Indigenous knowledge in agriculture with particular reference to medicinal crop production in Khorasan, Iran

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Abstract

Khorasan province in Iran with a diverse climatic conditions has accommodated a wide range of plant communities particularly herbs, spices and medicinal plants. Among these saffron (*Crocus sativus L.*), cumin (*Cuminum cyminum*) and barberry (*Berberis vulgaris*) have been the most cultivated plants for thousands of years. These crops deliver unique interests and applications, which among them, the novel use of saffron in recent years in cancer cure have been promenaded and stimulated more investigation on this crop. Almost 89% of the total world's saffron production (270 t) and 92% of the total Iran's saffron production (240 t) originates from Khorasan province. Almost all the barberry production in the world (8540 t), and 52% of the total world's cumin production (29,000 t) and 88% of the total Iran's cumin production (15,410 t) are produced in this area too. Water scarcity mostly associated with low rain and hot summer, along with low soil fertility are the most limiting factors of crop production in this region. These crops are not only the most important source of income for farmers but also historically strong socio-cultural activities have been formed within the local community. To understanding scientific bases of indigenous knowledge of spice producing communities, the Centre of Excellence for Special Crops was established in 2001 in the Faculty of Agriculture, Ferdowsi University of Mashhad. Although indigenous knowledge has developed quite independently from science, these two should be considered as two sources of knowledge that can supplement, rather than compete, with each other. This paper highlights results of various ongoing researches at Khorasan area with intention of exploring possible opportunities for developing international collaboration.

1 Introduction

Indigenous knowledge can be defined as accumulated knowledge, skill and technology of local people derived from their direct and indirect interaction with the environment and nature (Altieri, 1990). Information transferred through generations is improved into systems of understanding of natural resources, farming systems and relevant ecological processes (Pawluk et al., 1992). Farming has a long history in Iran and dates back to 10,000 years. This country is one of the centres of biodiversity of plants and has a history of domestication of various current commercial crops and animals (Koocheki, 2004). Farmers who are dependent on locally available resources have developed indigenous technologies to provide water, maintain soil fertility and protect their crops.

The common principles and processes of farming practices in this area (Koocheki, 2004) are:

1 holistic view on utilisation of natural resources
2 optimal use of local resources with low external inputs
3 genetic and physical diversity
4 soil protection and conservation
5 participatory, cooperation and collaboration.

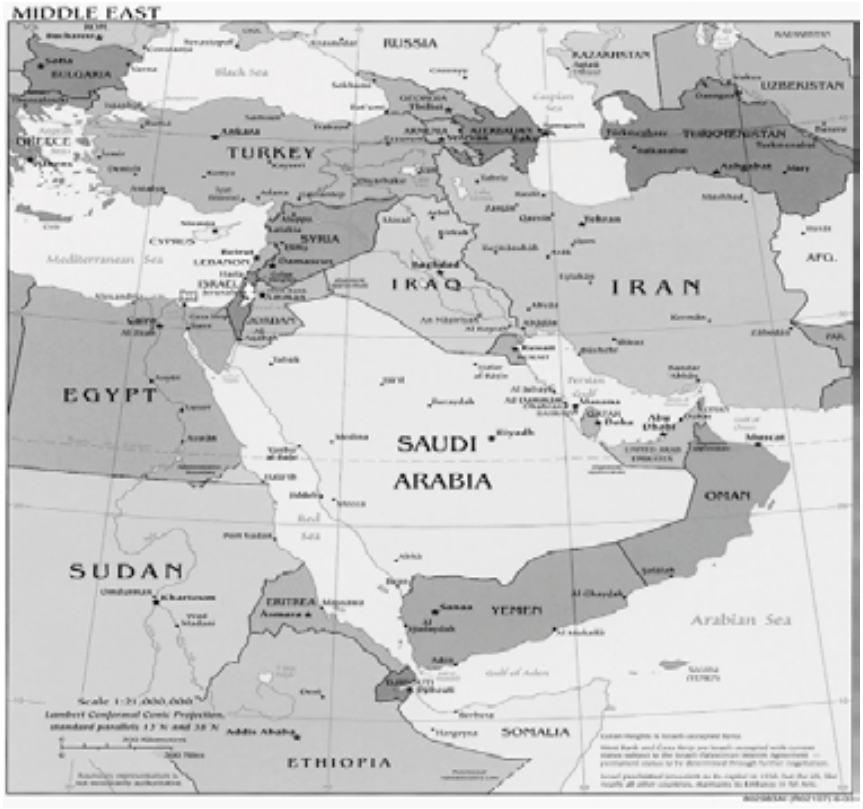
Khorasan province under the impact of a diverse climatic conditions, hosting a large number of valuable medicinal plants, which some of them are cultivating (such as saffron, cumin and barberry) by farmers and some of them (*Astragalus gummiferu, Pistacia trebenthns, Ferula gumosa*, *Dorema ammoniacum* and *Ferula assa-foetide*) growing naturally, mainly in fragile ecosystems that are predominantly inhabited by rural and indigenous communities. Saffron, cumin and barberry are unique for the area where water scarcity is the most limiting factor in crop productions for the farmer. All these plants are almost cultivated and harvested and also to some extent processed by family workers and community cooperation bases. Cultivation area and its surrounding environment conditions and production volume of herbs, mostly saffron, has made Khorasan province a unique location in the world for such crops.

The sustainable management of these traditionally cultivated and used plants not only helps to conserve nationally and globally important biodiversity but also provides critical resources to sustain livelihoods.

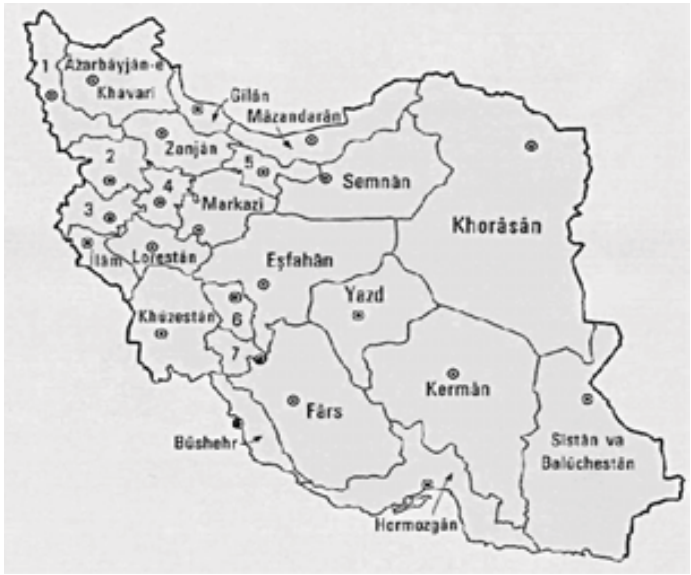
2 Area of study

Khorasan province in the North East of Iran is the largest province which occupies one-fifth of land surface (>300,000 km^2) of the whole country (Figure 1). This province has a large border with two main deserts of the country, Kavir Loot and Kavir Namak. The altitude, the location of plateaus and the deep valleys are some of the most important causes of its diverse climatic conditions. Khorasan has four main climatic zones of steppes, substeppe, subdeserted and mountainous. Annual mean of precipitation of this province is less than 220 mm. Due to saline ground water, presence of a salt layer in the soil, intensive irrigation, high evaporation and low precipitation, there is a large saline area in this part of the country (Abbaspour and Sabetraftar, 2005; Moghaddam and Koocheki, 2003).

Figure 1 Location of the study area. Map (a) shows the location of Iran in Middle East and map (b) shows the location of the Khorasan province in Iran



(a)



(b)

2.1 Saffron production

Saffron (*Crocus sativus L.*), a monocotyledon, perennial and triploid species belongs to the Iridaceae family (Figure 2). This crop has been historically evolved based on earlier mentioned farming principles as a 'system of production' according to local technical, social and cultural criteria (Koocheki, 2004). This crop has a role in the history of Iranian farming systems and food habits. It is believed (Koocheki, 2004) that saffron was first cultivated by Iranian farmers and then spread to other parts of the world. Diversity of wild species (13 species) could also support this claim (Koocheki, 2004). Citation of this crop in historical books and at least records of 2500 years intensive application of saffron by Iranian monarchies is further supporting evidence for such a claim.

Figure 2 Plant of saffron with flowers and leaves

Saffron is the world's most expensive spice and 89% of the production is coming from Iran (Kafi et al., 2006b). It has been used as food additive, culinary purposes, medicinal and colouring agents. The novel use of saffron in recent years has been associated in cancer cure (Abdullaev, 2002; Abdullaev and Espinosa-Aguirre, 2004; Escribano et al., 1996).

The stigma of saffron is used in Chinese, Iranian and Indian traditional medicine for anodyne, antidepressant, a respiratory decongestant, antispasmodic, aphrodisiac, diaphoretic, emmenagogue, expectorant and sedative, and its crude extract and purified chemicals have been demonstrated to prevent tumours formation, atherosclerosis or hepatic damage (Ma et al., 1998; Zargari, 1990). It has been used against scarlet fever, smallpox, colds, asthma, eye and heart diseases. Saffron can also be used to help to clear up conquer sores and to reduce the discomfort of teething infants (Zargari, 1990).

Saffron blooms only once a year (October–November) and would be harvested by hand. The flowers should be harvested before sunrise, otherwise the quality of the saffron in terms of colour and aroma will decline. After manual harvesting of petals, the stigmas are separated by hand from petals and then are dried. While the amount of individual stigmas collected from each flower would highly determine the final yield, their size would define the quality of saffron. Generally, each kg of fresh saffron flower

consists of 2173 flower, 47.93 g fresh stigma and 9.48 dry stigmas (Kafi et al., 2006b). At present, its production is 240 t in Iran and is cultivated in an area of 57,694 ha (Table 1). About 92% of production and 98% of cultivation area is located in Khorasan, of which, 40 t would be for domestic consumption and the rest are exported. Between 70,000 and 200,000 flowers are needed to produce 1 kg of dried saffron, which is equivalent to around 370–470 hr of work. Consequently, the cultivation of this crop for its flowers and specifically its stigmas is very labour-intensive and demand for which results in its high costs (Kafi et al., 2006b). Almost 85,000 families are depending mainly on saffron for their livelihood and they are farmers grown up and live in a hostile environment.

Table 1 Cultivated area, production and yield of saffron, cumin and barberry in, Iran

	Cultivated area (ha)	*Annual production (t)*	*Yield (kg/ha)*	
			Rainfed	*Irrigated*
Saffron	57,694	240	4.16	–
Cumin	32,364	15,140	190	588
Barberry	8082	8540	1178	1301

Source: Anonymous (2005).

The stigmas of the saffron flower contain many chemical substances. Carbohydrates, minerals, mucilage, vitamins (especially riboflavin and thiamine) and pigments, amino acids, proteins, starch, gums and other chemical compounds have also been described in saffron. The value of saffron (dried stigmas) is determined by the existence of three main secondary metabolites: crocein and its derivatives which are responsible for bright yellow colour; picrocrocein, responsible for bitter taste and saffronal responsible for spicy aroma (Escribano et al., 1996; Tarantilis, 1995). The amount of these compounds in dried stigma tissues is the most important indicator of quality of this spice.

Saffron production technologies have not changed for a long time and all that has been practiced is based almost completely on indigenous knowledge. There are no registered varieties of saffron and the present seed stock is the work of continuous selection over time by farmers, so the intellectual property right of saffron belongs to the local communities.

2.2 Cumin production

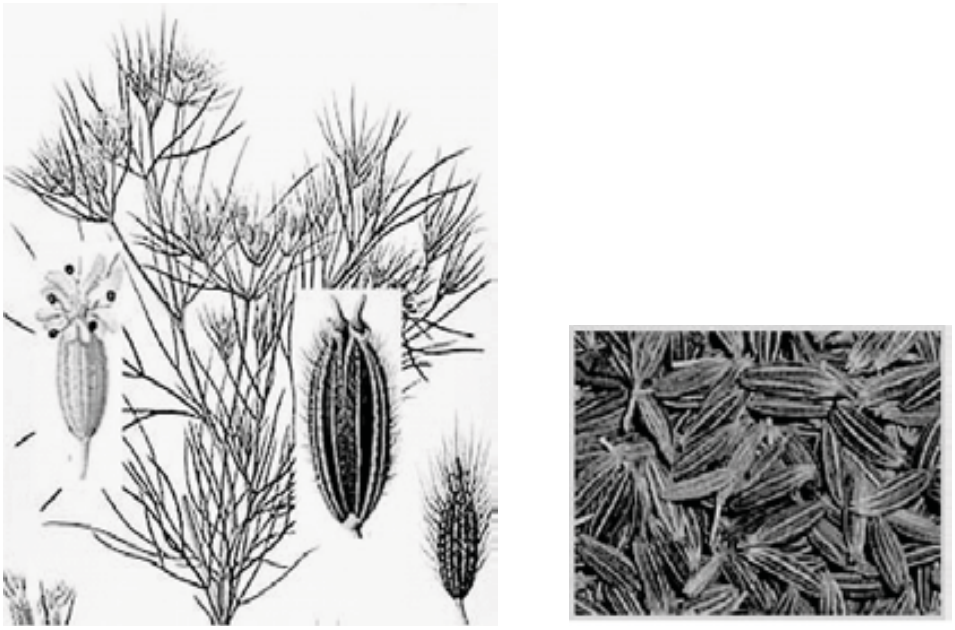
Cumin (*Cuminum cyminum*) is an annual, dicotyledon, aromatic and herbaceous species belonging to the Apiaceae family (Figure 3). This species has a wide range of applications such as medicinal, spice, cosmetic and food industry. Iran has the most contribution in the world cumin production and usually between 52% of the world cumin exportation comes from Iran (Kafi et al., 2006a). In 1994 total cumin seeds were exported with a value of $30 million (Anonymous, 1997; Riazi, 1997). The cumin acreage and seed production has been increased during recent years. Cumin cultivation area in Iran in year 2004 was 32,364 ha and the seed production was 15,140 t (Table 1) (Anonymous, 2005). About 88% of the total Iran's cumin production originates from Khorasan province (Anonymous, 2005; Fazel, 1995; Riazi, 1997).

Cumin is an important crop that due to its special environmental growing requirements, is planted in limited parts of the world. Iran, India, Indonesia and Lebanon

are the main exporters of cumin, but to a lesser degree, countries such as Turkey, Egypt, Syria, China, Cyprus, Argentina and Mexico also export cumin. The number of people who benefit from cumin varies annually at local and national levels. It was estimated that around 10,000–80,000 people would be involved in cumin growing during drought or rainy years, respectively (Kafi et al., 2006a).

Fruit of cumin is the main economical part with high usage value. Fruits contain oil (7%), resin (13%), essential oil (2.5–4%) and aleuron. Essential oil obtained by distillation of smashed fruit, has a very strong odour with mass volume of 0.91–0.93 (g/cm^3) (Zargari, 1990). The essential oils are composed of cuminiqué aldehyde or cuminol ($CH_{10}H_{12}O$). The special odour of essential oil and fruit is due to cuminol. In cumin essential oil, other chemicals such as cymene phllandrene, carvone, cuminiqué alcohol are present in low amount (Judd et al., 1999).

Figure 3 Plant of cumin and seeds



2.3 Barberry production

Barberry (*Berberis vulgaris*) is a dicotyledon and perennial species belonging to the Berberidaceae family (Figure 4). Barberry is a well-known medicinal plant in Iran and has also been used as a food product. Seedless barberry (*Berberis vulgaris* var. asperma) is cultivated as a domestic plant for many years in southern parts of Khorasan province. There is evidence that the barberry was domesticated about 200 years ago in this region (Kafi and Balandari, 2004). Higher price in the internal markets encouraged growers to establish new orchards of this crop. Cultivation area increased from 704 ha in 1981 to 8082 ha in 2005 and barberry production increased from 941 t to more than 8540 t in recent years (Table 1). The province of Khorasan with a production of more than 90% of the total production is the main region of barberry production in Iran (Kafi and Balandari, 2004).

Figure 4 Plant of barberry (A) before fruit maturity stage (B) fruit maturity stage

(a)

(b)

The climatic condition of this crop production area is mostly desert and semi-desert types with hot summer, cold winter, low relative humidity and high variable range of daily maximum and minimum temperatures (Table 2). Average precipitation in the region is 193 mm/year.

Table 2 Climate information of the southern part of the Khorasan province (Birjand)

Annual average relative humidity (%)	*Annual average evaporation–transpiration (mm/year)*	*Annual average maximum temperature (°C)*	*Annual average minimum temperature (°C)*	*Annual average precipitation (mm/year)*
35.9	1896.3	21.9	5.8	193.3

Source: Anonymous (2002).

Barberry is a deciduous shrub which grows up to 4 m high. The leaves are small, oval, 2–5 cm long and 1–2 cm wide, with a short petiole, presenting various gradations from leaves into spines. The flowers are small, pale yellow, arranged in pendulous racemes. The fruit is an oblong red berry 7–10 mm long and 3–5 mm wide, ripening in late summer or autumn. They are edible but very sour, and pleasantly acidulous. It is generally propagated by suckers and ripened cuttings (Tehranifar, 2003).

Due to spiny stems and special shape of shrubs the harvesting is one of the most difficult and laborious stages in barberry production (Tehranifar, 2003).

The barberry used to be cultivated for the fruit, which was picked and used for garnishing dishes and medicinal purpose. In south-western Asia, especially Iran and in Europe, the berries are used for cooking and for making jam.

Barberry is one of the best remedies for correcting liver function and promoting the flow of bile (Shamsa et al., 1999). It is indicated when there is an inflammation of the gall-bladder or in the presence of gallstones, as a bitter tonic with mild laxative effects, it is used with weak or debilitated people to strengthen and cleanse the system. An interesting action is its ability to reduce an enlarged spleen. It acts against malaria and is also effective in the treatment of protozoal infection due to *Leishmania spp*. The berries contain citric and malic acids, and possess astringent and antiscorbutic properties. They are useful in inflammatory fevers, especially typhus, also in bilious disorders and scurvy, and in the form of a jelly are very refreshing in irritable sore throat, for which also syrup of barberries made with water, proves an excellent astringent gargle. It is also used in all cases of jaundice, general debility and biliousness and for diarrhoea.

The stem- and root-bark are used as medicinal components too. The chief constituent of barberry bark is berberine, a yellow crystalline, bitter alkaloid, one of the few that occurs in plants belonging to several different natural orders (Zargari, 1990). Other constituents are oxyacanthine, berberine, other alkaloidal matter, a little tannin, also wax, resin, fat, albumin, gum and starch. It is used in the form of a liquid extract, given as decoction, infusion or tincture, but generally a salt of the alkaloid berberine is preferred. As a bitter stoma-chic tonic, it proves an excellent remedy for dyspepsia and functional derangement of the liver, regulating the digestive powers, and if given in larger doses, acting as a mild purgative and removing constipation (Zargari, 1990).

Since 200 years ago, barberry, where domesticated, there have been no changes in barberry production technologies. The same as saffron, which all that has been practiced is based almost completely on indigenous knowledge. There is no registered cultivar in barberry.

2.4 Exudates production

Khorasan province is one of the main producers of gum Tragacanth (*Astragalus gummiferus*) within Iran (Iqbal, 1995). Small quantities are also produced in Afghanistan, but about 70% of export supply originates from Iran. According to agricultural products statistics, total annual average production has been estimated around 1400 t (Iqbal, 1995; Nadjafi and Koocheki, 2002). Gums of other plants such as, *Pistacia terebinthus*, *Ferula gumosa*, *Dorema ammoniacum* and *Ferula assa-foetide* which grow naturally in Khorsan province are also exported in large quantities to other countries, especially Germany and France (Table 3). The quantities and values of these gums which are exported are 4255 t with a value of US$201.5 million (Table 4).

Table 3 Iran's export in tonnes of tragacanth during 1987–1990

Year	*1987*	*1988*	*1989*	*1990*
Export quantity	91	142	176	257

Source: Iqbal (1995).

Table 4 Exudates production in Iran during 1990–1994

Plant (gums)	*Production quantity (t)*	*Total value 1000 IRR*	*Total value (US$ '000)*[a]
Astragalus gummiferum	1459.273	8,025,996	8549.96
Pistacia terebinthus	1566.469	4,699,488	3916.24
Ferula gumosa	200.065	2,400,780	2000.65
Ferula assa-foetide	650.865	4,554,795	3795.66
Dorema ammoniacum	377.963	2,267,778	1889.81
Others	8450.519	631,920	27,765.67
Total	12705	32,686,883.5	47,917.99

[a]Based on each US$ = 1200 IRR in 1993.

Source: Nadjafi and Koocheki (2002).

Due to over utilisation of these plants in natural environments, collection from these habitats is no longer sustainable. Therefore proper plans for bringing these plants and cultivating them are required.

3 Scientific support

There is a potential to increase current benefits of different medicinal plants to producers and collectors. It requires a linkage between scientific research and traditional knowledge. For supporting the spice producing communities and also producing the linkage between science and traditional knowledge, Centre of Excellence on special crops was founded in 2001 based on its mandate to conduct research on special local crops such as saffron, cumin, barberry and other medicinal plants on the basis of low input sustainable practices and organic production technologies. Halophyte cash cropping and underutilised crops such as sesame, caster bean, etc. are also parts of activities of the centre. There have been different activities related to the medicinal and underutilised crops at this centre. More than 16 research projects were in progress at the Centre of Excellence on special crops. Studies of the agronomical, ecological, physiological and economical aspects of saffron and cumin are the main research projects in progress. Based on the goal of the centre, more than 15 postgraduate dissertations have been conducted on medicinal plants. Growth evaluation of cumin under climatic conditions of Mashhad, ecological zoning of saffron in Khorasan, physiological and ecological aspects of different medicinal plants with special references to second metabolic components are examples of ongoing researches. For building capacity and transfer of knowledge, several workshops were conducted at the Centre of Excellence on special crops including the Second International Symposium on Saffron in 2006 (http://saffron-ir.um.ac.ir/).

4 Conclusion

The importance of herbs, spice and medicinal plants has been increasing continuously for the past 100 years. Although, for thousands of years, these plants have contributed to the quality of human life, further utilisation of these plants for various human requirements requires more exploration on the techniques and methods for more efficient production together with high quality plant materials in sufficient quantities.

There is a huge increasing demand on a worldwide scale for utilisation of herbs, spice and medicinal plants, therefore, new biological, agronomical and economical development, and cooperative programmes on technological and medicinal studies are urgently required, which would result in not only higher financial income for stakeholders but more sustainable farming systems.

To meet these requirements, however, the production systems (such as harvesting and post-harvesting methods with special references to saffron) are needed to modernise current practices. Supplementing indigenous knowledge with new scientific researches findings, would benefit both the farmers and the environment. In addition, new methods of domestication and protection are required for natural products such as gum plants. There is also a requirement for improving the technology related to post-harvest processing, quality control and product development of all such crops considering the historically available indigenous knowledge.

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