Review Article

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

Mohammad Sadegh Amiri¹,*, Mohammad Reza Joharchi², Mohabat Nadaf¹, Yasamin Nasseh²

¹Department of Biology, Payame Noor University, Tehran, Iran
²Department of Botany, Research Center for Plant Sciences, Ferdowsi University of Mashhad, Mashhad, Iran

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. glycyphyllus* 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).

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. glycyphylos 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).

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
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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. vescarius* 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 (Çakılcioğlu et al., 2010). Some other *Astragalus* species are also well documented for their folkloric use as antidiabetics 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. crasscarpus* 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 (Chermet and Gharzouli, 2015). Moreover, *A. arpiilobus* subsp. *hauarenis* (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 ethno-botanical 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    | -           | Kidney disease, hypertension, burns, demulcent | Egamberdieva et al., 2013     |
|    |                         |               |                       | exudation        |             |                                      |                               |
| 2  | *A. americana*          | America       | American milkvetch    | Root             | Chewing    | Stomach pain and flu                | Dexter et al., 2014           |
| (Hook.) M.E.Jones      |               |               |                      |                 |             |                                      |                               |
| 3  | *A. amherstianus*       | Pakistan      | Oaxxai               | Whole plant      | -           | Galactagogue in animals             | Ullah et al., 2014            |
| Benth.                   |               |               |                      |                 |             |                                      |                               |
| 4  | *A. amphioxys*          | America       | Chidola awan ak’wa   | Root             | The root is chewed by the medicine man before sucking upon the wound; chewed root is applied to the bite | Camazine and Bye, 1980          |
| A.Gray                    |               |               |                      |                 |             |                                      |                               |
| 5  | *A. angustifolius* Lam. | Lebanon       | Kodaot Haramon       | Root             | -           | Ornamental, medicinal plant used as astringent | Arnold et al., 2015           |
|               |               |               |                      |                 |             | It used as animal fodder             | Kargoğlu et al., 2008         |
|               |               | Turkey        | Kokar geven          | Root             | -           | leishmaniasis, helmintiasis          | Chermat and Gharzouli, 2015   |
| 6  | *A. armatus* Wild.      | Algeria       | -                     | Root, seed       | -           | leishmaniasis, helmintiasis          |                               |
|               |               |               |                      |                 |             |                                      |                               |
| 7  | *A. baibutenis*         | Turkey        | Geven, Eş tweaked geve | Whole plant      | -           | It used as animal fodder             | Kargoğlu et al., 2008         |
| Bunge                   |               |               |                      |                 |             |                                      |                               |
| 8  | *A. brachycalyx* Fisch. | Iran          | Gazangabin           | Manna            | -           | Laxative, febrifuge, and digestive  | Amiri and Joharchi, 2013      |
| ex Boiss. (Syn. *A. |               |               |                      |                 |             | Diabetes                             |                               |
| adscendens* Boiss. &   |               |               |                      |                 |             |                                      |                               |
| Hausskn.)              |               | Turkey        | Gewen               | Root, Decoction  |             |                                      |                               |
| 9  | *A. cadmicus* Boiss.    | Turkey        | Geven                | Root             | -           | Crushed roots are applied as animal fodder | Kargoğlu 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        | Kevn                 | 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 | Özvidoğru et al., 2013         |
|               |               |               |                      |                 |             |                                      |                               |
| 12 | *A. camptoceras*        | Iran          | Eklilolmolk          | Seed             | Decoction   | Cold                                 | Rajaee et al., 2012           |
| Bunge                   |               |               |                      |                 |             |                                      |                               |
| 13 | *A. colateoides*        | Lebanon       | Kitad Kansouri       | Root             | Decoction   | Taken orally to treat diabetes and jaundice | Arnold et al., 2015           |
| Wild.                   |               |               |                      |                 |             |                                      |                               |
| 14 | *A. crassicarpus*       | 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           |
| Natt.                   |               |               |                      |                 |             |                                      |                               |
| 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 deterrent, 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. phylloketria* 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 |
| 26 | *A. gossypinus* Fisch. | 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 |
| 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 | | Mü kemre et al., 2015 |
| NO | Scientific name                  | Country | Vernacular name | Parts used | Preparation | Ethnobotanical uses                                                                 | Reference cited                  |
|----|----------------------------------|---------|-----------------|------------|-------------|-------------------------------------------------------------------------------------|----------------------------------|
| 29 | *A. hamosus* L.                  | India   | Iklil 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  | Girguni         | Root       | Infusion                               | Cardiac disorder, diabetes                                                      | Mukemre et al., 2015             |
| 35 | *A. microcephalus* Wild.          | 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  | Huanggi         | Root       | -                                      | Against body weakness, diuretic, against digestive system disorder, as supplement in cosmetic. Stem and leaves used as animal feed | Teng et al., 2011                |
|    |                                  |         |                 |            |                                         | Hypertension, dyspepsia, and common cold                                        | Hanlidou et al., 2004            |
|    |                                  |         |                 |            |                                         | Blood circulation                                                               | Kim and Song, 2011               |
| 37 | *A. monspessulanus* L.           | Italy   | Astragalo rosato | Root       | -                                      | Diuretic                                                                        | Guarino et al., 2008             |
| 38 | *A. macronifolius* Boiss.        | Iran    | Gonjar khari    | Root       | -                                      | Backache                                                                        | Soltanipoor, 2005                |
| 39 | *A. noveaenus* 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. opites* 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             |
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* Wild. 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* Bunge and *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 (Table 1).

**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 (Table 2). 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
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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.)<br>*A. brachycalyx* subsp. *eriostylus* (Boiss. & Hausskn.) Zarre (Basionym: *A. eriostylus* Boiss. & Hausskn.) | Gentry, 1957; Mozaffarian, 2013 |
| 4  | *A. caspicus* M.Bieb. | Mozaffarian, 2013 |
| 5  | *A. cerasocrenus* Bunge | Gentry, 1957 |
| 6  | *A. compactus* Lam. | Mozaffarian, 2013 |
| 7  | *A. condensatus* Ledeb. (Syn. *A. brachypterus* Fisch.) | Gentry, 1957 |
| 8  | *A. creticus* Lam. | Gentry, 1957 |
| 9  | *A. cyleneus* Boiss. & Heldr. ex Fischer | Gentry, 1957 |
| 10 | *A. cymbostegii* Bunge (Syn. *A. stromatodes* Bunge) | Gentry, 1957 |
| 11 | *A. diphtherites* Fenzl (Syn. *A. brachypterus* Fisch.) | Genty, 1957 |
| 12 | *A. dschuparensis* Freyn & Bornm. | Rajaei et al., 2012 |
| 13 | *A. echinata* Bunge | Mozaffarian, 2013 |
| 14 | *A. eriosphaerus* Boiss. & Hausskn. (Syn. *A. elymaiticus* Boiss. & Hausskn.) | Gentry, 1957 |
| 15 | *A. floccosus* Boiss. | Mozaffarian, 2013 |
| 16 | *A. floccosus* subsp. *rahensis* (Sirj. & Rech.) Zarre (Basionym: *A. rahensis* Sirj. & Rech.f.) | Gavlighi et al., 2013 |
| 17 | *A. geminanus* Boiss. & Hausskn. | Gentry, 1957 |
| 18 | *A. globiflorus* Boiss. | Mozaffarian, 2013 |
| 19 | *A. gossypinus* Fisch. | Mozaffarian, 2013 |
| 20 | *A. hypsogeton* Bunge | Mozaffarian, 2013 |
| 21 | *A. kurdicus* Boiss. | Gentry, 1957 |
| 22 | *A. longistylus* Bunge | Mozaffarian, 2013 |
| 23 | *A. microcephalus* Willd. (Syn. *A. senganensis* Bunge) | Mozaffarian, 2013; Gentry, 1957 |
| 24 | *A. muschianus* Kotschy & Boiss. (Syn. *A. gummifer* Labill.) | Mozaffarian, 2013 |
| 25 | *A. myriacanthus* Boiss. (Syn. *A. echideniformis* Sirj.) | Mozaffarian, 2013 |
| 26 | *A. microcephalus* subsp. *pycnoclados* (Boiss. & Hausskn.) Sirj. (Basionym: *A. pycnochlorus* Boiss. & Hausskn.) | Gentry, 1957 |
| 27 | *A. pycnocephalus* Fisch. | Mozaffarian, 2013 |
| 28 | *A. tragacantha* L. | Eftekharinasab et al., 2012 |
| 29 | *A. verus* Olivier (Syn. *A. brachycentrus* Fisch.; *A. heratensis* Bunge; *A. meschededensis* 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 repellent. They have the potential to be efficacious as pure repellent 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 antiabetic 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
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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.

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