curing the diseases of kidney and liver. As compared to the shoots the roots of *Asparagus officinalis* are more diuretic and they are recommended in dropsy and as a powerful cardiac sedative (Figure 3). They have also been utilized as a remedy for schistosomiasis and tuberculosis. Powdered dried roots exhibit galactogogic properties. They are reported to be useful against diarrhoea, dysentery and in general debility [24].

Fruits and seeds are also used for treatment of pimples and blood purification respectively. Pharmacologically the plant is very much precious as it includes anticancer, antioxidant, antifungal, antibacterial, anti-dysenteric, anti-inflammatory, anti-abortifacient, anti-oxytoxic, antiulcer, hypertensive and anticoagulant activities [29]. The plant is a source of a useable nutritious starch. Being low in calories and very low sodium contents, it is considered a good source of vitamins. The shoots have enormous potential to be used as an appetizer. The part of the plant that is used mostly is the root. Steroidal glycosides are identified in tuberous roots. Active compounds present in asparagus are well known for their multiple health benefits. Besides the presence high quantity of folic acid essential for production of new red blood cells other primary chemical constituents include essential oil, asparagine, arginine, tyrosine, flavonoids (kaempferol, quercetin, rutin), resin, and tannin. It is also responsible for increased rate of urine production by enhancing cellular activity of kidneys. It provides rutin, which strengthens the capillary walls [21,30].

The herb *A. officinalis* also facilitates the evacuation of the bowels with the help of increased fecal bulk with undigested fiber. The roots exhibit many folds medicinal importance as they are diuretic, laxative, induce sweating. They are also recommended for gout, dropsy, rheumatism and lowering the blood pressure. Antibiotic properties of

powdered seeds impart to relieve nausea by contributing a calming effect to the stomach. It has been reported that green *Asparagus* involved in the conversion of protein into amino acids results to dissolve uric and oxalic acid, and benefits arthritic conditions and kidney stones. It is also used as a tonic for the enhancement of the health of both male and female reproductive organs. In India, the racemosa species is utilized for increasing the sperm count and nourishment of the ovum [24].

Proper suitable dose for use

Add 45~60 g of cutted herb in 150 ml water. For making fluidextract ratio of 1:1 (g/ml) is taken that is 45~60 ml in volume concentration and for tincture solution ratio of 1:5 (g/ml) that is 225~300 ml in volume.

Safety and toxicity

Asparagus is generally regarded as safe when taken in the recommended doses. However, if someone kidneys are inflamed or if have diarrhea, do not use *Asparagus*. Also, do not take *Asparagus* supplements if someone has kidney disease.

Conservation status

Among the estimated 250,000-500,000 plant species, only a small percentage has been investigated for conservation status and the fraction submitted to IUCN Red list. Thus, there is a need of consistent effort for investigation of important plants, revealing only a very narrow spectrum over an area. Historically pharmacological screening of compounds of natural or synthetic origin has been the source of innumerable therapeutic agents from these plants and due to traditional uses of plants for food, shelter, fodder, health care and other cultural purposes the population of plants is decreasing day by day. Growing genetically defined plant material improves biomass quality and helps to protect the world germplasm from extinction as there are few breeding programs for medicinal plants [31]. Currently, the need for such documentation about conservation status has gain much importance concerning medicinal plants such as *Asparagus officinalis*, and act as a useful incentive for protecting the local flora. This plant is still distributed on wide range and not included in IUCN red list categories but with the passage of time it may face some threats from environment due to climate change, natural drifts, deforestation,

improper collection chain of medicinal plants, overharvesting and anthropogenic activities. Therefore, it is prudent to study *Asparagus officinalis*, at local, national and international levels for efficient conservation and management of its genetic diversity for future.

Conservation strategies

To conserve the flora particularly the flora possessing edible and medicinal significance, mass awareness campaigns both on governmental and community level should be launched to propagate awareness among then people. Moreover, extensive and intensive surveys are required to prepare a comprehensive inventory of resources of *A. officinalis*. To reduce pressure on natural flora, cultivation of medicinal plants on scientific lines will be considered a significant step. Vegetative propagation of *A. officinalis* through stem treated with different plant growth regulator viz. IAA, IBA, NAA, at varying concentrations must be optimized for further conservation and large scale propagation. Additionally, to this indirect method like callogenesis and somatic embryogenesis can be applied for production of plantlets helping in establishment of large scale plant nurseries [32-34]. Ali et al. [35] established a protocol for synthetic seed production by using artificial coating material (sodium alginate) and complexing agent (calcium chloride). This synthetic seed technology can also be very helpful for medicinal plants such as *Asparagus* species. *A. officinalis* seeds can be stored and germinate for a comparatively longer period if provided suitable conditions. Germination can be enhanced by treating seeds with exogenous hormone like chemicals dissolved in water [36]. Keeping in view the high medicinal importance of *Asparagus* species, they should be introduced in botanical gardens. Efforts must be made to ensure Public participation in conservation programs and awareness through training or utilization of mass media coupled with permanent monitoring programs. Permanent monitoring programs should be developed and conservation strategies should be planned to maintain threatened species.

Conclusion

In present review, an effort has been made to review the medicinally important plant as because the medicinal and aromatic plants have become of paramount importance due to ruthless extraction by upcoming biotechnology and pharmaceutical industry. This review summarizes researches conducted on *Asparagus officinalis* specifically in medicinal field. Numerous studies have been conducted on different parts of *Asparagus officinalis*, for the development of drugs by pharmaceutical industries. It has very important pharmacological compounds used to make drugs for cure of various diseases. Still, this specie has very large population over specific habitat but due to indiscriminate use of these resources overtime, deforestation, forest fires, habitat fragmentation and human interference the population of this plant may face the risk of becoming genetically impoverished in future. So, it is imperative that viable strategies should be adopted to conserve the surviving population and genetic resources of this specie. Finally, it is a matter of urgency, considering the medicinal importance of this species to protect it in its natural population and this review is a good source of literature survey for researchers who intended to do studies in this field.

Conflict of Interest

The authors declared no conflict of interest.

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