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A comprehensive review on *Allium hirtifolium* Boiss as a medicinal and edible plant

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ABSTRACT

Medicinal plants are native legacies with universal and global significance that are considered as one of the most valuable assets of each country. To gain knowledge of these plants is one of the most important indicators of development in any countries. Study of medicinal plants in any region is very important for different potentials of these plants such as pharmacologic and industrial aspects. Regarding recent interest in and lack of information on medicinal plants, their therapeutic properties, and the approaches to their preparation and extraction, native information and traditional knowledge could contribute significantly to initiating scientific investigations on these plants. Therefore, it is necessary to take significant measures to use and promote systematic methods of utilization of these valuable resources by knowing these plants and obtaining necessary information about their habitats, ecological characteristics, and therapeutic uses. In this article, the latest scientific information on Allium hirtifolium, a medicinal, industrial and edible plant, is presented.

Key words: *Allium hirtifolium*, medicinal plant, necessity of knowing

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INTRODUCTION

Human beings have long found that their lives, as with other animals, depend on the surrounding phenomena, especially on the growth of plants. They found that they could use plants and medicinal products for treatment of diseases and resulting complications. This requirement forced them to gain knowledge of medicinal plants and learn how to use them so that they could differentiate between useful and detrimental plants [1,2]. With scientific advances, novel utilizations of plants emerged and new mysteries of plants' wonderful world were divulged by extensive and comprehensive researches [3,4]. Because of emergence of diseases, human addressed the idea of using plants to treat them, which was an introduction to the term medicinal plants in different ethnics and cultures [5]. Generally, medicinal plants are very important natural resources which humans have turned to use to relieve pain and treat many diseases [6,7]. This utilization has increased with scientific advances, studies on medicinal plants, and extraction and identification of their chemical properties and compounds. A variety of compounds with different properties were found in plants [8,9]. There has been considerable debate over dangerous side effects of chemical drugs in pharmacology and medicine during past 20 years [10,11]. The best way to evade the side effects, both acute and long term, has been use of medicinal plants to date [12]. Historically, human has been dependent on medicinal plants, and this dependency has not reduced, rather increased, despite today's extensive and universal scientific and

industrial advances [1,2]. Generally, medicinal plant is referred to a plant with known effective substances, which is used to treat or prevent disease and has been registered in an international reliable pharmacopoeia. Pharmaceutical industries and research teams in many countries have focused their attention to cultivation and production of medicinal plants [13]. Iran, a vast country, enjoys extremely favorable conditions for global development of knowledge of medicinal plants because of its glorious past in the science of medicinal plants, climate and ecological diversity, as well as abundant genetic and species diversity of plants [14,15]. Currently, valuable species of medicinal plants are at risk of extinction because of pressures imposed on natural resources, and unfortunately many valuable species have gone already extinct. Out of medicinal plants *Allium hirtifolium*, as one of the most important medicinal, industrial and edible plants, grows wild and naturally in highlands [16,17]. Regarding high consumption of *A. hirtifolium* in Iran and likelihood of its extinction as a result of excessive exploitation of its natural habitats, research on domestication process and mass production of *A. hirtifolium* is necessary. Therefore, useful studies on cultivation, propagation, and medical uses of *A. hirtifolium* have been recently conducted to domesticate and extensively cultivate this valuable plant in agricultural ecosystems [18]. This article seeks to offer the latest data on various aspects of *A. hirtifolium*.

A review of Alliaceae family highlighting A. *hirtifolium*

Alliaceae family is a big family of flowering plants which is significant from gardening and ornamental viewpoints. Alliaceae family consists of approximately 250 genuses and 3500 species. Different species of Alliaceae family occur most regions of the world (The plants of this family are perennial, herbacious, and are rarely annual). Most plants of Alliaceae family have underground stem, corm, and bulb. Perianth parts are separate or continuous and mostly petaloid (4,6,8). The seeds are round, triangular or discoid. Overall, most plants of Alliaceae family are decoratively and aesthetically worthwhile. The habitats of these plants, such as *Fritillaria imperialis*, are mainly located in Zagros Mountains, western Iran. *Hyacinthus* spp and *Eremurus* spp which have been recently commercially available, and *ledebourii* and *colohicum* spp are some beautiful flowers of Liliaceae family. Mosir, garlic, onion, and leek are other commercially available plants of this family, which are approximately publicly known [19]. Table 1 shows some plants of Liliaceae family.

Table 1. A list of Liliaceae family plants [20]

Row	Scientific name	Persian name	English name	Geographical distribution in Iran
1	*Allium cepa L.*	*Piaz-e khoraki*	Onion	Golestan, Mazandaran, Gilan, Azarbaijan, Khuzestan, Hormozgan, Kerman, Isfahan, Tehran, Southern Khorasan
2	*Allium porrum L.*	*Tareh farangi*	Leek	This species is grown in Iran.
3	*Allium sativum L.*	*Sir*	Garlic	Golestan, Mazandaran, Gilan, Azarbaijan, Hamadan, Khuzestan, Fars, Isfahan, Tehran
4	*Allium hirtifolium Boiss*	*Mosir*	Mosir	West Azarbaijan, Kurdistan, Kermanshah, Hamadan, Lorestan, Isfahan, Chaharmahal and Bakhtiari, Kohgiluyeh and Boyer-Ahmad, Fars, Arak, Nahavand, Yasouj, Borujerd, Khansar
5	*Asparagus officinalis L.*	*Marchoubeh*	Asparagus	Mazandaran, East Azarbaijan, West Azarbaijan, Kermanshah, Arak, Tehran (Karaj)
6	*Colchicum speciosum steven*	*Gol-e hasrat-e* ziba	Meadow saffron	Different regions except for tropical regions
7	*Ruscus hyrcanus woron*	Kole-Khas	Butcher's bromm	Gorgan, Bandar-e Gaz, Mazandaran (Tonekabon), Gilan (Bandar-e Anzali), Ardabil
8	*Urginea maritima (L.)Baker*	Onsol	Shore sea onin	In different regions, oak forests, Fars (Nourabad, Kazeroun), Khuzestan (Izeh,Baghmalek)
9	*Fritillaria imperialis L.*	*Laley-e vajgoun*	Crown imperial	Kermanshah, Ilam, Isfahan, Arak, Chaharmahal and Bakhtiari, Lorestan, Fars, Kohgiluyeh and Boyer-Ahmad
10	*Smilax excels L.*	Azmolk	Rough bindweed	Gorgan, Mazandaran, Gilan
11	*Muscari spp.*	*Kalaghak*	Tassel hyacinth	East Azarbaijan, Kurdistan, Kermanshah, Lorestan, Kerman, Tehran

Allium genus consists of approximately 120 species, of which more than 30 occur only in Iran, spreading in approximately all regions of Iran from agricultural lands and orchards, sandy desert areas to high mountain peaks, except the southern coastal plain. Some of the species are widely known for their therapeutic properties and have been also cultivated, and some of them are generally used and eaten in vegetable rice or soup in different regions of Iran in early spring while their therapeutic properties are not precisely known. Plants of Allium genus clearly have a bulb[20]. Study findings indicate that the plants of Allium genus have antibacterial, antifungal, antiviral,

antiprotozoal, and antihelmintic properties [21,22]. The plants of Allium genus are rich in organosulfur compounds and flavonoids and exhibit antioxidant and antibacterial properties[23]. They also play a protective role against free radicals, which is attributed to allicin existing in most plants of Allium genus[24]. Table 2 classification of Allium spp in other among plants.

Tabhe 2: Clasification of Allium Spp

Classification	
Kingdom	**Plantae**
Division	**Magnoliophyta**
Class	**Monocotyledon**
Sub-class	**Lilioideae**
Order	**Liliales**
Family	**Liliaceae**
Genus	**Allium**
species	***Hirtifolium***

Botanical features of Mosir

A.hirtifolium Boiss, equivalent to *Allium stipitatum* Regel, is a bulbous, perennial plant from Liliaceae, which is native to Iran and grows in highlands and mountainous regions [25]. Occasionally, *A. hirtifolium* is mistakenly referred to as shallot in English vocabulary. But, shallot is equivalent to *Allium ascalonicum* L. which has been called as *Mosir* in some references. However, *A. ascalonicum* does not occur in Iran and *Mosir* is not a correct equivalent for this plant in Persian vocabulary. Clearly speaking, *Mosir* is the wild, mountainous type of *A. hirtifolium* and hence it is occasionally referred to as *sir-e kouhi* (mountainous garlic) in Persian. *Mosir* is slightly bitter and may be called as *talkh-e piaz* (bitter onion), as well. *A. hirtifolium* has cylindrical and hollow leaves reaching 30 cm in length. The flowers are orange and/or purple, and usually unproductive.*A. hirtifolium* bulbs are 2.5-4 cm in diameter, with gray outer shell and bare, slightly streaky stems of 80-120 cm in height, 4-5 leaves, with a ciliated or rarely trichome-free edge, more or less glabrous or almost trichome-free in basal part. Peduncles are 3.5-5 cm in length and the perianth is star-like, purple and rarely white. In the first year, *A. hirtifolium* produces a very small bulb, and in the fourth and/or fifth year simultaneously with production of inflorescence, produces a daughter bulb, turning into mother bulb in the next year. Therefore exploiting *A. hirtifolium* bulb by seeding takes a long time in order for the bulb to reach the desired size. *A. hirtifolium* seed has dormancy and should be sown in the autumn so that the dormancy period is broken under normal conditions [23,26]. The appropriate temperature for *A. hirtifolium* growth is 6-27°C with pH 4.5-8.3 as the most appropriate for growth.*A. hirtifolium* flowers are orange or purple and usually unproductive. *A. hirtifolium* bulb has the chromose number 16. The chromosomes are mainly metacentric (Out of eight chromosomes, seven are metacentric and one is submetacentric). *A. hirtifolium* karyotype is homogenous as the chromosomes are mainly metacentric rather submetacentric. The bulbs start to grow as the weather gets cold, and in autumn the primary roots of bulbs grow initially, while the growth speed of aerial parts including leaves increases and then inflorescence is developed depending on bulb's age and weight. June is the end of *A. hirtifolium* lifetime and its bulb enters into summer dormancy [27].

B.

Figure 1. *Allium hirtifolium* In Iran

A. *hirtifolium* medicinal and therapeutic features

Medically, *A. hirtifolium* is an important medicinal plant whose edible parts are leaves and bulbs. Bulbous plants are rich sources of antioxidants and valuable substances such as vitamins A, B, C, and D, beta-carotene, and essential amino acids. These plants also contain considerable amounts of potassium, phosphorus, calcium, sodium, magnesium, iron, copper, and manganese [28]. *A. hirtifolium* is also appetizing and contributes to strengthening digestive system, and since water comprises over 90% of vegetables weight, *A. hirtifolium* bulb with 30% dry material is a very valuable vegetable for production of dry products such as *A. hirtifolium* powder. The most important fatty acids of *A. hirtifolium* are linolenic acid, linoleic acid, palmitic acid, palmitoleic acid, stearic acid, and oleic acid. *A. hirtifolium* has a special taste and its dried bulb slices are used as an additive to yogurt and pickles. *A. hirtifolium* powder is used as a delicious additive or condiment for foods in Iran [29,26].

.*A. hirtifolium* could cause decrease in the level of high density lipoprotein (HDL) and low density lipoprotein, but it has no effect on triglyceride. In a study of *A. hirtifolium* alcoholic extract and male rats, three - week administration of the extract adversely decreased HDL cholesterol, mainly explained by incidence of enzyme disorders in the synthesis of this substance in liver tissue [30]. Studies have demonstrated that use of *A. hirtifolium* decreases the risk of coronary heart diseases. This plant has caused decrease in glycemia and hence resistance to insulin [21,31]. A study on healthy and diabetic mice demonstrated that steroid saponins of *A. hirtifolium* caused increased appetite and hence weight gain in healthy and diabetic mice through affecting circadian rhythms and behaviors related to eating [32]. Many plants of Allium genus have a compound called allicin, a strong antibiotic. Antibiotic property of 1 g allicin is equivalent to 15 units of penicillin. The plant extract at 500-800 µg/mL could inhibit different steps of angiogenesis, which was attributed to flavonoids, particularly quercetin, existing in *A. hirtifolium* ethyl acetate extract. Therefore might be useful when angiogenesis is pathologic (tumors, metastasis, arthritis) [33,34]. *hirtifolium* chloroform extract and the allicin extracted from it can partially inhibit the spread of tumor cells. Some saponins, which are abundantly found in *A. hirtifolium*, can reduce synthesis of cholesterol and fatty acid in the liver tissue. *A. hirtifolium* bulb inhibits cancer cell proliferation and is used for treatment of rheumatism, superficial wounds, kidney stones, blood pressure, and diarrhea [35,34,36]. Tables 3 and 4 show some saponins in *A. hirtifolium*.*A. hirtifolium* exerts considerable antioxidant and antibacterial properties because of containing flavonoids such as quercetin and sulfur compounds including dialyl disulfide, inhibiting the oral transmission of significant bacteria including *Listeria monocytogenes*, *Staphylococcus aureus*, Salmonella and *Escherichia coli* [37,38]. Table 5 shows some antimicrobial properties of *A. hirtifolium*

Table 3. Spirostane-type sapogenins identified in the Allium hirtifolium[39]

Common name	Structure
Gitogenin	**(25R)-5 α -spirostane-2 α ,3 β -diol**
Agapanthagenin	**(25R)-5 α -dpirostane-2 α ,3 β -,5 α -triol**
Alliogenin	**(25R)-5 α -spirostane-2 α ,3 β , 5 α , $\sigma\beta$ -tetrol**

Table 4. Steroidal saponins/sapogenins reported in Allium hirtifolium[39]

Glycoside common	sapogenin	Sugar residue
HIRTIFOLIOSIDE D HIRTIFOLIOSIDE A1 HIRTIFOLIOSIDE A2 HIRTIFOLIOSIDE B HIRTIFOLIOSIDE C1 HIRTIFOLIOSIDE C2	**Agigenin** **Furostane-2 α ,3 β ,22 α -triol** **Furostane-2 α ,3 β ,22 β -triol Furos-20(22)-ene-2 α ,3 β ,triol Furostane-2 α ,3 β ,22 α -triol Furostane-2 α ,3 β ,22 α -triol**	**3-O- β -D-Xy1-(1 $\rightarrow$3)-O- β -D-Glc- (1 $\rightarrow$4)-O- β -D-Gal** **26-O- β -D-Glc-3-O- β -D-Xy1-(1 $\rightarrow$3)- O- β -D-Glc-(1 $\rightarrow$4)-O- β -D-Gal** **26-O- β -D-Glc-3-O- β -D-Xy1-(1 $\rightarrow$3)- O- β -D-Glc-(1 $\rightarrow$4)-O- β -D-Gal** **26-O- β -D-Glc-3-O- β -D-Xy1-(1 $\rightarrow$3)- O- β -D-Glc-(1 $\rightarrow$4)-O- β -D-Gal** **26- β -D-Glc** **26- β -D-Glc**

Glucose(Glc), Galactose (Gal) ,Xylose(Xyl), Glucose(Glc)

Table 5. MIC and MBC (mg/ml or μ g/mL) for antibacterial activity of *Allium hirtifolium* Boiss againts particular pathogen

A.*hirtifolium* Part used	Collecting place	Province	Pathogense	Extract			
				MIC	MBC	Refrences	
Bulb	Ilam	-	MRSA MSSA S.aureus S.epidermidis S.pneumonia E.coli E.colia157:H7 S.typhimurium P.mirabilis K.pneumonia	1/88 1/88 1/88 1/88 3/75 7/50 3/75 3/75 7/50 3/75	7/50 7/50 3/75 15/00 15/00 30/00 15/00 7/50 30/00 15/00	Mg/mL	[40]
Bulb	shahrekord	Charmehabakh- teyari	B.subtilis E.faecalis S.aureus E.coli K.pneumoniae	7/5 15 15 15 0	- - - - -	Mg/mL	[23]
Bulb	Marghemalek	Charmehalba kheyari	B.subtilis E.faecalis S.aureus E.coli K.pneumoniae	15 15 15 15 0	- - - - -	Mg/mL	[23]
Bulb	Sahneh	Kermanshah	B.subtilis E.faecalis S.aureus E.coli K.pneumoniae	7/5 15 0 15 0	- - - - -	Mg/mL	[23]
Bulb	Alashtar	Lorestan	B.subtilis E.faecalis S.aureus E.coli K.pneumoniae	15 15 15 15 0	- - - - -	Mg/mL	[23]
Bulb	Khorramabad	Lorestan	B.subtilis E.faecalis S.aureus E.coli K.pneumoniae	3/7 15 15 15 0	- - - - -	Mg/mL	[23]
Bulb	Divandareh	Kurdestan	B.subtilis E.faecalis S.aureus E.coli K.pneumoniae	7/5 15 15 15 0	- - - - -	Mg/mL	[23]
Bulb	Asadabad	Hamedan	B.subtilis E.faecalis S.aureus E.coli K.pneumoniae	7/5 7/5 15 7/5 15	- - - - -	Mg/mL	[23]
Bulb	Malayer	Hamedan	B.subtilis E.faecalis S.aureus E.coli K.pneumoniae	15 15 15 15 0	- - - - -	Mg/mL	[23]

Bulb	**Nahavand**	**Hamedan**	**B.subtilis** **E.faecalis** **S.aureus** **E.coli** **K.pneumoniae**	**15** **15** **15** **15** **0**	**-** **-** **-** **-** **-**	**Mg/mL**	**[23]**
Bulb	**Avej**	**Qazvin**	**B.subtilis** **E.faecalis** **S.aureus** **E.coli** **K.pneumoniae**	**15** **15** **15** **15** **15**	**-** **-** **-**	**Mg/mL**	**[23]**
Bulb	**Esfahan**	**Esfahan**	**B.subtilis** **E.faecalis** **S.aureus** **E.coli** **K.pneumoniae**	**1/87** **7/5** **7/5** **7/5** **15**	**-** **-** **-** **-** **-**	**Mg /mL**	**[23]**
Bulb	**Samsami**	**charmehalbakhteyari**	**B.cereus** **L.monocytogenes** **P.vulgaris** **S.typhimurium**	**62/5** **125** **125** **125**	**-** **-** **-** **-**	**μg /mL**	**[41]**
Bulb	**Khaki**	**charmehalbakhteyari**	**B.cereus** **L.monocytogenes** **P.vulgaris** **S.typhimurium**	**125** **250** **125** **125**	**-** **-** **-** **-**	**μg /mL**	**[41]**
Bulb	**Dashte-Laleh**	**charmehalbakhteyari**	**B.cereus** **L.monocytogenes** **P.vulgaris** **S.typhimurium**	**62/5** **125** **125** **125**	**-** **-** **-** **-**	**μg /mL**	**[41]**
Bulb	**-**	**-**	**S.aureus** **S.epidermidis** **E.coli** **K.pneumoniae** **P.mirabilis** **P.aeruginosa**	**156-312** **19/5-78** **78-156** **156-312** **156-624** **20-80**	**-** **-** **-** **-** **-** **-**	**μg /mL**	**[42]**

CONCLUSION

The existence of 11 of 13 globally known climates, 300 sunny days a year, and 40-50°C difference in temperature between the coldest and hottest regions in Iran have provided the conditions for utilization of unique ecological conditions in a vast country such as Iran [43-45]. In Iran, there are about 500 aromatic and medicinal plant species, many of which are exclusively native to Iran. Increasing consumption of medicinal plants as raw materials for the production of herbal medicines without development of appropriate methods of planting and management leads to destruction of nature. Easy access to habitat of plants, lack of knowledge about the rate and methods of sustainable harvesting methods of medicinal plants, the profitable market, and no legal policies are some factors contributing to the excessive use of medicinal species and reducing their genetic diversity [46]. Medicinal plants are thought to be at less risk than other crops because of growing in their natural habitats. However, some factors including urban development in new areas, desertification and increased toxins in the environment are seriously threatening ecological balance and ecosystems of these valuable plants and also genetic diversity of many useful wild species. Therefore cultivation of these plants should be seriously considered. *A. hirtifolium* is a medicinal plant which is collected from natural habitats In Iran and is variously used by native people and also in traditional medicine [47]. However, excessive exploitation of natural areas by local communities has put this medicinal species at risk [48]. Therefore, sustainable utilization of *A. hirtifolium* from natural areas alongside domestication seems necessary to preserve *A. hirtifolium*. In addition, in case of codified planning and adequate monitoring of exploitation of *A. hirtifolium*, its harvesting could be continued. Therefore, some plants that could be cultivated and spread across different regions of Iran and are at risk of extinction could be appropriately cultivated in any regions through detailed and scientific works. Hence, support measures are recommended to detect, preserve, and proliferate medicinally valuable species in different regions of Iran. Most of therapeutic effects of A. hirtifolium has been attributed to its antioxidant activity. Antioxidants can scavenge free radicals which can cause a wide variety of diseases [49-88]. Therefore, other than mentioned therapeutic effects, A. hirtifolium may be effective in all of these oxidative stress induced diseases.

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