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Traditional knowledge and economic importance of *Ferula assa-foetida* in the rural areas of southeastern Iran

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Traditional knowledge is considered as knowledge, innovations, practices of indigenous and local communities embodying traditional life-styles; the wisdom developed over many generations, of holistic traditional scientific utilization of lands, natural resources and environment. Traditional knowledge is valid and necessary, and due to its relevance, it currently has wide application for human benefit. Many people in Mediterranean region who consult spiritual healers, homeopaths and herbalists are utilizing traditional therapies. These are the first choice for problems such as liver diseases, inflammation, skin diseases, infertility, impotence, diabetes, obesity, epilepsy, psychosomatic troubles and many other diseases. *Ferula assa-foetida* L. (Apiaceae) is one of the most important among the thirty species of *Ferula* distributed in Iran. One part used is an oleo-gum resin, called asa-foetida or Anghoze in Persian, which is obtained by incision from the roots. *Ferula* is one of the most important endangered medicinal plants, which is rare in nature due to poor seed germination. In this article, qualitative and participatory study on main characteristics, harvesting and economic importance of this valuable medicinal plant in South-Khorasan province, East of Iran, as a major producer and exporter, is introduced.

Key words: *Ferula*, traditional knowledge, medical plant, rural regions, Iran.

INTRODUCTION

Medicinal plants are an important element of the medical system. These resources are usually regarded as part of cultural traditional knowledge (Golmohammadi, 2013). The genus, *Ferula* belongs to the Umbelliferae family and consists of 140 species which are widespread from the Mediterranean region to central Asia. *Ferula assa-foetida* L. (Apiaceae) is one of the most important species of this

genus which is native to Iran and Afghanistan, and commonly known as *asa foetida*. It is a herbaceous, monoecious and perennial plant that grows up to 2 m in height, and is in two types, bitter and sweet (Iranshahi and Iranshahi, 2011). *F. assa-foetida* L. (Apiaceae) is a medicinal plant indigenous to Iran and Afghanistan. This plant is one of the most important among the thirty

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Table 1. Names of *Ferula assa-foetida* in different languages

Persian	English	French	German	Hindi	Arabic	Botanical name	Family
Anghose	Stinking assa	Stinkender assand	Teufels treck stinkender assand	Hing, Hingra	Zallouh	<i>Ferula assa – foetida</i>	Apiaceae

Golmohammadi (2013).



Figure 1. Medicinal plant collectors that are usually poor villagers and plant collection is their part time activity besides farming and herds keeping IN Sorond village of Tabas City, 300 km distance to Birjand, centre of South Khorasan province. 1a. Pool for storing mountain water for utilization by villagers and their herds, 1b. Herds of the villagers beside the shrubs of *F. assa foetida* in mountains and pasturelands (May 23, 2016).
Source: Golmohammadi (2016).

species of *Ferula* distributed in Iran. One part used is an oleo-gum resin, called *asa-foetida* 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 resin (*asa*) and Latin *foetida*, which refers to its strong sulfurous odour. Its pungent odour has resulted in it being called by many unpleasant names; in French it is known (among other names) as *merde du diable* (devil's faeces); in English, it is known as devil's dung, and equivalent names can be found in most Germanic languages (e.g. German *Teufelsdreck*, Swedish *dyvelstruck*, Dutch *duivelsdrek*, Afrikaans *duiwelsdrek*), also in Finnish, it is called *pirunpaska* or *pirunpihka*. In Turkish, it is known as *şeytannersi* (devil's sweat), *şeytan boku* (devil's crap) or *şeytanotu* (the devil's herb) (Hassani et al., 2009) (Table 1).

Medicinal plant collectors are usually poor villagers. Plant collection is their part time activity besides farming and livestock keeping (Hamayun et al., 2003). This situation has also been seen in South Khorasan province, south east of Iran (Figure 1).

MATERIALS AND METHODS

The study area is South Khorasan province, east of Iran. The

present study was conducted from 2010 to 2017 in rural regions of South Khorasan province, east of Iran (Figure 2). South Khorasan province consists of 11 counties namely: Birjand, Ferdows, Tabas, Qaen, Nehbandan, Darmian, Sarbisheh, Boshruyeh, Sarayan, Zirkouh and Khusf.

Two main regions in mountains and pastures where *Ferula assa-foetida* L. are grown are, Tabas and Darmian counties, thus majority of field research has been done in these locations. For this article, recent and most important articles in the domain of the research were used. Main instruments for gathering information in this article were qualitative and participatory research methods and place-based approaches, using in-depth semistructured interviews and participatory observation, discussions, experiments, documents, pictures and nonformal interview with villagers, related officers, specialists and professors in the domain of this research from 2010 to 2017.

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

F. assa foetida grows up to 2 m high, with a circular mass of 30 to 40 cm leaves. Stem leaves have a wide sheathing petioles. Flowering stems are 2.5 to 3 m high and 10 cm thick and hollow, with a number of schizogenesis ducts in the cortex containing the resinous gum. Flowers are pale greenish yellow in color, 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 a distinctive fetid smell (Table 2).

Resin-like gum is obtained from the dried sap, extracted from the stem and roots and is used as a spice. The resin is grayish-white when fresh but dark amber in color when dry. The *asa foetida* resin is difficult to grate and is traditionally crushed between stones or with a hammer. Today, the most commonly available form is

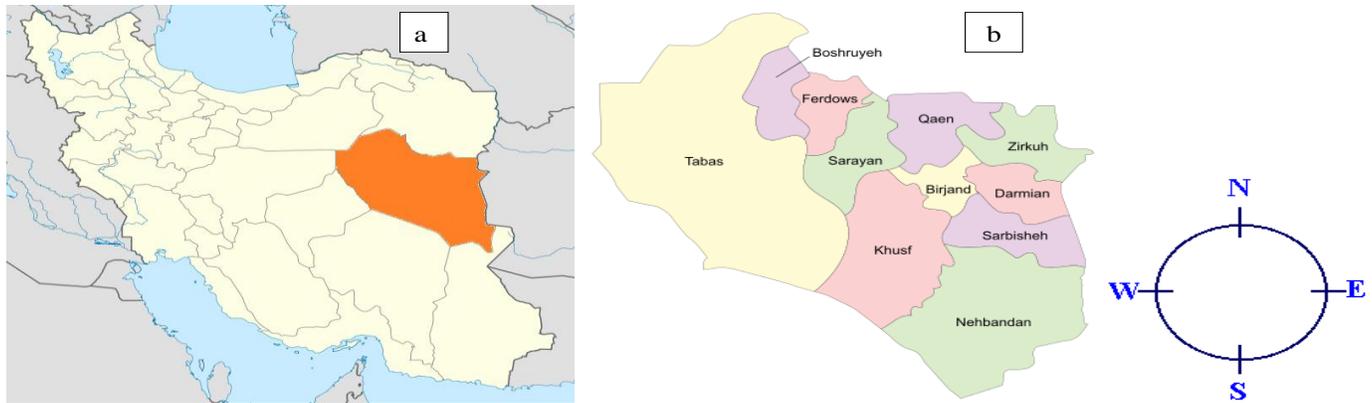


Figure 2. Maps of South Khorasan province in eastern part of Iran. a. Map of the main study area besides borders of Afghanistan; Coordinates: 32.8653°N 59.2164°E; b. Map of the cities of South Khorasan province (at a map scale of 1:1000000). Source: Information and Statistical Department (2016).

Table 2. Some of the meteorology, geology and botanical information of growth regions of *Ferula assa foetida* in South Khorasan province.

Average amount of rainfall in province (2005-2016)	81/03 mm
Maximum temperature (in June and July months)	46.59°C
Minimum temperature (in December and January months)	-2.11°C
Time for maturation of <i>Ferula assa foetida</i> shrubs and production of gum	5 years
Time of growth of <i>Ferula assa foetida</i> shrubs	From end of winter till end of June
Time of dormancy of immature <i>Ferula assa foetida</i> shrubs	From beginning of July till end of winter
Main type of lands where <i>Ferula</i> can grow	Sandy and lime
Main locations where <i>Ferula</i> can grow	Mountains and pastures
Main type of reproduction by <i>Ferula</i>	Only by seed
Average rainfall for growth of <i>Ferula</i> shrubs	90 – 150 mm
Slope of growth regions of <i>Ferula</i> shrubs	30-60%
Main origin regions of <i>Ferula</i> shrubs	Iran and Afghanistan
Acreage of potential pasture areas for production of 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

Information and Statistical Department (2016).



Figure 3. Shrub of *F. assa foetida* in mountains and pasturelands of South Khorasan province. Source: Golmohammadi (2016).

compounded *asa foetida*, a fine powder containing 30% *asa foetida* resin, together with rice flour and gum Arabic. *F. assa foetida* exudations are obtained by tapping the root stock of the plant.

The root of this plants have been used for perceived anthelmintic, antimicrobial, antispasmodic, aromatic, laxative, antispasmodic, diuretic and antiseptic actions in folk medicine. *F. assa-foetida* L. (Apiaceae) 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; Golmohammadi, 2013). In this regard, various stages for harvesting and obtaining Ferula gum are as follows:

- i. Selecting shrubs of *F. assa Foetida* which are ready for use as medicinal gum and marking them by rural people from April and November (Figure 3).
- ii. Fencing these selected shrubs with stones (Figure 4).
- iii. Harvesting gum; this is the final stage of producing dried gum, and supply to the market is done in June, July and August. In this stage, in every 4 to 5 days of these months, native medicinal plant collectors with their traditional tools (Figures 4 and 5) create a thin cutting on the stem and after this period, they gather resin-like gum discharges from the stem, which is again replicated with 12 to 16 rounds, each in 4 to 5 days on the stems of Ferula in these months (Figures 7 and 8). In gathering of the gum, before thin cutting of Ferula shrubs stems by native medicinal plant collectors with the above 12 to 16 rounds, they are collected and dried to obtain dried stem cutting of *F. assa* (Keshteh- in endemic Persian language), which will be taken to the market and processed by foreign medicinal factories (Figure 7 and Table 3). Each skillful native medicinal plant collector can in one day cut stems of 1000 Ferula shrubs and gather 4 to 10 g of resin-like gum from each stem cutting in 4 to 5 days. This means that a skillful native medicinal plant collector can obtain 2 to 3 kg gum from Ferula shrubs in dry and rainy seasons in the months of harvest (Figure 4).
- iv. Producing seeds from shrubs of *F. assa foetida* are set by the end of summer.
- v. Sowing seeds of *F. assa foetida* by rural people in winter and beginning a new germination of plant by the end of winter, originates a new spring (Figure 6) (Information and Statistical Department, 2016) (Table 3).

Essential oil of Ferula

Essential oils (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 acids, esters and phenolic compounds.

The percentage of components of the essential oils varies among species and plant parts, depending on the species, climate and altitude, time of collection and growth stage. The composition of essential oils might be different qualitatively and quantitatively.

F. assa-foetida is a herbaceous perennial plant with an unpleasant odour and is often considered to be the main source of oleo-gum-resin (OGR, a milky exudation 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 in plant by incision. It is a dark brown to black resin-like gum obtained from the juice of the rhizome. After drying, it becomes dark brown in color with resin-like mass. Different grades of resins, dried granules, chunks or powders are sold. It is marketed in three forms: tears, mass and pastes. Chemical composition and antibacterial activity of essential oils of commonly consumed herbs, such as *Citrus*

aurantium, *Citrus limon*, *Lavandula angustifolia*, *Matricaria chamomilla*, *Mentha piperita*, *Mentha 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 recent past, several useful features of this plant remains unknown (Kavoosi and Rowshan, 2013). Accordingly, essential oils obtained from *F. assa-foetida* OGRs in different collections had different chemical composition, antioxidant, reactive oxygen species (ROS), reactive nitrogen species (RNS), H₂O₂ and TBARS scavenging activities. The essential oil of OGR1 had high levels of acyclic sulfur-containing compounds [(E)-1-propenyl sec-butyl disulfide and (Z)-1-propenyl secbutyl disulfide] and bicyclic sesquiterpenes (10-epi-c-eudesmol) which showed the highest radical scavenging and the lowest antibacterial and antifungal activities.

Essential oil of OGR2 had 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) which showed moderate radical scavenging, antibacterial and antifungal activities. Essential oil of OGR3 had high levels of bicyclic monoterpenes (b-pinene and a-pinene) and heterocyclic disulfide (1, 2-dithiolane) which showed lowest radical scavenging and highest antibacterial and antifungal activities. For this 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 of *F. assa-foetida*. More professional studies are required to examine phenolic and flavonoid biosynthetic pathways and expression profiles of the related enzymes. With these expertise studies, tentative applications of essential oils can be discussed (Kavoosi and Rowshan, 2013).

Ferula and traditional medicine

In traditional medicine, this 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).

The old traditional phytomedicine asafoetida, an oleo-gum-resin obtained from the roots of different *F. assa-foetida*, is used in different countries for various purposes. This oleo-gum-resin has been known to possess antifungal, anti-diabetic, anti-inflammatory, anti-mutagenic and antiviral activities. A wide range of chemical compounds including sugars, sesquiterpene coumarins and polysulfides have been isolated from this plant. Recent studies have shown new promising antiviral sesquiterpene coumarins from this old phytomedicine. *Asa foetida* has been used as a spice and a folk phytomedicine for centuries and 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 asafoetida has aphrodisiac, sedative and diuretic properties.

Another biological activity of *F. assa-foetida*, which has been confirmed by a number of new studies, is cancer chemoprevention. Anthelmintic property (or anthelmintic) is another emphatically reported traditional use of *asa foetida* in different countries. In Iran, China and Nepal, it is traditionally used for the treatment of intestinal parasites infestation (Iranshahy and Iranshahi, 2011) and



Figure 4. Villagers performing various stages of preparing shrubs of *Ferula assa* and stem cutting harvesting for medicinal gum (Shireh). Sorond village of Tabas City, 300 km distance from Birjand centre of South Khorasan province. These stages are in the order: a. Establishing a hole around stem of the shrub; b. Preparing stem of shrub for next steps; c. Providing a stone sunshade for protecting stem from high temperature and drying; d. Cutting head of the stem for oozing and exudation of juice of *F. assa*; e. Juice of *Ferula assa*; f. Gathering of the juice by iron shaver (May 23, 2013, 2016). Source: Golmohammadi (2016).

(Gundamaraju, 2013). According to the Chinese, European, Iranian and Indian traditional medicines, oleo gum resin of *F. assa-foetida* (*asa foetida*) 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).

DISCUSSION

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.

Water is a major natural resource which is a limiting factor in the development of agriculture and natural resources, especially in a dry region such as Iran. Therefore, it is necessary to adopt water management technologies for utilizing the available water resources. Water is the most precious commodity in the arid region



Figure 5. Traditional tools of villagers for preparing shrubs of *Ferula assa* and cutting of stems for harvesting medicinal gum, in Sorond village of Tabas City, 300 km from Birjand, Centre of South Khorasan province. These tools are: a. A leather sack for storing and gathering juices; b. an adze for establishing holes around stem of shrubs; c. Iron shavers etc. for gathering juice of *Ferula assa* from stem cuttings (May 23, 2016). Source: Golmohammadi (2016).

of Iran due to prevalence of unfavorable hydro meteorological condition (Golmohammadi, 2012). We are living in a knowledge driven world where knowledge is the ultimate power (Kumari et al., 2014).

In this regard, indigenous traditional and local knowledge on medicinal plants are important elements of herbal and medicinal system. These resources are usually regarded as part of the cultural traditional knowledge. Despite all kinds of technological advances, the geographic variation is one element that is far from human control because of the different climatic conditions and edaphic factors that exist in each region.

Essential oil quality and quantity in general are extremely dependent on the weather conditions; also, several authors considered that the physico chemical characteristics are determinant factors in secondary

metabolites composition especially for quality of volatiles (Moghaddam and Farhadi, 2015).

Also, the natural habitats are quickly being depleted. There is thus an urgent need to develop and implement conservation strategies to exploit medicinal plant species. The medicinal plant is propagated through seeds. However, its natural populations are very limited in native habitats, which may be due to poor seed germination. Low seed germination in Apiaceae is also known (Moghaddam et al., 2014; Golmohammadi, 2012).

F. assa-foetida L. (Apiaceae) is one of the most important and valuable medicinal plants in pastures of Iran and especially, South-Khorasan province with the majority of its products (about 99%) being exported to foreign countries (especially for utilizing by medicinal factories in developed countries). Because of the above



Figure 6. Various stages of production of seeds from shrubs of *Ferula assa foetida*. These stages are: a. Recognizing shrubs of *Ferula assa foetida* that are ready for seeds production; b. Gathering seeds of *Ferula assa*; c. Preparing appropriate foothills and mountains for sowing *Ferula assa* seeds at the end of winter by local rural people; d. Germinating shrubs of *Ferula assa foetida* in winter (May, 2012, 2013). Source: Golmohammadi (2016).



Figure 7. Final production of dried thin stems cutting of *Ferula assa-foetida*, Keshteh- in endemic Persian language, for market supply and processing by medicinal factories in Sorond village of Tabas City, 300 km from Birjand centre of South Khorasan province (May 23, 2016). Source: Golmohammadi (2016).

province are sustainable exploitation plus maximum economic efficiency of this plant. *Ferula* is one of the most important endangered medicinal plants, which is rare in nature due to poor seed germination (Information and Statistical Department, 2016). The production of this valuable plant in South-Khorasan province in about 100000 ha, is 60 (in rainy years) and 15 to 20 tons (in dried years) annually and almost all of this production is exported because of, lack of processing industries in this province. This plant generates income for many rural and nomadic households, which in the conditions of their subsistence agriculture, have high dependence on this production.

South Khorasan province in the east of Iran has good ethnobotanical potential for medicinal plants. With the presence of the above mentioned cases, the author stated the following recommendations for sustainable management and exploitation with increased economic efficiency of this plant:

reasons, main goals of managers of Natural Resources and Watershed Administration of South Khorasan

i. Utilizing *F. assa-foetida* in the present traditional form namely, cutting its stem from above its root for producing



Figure 8. Essential medicinal oil (oleo gum resin, OGR) of *Ferula assa-foetida*. a. Shireh (in endemic Persian language) in jelly form (major), and b. solid form (final). These are obtained from pastures of Sorond village of Tabas City, 300 km from Birjand centre of South Khorasan province (May 23, 2016). Source: Golmohammadi, (2016).

Table 3. Some of the economic information of *Ferula assa foetida* in South Khorasan province.

Amount of medicinal fresh gum produced by one shrub of <i>Ferula assa foetida</i>	20-40 g
Value of annually exported 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 produce medicinal fresh gum of <i>Ferula assa foetida</i> in their pasture areas	Tabas, Qaen, Ferdows and Boshrooyeh
Value of one kg dried gum of <i>Ferula assa foetida</i> in global markets	130-17 \$ USD
Value of one kg dried gum of <i>Ferula assa foetida</i> bought by middlemen from native medicinal plant collectors (in 2016)	60-70 \$ USD
Value of one kg. dried stem of <i>Ferula assa foetida</i> bought by middlemen from native medicinal plant collectors (in 2016)	25-30 \$ USD
Selecting shrubs of <i>Ferula assa foetida</i> that are ready for obtaining their gum and marking on them by rural people	April and November
Harvesting gum for market supply	June, July and August
Sowing seeds of <i>Ferula assa foetida</i> by rural people	Winter
New germinating shrubs 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 are exported to global markets each year	Approximately 100%*
Main method of consumption of dried gum of <i>Ferula assa foetida</i>	Medicinal factories
Number of medicinal factories in South Khorasan province	Zero
Years for production of seeds by shrub of <i>Ferula assa foetida</i>	4 - 5 years
Number of times each shrub of <i>Ferula assa foetida</i> can produce seeds in its life time	Once **

*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 die because of the use of all its fresh gum (Information and Statistical Department, 2016).

gum is not a sustainable way for exploitation because after one season, production of gum by mature plant in the next year will result in the death of the plant. In this regard, in the research centers of Natural Resources and Watershed Organization of Iran, researchers have found methods for sustainable utilization 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), replacing the present prevailing hazardous traditional method.

Reduction in the number of small (especially goats and

sheep herds) and big livestock (cow's herds in second order) is the major weakness in pastures of South Khorasan province. Also, prevention from grazing by these livestock herds is mainly during 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*.

ii. Development of strategic planning for appropriate future exploitation-utilization of *Ferula* and other medicinal plants.

iii. Controlling exploitation stages and monitoring the quantity and quality of *Ferula* products.

iv. Conserving and restoring to life the germinating locals and pastures of *Ferula*.

v. Absorbing participation of local people in implementing *Ferula* plans and projects of Natural Resources and Watershed Organization by strengthening the local organizations of medicinal plant collectors.

vi. Establishing factories in the field of medicinal plants especially, *Ferula* in the South Khorasan province. This can create jobs for unemployed local youth, preventing them from raw and cheap selling and exporting of *Ferula* gum and increasing its final value. This is also an important step for accessing sustainable development and poverty alleviation goals, and criteria in this deprived, dried and remote region of Iran.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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