



Research Article

Volume 2 - Issue 3: 164-170 / July 2019

FERULA ASSA-FOETIDA AND ITS TRADITIONAL KNOWLEDGE AND ECONOMIC IMPORTANCE IN THE RURAL AREAS OF SOUTH EAST OF IRAN

Farhood GOLMOHAMMADI^{1*}

¹Department of Agricultural Extension and Education, Islamic Azad University, Birjand Branch, Birjand, Iran

Received: January 13, 2019; **Accepted:** May 15, 2019; **Published:** July 01, 2019


Abstract

Traditional knowledge is employed to mean knowledge, innovations, and practices of indigenous and local communities embodying traditional life-styles; the wisdom developed over many generations of holistic traditional scientific utilization of the lands, natural resources, and environment. Traditional knowledge is valid and necessary, and awaits its currently relevant wider application for human benefit. Many people in Mediterranean region who consult with 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, 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 introduce his field, qualitative and participatory study on main characteristics, harvesting and economical importance of this valuable medicinal plant in South-Khorasan province, south east of Iran as a major producer and exporter.

Keywords: *Ferula*, Traditional knowledge, Medical plant, Rural regions, Iran

***Corresponding author:** Department of Agricultural Extension and Education, Islamic Azad University, Birjand Branch, Birjand, Iran

E mail: farhood.gol@gmail.com (F. GOLMOHAMMADI)

Farhood GOLMOHAMMADI  <https://orcid.org/0000-0003-0939-4678>

Cite as: Golmohammadi F. 2019. *Ferula assa-foetida* and its traditional knowledge and economic importance in the rural areas of south east of Iran. *BSJ Agri*, 2(3): 164-170.

1. Introduction

The main aim of this study is introducing various aspects of Traditional Knowledge (TK) and Economic Importance of *Ferula assa-foetida* in the Rural Areas of South Khorasan province, south east of Iran and its importance for sustainable livelihood of people in these dried, disadvantaged and isolated regions and finally presenting solutions and approaches for improving its role and situation in economy, income and welfare of

these vernacular people. Medicinal plants are an important element of medical systems. These resources are usually regarded as part of cultural traditional knowledge (Golmohammadi, 2012; Golmohammadi, 2017).

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 that is native to Iran and Afghanistan, and

commonly known as *asa foetida*. It is herbaceous, monoecious and perennial plant that grows up to 2m in 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. 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 (Golmohammadi, 2017).

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 it being called by many unpleasant names; in French it is known (among other names) as *merde du diable* (devil's faeces); in some dialects of English, too, it is known as devil's dung, and equivalent names can be found in most Germanic languages (e.g. German *Teufelsdreck*, Swedish *dyvelsträck*, Dutch *duiwelsdrek*, Afrikaans *duiwelsdrek*), also in Finnish *pirunpaska* or *pirunpihka*. In Turkish, it is known as *şeytanti* (devil's sweat), *şeytan boku* (devil's crap) or *şeytanotu* (the devil's herb) (Hassani et al., 2009) (Please see 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 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, south east of Iran (Golmohammadi, 2017).

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

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

2. Materral and Method

Type of this research is qulititative, participatory and place-based approaches and methods. Location area of this study is South Khorasan province, south east of Iran. For indentifying the plant samples, author utilized from handbook and helps of an expert from Iran Flora institution. The present study has been done by author during 2010 - 2018 years in some disadvantaged rural regions in South Khorasan province. South Khorasan province consists of 11 counties namely Birjand, Ferdows,

Tabas, Qaen, Nehbandan, Darmian, Sarbisheh, Boshruyeh, Sarayan, Zirkouh and Khusf. Two main regions that in their mountains and pastures *Ferula assa-foetida* L. has been grown, are Tabas and Darmian counties, thus majority of author field research has been done in these locations (Figure 1).



Figure 1. Map of the South Khorasan province in east of Iran. 2a. Map of the main location of doing this research, and beside borders of Afghanistan. Coordinates: 32.8653°N 59.2164°E); 2b. Map of the cities of South Khorasan province, (At a map scale of 1:1000000), (Source: Information and Statistical Department, 2016).

For writing this article utilized from recent and most important articles in domain of the research. Main instruments for gathering information in this study were in-depth semistructured interviews and participatory observation, discussions, experiments, documents, pictures, and nonformal interviewing with villagers, related officers, specialists and professors in domain of this research during 2010 - 2018. The main importance of these methods are because of by utilizing them, author could attain correct, experimental and primary data for doing this study (Figure 2).



Figure 2. Shrub of *Ferula assa-foetida*.

2.1. 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 (Golmohammadi, 2013; Golmohammadi, 2017).

The percentage of the 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 (Gundamaraju, 2013; Golmohammadi, 2017).

Ferula assa-foetida is a herbaceous perennial 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 of the plant by incision (Figure 3). 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 (Figures 4 and Figure 5). Chemical composition and

antibacterial activity of essential oils from commonly consumed herbs, such as *Citrus aurantium*, *C. lemon*, *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 (Gundamaraju, 2013; Golmohammadi, 2017).



Figure 3. Juice of *Ferula assa-foetida*.



Figure 4. Final production of dried thin cutting stems of *Ferula assa-foetida*.



Figure 5. Essential medicinal oil – Oleo Gum Resin (OGR) - of *Ferula assa-foetida*.

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 *Ferula assa-foetida* have occurred in the recent past, several useful features of this plant remains unknown (Kavoosi and Rowshan, 2013). Accordingly, essential oils obtained from *Ferula assa-foetida* OGRs in different collections had different chemical composition,

antioxidant, ROS, RNS, H₂O₂ and TBARS scavenging. The essential oil from OGR1 constituted 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] 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 [b-pinene and a-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 *Ferula 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 *Ferula 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 *Ferula 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 we can talk with assurance about tentative applications of essential oils (Kavoosi and Rowshan, 2013; Golmohammadi, 2017).

2.2. *Ferula assa-foetida* 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).

The old traditional phytomedicine asafoetida, an oleo-gum-resin obtained from the roots of different *Ferula 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 (Gundamaraju, 2013; Golmohammadi, 2017).

Another biological activity of *Ferula assa-foetida*, which has been confirmed by a number of new studies, is cancer chemoprevention. Antihelminthic 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 infestation with intestinal parasites (Iranshahy and Iranshahi, 2011; Gundamaraju, 2013). According to the Chinese, European, Iranian and Indian traditional medicines, oleo gum resin of *Ferula 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; Golmohammadi, 2017).

3. Results

Ferula assa-foetida grows up to 2 meters high, with a circular mass of 30–40cm leaves. Stem leaves have wide sheathing petioles. Flowering stems are 2.5–3 meters high and 10cm thick and hollow, with a number of schizogenesis 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 (Table 2).

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 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

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 *asa foetida* resin is difficult to grate and is traditionally crushed between stones or with a hammer. Today, the most commonly available form is compounded *asa foetida*, a fine powder containing 30% *asa foetida* resin, along with rice flour and gum Arabic. *Ferula assa-foetida* exudations are obtained by tapping the root stock of the plant. The root of plants has been used for their perceived anthelmintic, antimicrobial, antispasmodic, aromatic, laxative, antispasmodic, diuretic and antiseptic actions in folk medicine. *Ferula 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 catching *Ferula* gum are as following:

- A) Selecting shrubs of *Ferula assa-foetida* that are ready for catching its medicinal gum and marking on them by rural people in April and November (Please see figure 3);
- B) Fencing of stones around these selected shrubs (Please see figure 6);



Figure 6. Fencing of stones around these selected shrubs.

C) Harvesting its gum - the final stage for producing dried gum for supplying to the market- in June, July and August. In this stage in each 4-5 days of these months, native medicinal plant collectors with their traditional tools create a thin cutting on the stem and after this time period, gathering resin-like gum that oozes from the stem, and then again replicating this process in 12-16 rounds each 4-5 days on the stems of *Ferula* in these months. 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-foetida* (Keshteh - in endemic Persian language) for supplying to the market and processing by foreign medicinal factories (Figure 4 and Table 3);

Each skillful native medicinal plant collector can in one day cut stems of 1000 *Ferula* shrubs and gather 4-10 grams of resin-like gum from each cutting stem from 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.

- D) Producing seeds from shrubs of *Ferula assa-foetida* that are ready for this by the end of summer;
- E) Sowing seeds of *Ferula assa-foetida* by rural people in winter and beginning a new germinating shrub of plant by the end of winter and beginning of spring (Figure 7

and Table 3; Information and Statistical Department, 2016).

Table 3. 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 grams
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 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 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 assa Foetida</i> can produce seeds in his life period	One time **



Figure 7. Gathering seeds of *Ferula assa-foetida*.

4. 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 of Iran due to prevalence of unfavorable hydro meteorological condition (Golmohammadi, 2012; Golmohammadi, 2017).

We are living in a knowledge driven world where knowledge is the ultimate power (Kumari, 2014). In this regard indigenous, traditional and local knowledge about 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 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 physic chemical characteristics are determinant factors in secondary metabolites composition especially for quality of volatiles (Moghaddam and Farhadi, 2015; Golmohammadi, 2017).

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. 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 known (Moghadam et al., 2014; Golmohammadi, 2012; Golmohammadi, 2017).

Ferula 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 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 economic efficiency from this plant.

Also *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).

Most production of this valuable plant, produce in South-Khorasan province in extent of 100000 ha, that produce 60 tons (in rainy years) and 15-20 tons (in dried years) annually and almost all of this production export to abroad because of lack of processing industries in this province. This plant generates incomes for many rural and nomadic households, which in the conditions of their subsistence agriculture, have high dependence to this production.

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

- 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, 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. Reducing numbers 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. In addition, prevention 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 of strategic planning for appropriate future exploitation - utilization of Ferula and other medicinal plants.
- Controlling exploitation stages and monitoring the quantity and quality of Ferula products.
- Conserving and restoring to life of germinating locals and pastures of Ferula.
- Absorbing participation of local people on implementing Ferula plans and projects of Natural Resources and Watershed Organization by strengthening their local organizations of medicinal plant collectors.
- Establishing factories in the field of medicinal plants especially for Ferula in the South Khorasan province. This can create jobs for unemployed local youth, 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.

Conflict of interest

The author declare that there is no conflict of interest.

References

- Golmohammadi F. 2017. Medical plants in rural regions of Iran. LAP Lambert Academic Publishing, Germany. Number of pages: 180. ISBN-13: 978-3330324428, ISBN-10: 3330324422.
- Golmohammadi F. 2012. Sustainable agriculture and rural development in Iran, Some modern issues in sustainable agriculture and rural development in Iran: Germany, LAP LAMBERT Academic Publishing GmbH & Co. KG.
- Golmohammadi F. 2013. Medical plant of Ferula assa-foetida and its cultivating, main characteristics and economical importance in South khorasan province - east of Iran. Tech J Engin Applied Sci, 3(18): 2334-2346.
- Golmohammadi F. 2016. Certification for scientific collaboration and scientific field participation in Medical plant of Ferula assa Foetida- with research team from: General Director, Mangyshlak Experimental, Botanical Garden, Candidate of Biology Science, Akzhunis Imanbayeva, Aktau, Kazakhstan. Belonged to Ministries of Education and science of the Republic of Kazakhstan.
- Gundamaraju R. 2013. Evaluation of anti-helmintic activity of Ferula foetida "Hing- A natural Indian spice" aqueous extract. Asian Pac J Trop Dis, 3(3): 189-191.
- Information and Statistical Department. 2016. Annually reports of natural resources and watershed organization of South Khorasan province, Iran.
- Iranshahy M, Iranshahi M. 2011. Traditional uses, phytochemistry and pharmacology of asafoetida (Ferula assa-foetida oleo-gum-resin) - A review. J Ethnopharmacol, 134: 1-10.
- Kavoosi G, Rowshan V. 2013. Chemical composition, antioxidant and antimicrobial activities of essential oil obtained from Ferula assa-foetida oleo-gum-resin: Effect of collection time. Food Chem, 138: 2180-2187.
- Kumari NC, Jha SBSK, Singh SRK. 2014. Radio: An educational media to transfer agricultural information among farmers. Indian Res J Ext Edu, 14(2): 130-132.
- Moghadam FH, Dehghan M, Zarepur E, Dehlavi R, Ghasemini F, Ehsani S, Barzegar K. 2014. Oleo gumresinof Ferula assa-foetida L. amelioratesperipheral neuropathyinmice. J Ethnopharmacol, 154: 183-189.
- Moghaddam M, Farhadi N. 2015. Influence of environmental and genetic factors on resin yield, essential oil content and chemical composition of Ferula assa-foetida L. populations. J Applied Res Med Aromatic Plants, 2: 69-76.