A contribution to ethnobotany and review of phytochemistry and biological activities of the Iranian local endemic species *Sclerorhachis leptoclada* Rech.f.

Toktam Mohammadi, Atefeh Pirani, Jamil Vaezi and Hamid Moazzeni

Reviews

Abstract

Background: *Sclerorhachis leptoclada* Rech.f. is endemic to the South Khorassan province in east of Iran. Although *S. leptoclada* has been widely used as medicinal and edible plant by indigenous people, its ethnobotanical uses have not been well documented yet. This study presents the results of an ethnobotanical survey and reviews phytochemistry and biological activities of *S. leptoclada*.

Methods: The ethnobotanical study was conducted in Birjand and adjacent areas between March 2018 and December 2019. During this survey, 58 local people were interviewed using a semi-structured questionnaire. The ethnobotanical data were analyzed by using indices Fidelity Level (FL) and Relative Frequency of Citation (RFC). In addition, the available scientific literatures were reviewed to avail the information on phytochemistry and biological activities of *Sclerorhachis leptoclada.*

Results: The present study revealed the folklore uses of *Sclerorhachis leptoclada* for different purposes such as increasing lactation, blood purification, treating digestive disorders, headache, body pains, herpes, and cold. The literature review showed that a total of 57 compounds have been isolated from *S. leptoclada*.

Conclusions: Variety of ethnomedicinal uses of *Sclerorhachis leptoclada* highlights its notable pharmacological potential. However, further tests on its bioactivity, active phytochemicals, and their mechanisms of action are needed to ensure a safe use. The limited distribution of the plant and excessive harvesting of the aerial plant parts necessitate educating local people to conserve populations of this local endemic species.

Keywords: Asteraceae, ethnobotany, Iran, medicinal plants, *Sclerorhachis*

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Background

As a result of its unique climatic and geographical conditions, Iran enjoys a rich flora of ca. 8000 plant species, including a considerable number of medicinal plants (Ghahremaninejad & Nejad-Falatoury 2016, Mohammadhosseini *et al.* 2017). The family Asteraceae includes a high number of popular medicinal genera (e.g., *Achillea* L., *Artemisia* L., *Calendula* L., and *Tanacetum* L.). Nonetheless, some of the medicinally important genera of the family are not well-known, most probably due to their limited geographical distribution. As one of the small and less-known genera of this family, *Sclerorhachis* (Rech.f.) Rech.f. (called "Minaei" in Persian) distributes mainly in dry highlands of Iran, Afghanistan, and Turkmenistan (Hassanpour *et al.* 2018, Kadereit & Jeffrey 2007, Mozaffarian 2008, Rechinger 1986, Sales & Hedge 2013).

Sclerorhachis comprises perennial herbs with deeply dissected leaves and a lax corymb inflorescence of discoid capitula (Oberprieler *et al.* 2007). It includes six species namely: *S. binaludensis* Sonboli, *S. leptoclada* Rech.f. and *S. platyrachis* (Boiss.) Podl. that are endemic to northeast and east of Iran (Hassanpour *et al.* 2018, Mozaffarian 2008, Rechinger 1986); *Sclerorhachis polysphaera* (Aitch. & Hemsl.) Rech. f. which is endemic to Afghanistan (Sales & Hedge 2013); *Sclerorhachis caulescens* (Aitch. & Hemsl.) Rech. f. occurring in Iran and Afghanistan (Sales & Hedge 2013); and *Sclerorhachis kjurendaghi* (Kurbanov) Kovalevsk. that inhabits Iran and Turkmenistan (Sales & Hedge 2013).

Sclerorhachis leptoclada, locally known as "Mastar" (mæstɑːr), is widely used by local people and traditional healers as a medicinal and edible plant in Birjand and its adjacent areas (South Khorassan province). It is sold freshly as an ordinary vegetable in the local markets of the study area during the growing season (Fig.1).

Figure 1. *Sclerorhachis leptoclada* A-B. Habitat, C. Basal leaves, D. Aerial parts of *S. leptoclada* sold in a local market in Birjand (Photos by MA. Khaledi & T. Mohammadi)

Botany, ecology and geography

Sclerorhachis leptoclada is a perennial herb reaching the height of 15-30 cm, covered with rough hairs, almost leafless in the upper half. Leaves are bipinnately dissected, shortly petiolated, and the inflorescence is a semi-spherical corymb. Flowers are tubular and fruit is an achene in brown (Kadereit & Jeffrey 2007, Rechinger 1981, Rechinger 1986;

Fig.1 A-C). The flowering period is from April to May. From the ecological point of view, it prefers open sunny areas, especially on top of rocky mountains. The distribution map and *S. leptoclada* is presented in Fig. 2B.

Study area description

Birjand is the capital city of South Khorassan province situated (59° 13′N and 32° 53′E) in the east of Iran (Fig. 2A). Having an average annual rainfall of ca. 160 mm, the climate of Birjand is classified as warm and dry (Ahmadian 1995, Behnia 2002, Vafaie-Fard 2005). The predominant vegetation elements of the area are Xerophytes e.g., *Artemisia* spp., *Astragalus* spp, *Haloxylon* spp. and *Tamarix* spp.). Barberry and saffron are the main agricultural products of this region (Ahmadian 1995, Behnia 2002, Vafaie-Fard 2005)..

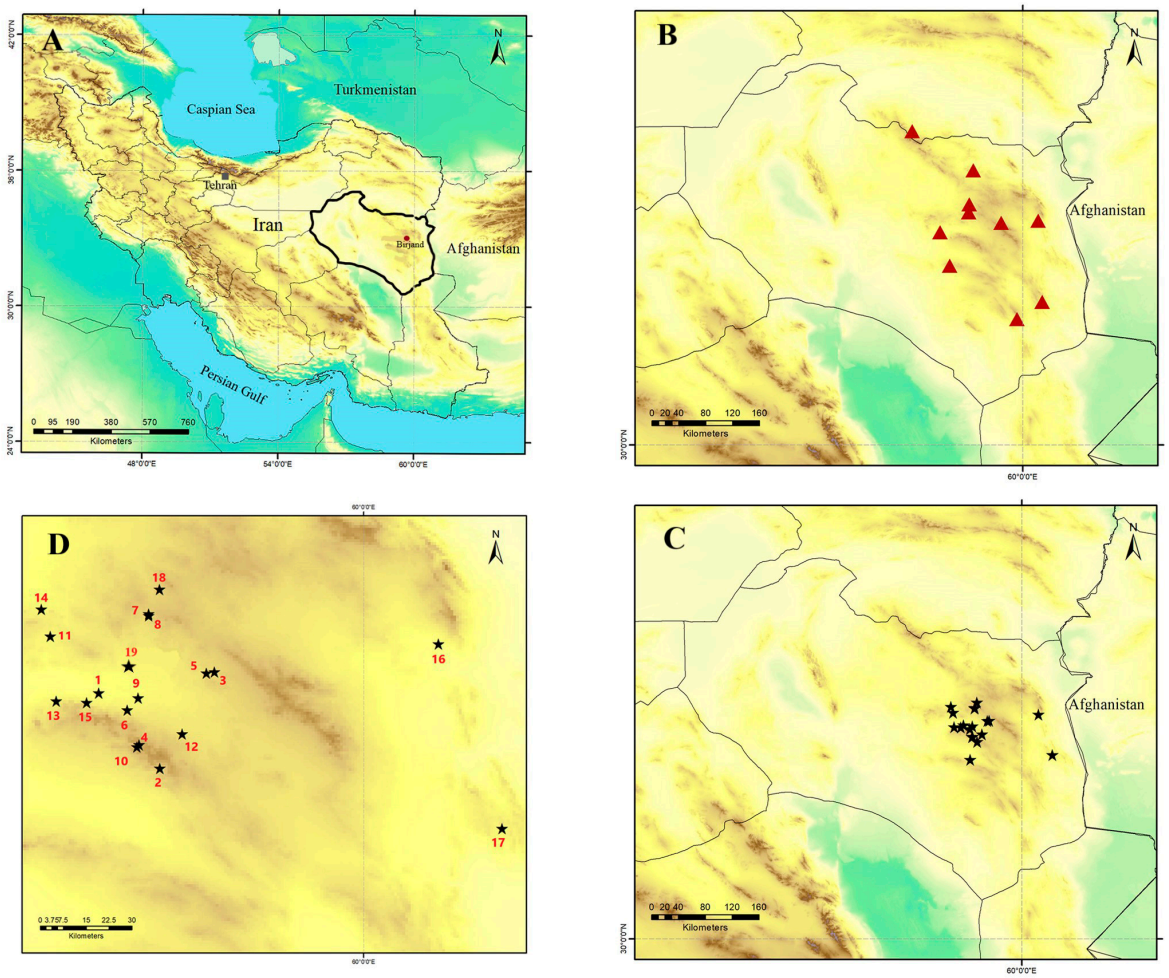

Figure 2. A: Map of Iran showing position of South Khorassan provinceB. Distribution map of *S. leptoclada*; C. Geographical position of the visited sites; D. Details of the visited locations: 1.Esfahroud, 2.Islam-abad e Shokri, 3.Eshtakhan, 4.Akbar-abad, 5.Elghar, 6.Bojd, 7.Borj-e Ziad, 8.Bozghonj, 9.Bijar, 10.Hasan-abad, 11.Chahowz, 12.Chenesht, 13.Rokat, 14.Shoushoud, 15.Kase sang, 16. Gazik, 17.Makhounik, 18.Mahouk, 19. Birjand.

Historically, Birjand and its adjacent areas have been part of a region called "Qohestan" or “Kohistan” (which means mountains). The topological structure of this area is composed of mountains and plains whose origin dates back to the first to the third geological era (Behnia 2002, Nakhaee-Nezhadfard *et al.* 2013). This area is bordered from central Iran by Siah-Kuh mountain range. This mountainous barrier along with the warm and dry climate have played an important role in protecting "Qohestan" from attacks by outlanders. Therefore, the traditions and language of its inhabitants have been less affected by non-local people (Ahmadian 1995, Behnia 2002, Vafaie-Fard 2005). This implies the importance of conducting ethnobotanical studies in Birjand and the neighboring areas.

Although *Sclerorhachis leptoclada* has been widely used by indigenous people in the south of Khorassan, little is known about its ethnobotany and pharmacological properties. Only a few studies have partially investigated phytochemistry and biological activities of *S. leptoclada*, while its ethnobotanical data has not been documented yet. The aims of the

present study are to 1) document traditional uses of *S. leptoclada* 2) review phytochemical properties and biological activities of *S. leptoclada*.

Materials and Methods

Data collection

To document local knowledge and different uses of *Sclerorhachis leptoclada*, several field trips were conducted during March and April in 2018 and 2019. Birjand and 18 different neighboring villages were visited (Figure 2C-D). Medicinal plant vendors and 15 local markets offering edible and medicinal plants were also visited. We interviewed 58 traditional healers and elderly knowledgeable people using semi-structured questionnaires, oral, and personal observations. We used open-ended type of questions as shown in Table 1.

Table 1. Structure of the questionnaire used to interview with the informants.

Questionnaire sections	Details
Demographic information	Name, gender, age, ethnic group and address of informant, how to get information about the plant
Uses of plant	Category of uses (medicinal, industrial, food and religious), plant part uses, modes of preparation, and routes of administration
Botanical information	The scientific name, local name, locality of collection, type of habitat

The informants were asked to either identify the plant in the field or confirm the fresh samples we collected as "Mastar". We used Flora Iranica (Rechinger 1986) and Flora of Iran (Mozaffarian 2008) to determine the scientific name of the collected specimens. The voucher specimens are deposited at FUMH.

The disorders treated by *S. leptoclada* were classified according to the categories suggested by the International Classification of Primary Care (ICPC3; https://icpc3.icpc-3.info/).

To overview phytochemistry and biological activities of *Sclerorhachis leptoclada,* we reviewed online and grey literature, including journals and books published in English and Persian languages until August 2019. The information was collected from medicinal plants textbooks, ethnobotanical, pharmacological, and phytochemical studies, and scientific databases. The scientific and author names of the plant species were checked for the latest changes according to "IPNI" (https://www.ipni.org) and "plants of the world online" (http://www.powo.science.kew.org). The distribution maps were prepared using the species incidence data in ArcMap 10.3 (Esri 2011).

Data analyses

The collected ethnobotanical data were analyzed using Fidelity Level (FL) and Relative Frequency of Citation (RFC) indices. The statistical analyses were performed using Microsoft Excel 2016 and "ethnobotanyR" package in R version 4.0.2 (Oksanen *et al.* 2017). Fidelity level (FL) is obtained by dividing the number of informants mentioning a specific use for certain plant species (I_p) by the total number of informants participating in the study (I_u) multiplied by 100 which is calculated by following formula (Hoffman & Gallaher 2007):

$$FL(\%)=\frac{I_p}{I_u}\times 100$$

Relative Frequency of Citation (RFC) is obtained by dividing frequency of citation (FC) (the number of informants mentioning the use of the species) by total number of informants participating in the survey (N). RFC varies from 0 (if nobody refers to the plants as useful) to 1 (if every informant would mention it as useful) and is calculated by the following formula (Tardio & Pardo-de Santayana 2008):

$$RFC=\frac{FC}{N}$$

Results and Discussion

Informant data

A total of 58 local informants including 31 women (53.45%) and 27 men (46.55%) aged from 20 to 90 years old were interviewed (Table 2). However, the majority of the interviewees were over 60 years old. The participants were mainly medicinal plant vendors (33.9%) and housewives (32.30%). The local people describe and identify "Mastar" as a plant that has shrubby lifeform, relatively short green leaves with a bitter taste as well as its button-like flowers.

Plant part used

Aerial parts (74.28%) and young fresh leaves of *Sclerorhachis leptoclada* (25.72%) are consumed. The priority of leaves might be due to their availability and easy cutting. This is in accordance with Kunwar *et al*. (2020) that hypothesized people frequently forage the most visible and accessible plants.

Table 2. Number and gender of informants interviewed in this study.

Locations 1 to 19 represent visited sites (1. Akbar-abad, 2. Bijar, 3. Bojd, 4. Borj-ziad, 5. Bozghoj, 6. Chahowz, 7. Chenesht, 8. Esfahroud, 9. Eshtakhan, 10. Elghar, 11. Ggazik, 12. Hasan-abad, 13. Islam-abad Shokri, 14. Kase-sang, 15. Mahouk, 16. Makhounik, 17. Rokat,18. Shoushoud, 19. Birjand).
F: Female; M: Male.

Age	Location																																	
	1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17		18		19	
	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
20-30																			2	0											0	1					0	4
30-40																															0	1					1	3
40-50					1	0					1	0			1	0																			0	4
50-60											1	0									0	1	1	0									1	0			2	3
60-70			2	0	1	0	0	1	0	1			2	1			1	0	1	0			1	0			1	0					1	0			1	0
70-80	1	1	1	0			1	0			1	1			2	0									1	1			1	0					1	1	0	1
80-90																							0	1					2	0								

Modes of preparations

Table 3 lists the preparation modes of *Sclerorhachis leptoclada*. The most common preparation modes are decoction (74.28%), followed by raw (11.42%), and infusion (8.57%). In 77.14% of the reports, it is used as pure, while in 22.86% of the cases used as mixed. It is mixed with tea, pottage, yogurt, or other medicinal plants such as *Fumaria asepala* Boiss. (Fumariaceae), and *Tribulus terrestris* L. (Zygophyllaceae). The widespread use of decoction in the present study is comparable to several studies in Iran (e.g., Khajoei Nasab & Khosravi 2014, Maleki & Akhani 2018, Mosaddegh *et al.* 2012; Sadat-Hosseini *et al.* 2017) that reported decoction as the most commonly utilized method of preparation.

Routes of administration

Except for one case of topical administration (herpes), all of the documented administration modes of *Sclerorhachis leptoclada* are oral (Table 3). The predominance of oral administration could be due to the high incidence of internal disorders in the region (Mohammadi *et al.* in prep.). Besides, oral administration of medicinal plants is the most common mode of use reported by recent ethnobotanical studies in Iran (e.g., Khajoei Nasab & Khosravi 2014, Maleki & Akhani 2018, Mosaddegh *et al.* 2012; Sadat-Hosseini *et al.* 2017).

Ailments Treated

Sclerorhachis leptoclada is used by local people in various cases such as digestive problems, blood purification, treatment of body pains, lactation insufficiency, herpes, cold, sore throat, and headache (Table 3).

Different uses of *S. leptoclada* can be classified as below:

Table 3. Lists of uses, preparation modes, and part use of *Sclerorhachis leptoclada* reported in the present study.

Part used	Mode(s) of preparation	Mode of administration	Use(s)
Aerial parts	Decoction or infusion	Oral	Galactogogue,
			Heat exhaustion,
Leaves and flowers			Blood purifier
	Decoction or infusion (mixed with black tea)	Oral	Headache and body pain
Leaves and flowers	Liniment	Topical	Herpes symptoms
Leaves and flowers or the aerial parts	Decoction or powdered	Oral	Digestive disorders (including: antacid, stomachache, nausea, gastric ulcer, and intestinal problem)
Young leaves and flowers	Infusion	Oral	Food poisoning
Leaves	Raw or cooked Decoction or infusion	Oral	Vegetable Cold, cough, sore throat, and flu

The main application of *Sclerorhachis leptoclada* in the visited area is for lactation promotion in human. Decoction or infusion of the plant aerial parts is taken for mik augmentation. Our literature survey shows that majority of the plants prescribed as galactogogue by Iranian traditional medicine belong to the family Apiaceae with *Foeniculum vulgare* Mill. as the most cited species (Table 4). So far, only one species from the family Asteraceae (*Cnicus benedictus* L.) has been documented for lactation promotion (Khodayari *et al.* 2015, Table 4). Here, we report *S. leptoclada* as another species from this family with local usage as galactogogue. The milk augmentation effect of this plant might be attributed to its phenolic compounds (Kahkeshani *et al.* 2015, Mohanty *et al.* 2014).

Decoction or infusion of leaves and flowers are used for blood purification, to treat digestive problems (stomachache, high stomach acidity, nausea, gastric ulcer and intestinal problems), Infective disorders (cold, cough, sore throat and flu), dissipate and treat heat exhaustion, relieve body pain and headache, and food poisoning. Furthermore, powder of leaves and flowers are used as liniment against herpes. Local people also eat fresh leaves as raw or added to the potage.

Quantitative analysis

Fidelity level index (FL)

We considered fidelity level (FL) for each category-use of *Sclerorhachis leptoclada* (Table 5). FL value varied from 4.55% to 63.64%. The highest number of FL belongs to Digestive System category (63.64%),

followed by General and Unspecified (infection category) (31.82%), Pregnancy, Childbearing, Family Planning (18.18%), and the lowest number of FL belongs to Skin, Neurological, and Musculoskeletal categories (4.55%). These findings signify that digestive and infectious disorders are widespread in the study area. The prevalence of digestive problems has already been reported by ethnobotanical surveys in different parts of Iran (e.g., Ghorbani 2005, Khajoei-Nasab *et al*. 2014, Mosaddegh *et al*. 2012, Sadat-Hosseini *et al*. 2017).

Table 4. List of medicinal plants introduced as galactogogue by Iranian traditional medicine and ethnobotanical studies.

Scientific name	Common name (Arabic)	Vernacular name	Plant part(s) used	Province	Ref.
Apiaceae					
Anethum graveolens L.	Dill (Shebet)	Shevid	Seeds, leaves, fruit	Razavi Khorassan	Ahwazi 1877, Amiri & Joharchi 2013, Ibn-Sina 2015, Razi 1986
Bunium persicum (Boiss.) B.Fedtsch.	Black Cumin	Zireh Siah	Fruit	Razavi Khorassan	Amiri & Joharchi 2013
Coriandrum sativum L.	Coriander	Gardilou, gishniz	Seeds, leaves, stem	Khuzestan and Bushehr	Dolatkhahi & Nabipour 2014, Khodayari *et al.* 2015
Cuminum cyminum L.	Cumin	Zireh Sabz	Fruit	Razavi Khorassan	Amiri & Joharchi 2013
Foeniculum vulgare Mill.	Fennel (Razianaj)	Razouneh	Seeds, leaves, fruit, and root	Khuzestan, Bushehr and Razavi Khorassan	Ahwazi 1877, Amiri & Joharchi 2013, Heravi 1967, Ibn-Sina 2015, Jorjani 1976, Khodayari *et al.* 2015, Lavari *et al.* 2017, Razi 1986
Pimpinella anisum L.	Anise (Razianaj roomi, Badian)	-	Seeds	-	Aqili Khorasani 1992, Ibn-Sina 2015, Razi 1986
Trachyspermum ammi (L.) Sprague	Ajwain	Zenyan (Khordaneh)	Fruit	Razavi Khorassan	Amiri & Joharchi 2013
Trachyspermum copticum (L.) Link.	-	Zenian	Seeds	Bushehr	Dolatkhahi & Ghorbani 2013
Asteraceae					
Cnicus benedictus L.	Cnicus	Khar-e Moghaddas	Seeds, fruit	Khuzestan	Khodayari *et al.* 2015
Brassicaeeae					
Lepidium sativum L.	Garden cress	Teleh	Leaves	Khuzestan and Bushehr	Dolatkhahi & Nabipour 2014
Nasturtium officinale R.Br.	Watercress	Boulaq Outi	Flowering branch	East Azarbaijan	Khaleghi *et al.* 2016
Fabaceae					
Cicer arietinum L.	Chickpea (Hemmas)	-	Seeds	-	Heravi 1967, Jorjani 1976, Razi 1986

Medicago sativa L.	Alfalfa (Ratbeh)	-	Seeds	-	Aqili Khorasani 1992
Trigonella foenum-graecum L.	Fenugreek (Holbeh)	-	Seeds, leaves	-	Jorjani 1976, Razi 1986
Malvaceae					
Malva sylvestris L.	Marshmallow (Khobbazi)	-	Flowers, leaves	-	Ibn-Sina 2015, Jorjani 1976
Poaceae					
Hordeum vulgare L.	Barley (Shaeer)	-	Aqueous extract	-	Ibn-Sina 2015, Jorjani 1976, Razi 1986
Ranunculaceae					
Nigella sativa L.	Blackcumin (Shoniz)	Siah Daneh	Seeds	Razavi Khorassan	Amiri & Joharchi 2013, Aqili Khorasani 1992, Ibn-Sina 2015
Schisandraceae					
Illicium verum Hook.f	Star anise	Badian Khatai	Fruit	Razavi Khorassan	Amiri & Joharchi 2013
Verbenaceae					
Vitex agnus-castus L.	Chaste tree (Aslagh)	-	Fruit	-	Aqili Khorasani 1992, Ibn-Sina 2015, Razi 1986

Table 5. Percentage of FL (Fidelity Level) based on $\mathrm{ICPC}-3^{*}$ (International Classification of Primary Care) on *Sclerorhachis leptoclada*.

Categories of disease	**FL**
Digestive system	63.64
General and Unspecified	31.82
Pregnancy, Childbearing	18.18
Blood, Blood Forming Organs and Immune Mechanism	9.09
Respiratory system	9.09
Musculoskeletal system	4.55
Neurological system	4.55
Skin	4.55

* Retrieved from https://app.icpc-3.info/

Relative Frequency of Citation (RFC)

Sclerorhachis leptoclada acquired 0.4 for RFC index which indicates that it is one of the most popular medicinal plants agreed by the majority of the informants in the study area. This also implies that *S. leptoclada* has been neglected by previous contributions to the ethnobotany of Birjand (Ganjali & Khaksafidi 2016, Ghollassi-Mood 2008).

Phytochemistry

There are only a few investigations on chemical composition and phytochemistry of *Sclerorhachis leptoclada*. Isolation of essential oil from flowering parts of *S. leptoclada* by hydro-distillation method and analyzing its chemical composition by GC and GC-MS system (Akramian *et al.* 2008, Mohanty *et al.* 2014, Sonboli *et al.* 2014, Tahmasebi *et al.* 2012, Zamani 2013) has resulted in reporting 57 compounds (Appendix 1). Among the important compounds are α-pinene, δ- cadinene, p-cymene, 1,8-cineole, bornyl acetate, camphene, Germacrene D, phenols and thymol, of which bornyl acetate, camphor, and δ-cadinene are the most significant (Akramian *et al.* 2008, Mohanty *et al.* 2014, Sonboli *et al.* 2014, Tahmasebi *et al.* 2012).

Bornyl acetate

It is an acetate ester of borneol that is used as an aromatic agent and a food additive for flavoring. It also possesses medicinal properties, including analgesic, anti-inflammatory, sedative, and antitumor (Wu *et al.* 2005, Yang *et al.* 2014).

Camphor

It is an oxygenated monoterpene which has different uses in the perfume industry, traditional and modern medicine. Its general effects can be summarized as slowed breathing, reduced appetite, as well as

increased heart rate, perspiration, and urination (Cooper & Nicola 2015, Donkin 1999).

Cadinenes
Cadinenes are bicyclic sesquiterpenes which happen in essential oil-producing plants. For example, δ-cadinene is usually found in the family Asteraceae (Borg-Karlson *et al.* 1981, Nishamura *et al.* 1981). Cadinenes display antioxidant activities (Kundu *et al.* 2013).

Hydrodistilled essential oil of *Sclerorhachis leptoclada* contains 54 compounds including high amounts of oxygenated monoterpenes from which terpinen-4-ol, camphor, and 1,8-cineole constitute the main ingredients (Sonboli *et al.* 2014). Terpinen-4-ol is an isomer of terpineol and the primary antibacterial component of tea tree oil which its biological properties and potential for clinical uses have not been investigated yet (Dewick 2009). 1,8-cineole inhibits mitosis and reduces germination in plants (Yang *et al.* 2014).

Sonboli *et al.* (2014) showed that oxygenated sesquiterpenes constituted 26.8% of the total essential oil of *Sclerorhachis leptoclada*, and (E)-nerolidol was the principal component of this group of compounds. Nerolidol has a woody smell and is used as a flavoring agent, detergent, and cleanser in perfumery (Chan *et al.* 2016). It also shows antioxidant, antifungal, anticancer and antimicrobial properties (Chan *et al.* 2016, Osbourn & Lanzotti 2009).

Based on the results of Sonboli *et al.* (2014), 16.1% of the essential oil of *Sclerorhachis leptoclada* is composed of monoterpene hydrocarbons, among which p-cymene and γ-terpinene were the major ingredients. They also reported that sesquiterpene hydrocarbons represent 7.9% of the total oil (Sonboli *et al.* 2014). The p-cymene is an aromatic organic compound with antimicrobial properties (Dewick 2009, Marchese *et al.* 2017), while γ-terpinene is a colorless liquid with a turpentine-like smell and is used as a flavoring agent and carminative (Dewick 2009, Eggersdorfer 2012).
Some nutrient compounds, such as fibers, proteins and phenolic compounds have been reported to exist in *S. leptoclada* (Dourandishan *et al.* 2013). Phenolic compounds are used as flavoring agent and many of them have antimicrobial and antioxidant activity (Cooper & Nicola 2015).

Pharmacological uses
To date, very limited studies have been carried out to establish the pharmacological description of *Sclerorhachis leptoclada* (Sonboli *et al.* 2014, Tahmasebi *et al.* 2012, Zamani 2013). Pharmacological activities of this species are summarized as follows:

Antibacterial activity
The essential oil of *Sclerorhachis leptoclada* has inhibitory activity against eight bacteria including *Bacillus subtilis*, *Candida albicans*, *Enterococcus faecalis*, *Escherichia coli, Klebsiella pneumonia, Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *S. epidermidis* (Sonboli *et al.* 2014). Moreover, the results of bioassay tests displayed that the gram-positive *Bacillus subtilis* and *Staphylococcus epidermidis* show the most sensitivity to the essential oil of *S. leptoclada*(Sonboli *et al.* 2014). The antimicrobial properties of *S. leptoclada* support the results of our ethnobotanical results, where the plant is used for the treatment of infectious diseases (cold, cough, and sore throat).

Antifungal activity
The essential oil of *Sclerorhachis leptoclada* has strong antifungal activity against *Aspergillus flavus*, *Fusarium verticilloides,* and *Saccharomyces cerevisiae* (Sonboli *et al.* 2014, Tahmasebi *et al.* 2012). Sonboli *et al.* (2014) reported that *Saccharomyces cerevisiae* is greatly inhibited by the oil of *Sclerorhachis leptoclada* and suggested that it could be used as a natural source of fungicides in agronomic crops and foods.The antifungal activity of essential oil of *S. leptoclada* may be related to its (*E*)-nerolidol and terpinene-4-ol content (Jeung 2007, Mondello *et al.* 2006, Sonboli *et al.* 2014).

Insecticidal activity
The methanol extract of leaves of *Sclerorhachis leptoclada* has toxic effect on adults and larvae of the lesser pumpkin fly (*Dacus ciliatus*) (Zamani 2013).

Nutritional value
The nutritious compounds of *Sclerorhachis leptoclada* e.g., phenolic compounds, fibers, and proteins are of great importance in the diabetic diet which highlights the significant nutritional value of this plant (Dourandishan *et al.* 2013).

Conservation status
Sclerorhachis leptoclada is restricted to a few localities in the east of Iran. Due to its medicinal and edible uses in the region, the aerial parts of the plant are harvested by local people and medicinal plant vendors. However, there are no restrictions or prohibitions for people to harvest this species. The overexploitation of this plant and lack of conservation can lead to decrease of its population in the area. Therefore, training the local people about conservation and sustainable use of *S. leptoclada* is a critical issue.

The ethnobotanical importance of *Sclerorhachis leptoclada* has not been properly addressed due to its limited and local distribution in the east of Iran. However, it has still retained its importance as a plant resource for medicine among the local community. Here, we document the traditional uses of *S. leptoclada* for the first time. Our field survey revealed that *S. leptoclada* is generally prepared as a decoction or infusion for the treatment of cold, cough, sore throat, the sign of food poisoning, and lactation promotion in humans. However, its biological activity, active compounds, and chemical characterization need to be further evaluated and authenticated to ensure a safe use. Due to the extensive harvesting of the aerial plant parts and local distribution of the plant, it is critical to educate the local community in terms of conservation and sustainable use of *S. leptoclada*.

Declarations

Ethics approval and consent to participate: We obtained prior oral informed consent from all study participants before any study. Ethical committee permits were not needed. Collecting voucher specimens needed no permits.

Competing interests: The authors declare that there is no conflict of interest.

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Authors' contributions: Toktam Mohammadi interviewed with local people and prepared the first draft of the manuscript; Atefeh Pirani supervised the study, and contributed to the manuscript preparation; Hamid Moazzeni supervised the study and contributed to the manuscript preparation; Jamil Vaezi advised the study and revised the manuscript.

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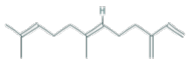
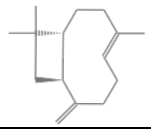
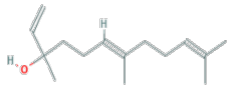
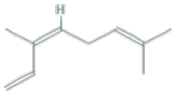
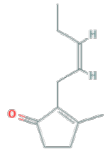
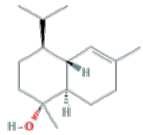
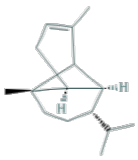
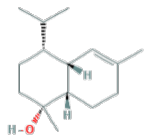
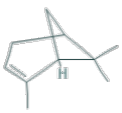
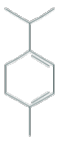
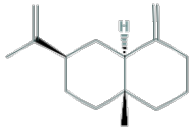
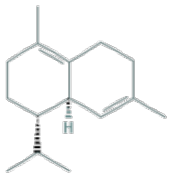
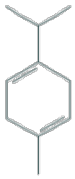
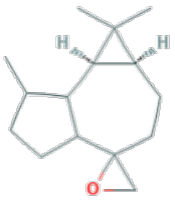
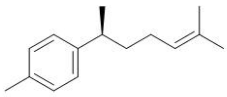
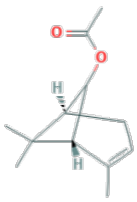
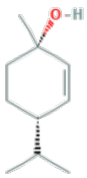
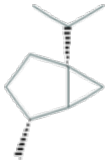
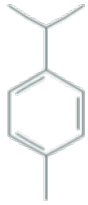
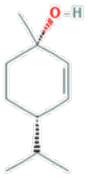
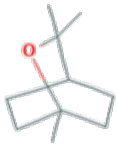
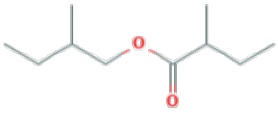
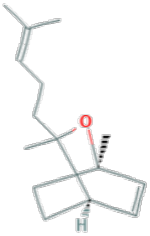
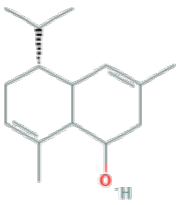
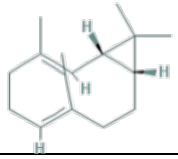
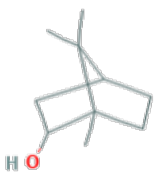
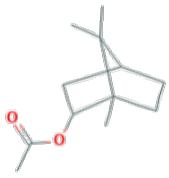
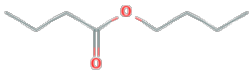
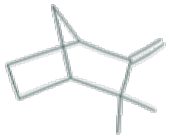
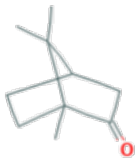
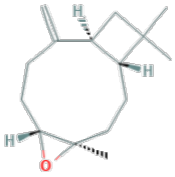
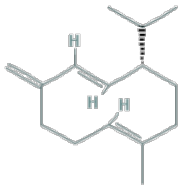
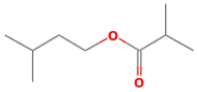
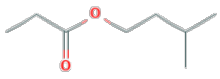
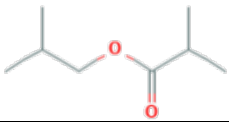
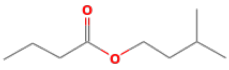
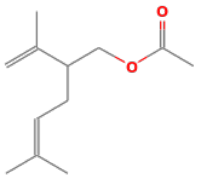
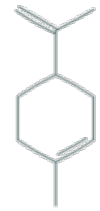
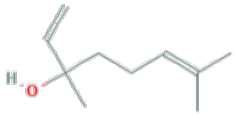
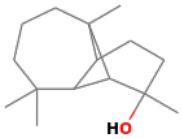
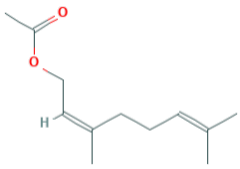
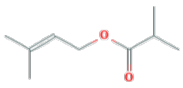
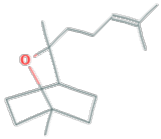
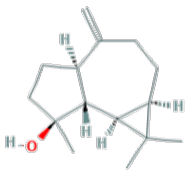
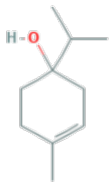
Appendix 1. Chemical composition of *Sclerorhachis leptoclada*

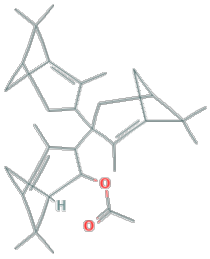
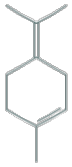
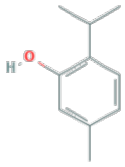
No.	Compound	Molecular formula	Chemical structure (2D)	Plant organ	Extract	Ref.
1	*(E)*-β-farnesene	$C_{15}H_{24}$		Aerial flowering parts	Distilled water	Sonboli *et al.* 2014
2	*(E)*-caryophyllene	$C_{15}H_{24}$				
3	*(E)*-nerolidol	$C_{15}H_{26}O$				
4	*(Z)*-β-ocimene	$C_{10}H_{16}$				
5	*(Z)*-jasmone	$C_{11}H_{16}O$				
6	α-bisabolol	$C_{15}H_{26}O$				
7	α-cadinol	$C_{15}H_{26}O$				
8	α-copaene	$C_{15}H_{24}$				
9	α-muurolol	$C_{15}H_{26}O$				
10	α-pinene	$C_{10}H_{16}$				
11	α-terpinene	$C_{10}H_{16}$				

12	α-terpineol	$C_{10}H_{18}O$				
13	α-thujene	$C_{10}H_{16}$				
14	β-pinene	$C_{10}H_{16}$				
15	β-selinene	$C_{15}H_{24}$				
16	δ- cadinene	$C_{15}H_{24}$				Akramian *et al.* 2008, Tahmasebi *et al.* 2012, Sonboli *et al.* 2014
17	γ-terpinene	$C_{10}H_{16}$				Sonboli *et al.* 2014
18	*allo*-aromadendrene epoxide	$C_{15}H_{24}O$				
19	*ar*-curcumene	$C_{15}H_{22}$				
20	*cis*-chrysanthenyl acetate	$C_{12}H_{18}O_2$				
21	*cis*-p-menth-2-en-ol	$C_{10}H_{18}O$				

22	*cis*-sabinene hydrate	$C_{10}H_{18}$				
23	*p*-cymene	$C_{10}H_{14}$				
24	*trans*-p-menth-2-en-ol	$C_{10}H_{18}O$				
25	1,8-cineole	$C_{10}H_{18}O$				
26	2-methyl butyl-2-methyl butyrate	$C_{10}H_{20}O_2$				
27	1,2-dehydrosesquicineole	$C_{15}H_{24}O$				
28	Amorpha-4,9-dien-2-ol	$C_{15}H_{24}O$				
29	Bicyclogermacrene	$C_{15}H_{24}$		Aerial flowering parts	Distilled water	
30	Borneol	$C_{10}H_{18}O$				

31	Bornyl acetate	$C_{12}H_{20}O_2$				Akramian *et al.* 2008, Tahmasebi *et al.* 2012, Sonboli *et al.* 2014
32	Butyl butanoate	$C_8H_{16}O_2$				Sonboli *et al.* 2014
33	Camphene	$C_{10}H_{16}$				
34	Camphor	$C_{10}H_{16}O$				Akramian *et al.* 2008, Tahmasebi *et al.* 2012, Sonboli *et al.* 2014
35	Caryophyllene oxide	$C_{15}H_{24}O$				Sonboli *et al.* 2014
36	Chrysanthenone	$C_{10}H_{14}O$				
37	Fiber	-	-	-	Ethanol, ethyl acetate	Dourandishan *et al.* 2013
38	Germacrene D	$C_{15}H_{24}$		Aerial flowering parts	Distilled water	Sonboli *et al.* 2014
39	Isoamyl isobutyrate	$C_9H_{18}O_2$				
40	Isoamyl propionate	$C_8H_{16}O_2$				
41	Isobutyl isobutyrate	$C_8H_{16}O_2$				
42	Isopentyl butanoate	$C_9H_{18}O_2$				

43	Lavandulyl acetate	$C_{12}H_{20}O_2$				
44	Limonene	$C_{10}H_{16}$				
45	Linalool	$C_{10}H_{18}O$				
46	Longipinanol	$C_{15}H_{26}O$				
47	Neryl acetate	$C_{12}H_{20}O_2$				
48	Phenols	-	-	-	Ethanol, ethyl acetate	Dourandishan *et al*. 2013
49	Prenyl isobutyrate	$C_9H_{16}O_2$		Aerial flowering parts	Distilled water	Sonboli*et al.* 2014
50	Sabinene	$C_{10}H_{16}$				
51	Sesquicineole	$C_{15}H_{26}O$				
52	Spathulenol	$C_{15}H_{24}O$				
53	Terpinen-4- ol	$C_{10}H_{16}O$				

54	Terpinen-4-ol acetate	$C_{32}H_{46}O_2$				
55	Terpinolene	$C_{10}H_{16}$				
56	Thymol	$C_{10}H_{14}O$				
57	Thymol methyl ether	$C_{11}H_{16}O$