Research article
Curr. Pers. MAPs, (2023); 6(1):7-26

Current Perspectives on Medicinal and Aromatic Plants

An International Journal
ISSN: 2619-9645 | e-ISSN: 2667-5722

The Contribution of Protected Areas to Human Health. A Case Study from Djurdjura Biosphere Reserve (Algeria), with New or Rarely Reported Medicinal Plants

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http://doi.org/10.38093/cupmap.1243327

Received : 29/01/2023
Accepted : 30/03/2023

Abstract

In the protected areas of the Mediterranean Basin, inventories on the ethnomedicinal uses of plants have been carried out both on its northern and southern shores. An outstanding wealth of ancestral knowledge on traditional medicine still exists in the mountainous area of the Djurdjura Biosphere Reserve. An ethnomedicinal survey was performed in the field with 64 informants from the villages of three municipalities, through a semi-structured questionnaire and direct interviews. It is especially illiterate women without activity, over 45 years old, who hold the best knowledge about this traditional medicinal practice. Overall, 121 plant species have been identified, with 42 plant species newly recorded. They belong to 108 genera and 56 families. The Lamiaceae are the most mentioned family with 13 species. The majority of these medicinal plants are growing in the wild (79.3%). They are used to treat a wide range of 83 diseases and symptoms. Digestive disorders are the disease group the most treated in the study region, with 63 species. Indigestion and diarrhea are the most commonly treated ailments by the local population, which mainly use the fresh leaves (48.51%) as infusion or decoction, the most common preparations. From the perspective of conservation and improvement of this ethnobotanical knowledge, the medicinal plants recorded, particularly the 12 endemic and/or rare species (e.g. *Origanum vulgare* L. subsp. *glandulosum* (Desf.) Ietswaart, which cures the highest number of diseases), deserve the greatest conservative attention for their patrimonial and therapeutic values.

Key Words: Ethnoflora, Ethnomedicinal Uses, Traditional Knowledge, Biodiversity, Protected Area, Djurdjura.

1. Introduction

Protected areas provide a variety of ecosystem services, including the direct use of plants, of which medicinal plants play a major role (Zank and Hanazaki 2011). The protected areas are particularly interesting from an ethnomedicinal point of view because they show not only the wide range of medicinal plants but also a huge knowledge on their uses by local populations (da Silva et al. 2019). In the protected areas of the Mediterranean Basin, inventories on the ethnomedicinal uses of plants have been carried out both on its northern shore (di Sanzo et al. 2013; Belda et al. 2013; Leto et al. 2013; Vitalini et al. 2015; Menale et al. 2016; Vinagre et al. 2019) than on its southern

shore (Bounar et al. 2013; Rhafouri et al. 2015; Rhattas et al. 2016; Boughrara and Belgacem 2016; Benaissa et al. 2018; Souilah et al. 2018; Chohra and Ferchichi 2019; Lazli et al. 2019; Hadjadj et al. 2019; Zatout et al. 2021). These inventories of medicinal plants and their uses in protected areas concerned some Algerian protected areas, such as those of El Kala, Taza, Belezma, Tlemcen and Djebel Aissa. On the other hand, to our knowledge, the Djurdjura Biosphere Reserve (DBR) has been the subject of only one published ethnobotanical study (Meddour et al. 2020). Without such ethnobotanical studies, information would not be recorded and, as the knowledge base evolves, it could eventually be lost. Moreover, the study of local knowledge on medicinal plants is becoming increasingly important in defining strategies for the conservation and sustainable use of plant resources (da Silva et al. 2019).

In this global framework, the major objective of this ethnobotanical study is to identify and document the indigenous knowledge on traditional uses of plant species used by the local populations for human health. The results will bring to limelight the plant species of high ethnobotanical value. This knowledge is also necessary to assist managers and decision makers in incorporating actual and potential valuable species into economic future planning, policy, and investment.

2. Material and Methods

2.1. Study area

The Djurdjura Biosphere Reserve (and National Park) is located 30 km south-east of Tizi Ouzou and 50 km from the Mediterranean Sea (Figure 1A), on the high slopes of the Djurdjura mountain range, between 800 and 2300 m a.s.l. It covers an area of 18550 ha, between latitudes 36°25'42'' and 36°32'02'' North and longitudes 3°57'23'' and 4°19'43'' East. This biosphere reserve, a Mediterranean mountainous site, very diversified in terms of flora and landscape (UICN 2015), was set up as a biosphere reserve in 1997. This study is carried out at the level of 14 villages surrounding or enclosed in the territory of the DBR. These villages depend on the municipalities of Iboudrarene (4 villages), Akbil (4), and Saharidj (6) (Figure 1B). The rural population of these three municipalities was estimated in 2008 at 22817 inhabitants in total, with a high human occupation density of 167 to 235 inhabitants per km^2 on northern slope and only 92 inhabitants per km^2 on southern slope (UICN 2015). In this wooded region of the biosphere reserve, with its mountainous and isolated relief (deep valley), traditional practices are preserved, in particular the use of herbal medicine by rural populations.

2.2. Data collection

To collect ethnomedicinal data, we carried out an inventory of current popular uses of medicinal plants as daily primary health care. We followed standard ethnobotanical data collection procedures (Bellakhdar 2008; Albuquerque et al. 2014). The choice of the sample was focused on the research of informants considered the most knowledgeable, with expertise regarding local medicinal plants. At the villages concerned by the survey, we applied the snowball technique (Martin 2004), to select the informants. The field survey was therefore performed with our key informants, who are native to the villages studied, via direct interviews in Kabyle (the Berber language of Northern Algeria) with a semi-structured questionnaire prepared in French. This implies an in-depth knowledge of the local culture.

During our survey in March-July 2019, we interviewed 64 informants from the villages. The code of ethics of the International Society of Ethnobiology (ISE 2006) was strictly followed. Prior informant consent (PIC) was obtained orally from all informants before beginning any of the interviews. They were

assured anonymity to participate in the survey and freely share their ethnobotanical knowledge (Vitalini et al. 2015). Direct face-to-face interviews alternated with botanical field trips, where the informant directly told us about the plant and its uses.

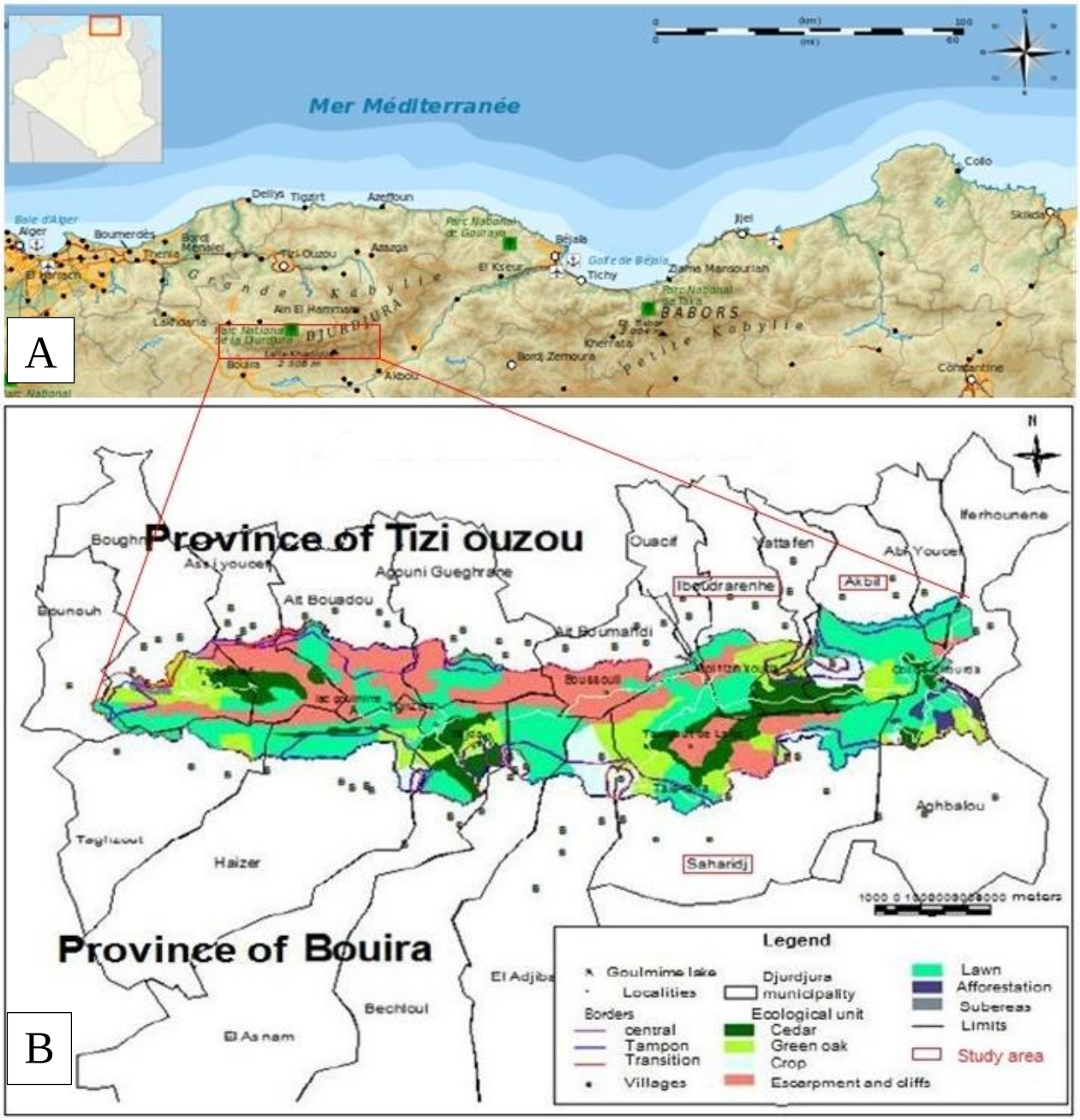

Figure 1. Location of the Djurdjura National Park in northern Algeria (A) (https://fr-ch.topographic-map.com/maps/4c2a/), and the study municipalities (B): Iboudrarene and Akbil are located on the northern slope of the DBR, and Saharidj on its southern

The systematic identification of plants, labelled with their vernacular names, was performed using the "Flora of Algeria" (Quézel and Santa 1962-1963). The nomenclature was updated according to the synonymic index of Dobignard and Chatelain (2010-2013). The specimens of plants collected were deposited at the Herbarium of the Faculty of Biological and Agronomic Sciences (Mouloud Mammeri University of Tizi Ouzou, Algeria).

2.3. Data analysis

The ethnobotanical data was entered into a table of raw data and processed using the Microsoft Excel® 2016 spreadsheet. We have standardized the information relating to the following aspects, frequency of use of medicinal plants, local medicinal uses and other uses of each plant, plant parts used, pharmaceutical preparation methods, administration modes (internal or external use), diseases and symptoms treated. To perform a simple statistical analysis of the collected data, we calculated the relative frequency of citation (RFC) at which each species of plant was used for its medicinal properties (Belda et al. 2013). This index, proposed by Tardío and Pardo-de-Santayana (2008), reflects the local therapeutic importance of each species and it results from the frequency of citation (FC), i.e. the number of informants who mentioned a given species, divided by the total number of informants (N); RFC = FC/N (0 < RFC < 1). The diseases and symptoms have been clustered into 10 major disease groups following the classification adopted in the Mediterranean region by Gonzalez-Tejero et al. (2008).

3. Results and Discussion

3.1. Informants' profile

We conducted our survey with 64 informants, whose characteristics are summarized in Table 1. Women have a numerical advantage over men (65.96% against 34.04%). Most of the surveyed population that has ethnobotanical knowledge is that of age groups over 45 years (45-60, 60-75, 75-90 years), a total of 65.96%. Age groups under 45 years (15-30, 30-45 years) are only represented by 34.04% (15-30 years old account for much less, i.e. 17.02%).

The holders of ethnomedicinal knowledge are thus people over 45 years of age and more often women, who are traditionally the legatees of ethnomedicinal information (Aquaron 2006). They are better informed about local medicinal practices compared to men, due to their social relationships, where they exchange more information related to family health care (Hoang et al. 2008; Sousa et al. 2012). These findings on the gender and age of the informants were likewise reported by other authors in Algeria (Boutabia et al. 2011), in Morocco (Mehdioui and Kahouadji 2007; Benkhnigue et al. 2011), and as well in Vietnam (Hoang et al. 2008). In addition, the younger generations compared to the elderly, know much less about the uses of plant species, as knowledge and experience are accumulated with age (Susanti and Zuhud 2019).

The people surveyed are housewives (27.66%), unemployed (10.64%), or retirees, with 8.51%. This shows that the majority (46.81% in all) of people surveyed are unwaged in this isolated mountainous region. Besides, farmer-herders are represented with 38.3%. Ethnobotanical information can be acquired from different sources. However, the main source of informants comes from family knowledge held by the elderly (65.45%). The other sources are represented by 12.73% for other persons (neighbors, friends), 16.36% for books (written sources), and 5.45% for the media and internet.

The majority of informants are illiterate, with a high percentage of 48.94%. It is obvious that there is a significant risk of loss due to illiteracy and especially to the non-transcription of local knowledge (Baydoun et al. 2017). The main source of ethnobotanical information for the holders of this ancestral knowledge is family knowledge transmitted by old people. This attests to the originality of ethnomedicinal knowledge, transmitted primarily orally within the family, between individuals, and from one generation to another in the Djurdjura Mountains, without resorting to the literature, as in other areas of Algeria

(Hamel et al. 2018). Mattalia et al. (2020) confirm likewise the vertical transmission of traditional medicinal knowledge from one generation to the next through family members (especially from mothers to daughters).

Table 1. Socio-demographic characteristics of the informants

Characteristics	Categories	Percentage of informants (%) (N = 64)
Gender	Men	34,04
	Women	65,96
Age group	15-30	17,02
	30-45	17,02
	45-60	25,53
	60-75	29,79
	75-90	10,64
Education level	Illiterate	48,94
	Primary	14,89
	Secondary	19,15
	High school	12,77
	University	4,26
Profession	Housewives	27,66
	Unemployed	10,64
	Retirees	8,51
	Students	4,26
	Farmers-herders	38,30
	Workers	10,64
Residence	Akbil	26,56
	Iboudraren	37,50
	Saharidj	35,93
Source of knowledge	Family members	65,45
	Other persons	12,73
	Books	16,36
	Media, Internet	5,45

3.2. Analysis of the medicinal flora recorded in the study region

In the DBR, informants from the villages reported 121 plant species that have medicinal uses for humans, belonging to 108 genera and 56 families. All these recorded medicinal plants are presented in Table 2, in alphabetical order of species and subspecies. The number of 121 plant species, although far from being complete, reflects a greater diversity of medicinal flora in Djurdjura Biosphere Reserve, compared to the first contribution (cf. Meddour et al. 2020), and with 42 plants newly recorded. On the other hand, it reveals also a bigger diversity compared to those recorded in similar ethnobotanical studies in other protected areas in Algeria. Indeed, the number of medicinal plants inventoried varies from 23 to 59, according to data from Bounar et al. (2013), Boughrara and Belgacem (2016), Benaissa et al. (2018), Chohra and Ferchichi (2019), Hadjadj et al.

(2019) and Lazli et al. (2019). However, Zatout et al. (2021) and Souilah et al. (2018) report 109 and 111 medicinal plant species in Tlemcen and El Kala National Parks, respectively.

Among the 56 families, the Lamiaceae are the most represented with 13 species (10.7% of all species recorded), followed by Asteraceae (9.1%), Apiaceae (7.4%), Rosaceae (6.6%), Poaceae, Amaryllidaceae, and Fabaceae (3.3% each), Fagaceae and Oleaceae (2.5% each). The remaining 47 families are represented by one or two species. The preponderance of families, such as Lamiaceae and Asteraceae, in medicinal flora is a well-established fact through the Mediterranean Region (Gonzalez-Tejero et al. 2008), particularly in Algeria (Hadjadj et al. 2019), in Morocco (Ennabili et al. 2000; Mehdioui and Kahouadji 2007), and in Spain (Belda et al. 2013). It has also been observed elsewhere in protected areas (e.g., Zank and Hanazaki 2011).

Allium (4 species), *Mentha* and *Prunus* (3 species each) are the most represented genera, followed by *Acer*, *Daphne*, *Malva* and *Quercus*, with two species each. The species most frequently cited by the informants with the highest RFC value (= 0.43) is *Origanum vulgare* subsp. *glandulosum* (Desf.) Ietswaart. It is followed by another *Lamiaceae*, *Marrubium vulgare* L., with a RFC value = 0.34. According to Rhattas et al. (2016), *Marrubium vulgare* L. is also one of the species most cited by informants in a protected area of Rif (Morocco). These aromatic plants are of very wide therapeutic use, given their efficacy, their status in the local pharmacopoeia, and are easily available in the DBR. Then, twenty-five species (20.7% of all recorded plants) are mentioned with a RFC value > 0.15, of which 12 have a RFC value > 0.21. However, a great number of species (70 or 58%) are cited with the lower RFC value (< 0.06).

On the other hand, the spontaneous plants growing in the wild participate with a high rate (79.3%) in the traditional pharmacopoeia of the DBR. Fully cultivated species are represented with only 20.7% (n = 25). Thus, local populations most often resort to wild flora, given the importance of spontaneous plant resources in this forested region. Belda et al. (2013) also found that medicinal plants are mostly collected from scrubland or forests. Globally, at least 60% of medicinal plants are gathered from the wild (Bonet and Vallès 2007). This demonstrates the strong connection of local populations with their immediate natural environment (Zank and Hanazaki 2011).

Most of the medicinal plants listed in the DBR are common species. However, the local population has recourse to some rare and/or endemic plants (10.8% of all plants), collected within this protected area, for medicinal and other uses. These rare and endemic plants species are *Cedrus atlantica* (Endl.) Manetti ex Carrière, *Thymus numidicus* Poir., *Origanum vulgare* subsp. *glandulosum*, *Isatis djurdjurae* Coss. & Durieu, and rare non-endemic plants are *Artemisia absinthium* L., *Daphne laureola* L., *Lonicera etrusca* Santi, *Acer monspessulanum* L., *Acer obtusatum* Waldst. & Kit. ex Willd., *Ilex aquifolium* L., *Taxus baccata* L., and *Tussilago farfara* L. (montane plants). This part of the ethnoflora deserves the greatest conservatory attention for its heritage value. In particular, the Djurdjura pastel (*Isatis djurdjurae*), endemic to Algeria and Morocco, is used for skin diseases (boils and abscesses). Otherwise, the traditional exploitation of these species must be done in a reasonable way in order to preserve them and ensure their sustainability in this protected area. Local people should be informed on sustainable methods of harvesting plants to treat diseases today without compromising their availability for future use (Adaeze et al. 2018).

Table 2. Medicinal plants reported by the informants in the Djurdjura Biosphere Reserve with their ethnomedicinal uses.
For each species, we mention the scientific name, the family, the Kabyle vernacular names, its relative frequency of citation (RFC), whether spontaneous (S) or cultivated (C) type. Data such as therapeutic uses or treated diseases, plant parts used, mode of preparation, administration route, are likewise provided. * Newly recorded plant species compared to Meddour et al. (2020).

Plant species	Families	Vernacular names	Parts used	Preparation methods	Administration modes	Treated diseases/Therapeutic uses	Type	RFC
**Acer monspessulanum* L.	Sapindaceae	Adharchi	leaves	decoction	bath	hair loss	S	0,06
**Acer obtusatum* Waldst. & Kit. ex Willd.	Sapindaceae	Lqikev	leaves	decoction	bath	hair loss	S	0,04
Ajuga iva (L.) Schreb.	Lamiaceae	Chkentoura	leaves	infusion	oral ingestion	diabetes, stomach pain, circulatory disorders	S	0,15
			leaves	maceration	local application	scars		
Allium ampeloprasum L.	Amaryllidaceae	Tharnast	leaves, bulbs	cooking	oral ingestion	physical weakness, indigestion, dry cough	C	0,19
Allium cepa L.	Amaryllidaceae	Levsel	bulbs	raw	compresses	headache	C	0,09
			bulbs	raw	poultices	furuncles, abcesses		
			bulbs	juice	local application	warts		
Allium sativum L.	Amaryllidaceae	Thicherth	bulbs	raw	oral ingestion	cough, diabetes	C	0,04
			bulbs	raw	local application	bee stings		
Allium triquetrum L.	Amaryllidaceae	Vivras	aerial part	raw	oral ingestion	indigestion, general fatigue	S	0,06
**Aloysia citriodora* Paláu	Verbenaceae	Tizane, Zatage	leaves	infusion	oral ingestion	insomnia, headache, stomach pain	C	0,02
**Ampelodesmos mauritanicus* (Poir.) T. Durand & Schinz	Poaceae	Adless	leaves	decoction	gargle	oral conditions, canker sores	S	0,06
Apium graveolens L.	Apiaceae	Kravez	leaves	decoction	rinses	frostbites	C	0,02
Arbutus unedo L.	Ericaceae	Issisnou	leaves	decoction	oral ingestion	diarrhea	S	0,04
Artemisia absinthium L.	Asteraceae	Jaret meriem	leaves, flowers	infusion	oral ingestion	diabetes, diarrhea	S	0,23
			leaves	powder	oral ingestion	anorexia, nausea		
			leaves	maceration	oral ingestion	fever, stomach pain		
			leaves	juice, maceration	oral ingestion, local application	diarrhea, vomiting (babies)		
Arum italicum Mill.	Araceae	Aveqouq	leaves	decoction	oral ingestion	influenza, indigestion	S	0,09
**Arundo donax* L.	Poaceae	Aghanim	leaves	juice	oral ingestion	tonsillitis	S, C	0,06
			rhizomes	decoction	oral ingestion	tonsillitis		
**Asphodelus ramosus* L.	Asphodelaceae	Abarwaq	tubers	heating	instillation	otitis	S	0,02
Asplenium ceterach L.	Aspleniaceae	Thiwjrirhin	leaves	infusion	oral ingestion	kidney stones	S	0,21
Beta vulgaris L.	Amaranthaceae	Thividhest	leaves	raw	oral ingestion	anemia, indigestion	S, C	0,04
Blackstonia grandiflora (Viv.) Maire	Gentianaceae	Qlilu	aerial part	infusion	oral ingestion	anemia, diabetes, lack of appetite, nausea, indigestion	S	0,04
Borago officinalis L.	Boraginaceae	Ahledjedh, Chikh levqoul	leaves, flowers	juice	oral ingestion	indigestion	S	0,04
			flowers	infusion	oral ingestion	bronchitis, cold, joint pain		
Calicotome spinosa (L.) Link	Fabaceae	Uzzu	aerial part	lotion	local application	sores and injuries, hemorrhage	S	0,13
			seeds	powder	mask	headache		

Chamaeleon gummifer Cass.	Asteraceae	Addadh	flowers	crushed	oral ingestion	headache, cough	S	0,04
			flowers	crushed	bath	hemorrhoids		
**Castanea sativa* Mill.	Fagaceae	Abeludh urumi	fruits	raw	oral ingestion	diarrhea	S, C	0,02
Cedrus atlantica (Endl.) G.Manetti ex Carrière	Pinaceae	Avawel	leaves, bark	decoction	oral ingestion	bloating, cold	S	0,11
			bark, roots	tar (qedhran)	oral ingestion	cough, general fatigue		
**Celtis australis* L.	Cannabaceae	Ivikes	flowers	infusion	oral ingestion	hypertension, nervousness	S	0,06
**Centaurium erythraea* Rafn	Gentianaceae	Qlilu	flowers	infusion	oral ingestion	anemia, diabetes, lack of appetite, nausea, indigestion	S	0,09
**Ceratonia siliqua* L.	Fabaceae	Akharouv	leaves	infusion	oral ingestion	diarrhea, nausea, stomach pain, fever, insomnia	S	0,04
			leaves	juice	inhalation	nasal congestion		
			leaves	juice	oral ingestion	vomiting		
Citrus limon (L.) Osbeck	Rutaceae	Lkares	fruits	juice	oral ingestion	tonsillitis, cold, general fatigue	C	0,09
			leaves	infusion	oral ingestion	influenza, cold, anxiety		
**Coriandrum sativum* L.	Apiaceae	Leksvar	seeds	infusion	oral ingestion	bloating	S, C	0,06
			seeds	crushed	massage	joint pain, rheumatism		
Crataegus monogyna Jacq.	Rosaceae	Idhmim	fruits	infusion	oral ingestion	insomnia, hypertension	S	0,06
**Cupressus sempervirens* L.	Cupressaceae	Thaydha	resin	raw	local application	scars	C	0,09
			leaves	decoction	oral ingestion	influenza, cold		
			bark	powder	oral ingestion	stomach ulcer		
Cydonia oblonga Mill.	Rosaceae	Thakthounia	leaves	infusion	oral ingestion	colon pain	C	0,04
			fruits	cooking	oral ingestion	indigestion		
Cynara cardunculus L.	Asteraceae	Thaga	leaves	raw	oral ingestion	indigestion	S, C	0,06
Cynodon dactylon (L.) Pers.	Poaceae	Affar	leaves	infusion	oral ingestion	colon pain	S	0,04
			leaves	decoction	oral ingestion	kidney stones		
Daphne gnidium L.	Thymelaeaceae	Alezaz	leaves	decoction	oral ingestion	constipation	S	0,04
Daphne laureola L.	Thymelaeaceae	Telt drar	leaves	powder	oral ingestion	constipation	S	0,02
**Daucus carota* L.	Apiaceae	Thazdelt	seeds	crushed	poultices	burns, furuncles	S	0,04
**Daucus carota* subsp. *sativus* (Hoffm.) Arcang.	Apiaceae	Zrodia	roots	raw	oral ingestion	vomiting, heartburn, diarrhea	C	0,04
			roots	paste	mask	rough skin		
Dittrichia viscosa (L.) Greuter	Asteraceae	Amagraman	leaves	decoction	poultices	rheumatism, muscle aches	S	0,28
			leaves	juice	local application	scars, hemorrhages		
			aerial part	infusion	oral ingestion	colon pain		
			leaves	paste	local application	cracks in the feet		
Ecballium elaterium (L.) A.Rich.	Cucurbitaceae	Afequs lehmir	leaves	infusion	oral ingestion	hemorrhoids, jaundice	S	0,04
Erica arborea L.	Ericaceae	Akhlenj	flowers	decoction	oral ingestion	indigestion, nervousness	S	0,04
**Eriobotrya japonica* (Thunb.) Lindl.	Rosaceae	Thouvrest	leaves	decoction	oral ingestion	menstrual pains, indigestion	C	0,11
Eucalyptus globulus Labill.	Myrtaceae	Kalytous	leaves, flowers	infusion	inhalation	bronchial evacuation, cold, cough	C	0,04
			bark	decoction	mouthwash	dental pain		
Ferula communis L.	Apiaceae	Awli, Afougel	stem	splints	local application	fracture	S	0,06

Ficus carica L.	Moraceae	Thiqlets	fruits	raw	oral ingestion	general fatigue, constipation	S, C	0,15
Foeniculum vulgare (Mill.) Gaertn.	Apiaceae	Besvas	leaves, seeds	infusion	oral ingestion	bloating, lack of appetite, intestinal worms	S, C	0,06
			roots	decoction	oral ingestion	diarrhea, menstrual pains		
Fraxinus angustifolia Vahl	Oleaceae	Aslen	leaves	infusion	oral ingestion	fever	S, C	0,17
			bark	decoction	oral ingestion	stomach ulcer		
			seeds	powder	poultices	scars, joint pain		
**Fumaria officinalis* L.	Papaveraceae	Thijujar n yesghi	leaves	crushed	local application	rheumatism	S	0,04
Glebionis segetum Fourr.	Asteraceae	Wamlal	leaves	raw	oral ingestion	indigestion	S	0,04
			aerial part	juice	local application	rough skin, varicose veins		
Globularia alypum L.	Plantaginaceae	Thasselgha	leaves	infusion, decoction	oral ingestion	asthma	S	0,06
**Hyoscyamus albus* L.	Solanaceae	Bounarjouf	leaves	cooking	oral ingestion	infertility	S	0,02
			leaves	powder	mask	acne and pimples		
Hyoseris radiata L.	Asteraceae	Tughmas n temgharin	leaves	salad	oral ingestion	colon crisis, digestive disorders, bloating	S	0,16
**Ilex aquifolium* L.	Aquifoliaceae	Iskerchi	leaves	decoction	oral ingestion	?	S	0,04
Isatis djurdjurae Coss. & Durieu	Brassicaceae	Messlama	leaves	decoction	poultices	furuncles, abcesses	S	0,04
Juglans regia L.	Juglandaceae	Thajujets	roots (bark)	maceration	gargle, mouthwash	oral conditions, gum infection	C	0,06
			leaves	decoction	bath, rinçage	dull hair, bad foot odor		
Juniperus oxycedrus L.	Cupressaceae	Taqqa	leaves	decoction	oral ingestion	insomnia	S	0,02
Laurus nobilis L.	Lauraceae	Arihan, arend	leaves	infusion	oral ingestion	indigestion, insomnia	S, C	0,13
			leaves	decoction	oral ingestion	intestinal pain		
Lavandula stoechas L.	Lamiaceae	Amezir beghyul	flowers	infusion	oral ingestion	heartburn	S	0,11
			leaves	decoction	bath	scabies		
Lawsonia inermis L.	Lythraceae	L'Henni n yifer	leaves	powder	bath	eczema, hair loss	C	0,03
Lonicera etrusca Santi	Caprifoliaceae	Anaref	leaves, flowers	infusion, decoction	oral ingestion	angina, cough	S	0,06
Malva multiflora (Cav.) Soldano, Banfi & Galasso	Malvaceae	Mejjir	leaves	raw	poultices	boils, mumps	S	0,23
				infusion	inhalation	sinusitis		
**Malva sylvestris* L.	Malvaceae	Mejir	flowers	infusion	inhalation	bronchitis, cough	S	0,06
Marrubium vulgare L.	Lamiaceae	Marnuyeth	leaves	decoction	oral ingestion	diarrhea, intestinal worms, fever	S	0,34
			leaves, roots	crushed	poultices	weakness of children (thagdhit)		
			leaves, roots	decoction	instillation	otitis		
Melissa officinalis L.	Lamiaceae	Ifer tzizwith	leaves	infusion	oral ingestion	bloating, insomnia	S	0,19
			leaves	decoction	inhalation	influenza		
Mentha pulegium L.	Lamiaceae	Flegu	leaves	infusion	oral ingestion	cold, insomnia	S	0,28
			leaves	decoction	oral ingestion	indigestion, anemia, lack of appetite		
			aerial part	maceration	oral ingestion	general fatigue		
Mentha spicata L.	Lamiaceae	Naanaa	leaves, flowers	infusion	oral ingestion	insomnia, influenza, cough, menstrual evacuation, vomiting	C	0,13
Mentha suaveolens Ehrh.	Lamiaceae	Thimeja	aerial part	infusion	oral ingestion	fever, dizziness	S	0,23
			leaves	decoction	compresses	diarrhea		

			leaves	decoction	rinses	hair loss		
**Myrtus communis* L.	Myrtaceae	Chilmoun	leaves	infusion, decoction	oral ingestion	cold, bronchitis, hemorrhoids	S	0,04
Nerium oleander L.	Apocynaceae	Ilili	leaves	infusion	mouthwash	oral infection	S	0,11
			leaves	latex	local application	scabies, pimples, warts		
Nigella damascena L.	Ranunculaceae	Sanoudj	seeds	maceration	oral ingestion	lack of appetite	S	0,06
			seeds	infusion	gargle	dental pain		
Ocimum basilicum L.	Lamiaceae	Lahvek	leaves	infusion	oral ingestion	galactogenic	S, C	0,06
Olea europaea L. subsp. *europaea* var. *europaea*	Oleaceae	Azemour	fruits	oil	oral ingestion	food poisoning, sore throat	C	0,26
			fruits	oil	massage	lumbago, furuncles		
			leaves, fruits	decoction	oral ingestion	hypertension		
Olea europaea L. subsp. *europaea* var. *sylvestris* (Mill.) Lehr	Oleaceae	Ahechadh, Azeboudj	leaves	decoction	local application	heavy legs, varicose veins	S	0,13
			bark	decoction	oral ingestion	indigestion		
**Ophrys apifera* Huds.	Orchidaceae	Thiheythin thimeythin	bulbs	cooking, powder	oral ingestion	sexual impotence	S	0,06
**Opuntia ficus-indica* (L.) Mill.	Cactaceae	Akarmous	flowers	infusion	oral ingestion	diarrhea	C	0,06
			fruits	raw	oral ingestion	diarrhea, general fatigue		
			cladodes	raw	poultices	sciatica		
Origanum vulgare subsp. *glandulosum* (Desf.) Ietswaart	Lamiaceae	Zaatar	aerial part	infusion	oral ingestion	diabetes, general fatigue, fever, influenza, cold, cough, angina, indigestion, lack of appetite, stomach pain, nausea, vomiting	S	0,43
				crushed	poultices, friction, mask	joint pain		
				decoction	inhalation	insomnia, nervousness, headache, migraine, dizziness		
Papaver rhoeas L.	Papaveraceae	Wahrir, Djihbut	flowers	infusion	oral ingestion	cough, insomnia	S	0,09
Paronychia argentea Lam.	Caryophyllaceae	Latay n'lakhla	flowers	infusion	oral ingestion	intestinal problems	S	0,06
**Peganum harmala* L.	Nitrariaceae	Elharmel	aerial part	maceration	rinses	rheumatism	S	0,04
Petroselinum crispum (Mill.) Fuss	Apiaceae	Maadnous	aerial part	decoction	oral ingestion	cardiotonic, hypertension	S, C	0,11
			aerial part	raw	local application	dental pain		
			leaves	juice	instillation	otitis		
**Pimpinella anisum* L.	Apiaceae	Hebet hlawa	seeds	decoction	oral ingestion	cough, bronchitis	C	0,02
**Pinus halepensis* Mill.	Pinaceae	Azoumbi	seeds, bark	decoction	mouthwash	canker sores, oral infection	S	0,04
Pistacia lentiscus L.	Anacardiaceae	Thidhekth	leaves	infusion	oral ingestion	hypertension, bronchial evacuation	S	0,17
			leaves	decoction	oral ingestion	colon pain, stomach pain, diarrhea, dizziness		
			leaves	powder	oral ingestion	hemorrhoids		
Plantago lanceolata L.	Plantaginaceae	Thahchicht n'hmed	leaves	powder	local application	eczema, skin fungus	S	0,30
			leaves	raw	poultices	abcesses, foot nails		
			leaves	juice	local application	hemorrhages, scars		
**Prunus armeniaca* L.	Rosaceae	Elkhoukh	leaves	juice	poultices	?	C	0,04
**Prunus avium* (L.) L.	Rosaceae	Ardherim	fruits (peduncles)	infusion	oral ingestion	urine retention, diarrhea	S	0,06

Prunus cerasus L.	Rosaceae	Lesriz, Heb lemlouk	fruits (peduncles)	infusion	oral ingestion	urine retention, kidney stones, diarrhea, stomach pain	C	0,15
**Pteridium aquilinum* (L.) Kuhn	Dennstaedtiaceae	Ifelkou	rhizomes	decoction	oral ingestion	intestinal worms	S	0,02
			rhizomes	oil	massage	joint pain		
Punica granatum L.	Lythraceae	Reman	fruits	juice	oral ingestion	cold, fever, diarrhea, hemorrhoids, lack of appetite	C	0,23
			fruits	maceration	gargle	canker sores, oral infection		
			bark	powder	oral ingestion	indigestion, vomiting		
Quercus rotundifolia Lam.	Fagaceae	Abeludh	bark	decoction	oral ingestion	stomach ulcer	S	0,13
			fruits	infusion	bath	urinary tract infection		
**Quercus suber* L.	Fagaceae	Akarouch	leaves	decoction	oral ingestion	indigestion	S	0,04
			bark	decoction	bath	heavy legs		
Rhamnus alaternus L.	Rhamnaceae	Imliles	roots	decoction	friction, mask	jaundice	S	0,02
**Nasturtium officinale* R.Br.	Brassicaceae	Garninouch	aerial part	paste	mask	acne and pimples	S	0,04
			aerial part	raw	oral ingestion	heartburn		
Rosa canina L.	Rosaceae	Iaâfar	seeds	powder	oral ingestion	urine retention,	S	0,15
			fruits	raw	oral ingestion	diarrhea		
Rosmarinus officinalis L.	Lamiaceae	Amezir, Thiklilt	leaves	infusion	oral ingestion	menstrual pains	S, C	0,11
			leaves	powder	oral ingestion	menstrual pains		
Rubus ulmifolius Schott	Rosaceae	Inigel	leaves, roots	decoction	oral ingestion	diabetes	S	0,30
			leaves	infusion	oral ingestion	hypertension		
			leaves	maceration	oral ingestion	tonsillitis, tooth decay		
			fruits	juice	oral ingestion	goiter		
			leaves	raw	local application	wounds, burns, hemorrhages		
Rumex conglomeratus Murray	Polygonaceae	Tassemumt n yezgaren	leaves	raw	poultices	boils, sores, indigestion, diarrhea	S	0,13
**Ruscus aculeatus* L.	Asparagaceae	Icher n'yizem	leaves	infusion	oral ingestion	fever, inflammation urinaire	S	0,02
			roots	decoction	oral ingestion	improves blood circulation		
Ruta angustifolia Pers.	Rutaceae	Awermi	flowers	infusion	oral ingestion	anemia, anorexia, stomach pain	S	0,19
			roots	raw	poultices	burns, scars		
**Salix alba* L.	Salicaceae	Issemlel	bark	decoction	oral ingestion	colon pain, rheumatism, sciatica	S	0,06
**Salvia officinalis* L.	Lamiaceae	Marissem	leaves	infusion	oral ingestion	indigestion, diabetes	C	0,06
Sambucus nigra L.	Viburnaceae	Arwuri	leaves	raw	poultices	back pain	S	0,06
Scolymus hispanicus L.	Asteraceae	Thilitsen, Taghediwth	leaves (ribs)	sauce	oral ingestion	physical weakness, indigestion	S, C	0,26
Scrophularia canina L.	Scrophulariaceae	Harm larvi	aerial part	raw	poultices	back pain, joint pain, rheumatism	S	0,16
Silene vulgaris (Moench) Garcke	Caryophyllaceae	Thaghighachth	roots	crushed	compresses	infertility	S	0,09
			aerial part	raw	oral ingestion	general fatigue		
**Solanum tuberosum* L.	Solanaceae	Batata	tubers	raw	local application	migraine, headache	C	0,09
Sonchus oleraceus L.	Asteraceae	Thifaf	leaves	juice	local application	scars, burns	S	0,09
			leaves, stems	raw	oral ingestion	kidney stones		
Tamarix gallica L.	Tamaricaceae	Amemmay	leaves	decoction	oral ingestion	asthma, cough	S	0,03

**Taraxacum erythrospermum* Andrz. ex Besser	Asteraceae	Thughmes temgharth	leaves aerial part	raw juice	oral ingestion friction	indigestion jaundice	S	0,04
**Taxus baccata* L.	Taxaceae	Thifuzalet	leaves	decoction?	?	urinary disorders, rheumatism	S	0,02
Teucrium polium L.	Lamiaceae	Jaada	leaves leaves	decoction powder	oral ingestion oral ingestion	menstrual evacuation infertility	S	0,02
Thapsia garganica L.	Apiaceae	Adviv	roots leaves	decoction crushed	oral ingestion poultices	general fatigue, indigestion joint pain	S	0,13
Thymus numidicus Poir.	Lamiaceae	Thimezirth	aerial part aerial part	infusion rinses	oral ingestion rinses	bloating, cholesterol, cough wounds, rough skin	S	0,19
**Tragopogon porrifolius* L.	Asteraceae	Thawelment	leaves	infusion	oral ingestion	urine retention	S	0,11
**Trigonella foenum-graecum* L.	Fabaceae	Thifidhas	seeds seeds seeds	infusion powder powder	oral ingestion maceration mask	anemia, nausea, nervousness asthma hair loss	C	0,26
**Tussilago farfara* L.	Asteraceae	Ifer budhi	leaves leaves	decoction rinses	oral ingestion rinses	cough, indigestion rough skin	S	0,02
**Ulmus minor* Mill.	Ulmaceae	Oulmou	roots leaves	infusion raw	bath poultices	hair loss, scars joint pain	S	0,06
Umbilicus rupestris (Salisb.) Dandy	Crassulaceae	Thichoufthin	leaves	heating	poultices	furuncles, pimples	S	0,02
Urtica dioica L.	Urticaceae	Azegdouf	aerial part leaves, roots	infusion infusion	oral ingestion bath	anemia hair loss, pellicules, rheumatism	S	0,19
**Vicia faba* L.	Fabaceae	Ivawen	flowers fruits (pods)	raw raw	inhalation friction	food poisoning skin fungus (thifiri)	C	0,04
Vitis vinifera L.	Vitaceae	Thara thaezgeghth	leaves leaves	infusion juice	oral ingestion bath	anxiety, nervousness circulatory disorders	S, C	0,09
**Zea mays* L.	Poaceae	Akvel	seeds flowers (beard)	cooking infusion	oral ingestion oral ingestion	diarrhea urine retention, rough skin	C	0,06

3.3. Plants parts used, preparation and administration mode

The local population of the DBR uses plants mainly in their fresh form (68.46% of citations). This is linked to the direct relationship between local populations and nature and the daily harvest of fresh plants, which may eventually be also used for food. Conversely, the local population has little recourse to dried plants (12.61%). In addition, 18.91% of plants are used fresh or dried. Leaves are the most frequently used part in traditional medicine recipes, accounting for 48.51% of all citations by informants (Figure 3). This wide use of leaves has been largely reported in other similar ethnobotanical studies conducted in the Maghreb countries (Benkhnigue et al. 2011; Boutabia et al. 2011) or elsewhere (Leto et al. 2013). This can be explained by the availability and ease of collecting the leaves (Nasution et al. 2018), and as the leaves are the main organs of photosynthesis (Susanti and Zuhud 2019), which have chemicals that could be responsible for medicinal effects (Balick and Cox 1997). Otherwise, leaf collection, when moderate, does not damage or compromise the development of the plants (Brito et al. 2017). The underground vegetative organs (roots, bulbs, rhizomes, and tubers) come second with 12.87%. Aerial parts and fruits in third place (8.41% each), seeds (6.93%) and flowers (6.43%) follow them. The other organs (barks, stems) are mentioned less (5.94% and 2.47% respectively).

Infusion and decoction are the most common preparations among local populations of DBR, accounting for 26.53% of all citations each, followed by raw consumption with 13.78%. This reflects the ease of preparing the infusion and decoction with water. This is likewise the case in other studies (Estrada et al. 2007), where these preparations play a very important role in local traditional medicines, both for oral and topical routes (Vinagre et al. 2019). On the other hand, it is often enough for local populations of the DBR to consume wild plants uncooked (as salads), to cure the common diseases from which they suffer. Lastly, the other methods of preparation (juice, maceration powder, cooked, crushed and others) are cited with amounts of less than 10% each.

Oral ingestion is the predominant mode accounting for 58% of all citations. This high rate is related to the large number of internal diseases (digestive, circulatory and respiratory disorders) encountered during our study. The other modes of internal administration (inhalation, instillation, gargles and mouthwashes) are represented with 8.5% in all. In consent with Vinagre et al. (2019), internal administration, essentially the oral route, represents the most recommended mode. Local applications come in second, with 9.5% of citations, followed by other modes used externally, such as baths and rinses (9%), poultices (8.5%), masks, and friction (6.5%). They are mainly linked to skin ailments, but also musculoskeletal problems.

3.4. Traditional medicinal uses of recorded plant species

A wide range of 83 diseases and symptoms, reported by the local population of DBR during our investigation, were assembled into 10 disease groups, based on the body system (Table 3). The number of diseases in each group varies between 3 and 17. Three groups (circulatory, digestive, and skin disorders) include 10, 14 and 17 treated diseases, respectively. They are followed by mental-nervous, genitourinary group (8 each), respiratory group (7), skeletomuscular group (6), oral-dental and other diseases groups (5 each), and endocrine-metabolic-nutritional group (3).

Table 3. Major disease categories, diseases treated, and number of plant species used in the study area

Disease categories	Number of diseases treated	Number of species used per group	Diseases (number of species used per disease)
Digestive diseases	14	63	**indigestion (23), diarrhea (16)**, stomach pain (10), bloating (7), colon pain (7), lack of appetite (7), nausea (6), constipation (3), heartburn (3), intestinal worms (3), stomach ulcer (3), vomiting (3), food poisoning (1), hepatic-biliary insufficiency (1)
Skin diseases	17	35	**scars (11),** rough skin (8), hair loss (6), furuncles (4), abscesses (3), scabies (2), acne and pimples (2), wart (2), skin fungus (2), eczema (1), dandruff (1), burns (1), wound (1), bites (1), cracked feet (1), dull hair (1), bad foot odor (1)
Cardiovascular and circulatory diseases	10	27	anemia (7), hypertension (6), hemorrhages (4), hemorrhoid (4), jaundice (3), heavy legs (2), varicose veins (2), circulatory disorders (2), heart weakness (1), frostbite (1)
Respiratory diseases	7	23	**cough (11),** cold (9), influenza (5), bronchitis (3), angina (3), asthma (2), discharge of mucus (2)
Mental-nervous diseases	8	21	insomnia (9), headache (5), nervousness (4), sciatica (2), anxiety (2), dizziness (2), migraine (2), anorexia (2)
Other diseases	5	18	general fatigue (9), fever (8), otitis (4), tiredness (2), weakness of children (1)
Genitourinary and reproductive diseases	8	17	urine retention (7), kidney stones (4), infertility (3), menstrual pains (2), menstruation evacuation (2), genital impotence (1), galactogenic (1), urinary tract infection (1)
Skeletomusclar diseases	6	13	rheumatism (7), joint pain (5), muscle aches (2), lumbago (1), fracture (1), back pain (1)
Oral-dental diseases	5	12	oral infection (5), dental pain (5), tonsillitis (3), canker sores (2), gum infection (1)
Endocrine, metabolic and nutritional diseases	3	9	diabetes (6), cholesterol (1), goiter (1)

The disease group that is treated by the largest number of plants (63 in total) is those of digestive disorders (indigestion, diarrhea, stomach pain). This disease group is the most treated in several Mediterranean countries (Gonzalez-Tejero et al. 2008), thus confirming our observations and giving a broad character to this fact. The group of skin conditions takes second place, with 35 plants used to cure them; third place goes to the group of cardiovascular-circulatory disorders (27), fourth to respiratory problems (23). Nervous-mental group (21), other diseases (18), genitourinary group (17), skeletomuscular group (13), oral-dental group (12), and endocrine-metabolic-nutritional group (9) follow them. The predominance of digestive, skin and respiratory disorders treated by local populations is similarly observed in several Mediterranean countries (Scherrer et al. 2005; Gonzalez-Tejero et al. 2008; di Sanzo et

al. 2013; Menale et al. 2016). This is also the case in non-Mediterranean areas (Sousa et al. 2012; Safeer et al. 2017). Out of the 83 diseases identified in our survey, 31 of them are commonly treated with a large number of plants, at least four (Figure 2). Indigestion and diarrhoea are the most treated ailments by the local population, with 21 and 16 species respectively, followed by cough and scars, with 11 species each, and stomach pains, with 10 species. In addition, nine species can treat insomnia, cold or general fatigue. According to Belda et al. (2013), most of the reported species were likewise used to treat indigestion and diarrhea. In other studies, medicinal plants are mentioned mainly for the same therapeutic uses, indigestion (Sousa et al. 2012) or diarrhea (Qureshi 2012). Finally, the 41 remaining diseases are treated with one or two species.

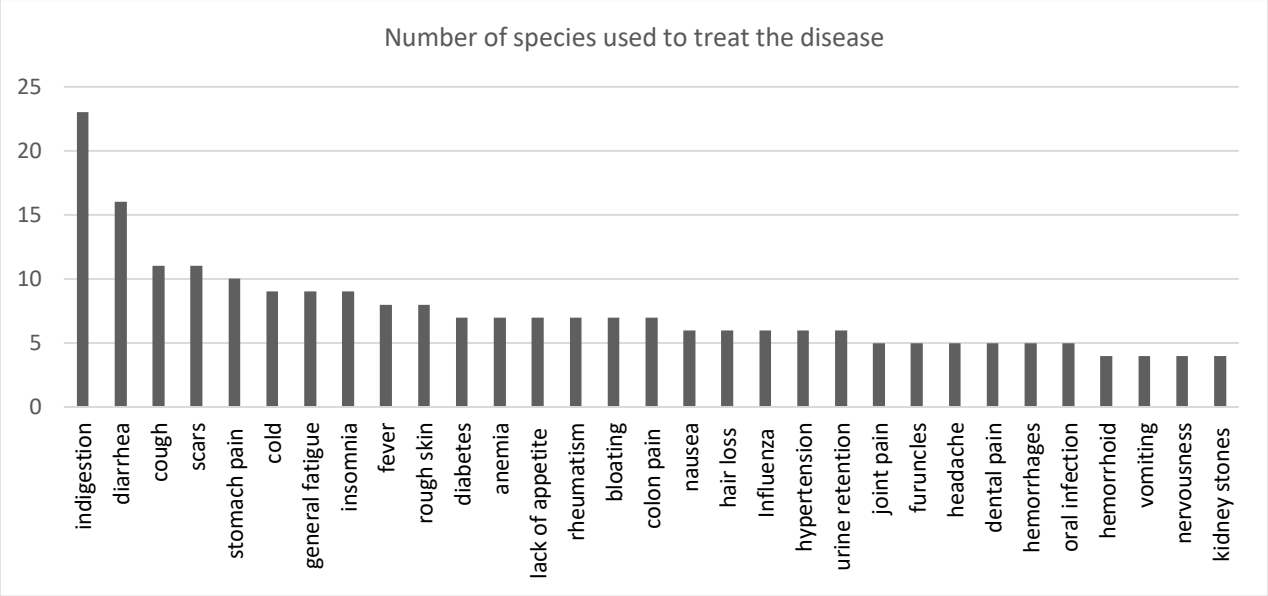

Figure 2. The most treated diseases and the number of species used in each case (≥ 4)

The DBR villagers use 22 medicinal plants to treat a minimum of five diseases per plant (Table 4). Oregano (*Origanum vulgare* L. subsp. *glandulosum* treats the maximum number of diseases (18), such as diabetes, insomnia, headache, digestive disorders (indigestion, stomach pain, nausea …) and respiratory problems (cough, cold, influenza, and angina). Then, *Rubus ulmifolius* Schott is used in eight therapeutic usages (diabetes, wounds, burns, hypertension, tonsillitis, haemorrhage, toothache, goitre). To treat seven diseases (angina, lumbago, back pain, hypertension, sore throat, food poisoning, furuncles), local people use the olive tree (*Olea europaea* L. subsp. *europaea* var. *europaea*); its oil is considered a panacea in local pharmacopoeia. These plants are followed by *Artemisia absinthium*, used to remedy seven diseases, such as anorexia, diabetes, fever, and digestive disorders (diarrhoea, stomach pain, nausea, vomiting), *Punica granatum* L. (diarrhea, indigestion, cold, haemorrhoids, canker sores…), and *Pistacia lentiscus* L. (colon pain, stomach pain, diarrhoea, hypertension, dizziness, etc.). The greater figures of therapeutic uses of these species can be explained by their abundance in the study area and by their reputation in the local pharmacopoeia. Lastly, the majority of the plants (82%) are used to treat one to four ailments each.

Table 4. Classification of the most used plants treating more than five diseases

Medicinal plants treated	Relative Frequency of citation (RFC)	Number of diseases
Origanum vulgare subsp. *glandulosum* (Desf.) Ietswaart	0,43	18
Rubus ulmifolius Schott	0,3	8
Olea europaea L. subsp. *europaea* var. *europaea*	0,26	7
Artemisia absinthium L.	0,23	7
Punica granatum L.	0,23	7
Pistacia lentiscus L.	0,17	7
Plantago lanceolata L.	0,3	6
Mentha pulegium L.	0,28	6
Thymus numidicus Poir.	0,19	6
Urtica dioica L.	0,19	6
Petroselinum crispum (Mill.) Fuss	0,11	6
Ceratonia siliqua L.	0,04	6
Marrubium vulgare L.	0,34	5
Dittrichia viscosa (L.) Greuter	0,28	5
Trigonella foenum-graecum L.	0,26	5
Asplenium ceterach L.	0,21	5
Ruta angustifolia Pers.	0,19	5
Fraxinus angustifolia Vahl	0,17	5
Mentha spicata L.	0,13	5
Centaurium erythraea Rafn	0,09	5
Citrus limon (L.) Osbeck	0,09	5
Blackstonia grandiflora (Viv.) Maire	0,04	5

3.5. New or rarely reported medicinal plants and their uses

To evaluate the degree of originality of the ethnoflora reported in this study, we have compared our list of medicinal plants with: i) those reported in other regions of Kabylia (Ait Youssef 2006; Meddour and Meddour-Sahar 2015), ii) a large corpus of recently published articles (about 50) on Algerian ethnobotany (e.g. Gonzalez-Tejero et al. 2008; Boutabia et al. 2011; Bounar et al. 2013; Benarba et al. 2015; Boughrara and Belgacem 2016; Ouelbani et al. 2016; Benaissa et al. 2018; Souilah et al. 2018; Hamel et al. 2018; Hadjadj et al. 2019; Chohra and Ferchichi 2019; Lazli et al. 2019; Baziz et al. 2020, Zatout et al. 2021, etc.), and iii) the information available for Algeria in the Prelude database (2022).

From this comparison, it appears that eight species did not appear in this recent bibliography on medicinal plant uses in Algeria. Those are *Acer monspessulanum* and *Acer obtusatum* (both fights hair loss). *Blackstonia grandiflora* (Viv.) Maire (anaemia, diabetes, lack of appetite, nausea, indigestion), *Celtis australis* L. (hypertension, nervousness), *Daphne laureola* L. (constipation), *Isatis djurdjurae* (furuncles, abscesses), *Ophrys apifera* Huds. (sexual impotence) and *Tragopogon porrifolius* L. (diuretic). These plants are cited for the first time in Algeria as

medicinal, and their traditional therapeutic uses are therefore to be considered new and previously undocumented for the Algerian pharmacopoeia. Some other plants are rarely reported in Algerian ethnobotanical studies. They are confined in forest ecosystems of mountainous humid area. We will review them underneath.

Ilex aquifolium, used as a diuretic by local population of Djurdjura, is likewise diuretic and treats rheumatism in the Northeastern part of Algeria (Hamel et al. 2018). *Lonicera etrusca*, used to treat respiratory problems (angina, cough) in Djurdjura, is known as suitable for skin problems in Belezma National Park (East of Algeria) (Chohra and Ferchichi 2019). *Ruscus aculeatus* L., which improves blood circulation, and treats fever and urinary inflammation in the DBR, is mentioned for the treatment of several diseases (cardiovascular diseases, digestive disorders, spasms, sinusitis, and psoriasis) in the regions of Constantine and Mila (Ouelbani et al. 2016). *Taxus baccata* is used to manage urinary disorders and rheumatisms according to local population of Djurdjura. Elsewhere in Algeria, it is known to treat reproductive problems in Mitidja, Algiers region (Gonzalez-Tejero et al. 2008), anaemia and nervousness in Eastern Algeria (Ouelbani et al. 2016). *Tussilago farfara*, which has several local uses (cough, indigestion, rough skin) in Djurdjura, is similarly used to treat cough in Northwest of Algeria (Benarba et al. 2015). Finally, *Umbilicus rupestris* (Salisb.) Dandy, whose leaves treat skin disorders (furuncles, pimples) in Djurdjura, is used precisely to treat skin diseases (inflammation, rough skin (as softener), wound healing) in Aures mountains at eastern Algeria (Baziz et al. 2020), and also in Italy (Gonzalez-Tejero et al. 2008). In the northern Mediterranean rim, the leaves of this plant are used against inflammation of the skin, wounds, burns, and as an ophthalmic disinfectant (Benhouda et al. 2014). There is therefore a high consensus on the therapeutic indications of this plant in the Mediterranean basin.

4. Conclusion and outlooks

This ethnobotanical survey in the Djurdjura Biosphere Reserve, among rural populations isolated in a mountainous area, permitted the faithful transcription of noteworthy medicinal knowledge. The ethnobotanical data acquired are evidencing a diversity of medicinal flora and traditional therapeutic uses of plants and a vital role of the protected area in preserving the human health of local populations. The long-lasting interest of local populations in the therapeutic virtues of plants was clearly reflected in the important number of medicinal plant species (more than a hundred) used to manage primary human health care. Indeed, the local populations have succeeded in preserving the ancestral therapeutic practice of plants until today, by a use of plants deeply rooted in the local tradition that can make a significant contribution to sustainable development.

Finally, if management and decision-making are conducted through a participatory approach, local populations can play a crucial role in the *in situ* conservation of plant resources, by incorporating their traditional ecological knowledge (TEK) into a strategy for the sustainable management of this protected area, of national and international importance.

Acknowledgements

The authors are very grateful to all the informants and villagers of the DBR for their hospitality, kindliness, and for sharing willingly their time and information.

Author Contribution

RM and SO settled the research and data collection protocol, and wrote the manuscript. RM did the fieldwork. SO performed the data analysis and processing.

Conflicts of Interest

The authors reported no conflict of interest.

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