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Review Article

Ethnobotanical knowledge of *Astragalus* spp.: The world's largest genus of vascular plants

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Abstract

Objective: *Astragalus* L. (Fabaceae) is the largest genus of vascular plants in the world, that comprises an estimated number of 2900 annual and perennial species. The members of this genus have a broad spectrum of usages (e.g. medicine, food, fodder, fuel, ornamental plants, etc.). Here, we present a review of ethnobotanical applications of different species of *Astragalus* by various ethnic and cultural groupings worldwide, to provide an exhaustive database for future works.

Materials and Methods: Literature survey was performed using Scopus, Google Scholar, PubMed, Medline, and Science Direct, and English and non-English reference books dealing with useful properties of the *Astragalus* species from 1937 to 2018. Consequently, we reviewed a total of 76 publications that supported lucrative information about various uses of this huge genus.

Results: Several ethnobotanical uses of 90 *Astragalus* taxa were documented which were mainly originated from Asian and European countries. The two most frequently mentioned *Astragalus* treatments, were against urinary and respiratory diseases. The most commonly used part was gum and the most frequently used preparation method was decoction.

Conclusion: This review highlights that various *Astragalus* species have great traditional uses in different ethnobotanical practices throughout the world. However, there is still lack of phytochemical and pharmacological researches on many species of *Astragalus* and further studies are required to substantiate the therapeutic potential of them which will develop new generation of plant-derived drugs in the near future.

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Introduction

The genus *Astragalus* L. belongs to the well-known plant family Fabaceae and tribe Galegeae, which has high medicinal and economic values. The genus *Astragalus* is the largest genus of vascular plants with approximately 2900 species, which has two main centers of distribution

in the world, America (New World) and Eurasia (Old World). Most of the species are located in the Old world (ca. 2400 spp.) whereas ca. 500 species are restricted to the New World (Chaudhary et al., 2008, Zarre and Azani, 2013). It is a considerable example of adaptive radiation in a worldwide scale (Kazempour Osaloo et al., 2003). From a biogeographic point of view, *Astragalus* is a characteristic Irano-Turanian element and many species of it show a narrow geographic range (narrow endemics), which makes them particularly vulnerable to extinction (Jalili and Jamzad, 1999; Memariani et al., 2016). Iran is known for its high diversity of *Astragalus* that comprises 850 species of *Astragalus*, of which 527 species are endemics (Maassoumi, 1998; Maassoumi, 2005). Morphologically, its members can be broadly characterized by the presence of typical papilionaceous flowers. *Astragalus* species differ from short living annual herbs (ca. 80 spp.) to perennial rhizomatous or hemicryptophytic herbs (ca. 2500 spp.) and to cushion forming spiny shrubs (ca. 300 species). Most members of the genus are generally associated with semi-arid and arid habitats across the world, however, a few species select humid habitats (e.g. *A. glycyphyllos* L.), or are known as weeds. Due to the large size of the genus, it has fascinated different investigators, but much work remains to be done. There is much confusion regarding *Astragalus* taxonomy and phylogeny. Several authors have attempted to subdivide *Astragalus* to achieve a natural subgeneric classification by means of morphological characters. Among them, Bunge's classification of the genus (eight subgenera and 105 sections), has been extensively employed until recently (Zarre and Azani, 2013; Maassoumi, 1998; Maassoumi, 2005). As the largest genus of vascular plants, its circumscription will remain obscure until the majority of known morphological lineages, are surveyed for adequate numbers of plastid and nuclear markers (Zarre and Azani, 2013).

In the literature, multiple reports have described various ethnobotanical aspects of different species of the genus *Astragalus*. These invaluable plants are widely used as medicine, food, fodder, fuel and as ornamental plants in different ethnobotanical practices throughout the world (Table1). The most used part of *Astragalus* taxa is the gum tragacanth and Iran is the primary source of it (by supplying 70% of the commercially used gum tragacanth) in the world (Anderson and Grant, 1988; Anderson, 1989). Nowadays, several species of *Astragalus*, are reported to be commercially exploited for gum tragacanth (Table2). Despite the vast ethnobotanical knowledge on this genus that exists around the world, there are no distinct references on its applications and most of the publications are widely scattered. Furthermore, the number of phytochemical and pharmacological studies conducted on this big genus, is still too few. Therefore, this review aims to integrate the findings concerning the ethnobotanical aspects of *Astragalus* genus in order to support sufficient baseline data for subsequent works and commercial exploitation.

Materials and Methods

This review was prepared based on an extensive survey of major scientific databases namely, Google Scholar, Scopus, PubMed, Medline, and Science Direct, and English and non-English reference books dealing with useful properties of the *Astragalus* species over the past few decades (1937- 2018). After a holistic search, we reviewed a total of 76 publications that reported beneficial information about various aspects of the genus *Astragalus* globally. The most frequently published reports on this genus were from various regions of Iran, Turkey, India, Pakistan, China and American countries. In this paper, scientific and

author names of plant species were carefully scrutinized for latest changes via "The Plant List" (http://www.theplantlist.org) and also according to the most recent monograph of the genus (Podlech and Zarre, 2013).

Results

In this review, several ethnobotanical usages of 90 *Astragalus* taxa which mainly originated from Asia and Europe, were documented. These invaluable plants were arranged in alphabetical order for their scientific names, with the related data. The information comprises autochthonous names, the part(s) used, the method of preparation, and traditional applications along with literature sources. Various parts of *Astragalus* taxa have been used in different ethnobotanical practices around the world. The most used parts of the plants were gum (34 species) followed by root (28 species), aerial part (10 species), fruit (8 species), seed (6 species), whole plant (6 species), flower (3 species), leaf (3 species), wood (1 species) and manna (1 species) (Figure 1).

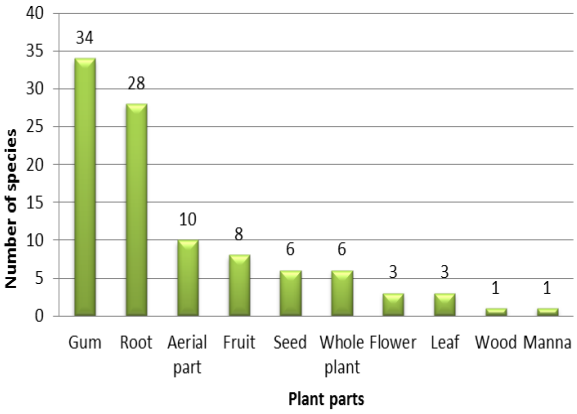

Figure 1. Proportional presentation of most used plant parts.

The most common methods of preparation were decoction (20 species), followed by infusion (5 species), poultice (4 species), chewing (4 species), powder (4 species) and bath (1 species). Many reports could be found representing ethnomedicinal uses of different members of this huge genus. Among them, *A. brachycalyx* Fisch. ex Boiss. (Syn. *A. adscendens* Boiss. & Hausskn.), *A. fasciculifolius* Boiss., *A. glycyphyllos* L., *A. gossypinus* Fisch., *A. gummifer* Labill., *A. hamosus* L., *A. microcephalus* Willd., *A. mongholicus* Bunge and *A. tribuloides* Delile are the most popular medicinal plants. The most treated illness categories were the urinary system (11 species), respiratory system (8 species), metabolic system (8 species), digestive system (7 species), nervous system (7 species), blood and circulatory system (5 species), and skin problems (4 species) (Figure 2).

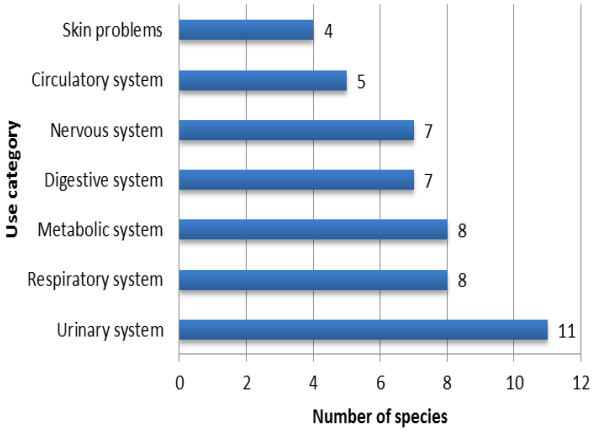

Figure 2. Proportional presentation of species applied in each medicinal use category.

The importance of ethnobotanical aspects

Literature review indicated that many cultures including Asian, European, American and African have used *Astragalus* species for alleviating a wide array of diseases. Some of its exemplary uses are given below while the others are summarized in Table 1. In Asian countries, particularly Iran, Pakistan, India, China and Korea, there are considerable reports on the traditional applications of *Astragalus* species. Iran is a region of high *Astragalus* biodiversity and thus, the rich tradition usage of *Astragalus* in this area is not surprising. Among them, *A. brachycalyx* Fisch. ex Boiss., *A. fasciculifolius* Boiss., *A. fischeri* Buhse ex Fisch., *A. globiflorus* Boiss., *A.gossypinus*

Fisch., *A. gummifer* Labill., *A. hamosus* L., *A. mucronifolius* Boiss., *A. ovinus* Boiss. and *A. verus* Olivier, are the most commonly used ones in different regions of Iran. The common Persian name of the majority of *Astragalus* species is "Gavan" (Mozaffarian, 2007). In Iran, the decoction of aerial parts of *A. hamosus* L. is considered very useful in the treatment of prostate problems. The decoction of flower, root and gum of *A. fasciculifolius* Boiss. locally known as "Gineh or Ginja", is recommended for the treatment of cold, joint pains, aching tooth, wounds and diabetic wounds (Mosaddegh et al., 2012). The decoction of its gum popularly known as "Anzerut", is also broadly used in Iranian Traditional Medicine system, as antitussive, laxative, and anthelmintic and to cure jaundice (Amiri et al., 2014; Mozaffarian, 2013). Moreover, it is used as a remedy for cold, and fatigue and for tightening bone fractures. Root decoction of *A. mucronifolius* Boiss. is also considered very useful in the treatment of back pain and bone fracture by traditional healers of Iran (Safa et al., 2013). In Traditional Chinese Medicine (TCM), *A. mongholicus* Bunge (Syn. *A. membranaceus* (Fisch.) Bunge; *A. propinquus* Schischkin), is one of the most famous tonic herbs. It is also an antiperspirant, and a diuretic, and is consumed for treatment of nephritis and diabetes (Yu et al., 2013). In Pakistan, the roots of *A. mongholicus* Bunge commonly known as "Shatra", are widely used in traditional medicine as an adaptogenic, immune stimulant, diuretic, vasodilator and antiviral agent (Ullah et al., 2014). In Jordan, the fruits of *A. hamosus* L. are applied externally as incense, and evil eye and for treatment of baldness (Lev and Amar, 2002).

The genus *Astragalus* is also well documented for its notable applications in the European Traditional Medicine. In Russian folk medicine, *A. laxmannii* Jacq. (Syn. *A. adsurgens* Pall.), *A. dahuricus* (Pall.) DC. and *A. penduliflorus* Lam. are used as a diuretic for treatment of oedema. In Belarus, *A. arenarius* L. and *A. cicer* L. are applied to heal heart and gastrointestinal diseases. In Bulgarian folk medicine, *A. corniculatus* M. Bieb., *A. ponticus* Pall. and *A. vesicarius* L. are used as a diuretic for treatment of hypertension, renal system ailments, nervous disorders and rheumatism**,** and as a diaphoretic (Lysiuk and Darmohray, 2016). Furthermore, a decoction of root of *A. gummifer* Labill. is used for diabetes (Çakılcıoğlu et al., 2010). Some other *Astragalus* species are also well documented for their folkloric use as anti-diabetics in traditional medicine of Turkey, Lebanon and Iran (Table1). In different geographical areas of American continent, remarkable reports that highlight ethnobotanical and traditional applications of the genus *Astragalus*, are found. In Argentina, *A. mongholicus* Bunge is used as an antifatigue, antistress (adaptogenic), antiaging, neuroprotective, and cognitive enhancer agent, and to treat sexual dysfunctions and genital sickness (Hurrell and Puentes, 2017). In the USA, various species of *Astragalus* such as *A. americanus* (Hook.) M. E. Jones, *A. amphioxys* A. Gray, *A. canadensis* L. and *A. crassicarpus* Nutt., are applied to treat different ailments (Table1). In African continent, the root and seed of *A. armatus* Willd. are used traditionally in the Algerian folk medicine as an effective treatment for leishmaniasis and helminthiasis (Chermat and Gharzouli, 2015). Moreover, *A. arpilobus* subsp. *hauarensis* (Boiss.) Podlech (Syn. *A. gyzensis* Bunge), called "Foul Alibil", is used against scorpion stings and snake bites (Lakhdari et al., 2016). In Ethiopia, the fresh chewing and poultice of *A. atropilosulus* (Hochst.) Bunge leaf known as "Teten agazen", is applied to treat teeth pain (Hishe and Asfaw, 2014). *Astragalus* taxa are reportedly used for a multitude of ethnobotanical purposes besides medicine consumption.

Table 1. Importance of ethnobotanical applications of *Astragalus* taxa in different countries around the world.

NO	Scientific name	Country	Vernacular name	Parts used	Preparation	Ethnobotanical uses	Reference cited
1	*A. abolinii* Popov	Uzbekistan	Astragal	Leaves, gummy exudation	-	Kidney disease, hypertension, burns, demulcent	Egamberdieva et al., 2013
2	*A. americanus* (Hook.) M.E.Jones	America	American milkvetch	Root	Chewing	Stomach pain and flu	Dexter et al., 2014
3	*A. amherstianus* Benth.	Pakistan	Oaxxai	Whole plant	-	Galactagogue in animals	Ullah et al., 2014
4	*A. amphioxys* A.Gray	America	Chitdola awan ak'wa	Root	The root is chewed by the medicine man before sucking upon the wound; chewed root is applied to the bite	Rattlesnake bite	Camazine and Bye, 1980
5	*A. angustifolius* Lam.	Lebanon	Kotad Haramon	Root	-	Ornamental, medicinal plant used as astringent	Arnold et al., 2015
		Turkey	Kokar geven	Root	-	It used as animal fodder	Kargıoğlu et al., 2008
6	*A. armatus* Willd.	Algeria	-	Root, seed	-	leishmaniasis , helminthiasis	Chermat and Gharzouli, 2015
7	*A. baibutensis* Bunge	Turkey	Geven, Eşşek geveni	Whole plant	-	It used as animal fodder	Kargıoğlu et al., 2008
8	*A. brachycalyx* Fisch. ex Boiss. (Syn. *A. adscendens* Boiss. & Hausskn.)	Iran	Gazangabin	Manna	-	Laxative, febrifuge, and digestive	Amiri and Joharchi, 2013
		Turkey	Gewen	Root	Decoction	Diabetes	Polat et al., 2013
9	*A. cadmicus* Boiss.	Turkey	Geven	Root	-	Crushed roots are applied as animal fodder	Kargıoğlu et al., 2010
10	*A. canadensis* L.	America	Canadian milkvetch	Root	-	Analgesic, eaten raw or boiled in blood to make broth	Dexter et al., 2014
11	*A. compactus* Lam.	Turkey	Keven	Whole plant	-	Roots are pounded to obtain a gum as glue. In winters spiny leaves of the plant are pounded after moistened with water and used as animal fodder	Özüdoğru et al., 2013
12	*A. camptoceras* Bunge	Iran	Eklilolmolk	Seed	Decoction	Cold	Rajaei et al., 2012
13	*A. coluteoides* Willd.	Lebanon	Kitad Kansouri	Root	Decoction	Taken orally to treat diabetes and jaundice	Arnold et al., 2015
14	*A. crassicarpus* Nutt.	America	Groundplum milkvetch	Root, fruit, pods	Decoction, eaten raw	Root decoction is tonic, anticonvulsive and anti-headache, fruits are eaten raw as a snack, pods are consumed raw, cooked, or pickled	Dexter et al., 2014

Ethnobotanical uses of *Astragalus* spp. around the world

NO	Scientific name	Country	Vernacular name	Parts used	Preparation	Ethnobotanical uses	Reference cited
15	*A. crenatus* Schult. (Syn. *A. corrugatus* Bertol.)	Iran	Nakhonak	Fruit	-	Kidney stone, sedative, arthrodynia, carminative	Emami et al., 2012
16	*A. creticus* Lam.	Pakistan	Aghazi Shatra	Aerial parts	-	Used as sedative and tonic	Ullah et al., 2013
17	*A. cruentiflorus* Boiss.	Lebanon	Kotad Ahmar	Root	Decoction	Ornamental plant, taken orally to treat diabetes and jaundice	Arnold et al., 2015
18	*A. cymbicarpos* Brot.	Spain	Cornizuelos	Unripe seeds	Raw	Eaten raw as a snack	Tardio et al., 2006
19	*A. dschuparensis* Freyn & Bornm.	Iran	Gini	Gum	-	Making tragacanth, used as detergent, Produce rope	Rajaei et al., 2012
20	*A. effusus* Bunge	Iran	Gavan	Gum	Boiled, brewed	Cough	Asadbeigi et al., 2014
21	*A. fasciculifolius* Boiss.	Iran	Gonjed	Stem, seed, root	Decoction, infusion, poultice	Tightening the roots of teeth, cough, nutritious, kidney, stomach ache, chest infection, toothache	Maleki and Akhani, 2018
22	*A. fischeri* Buhse ex Fisch. (Syn. *A. phyllokentrus* Hausskn. & Bornm.)	Iran	Shoun korouchok	Aerial parts, seed, root	Decoction, raw, poultice	Toothache, back ache, bone ache, kidney ache, bone fracture, and diabetes, and to induce abortion	Maleki and Akhani, 2018
23	*A. glaucacanthos* Fisch.	Iran	Miveh badkonaki	Fruit	-	Used in food and confectionery, tonic, gastric pain, headache	Ghasemi et al., 2013
24	*A. globiflorus* Boiss.	Iran	Gineye gaamur	Gum	Powdered gum with Teucrium	Healing deep infectious wounds	Mosaddegh et al., 2012
25	*A. glycyphyllos* L.	Montenegro	Orlovi nokti	Aerial parts	-	Increasing men's sexual potency	Menković et al., 2011
		Italy	Astragalo	Root, leaves	-	The roots and leaves are used for their refreshing, purifying, and diuretic properties. They were also used for kidney ailments, gout and rheumatism.	Guarino et al., 2008
26	*A. gossypinus* Fisch.	Iran	Gavan panbei	Gum	Boiled, brewed, incense	Cough	Asadbeigi et al., 2014
27	*A. grahamianus* Benth.	Pakistan	Aghazi Shatra	Whole plant	-	Used for treatment of abscesses and as an analgesic	Ullah et al., 2013
28	*A. gummifer* Labill.	Turkey	Günizer	Root	Infusion	Diabetes	Mükemre et al., 2015

NO	Scientific name	Country	Vernacular name	Parts used	Preparation	Ethnobotanical uses	Reference cited
29	*A. hamosus* L.	India	Iklilul Malik, Nakhuna	Fruit	Decoction, paste	The decoction of the beans is used internally in nervous system disorders; liver, kidney and spleen infection. The paste of the beans is massaged and applied externally on inflamed areas	Umer et al., 2017
30	*A. himalayanus* Klotzsch	India	Kayabachtp	Flower, Seed	Powder	Powdered seeds and flowers given in strangury	Rana et al., 2014
31	*A. jolderensis* B.Fedtsch.	Iran	Haram-chop	Root	Decoction, bath	Typhoid, and dermal problems	Ghorbani, 2005
32	*A. lamarckii* Boiss.	Turkey	Cuni	Root	Decoction	Ulcer	Polat et al., 2013
33	*A. leucocephalus* Bunge	Pakistan	Kathi	Aerial parts	-	Used as fuel wood	Hussain and Muhammad, 2009
34	*A. longifolius* Lam.	Turkey	Gırguni	Root	Infusion	Cardiac disorder, diabetes	Mükemre et al., 2015
35	*A. microcephalus* Willd.	Iran	Kalelak	Stem, root	Infusion, pulverized	Asthma, strengthen hair	Maleki and Akhani, 2018
36	*A. mongholicus* Bunge (Syn. *A. membranaceus* (Fisch.) Bunge; *A. propinquus* Schischkin)	China	Huangqi	Root	-	Against body weakness, diuretic, against digestive system disorder, as supplement in cosmetic. Stem and leaves used as animal feed	Teng et al., 2011
		Greece	Astragalos	Root	-	Hypertension, dyspepsia, and common cold	Hanlidou et al., 2004
		Korea	Hwanggi	Root	Decoction	Blood circulation	Kim and Song, 2011
37	*A. monspessulanus* L.	Italy	Astragalo rosato	Root	-	Diuretic	Guarino et al., 2008
38	*A. mucronifolius* Boiss.	Iran	Gonjar khari	Root	-	Backache	Soltanipoor, 2005
39	*A. noaeanus* Boiss.	Turkey	Keven	Root	Crushed	Varicosis	Han and Bulut, 2015
40	*A. oleifolius* DC.	Lebanon	Kotad Jareh	Root	Decoction	Ornamental plant, decoction of roots is orally applied as an emollient and as a remedy for diabetes and jaundice	Arnold et al., 2015
41	*A. ophiocarpus* Boiss.	Iran	Kahour kah	Aerial parts, fruit	Raw	Nutritious	Maleki and Akhani, 2018
42	*A. oplites* Benth. ex R. Parker	Pakistan	Dume ruba	Shoot	-	Shoots are collected in summer, stored and used as fuel wood in winter	Ali and Qaiser, 2009

Ethnobotanical uses of *Astragalus* spp. around the world

NO	Scientific name	Country	Vernacular name	Parts used	Preparation	Ethnobotanical uses	Reference cited
43	*A. ovinus* Boiss.	Iran	Gondkhorosi	Fruit	Orally	Stomachache,used in pickle	Mosaddegh et al., 2012.
44	*A. podolobus* Boiss. & Hohen.	Iran	Katek	Aerial parts, leaf, flower	Decoction, raw	Bellyache, and colic	Maleki and Akhani, 2018
45	*A. psilocentros* Fisch.	Pakistan	Maakhai	Aerial parts	-	Cataract, and stomach problems	Ullah et al., 2014
46	*A. rhizanthus* Benth.	India	Zomoshing	Root	-	It is used as animal fodder	Rana et al., 2014
47	*A. rhizanthus* subsp. *candolleanus* (Benth.) Podlech (Basionym: *A. candolleanus* Benth.)	India	Rudravanti	Root	-	Digestive disorders, Leucorrhea, and urinary troubles	Rana et al., 2013
48	*A. rubrivenosus* Gontsch.	Uzbekistan	Astragal	Leaves, gummy exudation	-	Kidney disease, hypertonic disease, burns, demulcent	Egamberdieva et al., 2013
49	*A. sarcocolla* Dymock	Jordan	Sarcocolla	Gum	-	Incense, pains	Lev and Amar, 2002
50	*A. sieversianus* Pall.	Iran	Gol Sefid	Fruit	-	Menstrual Disorders	Amiri and Joharchi, 2013
51	*A. thomsonianus* Benth. ex Bunge	India	Satkar	Whole plant	Powder	Gastric troubles, swelling and joint pains	Singh, 2012
52	*A. tmoleus* Boiss. (Syn. *A. tmoleus* subsp. *bounacanthus* (Boiss.) Ponert)	Turkey	Geven, Saçaklı geven	Gum	Chewing	Toothache	Sargin and Büyükcengi, 2018
53	*A. tribulifolius* Bunge	India	Yanglo	Whole plant	-	Whole plant is applied as a diuretic agent and to lower kidney disorders. Root extract purifies blood.	Kumar et al., 2009
54	*A. tribuloides* Delile	Iran	Sareng, Sateng	Arial part	Infusion	Urinary infection	Sadeghi and Mahmood, 2014
55	*A. verus* Olivier	Iran	Siahgavan	Wood	-	Antiparasitic, antimycotic and immunomodulatory activities	Ghorbani et al., 2015
56	*A. zanskarensis* Bunge	India	-	Arial part	-	Against worms	Buth and Navchoo, 1988

In Iran, the manna of *A. brachycalyx* Fisch. ex Boiss. is applied in preparation of honey and traditional Iranian sweet candy ("*Gaz*" in Persian) (Golmohammadi, 2013). In Turkey, the root of *A. condensatus* Ledeb. (Syn. *A. brachypterus* Fisch.) and *A. microcephalus* Willd. are pounded to obtain gum which is used as glue (Özüdoğru et al., 2013). Several species of *Astragalus* such as *A. alpinus* L. (bluish-purple flowers), *A. hypoglottis* L. (purple flowers), and *A. sinicus* L. (Syn. *A. lotoides* Pall.), are grown as ornamental plants in gardens (Golmohammadi, 2013). Some species of *Astragalus* including *A. leucocephalus* Bungeand *A. oplites* Benth. ex R. Parker are collected in summer, stored and used as fuel wood in winter (Ali and Qaiser, 2009; Hussain and Muhammad, 2009).

Furthermore, some plants like *A. angustifolius* Lam., *A. baibutensis* Bunge, *A. cadmicus* Boiss., *A. compactus* Lam., *A. mongholicus* Bunge and *A. rhizanthus* Benth. were documented as forage for livestock (Table1).

Tragacanthic species of *Astragalus*

Several tragacanthic species of the genus *Astragalus* gained fame owing to their potential in producing gum tragacanth which has a wide array of uses in medicine and many industries. Among them, *A. gummifer* Labill., *A. microcephalus* Willd., *A. brachycalyx* Fisch. ex Boiss., *A. myriacanthus* Boiss. (Syn. *A. echidnaeformis* Sirj.), *A. gossypinus* Fisch. and *A. kurdicus* Boiss. are the most important species to supply the gum tragacanth in global market (Verbeken et al., 2003). However, the contribution of other tragacanthic species is also significant (Table 2). The name "tragacanth" is derived from the two Greek words tragos (goat) and akantha (horn), referring to the white curled ribbons, the best grade of commercial gum (Whistler, 1993). Gum tragacanthic plants are perennial legumes, characterized by spine-tipped leaf rachises; sessile or subsessile flowers, glomerate in the axils of the leaves; and one-seeded pods enclosed in hairy persistent calyces (Gentry, 1957). Iran is well-known as the largest producer and exporter of gum tragacanth and supplies the highest quality of it for the world (Anderson and Grant 1988). Turkey is the second largest producer, but Turkish gum is deemed to be of an inferior quality. Much smaller amounts of gum are exported by Afghanistan and Syria (Verbeken et al., 2003). The United States, the United Kingdom, Russia, Germany, France, Italy and Japan have been the biggest importers of gum tragacanth (Whistler, 1993). Structurally, gum tragacanth is categorized into two general kinds, ribbon (highest grade) and flake or "kharmony". After collection, Iranian tragacanth ribbons are classified into five grades, while flakes are sold in seven various grades (Gentry, 1957; Verbeken et al., 2003).

Gum tragacanth comprises of two fractions including Tragacanthin (water-soluble) and Tragacanthic acid or bassorin (water-insoluble). Although the latter is insoluble in water, but has the capacity to swell and form a gel (Anderson and Bridgeman, 1985). Commercially, gum tragacanth has extensive applications as an emulsifier, stabilizer and thickening agent in various industries, due to its stability to heat and acids and because it is an effective emulsifying agent with an extremely long shelf life (Whistler, 1993). However, there are several reports in the literature that compositional discrepancies of gum tragacanth obtained from diverse tragacanthic species of *Astragalus*, can result in the chemical and physical changes (Balaghi et al., 2011).

Therapeutic and pharmaceutical applications

Gum tragacanth has been used therapeutically for thousands of years, with written evidence of its applications, described by Theophrastus in the 3rd century B.C. (Whistler, 1993). In some Asian countries, particularly Iran, various tragacanthic species of *Astragalus* have a broad habitation and many of them are important in folk medicine (Table2). In Iran, the tragacanth gum, commonly known as "*Katira*', has been largely used in medicine and confectionery since ancient times (Hopper and Field, 1937). In Iranian traditional medicine, gum tragacanth is broadly applied as an analgesic, general tonic, and laxative agent and to cure cough and lip fissures (Zarshenas et al., 2013). In Jordan, the gum of *A. gummifer* Labill., commonly known as "Tragacanth', is widely employed in traditional medicine for healing stomachache and coughs (Lev and Amar, 2002).

In addition to its usage in traditional therapeutics, the gum tragacanth has also

been applied as an excellent suspending agent for many pharmaceutical products. Mucilage of tragacanth is utilized in lotions for external applications. It is also applied at higher concentrations as a base for jelly lubricants. Gum tragacanth can act as the suspending agent in various kinds of toothpastes with a humectant, such as glycerol or propylene glycol. It forms a creamy and brilliant product. Its long shelf life and its film-forming properties make it beneficial in hair lotions and hand creams and lotions (Whistler, 1993).

Table 2. Some of the most important tragacanthic species of *Astragalus* L. (Fabaceae).

NO	Scientific name	Reference
1	*A. albispinus* Sirj. & Bornm.	Mozaffarian, 2013
2	*A. andalanicus* Boiss. & Hausskn.	Mozaffarian, 2013
3	*A. brachycalyx* Fisch. ex Boiss. (Syn. *A. adscendens* Boiss. & Hausskn.; *A. leioclados* Boiss.)	Gentry, 1957; Mozaffarian, 2013
4	*A. brachycalyx* subsp. *eriostylus* (Boiss. & Hausskn.) Zarre (Basionym: *A. eriostylus* Boiss. & Hausskn.)	Gentry, 1957
5	*A. caspicus* M.Bieb.	Mozaffarian, 2013
6	*A. cerasocrenus* Bunge	Gentry, 1957
7	*A. compactus* Lam.	Mozaffarian, 2013
8	*A. condensatus* Ledeb. (Syn. *A. brachypterus* Fisch.)	Özüdoğru et al., 2013
9	*A. creticus* Lam.	Gentry, 1957
10	*A. cylleneus* Boiss. & Heldr. ex Fischer	Gentry, 1957
11	*A. cymbostegis* Bunge (Syn. *A. stromatodes* Bunge)	Gentry, 1957
12	*A. diphtherites* Fenzl (Syn. *A. strobiliferus* Benth.)	Gentry, 1957
13	*A. dschuparensis* Freyn & Bornm.	Rajaei et al., 2012
14	*A. echidna* Bunge	Mozaffarian, 2013
15	*A. eriosphaerus* Boiss. & Hausskn. (Syn. *A. elymaiticus* Boiss. & Hausskn.)	Gentry, 1957
16	*A. floccosus* Boiss.	Mozaffarian, 2013
17	*A. floccosus* subsp. *rahensis* (Širj. & Rech.) Zarre (Basionym: *A. rahensis* Sirj. & Rech.f.)	Gavlighi et al., 2013
18	*A. geminanus* Boiss. & Hausskn.	Gentry, 1957
19	*A. globiflorus* Boiss.	Mozaffarian, 2013
20	*A. gossypinus* Fisch.	Mozaffarian, 2013
21	*A. hypsogeton* Bunge	Mozaffarian, 2013
22	*A. kurdicus* Boiss.	Gentry, 1957
23	*A. longistylus* Bunge	Mozaffarian, 2013
24	*A. microcephalus* Willd. (Syn. *A. senganensis* Bunge)	Mozaffarian, 2013; Gentry, 1957
25	*A. muschianus* Kotschy & Boiss. (Syn. *A. gummifer* Labill.)	Mozaffarian, 2013
26	*A. myriacanthus* Boiss. (Syn. *A. echidnaeformis* Sirj.)	Mozaffarian, 2013
27	*A. microcephalus* subsp. *pycnocladus* (Boiss. & Hausskn.) Širj. (Basionym: *A. pycnocladus* Boiss. & Hausskn.)	Gentry, 1957
28	*A. pycnocephalus* Fisch.	Mozaffarian, 2013
29	*A. tragacantha* L.	Eftekharinasab et al., 2012
30	*A. verus* Olivier (Syn. *A. brachycentrus* Fisch.; *A. heratensis* Bunge; *A. meschhedensis* Bunge; *A. parrowianus* Boiss. & Hausskn.)	Mozaffarian, 2013; Gentry, 1957; Gavlighi et al., 2013

Food applications

Due to its acid resistance and its long shelf life, gum tragacanth is lucrative in the preparation of different kinds of salad dressings, relishes, sauces, condiment bases, sweet pickle liquors, soft jellied products such as gefilte fish, thick broths, beverage and bakery emulsions, ice cream

and sherbets, bakery toppings and fillings and confectionary (Whistler, 1993).

Miscellaneous applications

Gum tragacanth can be employed in various kinds of polishes for furniture, floor, and auto polishes. It is beneficial in print pastes and sizes because of its good release properties. The gum is applied for stiffening silks and crepes. It is also utilized in the dressing of leather and in the preparation of leather polishes. Certain grades of gum tragacanth are lucrative as binding agents in ceramics because they contain a low ash content, and the gum acts to suspend different materials in a mass prior to the firing of the ceramic in the furnace. Gum tragacanth forms stable emulsions containing 50% insect repellant. They have the potential to be efficacious as pure repellant compounds against mosquitoes, mites, chiggers, ants, and certain fleas (Whistler, 1993).

The importance of identification credibility in ethnobotany

The validity of botanical identification is the first step in the ethnobotany studies. Nowadays, the ethnobotanical investigations can comprise a few erroneous and ambiguous identifications, due to the lack of services of taxonomic or botanical expertise. For instance, in the present literature review, we found that the gum of *A. ammodendron* Bunge has been employed for ethnobotanical applications (Sadeghi et al., 2014). However, this taxon does not occur in Iran (Podlech and Zarre, 2013). Thus, we omitted this plant from the list (Table 1). Moreover, one of the major problems ethnobotanists face is when identical names are attributed to various species, or different names to the same species. For example, the name Eklilolmolk is matched with *A. camptoceras* Bunge and *Melilotus officinalis* (L.) Pall. in different references (Rajaei et al., 2012; Mozaffarian, 2007). Therefore, correct identification of plant species should only be authenticated by a panel of experts including taxonomists (Joharchi and Amiri, 2012). Additionally, preparation of voucher specimens are crucial for scientific identification which can diminish such mistakes and help investigators with a better perception of their subjects (Bennett and Balick, 2008).

Discussion

The genus *Astragalus* is one of the most important genera in the Fabaceae family. This review highlights that different *Astragalus* species have great potential uses in medicine and many industries. The total number of 90 *Astragalus* taxa (the sum of the species in Table 1 and 2, as well as the taxa pointed in the text without repetition), reveals numerous ethnobotanical and ethnomedicinal applications around the world. Ethnomedicinal results showed that the most frequent traditional applications of *Astragalus* taxa in different countries, seems to be treatment of urinary diseases, respiratory ailments, digestive diseases, nervous ailments, circulatory diseases, skin problems, and as an antiseptic, tonic and antidiabetic agent. The most used part of *Astragalus* taxa is gum which has a broad applications in different industries, due to its outstanding characteristics. However, it is important to note that the gum exudate from various tragacanthic species of *Astragalus* has diverse chemical composition, so exhibits different properties and behaviors. Hence, any try for development of biomedical uses of gum tragacanth without considering the plant species, will result in misleading information (Balaghi et al., 2011). To our knowledge, there is still lack of phytochemical and pharmacological researches on many species of *Astragalus* that have been traditionally used in various countries. In addition, there are only few reports on the biological activity of some *Astragalus* species, of which the majority have investigated the anticancer effects (Yesilada et al., 2005). In this context, the

best and quickest way to species selection for phytochemical, biological and pharmacological studies, is by reviewing the ethnobotanical literature which highlights the importance of such studies (Amiri and Joharchi, 2016). Based on the data presented in this paper, some species should be given precedence to subsequent investigations, particularly, for the treatment of some globally prevalent diseases like diabetes including, *A. brachycalyx* Fisch. ex Boiss., *A. coluteoides* Willd., *A. cruentiflorus* Boiss., *A. fischeri* Buhse ex Fisch., *A. gummifer* Labill., *A. longifolius* Lam. and *A. oleifolius* DC. (Table 1). Besides the detailed information introduced in this article, supporting pharmaceutical and clinical trials should be undertaken to validate the therapeutic potential of different species of *Astragalus* which will develop new generation of herbal-based natural drugs for the optimal benefit to mankind. Finally, several *Astragalus* species, display a narrow geographic range (narrow endemics), with significant commercial and therapeutic value. These species are threatened due to intense harvesting pressure from the wild. Undertaking ecological investigation in *Astragalus* diversity hotspots such as Iran and Turkey is essential to conservation of this invaluable genus in these regions.

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Conflicts of interest

The authors declare that there is no conflict of interest associated with this work.

References

Ali H, Qaiser M. 2009. The ethnobotany of Chitral valley, Pakistan with particular reference to medicinal plants. Pak. J Bot, 41: 2009-2041.

Amiri MS, Joharchi MR. 2013. Ethnobotanical investigation of traditional medicinal plants commercialized in the markets of Mashhad, Iran. Avicenna J Phytomed, 3: 254-271.

Amiri MS, Joharchi MR, TaghavizadehYazdi ME. 2014. Ethno-medicinal plants used to cure jaundice by traditional healers of Mashhad, Iran. Iranian J Pharm Res, 13: 157-162.

Amiri MS, Joharchi MR. 2016. Ethnobotanical knowledge of Apiaceae family in Iran: A review. Avicenna J Phytomed, 6: 621-635.

Anderson DMW. 1989. Evidence for the safety of gum tragacanth (Asiatic *Astragalus* spp.) and modern criteria for the evaluation of food additives. Food Addit Contam, 6: 1-12.

Anderson DMW, Bridgeman MME. 1985. The composition of the proteinaceous polysaccharides exuded by *Astragalus microcephalus*, *A. Gummifer* and *A. Kurdicus*—The sources of turkish gum tragacanth. Phytochemistry, 24: 2301-2304.

Anderson DMW, Grant DAD. 1988. The chemical characterization of some *Astragalus* gum exudates. Food Hydrocoll, 2: 417-423.

Arnold N, Baydoun S, Chalak L, Raus T. 2015. A contribution to the flora and ethnobotanical knowledge of Mount Hermon, Lebanon. Fl Medit, 25:13-55.

Asadbeigi M, Mohammadi T, Rafieian-Kopaei M, Saki K, Bahmani,M, Delfan M. 2014. Traditional effects of medicinal plants in the treatment of respiratory diseases and disorders: an ethnobotanical study in the Urmia. Asian Pac J Trop Med,7:364-368.

Balaghi S, Mohammadifar MA, Zargaraan A, Gavlighi HA, Mohammadi M. 2011. Compositional analysis and rheological characterization of gum tragacanth exudates from six species of Iranian *Astragalus*. Food Hydrocoll, 25: 1775-1784.

Bennett BC, Balick MJ. 2008. Phytomedicine 101: plant taxonomy for preclinical and clinical medicinal plant researchers. J Soc Integr Oncol, 6: 1-10.

Buth GM, Navchoo IA. 1988. Ethnobotany of Ladakh (India) plants used in health care. J Ethnopharmacol, 8: 185-194.

Çakılcıoğlu U, Şengün MT, Türkoğlu İ. 2010. An ethnobotanical survey of medicinal plants of Yazıkonak and Yurtbaşı districts

of Elazığ province, Turkey. J Med Plant Res, 4: 567-572.

Camazine S, Bye RA. 1980. A study of the medical ethnobotany of the Zuni Indians of New Mexico. J Ethnopharmacol, 2:365-388.

Chaudhary LB, Rana TS, Anand KK. 2008. Current status of the systematics of *Astragalus* L. (Fabaceae) with special reference to the Himalayan species in India. Taiwania, 53: 338-355.

Chermat S, Gharzouli R. 2015. Ethnobotanical study of medicinal flora in the North East of Algeria-An empirical knowledge in Djebel Zdimm (Setif). J Mater Sci Eng, 5: 50-9.

Dexter DF, Martin K, Travis L. 2014. Prehistoric Plant Use at Beaver Creek Rock Shelter, Southwestern Montana, USA. Ethnobot Res Appl, 12: 355-384.

Eftekharinasab N, Zarei D, Paidar S, Moghadam MJ, Kahrizi D, Khanahmadi M, Chenari P. 2012. Identification of wild medicinal plant in Dalahoo mountain and their used indigenous knowledge (Kermanshah, Iran). Ann Biol Res, 3:3234-3239.

Egamberdieva D, Mamadalieva N, Khodjimatov O, Tiezzi A. 2013. Medicinal plants from Chatkal Biosphere Reserve used for folk medicine in Uzbekistan. Med Aromat Plant Sci Biotechnol, 7: 56-64.

Emami SA, Nadjafi F, Amine GH, Amiri MS, Khosravi Mt, Nasseri M. 2012. Les espèces de plantes médicinales utilisées par les guérisseurs traditionnels dans la province de Khorasan, nord-est de l'Iran. J Ethnopharmacol, 48: 48-59.

Gavlighi HA, Meyer AS, Zaidel DN, Mohammadifar MA, Mikkelsen JD. 2013. Stabilization of emulsions by gum tragacanth (*Astragalus* spp.) correlates to the galacturonic acid content and methoxylation degree of the gum. Food Hydrocoll, 31: 5-14.

Gentry HS. 1957. Gum tragacanth in Iran. Econ Bot, 11: 40-63.

Ghasemi PA, Momeni M, Bahmani M. 2013. Ethnobotanical study of medicinal plants used by Kurd tribe in Dehloran and Abdanan districts, Ilam province, Iran. Afr J Tradit Complement Altern Med, 10: 368-385.

Ghorbani A. 2005. Studies on pharmaceutical ethnobotant in the region of Turkmaen Sahra, north of Iran (part 1): general results. J Ethnopharmacol, 102: 58-68.

Ghorbani A, Aghjeh Qeshlagh M, Karamati Jabehdar S. 2015. Folk herbal veterinary medicines of Tehran Watershed (Iran). J Herbal Drugs, 6:31-39.

Golmohammadi F. 2013. A viewpoint toward medical plant of astragalus and its main characteristics, products and economical importance in Iran (Case study: Boldaji and lake Choghakhor in Chaharmahal and Bakhtiari Province). TJEAS J, 3: 3702-3721.

Guarino C, De Simone L, Santoro S. 2008. Ethnobotanical study of the Sannio area, Campania, southern Italy. Ethnobot Res Appl, 6:255-317.

Han Mİ, Bulut G. 2015. The folk-medicinal plants of Kadisehri (Yozgat-Turkey). Acta Soc Bot Pol, 84: 237-248.

Hanlidou E, Karousou R, Kleftoyanni V, Kokkini S. 2004. The herbal market of Thessaloniki (N Greece) and its relation to the ethnobotanical tradition. J Ethnopharmacol, 91: 281-299.

Hishe M, Asfaw Z. 2014. Review paper review on ethnobotanical studies on traditional medicinal plants used to treat livestock and human ailments in tigray region, Ethiopia. AJBSR, 3: 8-36.

Hooper D, Field H. 1937. Useful plants and drugs of Iran and Iraq. Field Museum of Natural History. Botanical Series, 9: 89-90.

Hurrell JA, Puentes JP. 2017. Plant species and products of the Traditional Chinese Phytotherapy in the Ciudade Autónoma de Buenos Aires, Argentina. Ethnobiol Conserv, 6: 1-43

Hussain T, Muhammad IC. 2009. A floristic description of flora and ethnobotany of Samahni Valley (AK), Pakistan. Ethnobot Leaflets, 7: 1-24.

Jalili A, Jamzad Z. 1999. Red Data Book of Iran. Research Institute of Forests and Rangelands Publications, Tehran, Pp. 748.

Joharchi MR, Amiri MS. 2012. Taxonomic evaluation of misidentification of crude herbal drugs marketed in Iran. Avicenna J Phytomed, 2: 105-112.

Kargıoğlu M, Cenkci S, Serteser A, Evliyaoğlu N, Konuk M, Kök MŞ, Bağcı Y. 2008. An ethnobotanical survey of inner-West Anatolia, Turkey. Hum Ecol, 36: 763-777.

Kargıoğlu M, Cenkci S, Serteser A, Konuk M,

Vural G. 2010. Traditional uses of wild plants in the middle Aegean region of Turkey. Hum Ecol, 38: 429-450.

Kazempour Osaloo S, Maassoumi AA, Murakami N. 2003. Molecular systematics of the genus *Astragalus* L. (Fabaceae): phylogenetic analyses of nuclear ribosomal DNA internal transcribed spacers and chloroplast gene ndhF sequences. Plant Syst Evol, 242:1-32.

Kim H, Song MJ. 2011. Analysis and recordings of orally transmitted knowledge about medicinal plants in the southern mountainous region of Korea. J Ethnopharmacol, 134: 676-696.

Kumar G, Gupta S, Murugan M, Bala Singh S. 2009. Ethnobotanical studies of Nubra Valley-A cold arid zone of Himalaya. Ethnobot Leaflets, 13: 752-765.

Lakhdari W, Dehliz A, Acheuk F, Mlik R, Hammi H, Gheriani S, Berrekbia M, Guermit K, Chergui S. 2016. Ethnobotanical study of some plants used in traditional medicine in the region of Oued Righ (Algerian Sahara). J Med Plants Res, 4: 204-211.

Lev E, Amar Z. 2002. Ethnopharmacological survey of traditional drugs sold in the Kingdom of Jordan. J ethnopharmacol, 82: 131-145.

Lysiuk R, Darmohray R. 2016. Pharmacology and ethnomedicine of the genus *Astragalus*. IJPPE, 3: 46-53.

Maleki T, Akhani H. 2018. Ethnobotanical and ethnomedicinal studies in Baluchi tribes: A case study in Mt. Taftan, southeastern Iran. J Ethnopharmacol, 217: 163-177.

Maassoumi AA. 1998. *Astragalus* in the Old World, Check List. Research Institute of Forests and Rangeland. Tehran, Pp. 617.

Maassoumi AA. 2005. The genus *Astragalus* in Iran, perennials, vol. 5. Research Institute of Forests and Rangelands, Tehran, 785 pp.

Memariani F, Akhan H, Joharchi MR. 2016. Endemic plants of the Khorassan-Kopet Dagh floristic province in the Irano-Turanian region: diversity, distribution patterns and conservation status. Phytotaxa, 249: 31–117.

Menković N, Šavikin K, Tasić S, Zdunić G, Stešević D, Milosavljević S, Vincek D. 2011. Ethnobotanical study on traditional uses of wild medicinal plants in Prokletije Mountains (Montenegro). J Ethnopharmacol, 133: 97-107.

Mosaddegh M, Naghibi F, Moazzeni H, Pirani A, Esmaeili S. 2012. Ethnobotanical survey of herbal remedies traditionally used in Kohghiluyeh va Boyer Ahmad province of Iran. J ethnopharmacol, 141: 80-95.

Mozaffarian V. 2007. A Dictionary of Iranian Plant Names.Tehran: Farhang-e Moaser, Pp. 62-64.

Mozaffarian, V. 2013. Identification of medicinal and aromatic plants of Iran. Farhang Moaser Publishers, Tehran. Pp. 1444.

Mükemre M, Behçet L, Çakılcıoğlu U. 2015. Ethnobotanical study on medicinal plants in villages of Çatak (Van-Turkey). J Ethnopharmacol, 166: 361-374.

Özüdoğru B, Akaydın G, Erik S, Yesilada E, 2011. Inferences from an ethnobotanical field expedition in the selected locations of Sivas and Yozgat provinces (Turkey). J Ethnopharmacol, 137: 85-98.

Podlech D, Zarre S. 2013. A taxonomic revision of the genus *Astragalus* L. (Leguminosae) in the Old World. Naturhistorisches Museum, Wien-Austria. 3 volumes, Pp. 2439.

Polat R, Cakilcioglu U, Satıl F. 2013. Traditional uses of medicinal plants in Solhan (Bingöl—Turkey). J Ethnopharmacol, 148: 951-963.

Rajaei P, Mohamadi N, Motamed M. 2012. Ethnobotanical study of medicinal plants of Hezar Mountain allocated in South East of Iran. Iranian J Pharm Res, 11: 1153-1167.

Rana CS, Ballabha R, Tiwari JK, Dangwal LR. 2013. An ethnobotanical study of the plant resources in the Nanda Devi Biosphere Reserve (a world heritage site), Uttarakhand, India. J Ethnobio Trad Med, 120: 591-601.

Rana PK, Kumar P, Singhal VK, Rana JC. 2014. Uses of local plant biodiversity among the tribal communities of Pangi Valley of district Chamba in cold desert Himalaya, India Sci World J, 1-15.

Sadeghi Z, Mahmood A. 2014. Ethno-gynecological knowledge of medicinal plants used by Baluch tribes, southeast of Baluchistan, Iran Rev Bras Farmacogn, 24: 706-715.

Sadeghi Z, Kuhestani K, Abdollahi V, Mahmood A. 2014. Ethnopharmacological studies of indigenous medicinal plants of Saravan region, Baluchistan, Iran. J

Ethnopharmacol, 153: 111-118.
Safa O, Soltanipoor MA, Rastegar S, Kazemi M, Dehkordi Kh, Ghannadi A. 2013. An ethnobotanical survey on hormozgan province, Iran. Avicenna J Phytomed, 3: 64-81.
Sargin SA, Büyükcengiz M. 2018. Plants used in Ethnomedicinal practices in Gulnar district of Mersin, Turkey. J Herb Med, 15: 1-18.
Singh KN. 2012. Traditional knowledge on ethnobotanical uses of plant biodiversity: a detailed study from the Indian western Himalaya. Biodiv Res Conserv, 28: 63-77.
Soltanipoor MA. 2005. Medicinal plants of the Geno protected area. Pajouhesh Sazandegi, 68: 27-37.
Tardío J, Pardo-de-Santayana M, Morales R. 2006. Ethnobotanical review of wild edible plants in Spain. Bot J Linn Soc, 152: 27-71.
Tavakol M, Mohammadifar MA. 2017. A review on Gum Tragacanth and its biomedical applications, NSMSI, 36:1-20.
Teng Y, Guo H, Liang Z, Shu Z, Li Z, Wu W. 2011. Ethnobotanical survey of medicinal plants and their utilization in Shaanxi Province, China. J Med Plants Res, 5:1762-1778.
Ullah M, Khan MU, Mahmood A, Malik RN, Hussain M, Wazir SM, Daud M, Shinwari ZK. 2013. An ethnobotanical survey of indigenous medicinal plants in Wana district south Waziristan agency, Pakistan. J Ethnopharmacol, 150: 918-924.
Ullah S, Khan MR., Shah NA, Shah SA, Majid M, Farooq MA. 2014. Ethnomedicinal plant use value in the Lakki Marwat District of Pakistan. J Ethnopharmacol, 158: 412-422.
Umer KH, Zeenat F, Ahmad W, Vakil A. 2017. Therapeutics, phytochemistry and pharmacology of Iklilul Malik (*Astragalus hamosus* Linn): A natural Unani Remedy. Int J Herb Med, 11: 1-5.
Verbeken D, Dierckx S, Dewettinck K. 2003. Exudate gums: occurrence, production, and applications. Appl Microbiol Biotechnol, 63:10-21.
Weiping W. 2000. Tragacanth and karaya. In G. O. Philips, & P. A. Williams (Eds.), Handbook of hydrocolloids. Cambridge, England: CRC Press, Pp. 231-246.
Whistler RL. 1993. Exudate gums, in Industrial gums. Academic Press, Pp. 309-339.
Yesilada E, Bedir E, Çalış İ, Takaishi Y, Ohmoto Y. 2005. Effects of triterpene saponins from *Astragalus* species on in vitro cytokine release. J Ethnopharmacol, 96: 71-77.
Yu DH, Bao YM, Wei CL, An LJ. 2005. Studies of chemical constituents and their antioxidant activities from *Astragalus mongholicus* Bunge. Biomed Environ Sci, 18: 297-301.
Zarre S, Azani N. 2013. Perspectives in taxonomy and phylogeny of the genus *Astragalus* (Fabaceae): a review. PBioSci, 3: 1-6.
Zarshenas MM, Arabzadeh A, Tafti MA, Kordafshari G, Zargaran A, Mohagheghzadeh A. 2013. Application of herbal exudates in traditional Persian medicine. Galen Med J, 1: 78-83.