



Ethnobotanical Potential of *Ferula assa-Foetida* as a main Medical Plant in East of Iran

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ABSTRACT

Ferula assa-Foetida L. (Apiaceae) is a medicinal plant indigenous to Iran and Afghanistan. This plant is one of the most important among the thirty species of *Ferula* distributed in Iran. Iran is one of the most important producers of this plant in the world. It is an herbaceous and perennial plant that grows up to 2 m high. One part used is an oleo-gum resin, called asa-foetida or Anghoze in Persian, obtained by incision from the roots. Many people in Mediterranean region who consult with spiritual healers, homeopaths and herbalists are utilizing traditional therapies. The demand for medicinal plants has increased globally due to the resurgence of interest in and acceptance of herbal medicine. The methods of extraction employed are almost invariably crude and unsystematic. As a consequence, the rates of exploitation may exceed those of local natural regeneration. *Ferula* is one of the most important endangered medicinal plants, which is rare in nature due to poor seed germination. It has been reported in Iranian folk medicine to be antispasmodic, aromatic, carminative, digestive, expectorant, laxative, sedative, nerving, analgesic, anthelmintic, aphrodisiac and antiseptic. In this article qualitative and participatory study on harvesting, main characteristics and economical importance of this valuable medicinal plant in South-Khorasan province, east of Iran has been described.

Keywords: Ferula, harvesting, medical plant, economic, Iran.

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INTRODUCTION

Medicinal plants are an important element of medical system, and indigenous knowledge and ethnobotany is integral part of the medicinal system (Singh *et al.*, 2005). These resources are

usually regarded as part of cultural traditional knowledge (Golmohammadi, 2013). The genus *Ferula* belongs to Umbelliferae family consists of 140 species which are widespread from Mediterranean region to central Asia.

Table 1: Agroclimatic information of growing regions of *Ferula assaFoetida* in South Khorasan province

Average amount of rainfall in province (2005-2016)	81/03 Millimeters
Maximum temperature (in June and July months)	46.59 Centigrade
Minimum temperature (in December and January months)	-2.11 Centigrade
Time that need for maturing <i>Ferula assa-Foetida</i> shrubs and producing gum	5 years
Time of growth of <i>Ferula assa-Foetida</i> shrubs	From end of winter until end of June
Time of dormancy of immature <i>Ferula assa-Foetida</i> shrubs	From beginning of July until end of winter
Main type of lands that <i>Ferula</i> can growth	Sandy and lime
Main locations that <i>Ferula</i> can growth	Mountains and pastures
Main type of reproducing of <i>Ferula</i>	Only by seed
Average rainfall that need for growth of <i>Ferula</i> shrubs	90 – 150 Millimeters
Slope of growth regions of <i>Ferula</i> shrubs	30 -60 Percent
Main origin regions of <i>Ferula</i> shrubs	Iran and Afghanistan
Acreage of potential pasture areas for producing medicinal fresh gum of <i>Ferula assa-Foetida</i>	100000 ha
Number of rural households that their income are dependent on <i>Ferula</i>	2000

Source: Information and Statistical Department, 2016

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Ferula assa-foetida L. is one of the most important species of this genus that is native to Iran and Afghanistan, and commonly known as asafoetida. It is herbaceous, monoecious and perennial plant that grows up to 2m height, and is in two types, bitter and sweet – (Iranshahy and Iranshahi, 2011). *Ferula assa-foetida* L. (Apiaceae) is a medicinal plant indigenous to Iran and Afghanistan. This plant is one of the most important among the thirty species of *Ferula* distributed in Iran. It is an herbaceous and perennial plant that grows up to 2 m high. One part used is an oleo-gum resin, called asafoetida or anghouzeh in Persian, obtained by incision from the roots. It has been reported in Iranian folk medicine to be antispasmodic, aromatic, carminative, digestive, expectorant, laxative, sedative, nervine, analgesic, anthelmintic, aphrodisiac and antiseptic.

Asafoetida's English and scientific name is derived from the Persian word for resin (asa) and Latin foetida, which refers to its strong sulfurous odour. Its pungent odour has resulted in its being called by many unpleasant names; thus in French it is known (among other names) as merde du diable (devil's faeces); in some dialects of English, too, it was known as devil's dung, and equivalent names can be found in most Germanic languages (e.g. German Teufelsdreck, Swedishdyvelsträck, Dutchduivelsdrek, Afrikaans duiwelsdrek), also in Finnishpirunpaska or pirunpihka. In Turkish, it is known as şeytantsersi (devil's sweat), şeytanboku (devil's shit) or şeytanotu (the devil's herb) (Hassani *et al.*, 2009). Medicinal plant collectors are usually poor villagers. Plant collection is their part time activity besides farming and live stock keeping (Hamayun *et al.*, 2003). This situation also has been seen in plant collectors that are usually poor villagers and medicinal plant collection is their part time activity besides farming and livestock keeping in villages of South Khorasan province. *Ferula assa-Foetida* is called Anghose in Persian, Stinkingassa in English, Stinkenderassand in French, Teufelstreck stinkenderassand in German, Hing, Hingra in Hindi and Zallouh in Arabic.

2. Various stages for harvesting *Ferula* gum, plus producing and sowing its seeds

Ferula assa-Foetida grows to 2 meters high, with a circular mass of 30–40 cm leaves. Stem leaves have wide sheathing petioles. Flowering stems are 2.5–3 meters high and 10 cm thick and hollow, with a number of schizogenes is ducts in the cortex containing the resinous gum. Flowers are pale greenish yellow produced in large compound umbels. Fruits are oval, flat, thin, reddish brown and have a milky juice. Roots are thick, massive, and pulpy. They yield a resin similar to that of the stems. All parts of the plant have the distinctive fetid smell. The resin-like gum comes from the dried sap extracted from the stem and roots and is used as a spice. The resin is grayish-white when fresh but dries to a dark amber color. The asafoetida resin is difficult to grate and is traditionally crushed between stones or with a hammer. Today, the most commonly available form is compounded asafoetida, a fine powder containing 30% asafoetida resin, along with riceflour and gum Arabic. *Ferula assa-Foetida* is exudates which are obtained by tapping the root stock of the plant. The root of plants have been used for their perceived anthelmintic,



Fig. 1: Shrubs of *Ferula assa-Foetida* in mountains and pasturelands of South Khorasan province in different stages of their growing

antimicrobial, antispasmodic, aromatic, laxative, antispasmodic, diuretic and antiseptic actions in folk medicine. *Ferula assa-foetida* L is one of the most important endangered medicinal plants, which is rare in nature due to poor seed germination. Although the flora of Persia is thus fairly well known, there are still very few works on its overall vegetation (Information and Statistical Department, 2016) and (Golmohammadi, 2016). In this regard, various stages for harvesting and catching *Ferula* gum are as following: A) Selecting shrubs of *Ferula assaFoetida* that ready for catching its medicinal gum and marking on them by rural people in April and November (Fig. 1). Plus gathering its gum, then thin cutting stems of *Ferula* shrubs by native medicinal plant collectors in above 12-16 rounds will be gathered and dried by them and present as dried cutting stems of *Ferula assa* (Keshteh - in endemic Persian language) for supplying to market and processing by foreign medicinal factories (Fig. 2) Each skillful native medicinal plant collectors in one day can cut stems of 1000 *Ferula* shrubs and gathering 4-10 grams of resin-like gum from each cutting stems in 4-5 days ago. This means that a skillful native medicinal plant collector can obtain 2-3 kg. Gum from *Ferula* shrubs in good and rainy seasons in these months of harvesting (Fig. 3).



Fig. 2: Various stages in preparing shrubs of *Ferula assa* and cutting its stem for harvesting medicinal gum

Table 2: Some of the economic information of *Ferula assa-Foetida* in South Khorasan province

Amount of medicinal fresh gum that produce from one shrub of <i>Ferula assa Foetida</i>	20-40 g
Value of annually exporting dried gum of <i>Ferula assa-Foetida</i>	4000000 \$ USD
Total amount of dried gum of <i>Ferula assa-Foetida</i> in rainy years	60 tons
Amount of dried gum of <i>Ferula assa-Foetida</i> in dried years	15-20 tons
Main cities that producing medicinal fresh gum of <i>Ferula assa-Foetida</i> in their pasture areas	Tabas, Qaen, Ferdows, Boshrooyeh
Value of one kg. dried gum of <i>Ferula</i> in global markets	130-170 \$ USD
Value of one kg. dried gum of <i>Ferula assa-Foetida</i> that buy by middlemen from native medicinal plant collectors (in 2016)	60-70 \$ USD
Value of one kg. dried stem of <i>Ferula assa-Foetida</i> that buy by middlemen from native medicinal plant collectors (in 2016)	25-30 \$ USD
Selecting shrubs of <i>Ferula</i> that ready for catching its gum and marking on them by rural people	April and November
Harvesting gum for supplying to market	June, July and August
Sowing seeds of <i>Ferula assa-Foetida</i> by rural people	Winter
New germinatings hrubs of <i>Ferula assa-Foetida</i> plants	End of winter and beginning of spring
Main pests of <i>Ferula assa-Foetida</i> shrubs	Desert mice, one type of worm, and grasshopper
Main targeted global markets for exporting dried gum of <i>Ferula assa-Foetida</i>	India, Europe Union, and Arab countries around the Persian Gulf
Percent of dried gum that each year exported to global markets	Approximately 100 %*
Main type consumption of dried gum of <i>Ferula assa-Foetida</i>	Medicinal factories
Number of Medicinal factories in South Khorasan province	zero
Years that need for producing seeds by shrub of <i>Ferula assa-Foetida</i>	4 -5 years
Times that each shrub of <i>Ferula assaFoetida</i> can produce seeds in his life period	One time **

*Consumption of dried gum among locally people is very limited and mainly in medicinal plants shops.

** Each shrub of *Ferula assa-Foetida* after producing seeds will be died because of using all of its fresh gum.

(Information and Statistical Department, 2016).

3. Essential oil of *Ferula*

Essential oil (volatile oils) are aromatic oily liquids obtained from plant materials such as flowers, herbs, buds, fruits, twigs, bark, seeds, wood, roots, resin, gum and latex. Essential oil components are chemically derived from terpenes and their oxygenated derivatives, which are aromatic and aliphatic acid, esters and phenolic compounds. The percentage of the components of the essential oils varies



A



B

Fig.3: Shrubs of *Ferula assa-Foetida* that ready for producing seed (Figure A) and its seeds (Figures B)

among species and plants parts which indicated that depending on the species, climate, and altitude, time of collection and growth stage. The composition of essential oils might be differed qualitatively and quantitatively. *Ferula assa-Foetida* is a medicinal plant in the Apiaceae family. The plant is an herbaceous perennial with an unpleasant odour and is often considered to be the main source of oleo-gum-resin (OGR, a milky exudates from certain plants that coagulates on exposure to air) which has a characteristic sulfurous odour and bitter taste –(Kavoosi and Rowshan, 2013). Oleo-gum resin is obtained as secretions of the upper parts of the roots of the plants by incision. It is dark brown to black resin-like gum

obtained from the juice of the rhizome. After drying, it becomes darker brown, resin-like mass. Different grades of resins, dried granules, chunks, or powders are sold. It is marketed in three forms-tears, mass, and paste (Fig.4).



Fig.4: Production of dried thin cutting stems of *Ferula assa* for processing by medicinal factories

Chemical composition and antibacterial activity of essential oils from commonly consumed herbs, such as *Citrus aurantium*, *C. limon*, *Lavandula angustifolia*, *Matricaria chamomilla*, *Mentha piperita*, *M. spica*, *Ocimum basilicum*, *Origanum vulgare*, *Thymus vulgaris*, *Salvia officinalis* and *Zataria multiflora* and their main components have been evaluated in many countries. The main constituent of OGR is essential oil which contains ferulic acid, sesquiterpene, sulfur-containing compounds, monoterpenes and other volatile terpenoids. Although advances in chemical and pharmacological evaluation of *F. assa-foetida* have occurred in the recent past, however several useful features of this plant have been remained unknown– (Kavoosi and Rowshan, 2013).

Accordingly, essential oils obtained from *F. assafoetida* OGRs in different collections had different chemical composition, antioxidant, ROS, RNS, H_2O_2 and TBARS scavenging. The essential oil from OGR1 was constituted high levels of acyclic sulfur-containing compounds [(E)-1-propenyl sec-butyl disulfide and (Z)-1-propenyl sec-butyl disulfide] and bicyclic sesquiterpenes [10-epi-c-eudesmol] and showed the highest radical scavenging and the lowest antibacterial and antifungal activities. Essential oil from OGR2 was constituted high levels of acyclic sulfur-containing compounds [(Z)-1-propenyl sec-butyl disulfide and (E)-1-propenyl sec-butyl disulfide] and bicyclic monoterpenes [b-pinene and a-pinene] and showed

moderate radical scavenging, antibacterial and antifungal activities. Essential oil from OGR3 was constituted high levels of bicyclic monoterpenes [β -pinene and α -pinene] and heterocyclic disulfide [1,2-dithiolane] and showed the lowest radical scavenging and the highest antibacterial and antifungal activities. For that reason, the essential oil obtained from the earlier stages of *F. assa-foetida* growth could be used as safe and effective natural antioxidants in food industry to improve the oxidative stability of fatty foods during storage while, the essential oil obtained from the later stages of *F. assa-foetida* growth could be used in health industry as a safe and effective source of antimicrobial agents. However, this is the first report on the effect of growth stage on the essential oil profile in *F. assa-foetida*. More professional study required to examine phenolic and flavonoid biosynthetic pathway and expression profile of the related enzymes. With these expertise study we can talk with assurance about tentative applications of essential oils –(Kavoosi and Rowshan, 2013).

4. Ferula and traditional medicine

In traditional medicine the plant is used for the treatment of different diseases, such as asthma, epilepsy, stomachache, flatulence, intestinal parasites, weak digestion and influenza –(Kavoosi and Rowshan, 2013). *Ferula assa-foetida* L. belongs to the Apiaceae (Umbelliferae) family of plants and its oleo gum resin is known as asafetida and people of some countries still consume it as a spice and medicinal herb. The old traditional phytomedicine asafetida, an oleo-gum-resin obtained from the roots of different *Ferula assa-foetida*, is used in different countries for various purposes. Asafetida is not only used as a culinary spice but also traditionally used to treat various diseases, including asthma, gastrointestinal disorders, intestinal parasites, etc. This oleo-gum-resin has been known to possess antifungal, anti-diabetic, anti-inflammatory, antimutagenic and antiviral activities. A wide range of chemical compounds including sugars, sesquiterpenecoumarins and polysulfides have been isolated from this plant. Recent studies have shown new promising antiviral sesquiterpenecoumarins from this old phytomedicine. Asafetida is an oleo-gum-resin obtained from the exudates of the roots of the Iranian endemic medicinal plant, *Ferula assa-foetida*. This species (*Ferula assa-foetida*) is often considered to be the main source of asafetida, although other *Ferula* species, such as *Ferula foetida*, *Ferula rubricaulis*, *Ferula rigidula*, *Ferula alliacea* and *Ferula narthex*, are also sources of asafetida. *Ferula assa-foetida* grows wild in the central and southern mountains of Iran. The oleo-gum-resin asafetida is called "Anghouzeh", "Khorakoma" and "Anguzakoma" in Iran. The plant, which belongs to the Apiaceae family, is an herbaceous perennial with an unpleasant odor that grows to about 2m in height. The oleo-gum-resin is often obtained by incision of the roots or removal of the stems. Hardened exudates (oleo-gum-resin) are then collected and packed for export. Asafetida occurs in two principle forms, tears and mass. Mass is the most common form of asafetida in the market. Asafetida has been used as a spice and a folk phytomedicine for centuries. Asafetida has a characteristic sulfurous odor and a bitter taste. It is used as a flavoring spice in a variety of

foods, particularly in India. In addition, Nepali people regularly consume it in their daily diets, and it is believed that asafetida has aphrodisiac, sedative and diuretic properties. It is traditionally used for the treatment of different diseases, such as asthma, epilepsy, stomachache, flatulence, intestinal parasites, weak digestion and influenza. Asafetida consists of three main fractions, including resin (40–64%), gum (25%) and essential oil (10–17%). The resin fraction contains ferulic acid and its esters, coumarins, sesquiterpenecoumarins and other terpenoids. The gum includes glucose, galactose, l-arabinose, rhamnose, glucuronic acid, polysaccharides and glycoproteins, and the volatile fraction contains sulfur-containing compounds, monoterpenes and other volatile terpenoids. Bioassay-guided fractionation studies of asafetida have led to the identification of some interesting bioactive compounds; for example, characterized antiviral sesquiterpenecoumarins from asafetida that are more potent than amantadine against influenza A. In Iranian folk medicine, asafetida is also used as a medicine for the treatment of asthma. It seems that the most frequent uses of asafetida are in upper respiratory diseases, including the treatment of asthma, bronchitis and whooping cough (as an expectorant), and gastrointestinal disorders as an antihelminthic, anti-flatulence and antispasmodic. Although asafetida has been reported to be obtained from different sources, *Ferula assa-foetida* is considered to be the main source of asafetida. This plant is native to central Asia, particularly eastern Iran and Afghanistan, from where it is exported to the rest of the world. Although asafetida is not native to India, it has been used in Indian medicine and cookery for ages. In addition, it has been used in traditional medicine of other countries such as Malaysia, Nepal and Fiji (Tyagi et al., 2006).

New pharmacological studies have almost confirmed the traditional uses of asafetida as an antihelminthic, antispasmodic and antibacterial agent. In addition, there is a correlation between some traditional uses of asafetida and those of new studies. For example, modern phytochemical and pharmacological studies have been revealed that umbelliprenin is one of the major components of asafetida possessing strong lipoxygenase inhibitory activity. Another biological activity of asafetida, which has been confirmed by a number of new studies, is cancer chemoprevention. Antihelminthic property (or anthelmintic) is another emphatically reported traditional use of asafetida in different countries. In Iran, China and Nepal, it is traditionally used for infestation with intestinal parasites. – (Iranshahy and Iranshahi, 2011) and (Gundamaraju, 2013). According to the Chinese, European, Iranian and Indian traditional medicines, oleo gum resin of *Ferula assa-foetida* (asafetida) has therapeutic effects on different kinds of diseases. Some of these effects are related to the diseases of nervous system such as hysteresis and convulsion –(Moghadam et al., 2014).

5. Situation of exploitation pastures of Ferula in the South Khorasan province

Pastures are the most valuable national resources for each

country which its proper utilization and basic management can provide an essential role in soil and water conservation, in addition to meeting the country needs for protein. Disproportion between the number of exploiters and thus the number of livestock units that feed on the pasture forage provide the grounds for the major problems including retrogression of pastures, reduction of the value pasture species, proliferation of invader species, soil erosion and totally destruction the environment. The different methods of range management including long-term exploitation, short-term exploitation and under grazing indicate the effects of grazing pressure on the reduction of vegetation and palatable species with forbs in the grazed pastures and by removing the factor of livestock grazing, the percent of vegetation and litter increases in the short and long-term. The exploitation also leads to increase the soil conservation and decrease the bare soil surface in the pasture (Tajali and Khazaeipool, 2012). In this regard, in South Khorasan province as a most deprived and dried region of Iran, we see all of the above problems plus high periods of drought and overgrazing of herds specially cattle's of goats and sheep (Information and Statistical Department, 2016).

6. Other important pasture medicinal plants in South Khorasan province

There are some other important pasture medicinal plants in South Khorasan province that local people traditionally collect and use them (Singh et al., 2010). During thousands of years accumulated a huge amount of indigenous and local knowledge about these medicinal plants which are important elements in traditional herbal and medicinal system of these native people. Nowadays we can observe this indigenous and local knowledge among native people from high rate of reception and going to meet from traditional shops of medicinal plants among various categories of society in South Khorasan province. We can note for example to followings medicinal plants: Ash tree, Pomegranate, Apricot, Black cherry, Borage, *Althaea officinalis*, *Portulca oleraceae*, *Tribulus terrestris*, *Achillea ophorad*, *Alhagipersarumboiss*, *Descurainia sofia*, *Portulca oleraceae*, *Tribulus terrestris*, *Onobrychis au cheriboiss*, *Peganum harmala*, *Malvaneglecta wallr*, *Common mallow*, *Cynodon dactylon L pers*, *Crataegus kestanica*, *Eremurus luteus Baker*, *Cuscuta sp*, *Polygonum aviculare L.*, *Artemisia dracuncululus L.*, *Allium porrum*, *Rumex chaale pensis miller*, *Tamarix serotina Juglans regia*, *Nigella sativa L.*, etc (Information and Statistical Department, 2016).

Suggestion for sustainable management of *Ferula assa-foetida*

Utilizing from *Ferula assa-foetida* in present traditional form namely cutting its stem from above of its root for producing gum is not a sustainable way for exploiting because of after one season producing gum by mature plant, in next year *Ferula* will die. In this regard in research centers of Natural Resources and Watershed Organization of Iran, researches have been found methods for sustainable utilizing of *Ferula* such as concave and staircase methods. These new, scientific and sustainable methods must be extended among farmers (especially by agriculture and natural resources extension

workers) and replacing to present prevailing hazardous traditional method. Reducing number of small livestock (especially goats and sheep herds) and big livestock (cow's herds in second order) in major weak pastures of South Khorasan province. Also preventing from grazing of these livestock herds especially in germination and exploitation seasons of *Ferula*.

In this regard Natural Resources and Watershed Organization of Iran must allow livestock grazing in these pastures only after the last exploitation stage of *Ferula*.

Development strategic planning for exploitation of *Ferula* in forward to achieving appropriate utilizing from available potentials in field of *Ferula* and other medicinal plants in South Khorasan province.

Controlling on exploitation stages and Monitoring on quantity and quality of *Ferula* products. Conserving and restoring to life of germinating locals and pastures of *Ferula* in South Khorasan province. Absorbing participation of local people on implementing *Ferula* plans and projects of Natural Resources and Watershed Organization of South Khorasan province by strengthening their local organizations of medicinal plant collectors that are usually poor villagers. Establishing factories in field of medicinal plants especially for *Ferula* in the South Khorasan province (Singh et al, 2010). This can plus providing job creating for unemployed youth local people, preventing from raw and cheap selling and exporting of *Ferula* gum and increasing its final achieving value. This also is an important step for accessing to sustainable development and poverty alleviation goals and criteria in this deprived, dried and remote region of Iran.

CONCLUSION

Ferula assa-foetida L. (Apiaceae) is one most important and valuable medicinal plants in pastures of Iran and especially South-Khorasan province that major of its products (about 99%) export to foreign countries (especially for utilizing by industrial medicinal factories in developed countries). Because of above reasons, main goals of managers of Natural Resources and Watershed Administration of South Khorasan province are sustainable exploitation plus maximum economical efficiency from this plant. The demand for medicinal plants has increased globally due to the resurgence of interest in and acceptance of herbal medicine. Most of the demand is being met through collection of large quantities of medicinal plants and plant parts from wild populations. The methods of extraction employed are almost invariably crude and unsystematic. As a consequence, the rates of exploitation may exceed those of local natural regeneration. Also, the natural habitats are quickly being depleted. There is thus an urgent need to develop and implement conservation strategies for exploited medicinal plant species. *Ferula* is one of the most important endangered medicinal plants, which is rare in nature due to poor seed germination, since it is propagated through seeds. However, its natural populations are very limited in native habitats, which may be due to poor seed germination. Seed dormancy is a common phase of the *Ferula assa Foetida* plant life cycle, and several parts of this seed can contribute to dormancy.

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