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Original Article

Ethnobotanical Survey of the Medicinal Plants used in the Southern Mediterranean. Case Study: The Region of Bissa (Northeastern Dahra Mountains, Algeria)

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ABSTRACT

Introduction: The present study falls within the framework of valorization of medical plants and traditional knowledge's in the Northeastern part of Dahra Mountain, Algeria. **Methods:** An ethnobotanical survey was conducted between 2016 and 2018 in order to study the traditional and therapeutic use of medical plants amongst the local population. Data collected was analyzed using quantitative indices such as the fidelity level (FL) and Informant Consensus Factor (FIC). **Results:** The results revealed 70 medicinal species belonging to 38 botanical families, among which, five families were the most commonly used by the local population, especially the families Lamiaceae and Asteraceae. In term of species, the highest frequencies of medicinal use were shown respectively by *Tetraclinis articulata* (Vahl) Mast. (6.49%), *Pistacia lentiscus* L. (6.11%), *Myrtus communis* L. (5.34%) and *Thymus vulgaris* L. (4.96%). Among the various parts of the plant, leaves were the most used part and decoction was the most frequent form of use. Finally, the gastro-intestinal system disorders were the most treated diseases with a percentage of 28.24%. **Conclusion:** This first ethnobotanical study conducted in the region of Bissa revealed a very rich local knowledge in term of traditional herbal medicine; this fact was reflected by the high diversity of species used in the treatment of several diseases. In light of this, it is therefore very important to subject some of the major species to further phytochemical and pharmacological studies in order to validate their traditional use and to probably discover new bioactive molecules.

Key words: Algeria, Ethnobotany, Indigenous population, Medicinal plants, Traditional medicine.

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INTRODUCTION

The study of the traditional use of medicinal plants by indigenous peoples and rural communities belongs to the domain of ethnobotany.[1,2] In most of the developing countries such as Algeria, the knowledge about traditional medicine has continued to be passed orally from generation to generation.[3-5] Unfortunately, with the recent development of life and the pharmaceutical industry, this knowledge became less and less transmitted and tends to disappear, thus, the necessity to archive and integrate the traditional medicine into the modern health system using ethnobotany and ethnopharmacology.[6]

In this context, several ethnobotanical surveys in relation to traditional medicine have been conducted throughout the world, such as Turkey,[7-10] Northeastern Brazil,[11,12] India,[13] Philippines,[14] Ghana,[15] Côte d'Ivoire[16] and Morocco.[17,18]

Recently, many ethnobotanical and ethnopharmacological studies were undertaken in various regions throughout the Algerian country, in order to preserve the indigenous knowledge and to develop a strategy to protect biodiversity and plant species.[4-6,19-28] However, due to the large Algerian surface and diversity, most its geographical areas and ethnic communities have still not been explored ethnobotanically.[5]

With the disappearance of the old indigenous connoisseurs, it became very urgent to document the traditional knowledge through ethnobotanical studies,[4] which is very important for the conservation of this knowledge, the use of the biological resources and at the same time represents an essential tool in the defense of biodiversity.[29] Therefore, the record of the local names and indigenous uses of plants has significant potential societal benefits.[30,31] In this context, interviews and inventories represent the most effective way to preserve this knowledge.[12]

The study of the local knowledge on biological resources used in traditional medicine, by rural communities in Zeboudja and Beni Haoua a south Mediterranean districts has become necessary for the valorization and conservation of the local flora in Bissa forest, an area known by its important floristic diversity and where no ethnobotanical surveys were conducted. The main purpose of this study was the elaboration of an ethnobotanical survey in order to identify the medicinal plants and the use of these plants.

MATERIAL AND METHODS

Study area and population

The study area, located in the Northwestern side of Algeria in the Eastern part of the Dahra Mountain, is

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a coastal ecosystem with a highly-developed forest. It extend between 1°12'56.9" and 1°42'4.1" of East longitude and between 36°18'9.5" and 36°33'26.7" of North latitude, at 45 km North of the Chlef state (Figure 1). It belongs to the districts of Zeboudja and Beni Haoua and extends over an area of 36671 ha.

It is a typical Mediterranean area in terms of landscape structure, composition and climate, distinguished by hot, dry summers and relatively rainy winters, with an annual dry period of 5 months and 74% of the annual precipitations are recorded during winter and autumn.[32,33]

It is a mountainous with elevations ranging from 400 to 1146 meters and woody area dominated by species such as *Pinus halepensis* L., *Quercus suber* L., *Quercus ilex* L., *Arbutus unedo* L., *Erica arborea* L. *and Cistus monspeliensis* L.

In 2017, the total population in the surrounding municipalities of Zebboudja, Beni Houa, Benairia and Berira was 94187 inhabitants, with a male/female ratio of 1.04. The population is mixed between Arabic and Berber ethnicity and the majority of them are farmers and farm workers. Although the availability of modern health care facilities, this rural population still prefer and practice the traditional medicine.

Ethnobotanical survey

In this study, the ethnobotany of medicinal plants used in Zeboudja, Beni Haoua and the surrounding areas were investigated over two years, from spring 2016 to spring 2018.

Interviews through a well-structured questionnaire were carried out during the busy hours in the common areas visited by local people such as markets, mosques and cafeterias and also at their homes without time limit.[34] Through, this questionnaire we recorded information, such as the demographic characteristics of the informant are shown in Table 1, the local names, the used part, the preparation method and the way of use of the plants.

Plant materials

A total of 70 species were collected throughout the study area, the local names of these species were given by the local population and the scientific names were provided by botanists and experts using the flora of Quezel and Santa[35] and the North African database index.[36]

Data analysis

The ethnobotanical analysis was performed according to several indices (Equation I, II).[4-5,13,23,26,37]

a) Informant consensus factor (FIC)

This index was given by the following formula:

$$FIC = \frac{(Nur - Nt)}{(Nur - 1)} \quad (I)$$

Where Nur is the number of use citations for each ailment category and Nt is the number of taxa used in that category.

b) Fidelity Level

The Fidelity level (FL) was calculated using the following formula:

$$FL(\%) = N_p/N \times 100 \quad (II)$$

Where Np refers to the number of informants citing the use of the plant for a particular ailment category and N is the total number of informants citing the plant for any disease category.

RESULTS AND DISCUSSION

Demographic characteristics of informants

Overall, this research showed that informants from Berber ethnicity were more used to the traditional medicine and provided us with considerably more information than the informants from Arabic ethnicity.

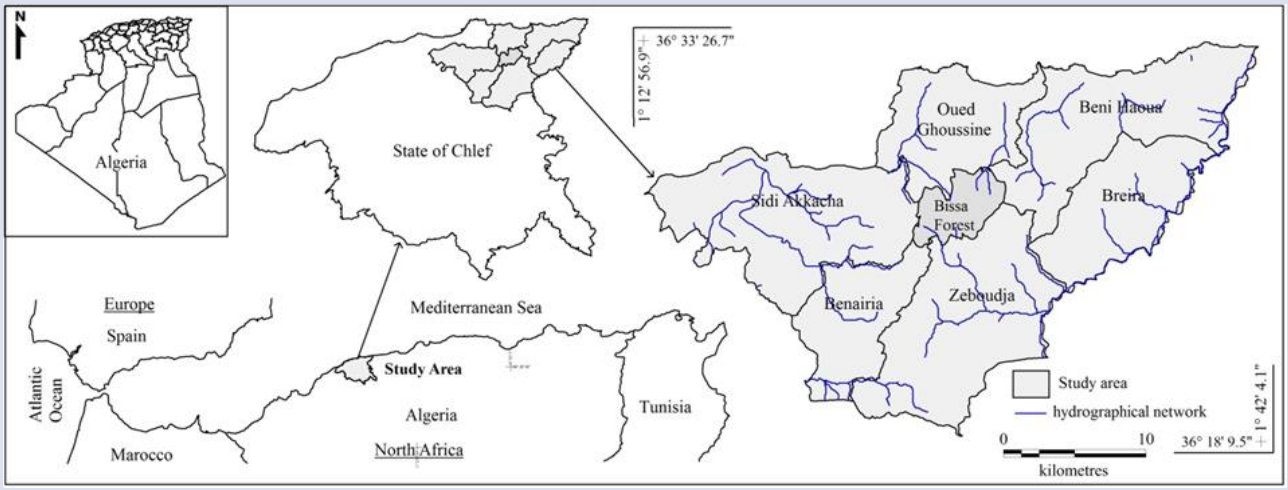

Figure 1: Location of the study area.

Table 1: Demographic characteristics of informants.

Demographical characteristics	Sex		Age (in years)					Education level				dwellers	
	W	M	<30	30-40	40-50	50-60	>60	Il	Pr	Se	Un	V	C
Number of informants	136	126	28	62	52	83	37	104	33	63	62	198	64
Percentage	50	48	10.7	23.7	19.8	31.7	14.1	39.7	12.6	24.0	23.7	75.6	24.4

W: Women; M: Men; Il: Illiterate level; Pr: Primary level; Sc: Secondary level; Un: university level; V: Villages; C: City.

Through this survey, it was shown that the exploitation of medicinal plants was highly widespread throughout the study area at a percentage of 89% of the total population. The knowledge of medicinal plants, their properties, preparations and use were generally acquired following a long experience accumulated and transmitted from generation to generation.

Practitioners of traditional medicine were classified into five unequal age intervals; the highest frequency of use (31.7%) was shown by the age group 50-60 years old, followed by the age groups 30-40 and 40-50 years old with 23.7% and 19.8% respectively, finally, the lowest frequency of use (10.7%) was related to the youngest age group below 30 years old.

These percentages are a good illustration of the local traditional medicine knowledge, mainly related to the older population. Indeed, the elderly people are more likely to provide reliable information, because this age category holds much of the ancestral knowledge, orally transmitted. Unfortunately, this knowledge is currently less and less transmitted and tends to disappear as the youngest generation is no more interested in this knowledge due to a completely new lifestyle, the modernization of the quality of life and the development of the pharmaceutical industry.[6,4,38-40]

It was also noticed that both men and women were involved in the traditional medicine, however; women were more informed about medicinal species compared to men (52% versus 48%). These findings were concordant with numerous national ethnobotanical studies, reporting women knowledge to be higher than men's herbal medicine (52-62%),[4,5,25,27] also in term of medicinal plants collection, storage and recipes preparation, women were more involved than men. This predominance of women over men can be explained by their responsibilities as mothers,[41,42] they are the ones who give first aid to their children in cases of illness and know the secrets of the kitchen and the tricks of the healthy meals and domestic chores.[17]

Most of the traditional medicine users in this inquiry were illiterate with a percentage of 39.7%. Fortunately, despite the inverse relationship between the educational level and customs and traditions, the results showed a significant percentage of users with high educational level, namely secondary or university level with 24% and 23.7% respectively. Indeed, according to Boughrara and Legseir[27] these findings are related to the development of herbal medicine culture, the easy exchange of information and the awareness about the benefits of medicinal plants.

Finally, the highest percentage of use was shown by the villagers (75.6%) against only 24.4% of city dwellers (Table 1).

Medicinal species used

Most represented botanical family

The species inventoried in this inquiry belong to 38 families not homogeneously distributed. The Lamiaceae, Asteraceae and Apiaceae were the most reported families with 14.29% and 12.86% and 5.71% respectively (Figure 2).

These results were concordant with several ethnobotanical studies conducted in Algeria, indeed according to Boudjelal *et al.*[6] Benarba *et al.*[23] Ouelbani *et al.*[28] Bouasla and Bouasla[4] and Miara *et al.*[5] Lamiaceae, Asteraceae and Apiaceae were the most commonly used families throughout the country.

According to Güzel *et al.*[8] the popularity of Lamiaceae and Asteraceae may be due to their aromatic characteristics and to their wide geographical spread. Several studies have confirmed the benefits of these families, according to Miliauskas *et al.*[43] Khled Khoudja *et al.*[44] Maulidiani *et al.*[45] their importance lies in their high phenolic and flavonoid contents, compounds responsible for the antioxidant activity.

In comparison to Lamiaceae and Asteraceae, the remaining families such as Asphodelaceae, Cupressaceae, Ericaceae, Fabaceae, Fagaceae, Myrtaceae, Oleaceae, Rhamnaceae accounted for 2.86% each, while Amaryllidaceae, Anacardiaceae, Aristolochiaceae, Asparagaceae Boraginaceae, Brassicaceae, Cistaceae, Cucurbitaceae, Cytinaceae, Gentianaceae, Iridaceae, Lauraceae, Linaceae, Malvaceae, Nitrariaceae, Papaveraceae, Pinaceae, Plantaginaceae and Urticaceae accounted for only 1.43% each.

Finally, in addition to their therapeutic role, the herbaceous families provide a favorable environment for the germination of the shrub layer seeds and the growth of young seedlings.[46]

Most frequently used species

Among the 38 families, 70 species were described as medicinal plant in the study area the most cited and used were *Tetraclinis articulata*, *Pistacia lentiscus*, *Myrtus communis* and *Thymus vulgaris* with 6.49%, 6.11%, 5.34% and 4.96% respectively (Figure 3).

Although the Lamiaceae and Asteraceae families were the most commonly used in the region, only few of their species were among the most cited; indeed, the results showed that the part of Lamiaceae and Asteraceae species did not exceed a percentage of use of 3%.

Regarding *Tetraclinis articulata* (6.49%), called *Aaraar* by the local population, the leaves were mostly used in the form of infusion or

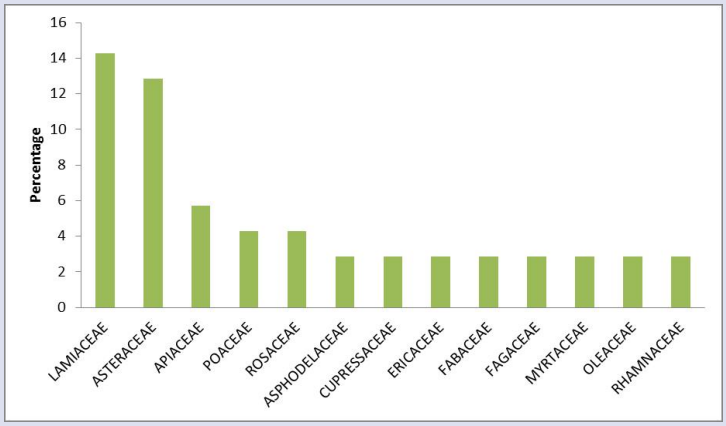

Figure 2: Most represented botanical families.

decoction to treat several digestive problems and metabolic disorders including diabetes. In addition to these properties the leaves were also confirmed to be effective against Hypoglycemia and hypotension while the seeds were efficient against Hypoglycemia,[20,21] In comparison to Algeria, *Tetraclinis articulata* is used in the same ways and treatments in Morocco (anti-diabetic and anti-hypertensive).[17]

According to Gonzalez-Tejero *et al.*[47] this species is recommended against respiratory system diseases, moreover, according to Ziyyat *et al.*[48] El Moussaouiti *et al.*[49] Bourkhiss *et al.*[50] Talbaoui *et al.*[51] besides its anti-hypertensive and anti-diabetic virtues, this plant is characterized by a high antibacterial activity.

Pistacia lentiscus (6.11%) was mainly used against the digestive and the respiratory system diseases. According to several studies this species is characterized by a high antioxidant capacity, the leaves are an important source of flavonoids, tannins, phenolic compounds and a very good source of natural pigments,[52-53] the extracts isolated from the aerial parts of this species have shown the presence of Terpineol, a substance known by its significant antimicrobial activity[54] and its ability to inhibit the Mycelian growth.[55]

When it comes to *Myrtus communis,* called *Rayhan,* it was mainly indicated locally in the treatment of digestive system diseases, in this context, the same treatment was reported by Gonzales-Terejo *et al.*[47] in Italy. According to Bouasla and Bouasla,[4] this plant is used in the form of infusion or decoction to treat hypotension, diabetes, rheumatism, diarrhea and anxiety in the Northeastern part of Algeria. In Morocco this species is traditionally used for the treatment of respiratory system diseases[47] and it is reported to be antihyperglycemic.[56] In Cyprus, Myrtus *communis* is known for the treatment of skin problems. Furthermore, the leaves and fruits extracts of this plant have been described as hypoglycemic and anti-inflammatory.[21]

Thymus vulgaris, called *Zaater* by the local population, was locally used in the form of infusion or decoction to treat genitourinary disorders, respiratory system troubles and certain digestive system diseases. An earlier study conducted by Bouzabata[21] in Souk Ahras in the Eastern part of Algeria showed that this species was used as stomachic, antiseptic and antispasmodic. *Thymus vulgaris* was also reported to be traditionally used as anti-diabetic in the South-East of Algeria.[26] Indeed, according to Hyun *et al.*[57] the Methanolic extract and the Ethyle Acetate fraction contained in this species play a strong antidiabetic activity. Furthermore, numerous studies have confirmed that Thymol and Carvacol isolated from this species exhibited anti-inflammatory effects.[4,58-61]

This inquiry also showed that *Anthemis arvensis* and *Mentha pulegium* were mostly used to treat respiratory diseases, *Lavandula stoechas* was frequently used for the treatment of digestive system diseases, while *Quercus ilex* was used in the case of digestive system diseases and rheumatic diseases. Finally, when used in the form of decoction, *Tetraclinis articulata* was a very effective remedy against flu, coughs and even rheumatism according to the local population. Other species mentioned by the local population according to their ethnopharmacological uses are presented in Table 2.

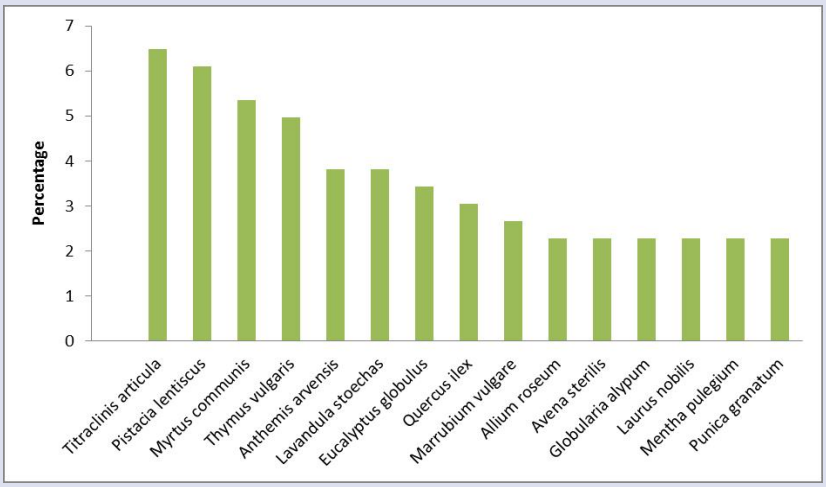

Figure 3: Most medicinal species used.

Table 2: List of medicinal plants and their related information.

Scientific name and FAMILY	Local names	Part used	Method of preparation	Mode of administration	Uses	Previous ethnobotanical literature records in Algeria
Ajuga iva (L.) Schreb. LAMIACEAE	Chendgoura	Le. A.pa.	Dec., Inf.	Ora.	colon ailments, stomachache, diabetes	6,21,23,26,28, 47,62-63
Allium roseum L. AMARYLLIDACEAE	Elthoum	Bu., A.pa.	Ckd.Inf. Pou.,Oth.	Ora.,Mas. Rin.	hypertension, stomachache,intoxications,cold, Cough, influenza,dental square	4,5
Aloe vera (L.) Burm.f. ASPHODELACEAE	Elsabar	Fl.	Oth.	Oth.	acne, hair loss	26
Ammoides pusilla (Brot.) Breistr. APIACEAE	Elnankha	Se.	Oth.	Ora.	menstrual cramps	
Ampelodesmos mauritanicus (Poir.) T.Durand & Schinz POACEAE	Eldiss	St.	Dec.	Rin.	Rhumatism, joints inflammation	6,63

Scientific name and FAMILY	Local names	Part used	Method of preparation	Mode of administration	Uses	Previous ethnobotanical literature records in Algeria
Anthemis arvensis L. ASTERACEAE	Elbabounej	Fl.,Le. A.pa.	Inf.,Dec. Pou.,Oth.	Ora.,Oth. Rin.	Migraine,nose allergy, sneeze,Hair loss,anxiety, Insomnia,joints pains,pulmonary allergy, sore throat (pharyngitis)	6,5
Anvillea radiata Coss. & Durieu ASTERACEAE	Elnagd	Fl.	Dec.	Ora.	Diabetes	63, 26
Arbutus unedo L. ERICACEAE	Lanj	Fr.	Oth.	Ora.	hypotension	27,47,63
Arisarum vulgare O.Targ.Tozz. ARACEAE	Elbgouga	Se.	Inf.	Ora.	constipation	
Aristolochia baetica L. ARISTOLOCHIACEAE	Borestom	A.pa.,Ro.	Oth.	Mas.,Ora.	wound,Tumors, cancers	6, 63
Asparagus acutifolius L. ASPARAGACEAE	Elzbiradj	St.	Dec.	Rin.	skin allergy,Migraine	23-24,47,62
Asphodelus ramosus L. ASPHODELACEAE	Elbarwag	Bu.,Ro.	Pou.,Oth.	Oth.	haemorrhoids,acne	4, 27,47
Atriplex halimus L. AMARANTHACEAE	Elktaff	Le.	Dec.	Ora.	intoxications	5-6,26, 28
Avena sterilis L. POACEAE	Elchoufan	Se.	Oth.	Ora.	Colon ailments,hypercholesterolemia, Diabetes, hypertension, obesity	
Borago officinalis L. BORAGINACEAE	Lsan elthour	Ro., Le.	Inf.,Dec. Pou.	Ora., Mas.	Depression,memory and neurological disorders, joints inflammation,gynecological problems	23, 27,47
Bunium bulbocastanum L. APIACEAE	Talghouda	A.pa.,Ro.	Oth.	Ora.	Asthma,pulmonary allergy, sore throat (pharyngitis),bronchitis	5,23
Calendula arvensis L. ASTERACEAE	Eldjomira	Le.,Ro.	Dec., Inf.	Ora.	Rhumatism	
Capparis spinosa L. CAPPARACEAE	Lakabbar	Ro.	Pou.	Mas.	joints pains,eczema	26,28,63
Carlina gummifera (L.) Less. ASTERACEAE	Leddad	Le.,Ba.,Ro.	Oth.,Pou.	Oth.	Spirituel,prostate infection	6
Centaurium erythraea Rafn GENTIANACEAE	Merradh el hnach	Le.,A.pa.	Inf.,Pou.	Ora.,Oth.	Diabetes	6,28
Ceratonia siliqua L. FABACEAE	Elkharoub	Fr.	Oth.	Ora.	stomachache,diarrhoea	4,28
Cistus monspeliensis L. CISTACEAE	Touzala	A.pa.,Le.	Dec.,Oth.	Ora.,Oth.	Diabetes,colon ailments,stomachache, kidney inflammations,wound	
Citrullus colocynthis (L.) Schrad. CUCURBITACEAE	Handhal	A.pa.	Oth.	Mas.	haemorrhoids	5-6,26,28,47,63
Clinopodium nepeta (L.) Kuntze LAMIACEAE	Elnabta	A.pa.,St.	Dec.,Inf.	Ora.	Colon ailments,stomachache,influenza, heart problems	
Crataegus oxyacantha L. ROSACEAE	Bab adjina	Le.	Dec.	Ora.	anxiety	4,27-28,47,63
Cupressus sempervirens L. CUPRESSACEAE	Elbostan	Le.	Dec.	Ora.	haemorrhoids	28,47
Cytinus hypocistis (L.) L. CYTINACEAE	Daghmous	Fl.	Oth.	Oth.	Heart problems	
Cytisus villosus Pourr. FABACEAE	Khiyatat lejrah, ratba	A.pa., Le.	Pou., Inf. Oth.	Oth., Ora.	wound, stomach ulcer , colon ailments, stomachache	27
Dittrichia viscosa (L.) Greuter ASTERACEAE	Magraman	A.pa. Le.	Pou., Oth.	Mas.,Oth., Rin.	Rhumatism, Seborrhea, joints pains	4,27-28,47,63
Erica arborea L. ERICACEAE	Elkhlilanj	St.	Inf., Dec.	Ora.	renal lithiasis, urinary infections, kidney inflammations,Pinworm infection, stomachache	23
Eucalyptus globulus Labill. MYRTACEAE	Elkalytous	Le.	Inf., Dec.	Ora., Oth.	Cold, Cough,bronchitis, pulmonary allergy,Rhumatism, nose allergy, sneeze,renal lithiasis	4,6,26-28,47
Ferula communis L. APIACEAE	Elawsaj	Le.	Oth.	Oth.	skin allergy	6
Gladiolus byzantinus Mill. IRIDACEAE	Baslate etdib	Bu.	Dec.	Rin.	female infertility	

Scientific name and FAMILY	Local names	Part used	Method of preparation	Mode of administration	Uses	Previous ethnobotanical literature records in Algeria
Globularia alypum L. PLANTAGINACEAE	Tassalgha	Le.	Dec.	Ora.	Diabetes,influensa ,gases, jaundice	4,6,26,28,47,63-64
Hordeum murinum L. POACEAE	Sboulet el far	Le.	Inf.	Ora.	jaundice	
Laurus nobilis L. LAURACEAE	Elrand	Le.	Dec., Inf. Oth.	Ora., Mas.	hypertension, hair loss	4, 27-28,47,63
Lavandula stoechas L. LAMIACEAE	Halhal, elkhozama	Fl., St. Le.	Dec., Inf. Oth., Ckd.	Mas.,Ora., Oth.	gases, anxiety,Heart problems, stomachache,Rhumatism, gynecological problems,pulmonary allergy	4, 27-28,47
Linum usitatissimum L. LINACEAE	Elkettan	Se.	Dec., Oth.	Ora., Rin., Oth.	emaciation, constipation, hypercholesterolemia,hypertension, pulmonary allergy,colon ailments,stomachache, earache,hair loss	4,28
Lonicera implexa Aiton CAPRIFOLIACEAE	Chahm elatrous	Le.	Oth., Dec.	Oth., Ora.	skin allergy eyes,enuresis	
Malva sylvestris L. MALVACEAE	Elkhobiz	Le.,Ro.	Ckd.,Inf. Dec.	Ora., whi.	hypertension, stomachache,Tooth ache, urinary infections	4,6,28,47
Marrubium vulgare L. LAMIACEAE	Timeriwat	Le., Fl., A.pa., St.	Dec., Inf. Ckd.	Oth., Ora.	Infertility, probleme des dents,Colon ailments, enuresis,haemorrhoids,Tumors, cancers,rhumatism	6,26,28,47,63
Mentha pulegium L. LAMIACEAE	Elfliou	Le.	Dec., Inf. Pou.	Ora., Oth.	Asthma, Migraine,anxiety,colon ailments, stomachache	4,6,28,47
Crataegus germanica (L.) Kuntze ROSACEAE	Elzaarour	Fl.,Le.	Dec.	Ora.	Heart problems,stomachache	4
Myrtus communis L. MYRTACEAE	Elrayhan	Le.	Dec., Inf. Pou.	Ora., Oth.	anxiety, gases, stomach ulcer, Throat of the nose,colon ailments, stomachache,constipation,anxiety, epistaxis,Asthma,Tooth ache	4,6,23,27-28,47,63, 65
Nepeta multibracteata Desf. LAMIACEAE	Timrsad	Le., A.pa.	Oth.	Ora., Oth.	gynecological problems, joints pains	
Olea europaea L. OLEACEAE	Elzebouj	Le.	Dec., Inf.	Ora., whi.	Rhumatism, gingivitis, tooth abscess	4,6,26-28,47,63
Opuntia ficus-indica (L.) Mill. CACTACEAE	Karmous nsara, hendi	St.	Oth.	Mas.	eczema	27,47
Papaver rhoeas L. PAPAVERACEAE	Benaaman	A.pa.	Dec.	Ora.	memory and neurological disorders	28,47
Peganum harmala L. NITRARIACEAE	Elharmel	Se.	Dec., Oth.	Ora.	stomachache, joints pains	4-6,26,28,47,64
Phillyrea latifolia L. OLEACEAE	Elktem	Le.	Inf.,Pou.	Ora., Oth.	stomachache, hair color	
Pinus halepensis Mill. PINACEAE	Elsnoubar	Se.	Oth.	Ora.	stomachache,kidney inflammations	4,23-24,47,63, 66
Pistacia lentiscus L. ANACARDIACEAE	Eldharou	Le., Se., A.pa.,	Oth., Dec. Inf., Pou. Oth., Ckd.	Mas., Ora.	Cough, Nervous colon, burns, Acne, skin allergy, wound, stomach ulcer, vomiting, stomachache, diarrhea,bronchitis, pulmonary allergy, earache	4-5,27-28,47,63
Punica granatum L. LYTHRACEAE	Kchour elroman	Ba.	Oth., Dec. Inf., Pou. Oth., Ckd.	Ora., Oth.	Colon ailments, wound,stomach ulcer , diarrhoea,cough	4,26-28,47
Quercus ilex L. FAGACEAE	Elbalout	Ba., Le. Fr.	Dec., Oth. Ckd.	Ora.	enuresis,Cough,stomach ulcer, haemorrhoids, Colon ailments,stomachache Diabetes,Bladder problems	47,63
Quercus suber L. FAGACEAE	Elfernan	Ba.	Oth.	Oth.	stomachache, enuresis,epistaxis	
Rhamnus alaternus L. RHAMNACEAE	Mlilles	St., Ba.	Dec.	Ora.	jaundice	5-6,23-24,28,47,66
Rosmarinus officinalis L. LAMIACEAE	Iklil eldjabel	Le., A.pa.	Dec., Inf.	Ora., Rin.	hypertension, Hair loss,eczema, colon ailments,stomachache	4-6,26-28,47,63
Rubus ulmifolius Schott ROSACEAE	Elaolig	St.,Fr.	Dec., Oth.	Ora., Oth.	scabies, Acne	27,47

Scientific name and FAMILY	Local names	Part used	Method of preparation	Mode of administration	Uses	Previous ethnobotanical literature records in Algeria
Ruta chalepensis L. RUTACEAE	Fidjel	A.pa., Le.	Dec.	Ora.	Insomnia, phobia, depression, anxiety	6, 24, 23-24,47,63
Salvia officinalis L. LAMIACEAE	Sauja	Se., Le. A.pa.	Inf., Oth.	Ora.	emaciation, stomachache, diarrhoea	4,6,26,28,47,63
Scolymus hispanicus L. ASTERACEAE	Guernina	A.pa. St.	Dec., Oth.	Ora.	colon ailments,stomachache, memory and neurological disorders, Rhumatism	
Silybum marianum (L.) Gaertn. ASTERACEAE	Elkhanfra	Fl.	Inf.	Ora.	hypotension	5
Sinapis arvensis L. BRASSICACEAE	Elkhardel	Se.	Oth.	Mas.	sciatica	
Sonchus arvensis L. ASTERACEAE	Elaasloudj	St.	Oth.	Ora.	anaemia	
Taraxacum officinale F.H.Wigg. ASTERACEAE	Elhendbaa	Le., Ro.	Inf., Dec.	Ora.	colon ailments,stomachache, constipation	6
Teucrium polium L. LAMIACEAE	Eldjaida	Le.	Inf.	Ora.	stomachache	4-6,26,28,47,63
Thymus vulgaris L. LAMIACEAE	Elzaater	A.pa., Le.	Oth., Dec.	Ora., Rin., whi.	Pinworm infection, influenza ,female infertility ,urinary infections ,Cold, Cough, Tooth ache ,Asthma, joints pains sore throat (pharyngitis), gynecological problems , Bladder problems, urinary infections, hypercholesterolemia,	4,26
Tetraclinis articulata (Vahl) Mast. CUPRESSACEAE	Aarar	Le.,A.pa., Fr.	Dec., Inf. Pou., Oth.	Ora., Oth.	Anxiety, stomach ulcer, cold tuberculosis, urinary infections, vertigo, Migraine, diarrhea, cough, colon ailments, stomachache	
Urtica dioica L. URTICACEAE	Horig, el kerras	A.pa.	Dec., Inf.	Ora.	Rheumatism,anemia, urinary infections, kidney inflammations, renal lithiasis, gases	4,6,27-28,47
Ziziphus lotus (L.) Lam. RHAMNACEAE	Sedra	Ro.	Dec.	whi.	Tooth ache	6,26,28

Inf: Infusion, Dec: Decoction, Ckd: Cooked, Pou: Poullice, Oth: Others, Ora: Oral, Rin: Rincing, Mas: Massage, Whi: Whitewashing, A.pa: Aerial parts, St: Stem, Le: Leaves, Fl: Flowers, Fr: Fruits, Bu: Bulbs, Ro: Roots, Se: Seeds, Ba: Barks.

Parts used and preparation

Among all the parts of medicinal plants, leaves were the most-used part throughout the study area with a percentage of 56.95% (Figure 4), in this respect, the predominance of leaves in traditional remedies has been reported by several studies in Algeria,[4-5,23,27,28] Spain,[67] Italy[68] and Turkey.[69]

The preference of leaves in traditional medicine can be explained by the ease and speed of harvest,[34,40,70] besides, the leaves are the site of photosynthesis and sometimes the storage site of secondary metabolites, responsible for the plant's biological properties.[71-73]

On the other hand, the insignificant use of fruits (2.67%), bulbs (2.67%) and roots (4.58%) is a very positive behavior, as it avoids the plant digging and guarantees the rapid recovery of the aerial part, similarly, the low use of flowers and fruits allows the natural seed dispersal and thus ensuring the survival of the species.

Decoction was the most frequent form of use in the study area with a percentage of 43.51% (Figure 5), the same finding was reported by several studies carried out throughout the Mediterranean basin including Algeria.[4-6,18,40,64,65,74]

In the study area, among all the surveyed population, the medicinal plants were orally administered in 71% of cases (Figure 6), whereas the remaining ways of use such as inhalation and fumigation were used in 18.3% of cases. In the cases of dermatological and rheumatic diseases, massaging was reported by 5% of the population.

According to Daoudi *et al.*[75] decoction in the form of tea, milk or water is the most common way of use in the cold areas; the decoction time varies from 15 to 20 min depending on the hardness of the leaves. The same authors report that decoction is the most effective way of use as long as it allows almost the full extraction and the best assimilation of the active compounds in addition to warming the body and disinfecting the plant; however, decoction could destroy some important active compounds.

Therapeutic indication

This inquiry showed that the majority of medicinal plants were mainly used against gastro-intestinal system diseases with a percentage of 28.24%, Ear, Nose and Throat (ENT) and respiratory diseases (14.12%), metabolic diseases (11.83%) and skin conditions (10.69 %) (Figure 7). The same findings have also been highlighted by several

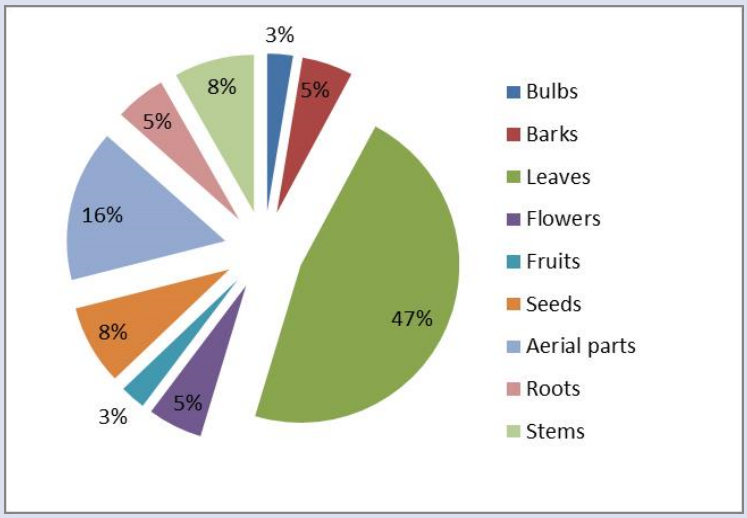

Figure 4: Medicinal plant parts used.

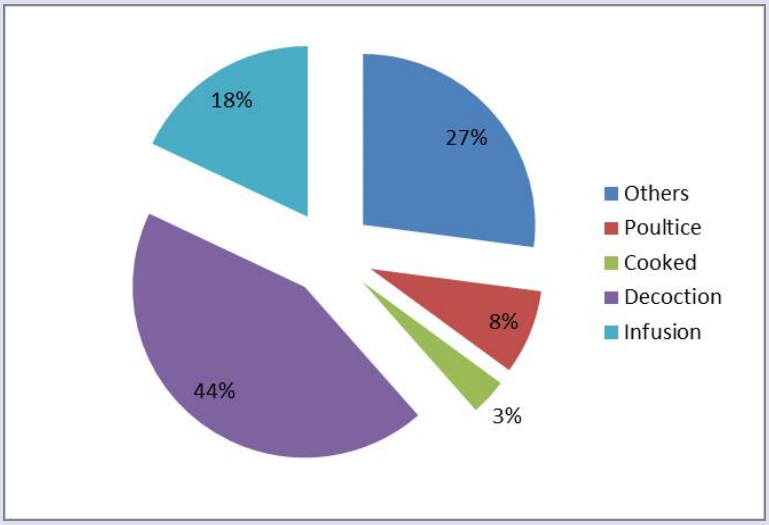

Figure 5: Methods of medicinal plants preparation used.

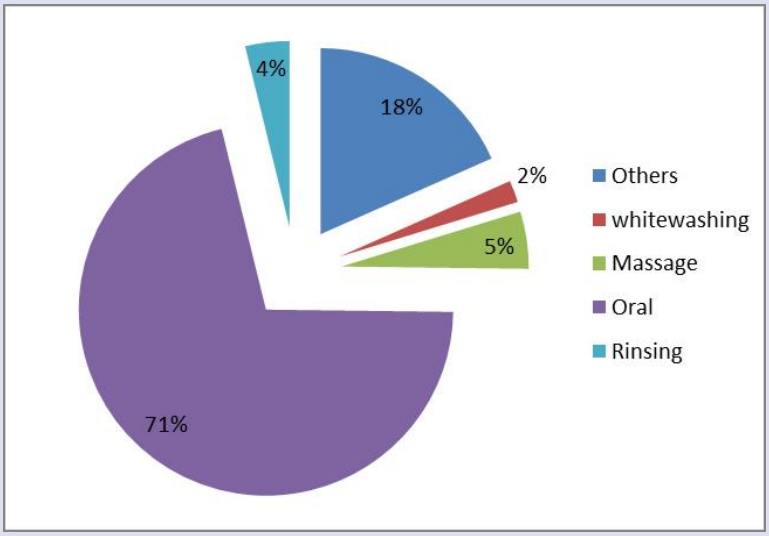

Figure 6: Modes of administration of medicinal plants used.

studies conducted in Algeria[4,5,28,62] and all around the Mediterranean basin[18,47,56,76,77] with slightly different percentages.

Statistical data analysis

Informant consensus factor (ICF)

Based on the used reports, the recorded data were classified into 10 different ailment categories (Table 3), the highest ICF values were related to the ENT and respiratory system diseases (0.67) followed by gastro-intestinal system diseases (0.59) and metabolic diseases (0.57), these high ICF values could be explained by the aptitude of informants to identify these categories of diseases known by their very common clinical signs, the simplicity of their treatment using medicinal plants[78-83] and also by the high incidence of these diseases in the study area. In the same context, osteo-articular diseases, oral cavity diseases and cancer showed the lowest ICF values.

Fidelity level (FL)

The fidelity level was calculated for the most cited species (15 plants), the higher the FL, the higher the preference of informants to a specific species compared to the rest (Table 4). The highest FL (100%) was shown for *Rhamnus alaternus,* a species mainly used in the study area against metabolic diseases, according to Benarba et *al.*[23] the same FL of 100% was shown for this species against hepatic diseases in Mascara in North-West Algeria. Indeed, *Rhamnus alaternus* is considered as hepatic active plant and is used against liver diseases. According to Azaizeh *et al.*[79] Ben Ammar *et al.*[80] Boudjelal *et al.*[6] Miara *et al.*[62] Khacheba *et al.*[81] this plant showed an encouraging inhibition of aflatoxin B1-, nifuroxazide-, sodium azide-induced mutagenicity and enzymatic activities of Aspergillus oryzae-amylase involved in hepatic cancers.

In term of skin diseases, the highest FL (25%) was observed for *Pistacia lentiscus*. In this context, the same finding was mentioned previously by Bouasla and Bouasla[4]. Regarding ENT and respiratory diseases

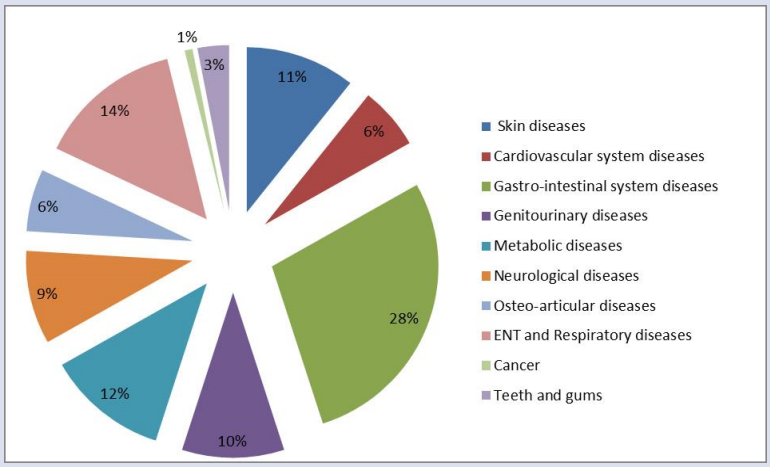

Figure 7: Main therapeutic indications.

Table 3: Informant Consensus Factor (IFC) per ailment category.

Category	Ailments/disorders	Number of used reports	Number of Taxa	IFC
Ear, Nose and Throat (ENT) and respiratory diseases	Cold, cough, asthma, bronchitis, influenza, pulmonary allergy, tuberculosis, earache, epistaxis, sore throat (pharyngitis), nose allergy, sneeze	37	13	0.67
Gastro-intestinal system diseases	Colon ailments, nervous colon, diarrhoea, gases, constipation, haemorrhoids, stomach ulcer, stomachache, intoxications, pinworm infection, vomiting	74	31	0.59
Metabolic diseases	Diabetes, hypercholesterolemia, emaciation, obesity, anemia, jaundice.	31	14	0.57
Neurological diseases	Migraine, depression, anxiety, insomnia, vertigo, phobia, memory and neurological disorders, spiritual	24	12	0.52
Skin diseases	wound, burns, hair color, hair loss, acne ,eczema, skin allergy, scabies, Seborrhea	28	19	0.33
Cardiovascular system diseases	Heart problems, hypertension, hypotension	16	11	0.33
Genitourinary diseases	Bladder problems, Prostate infection, menstrual cramps, Infertility, renal lithiasis, urinary infections, enuresis, kidney inflammations, gynecological problems.	26	18	0.32
Osteo-articular diseases	Rhumatism, joints inflammation, joints pains, sciatica.	16	13	0.20
Teeth and gums	Tooth ache, gingivitis, tooth abscess, dental square	8	7	0.14
Cancer	Tumors, cancers	2	2	0.00

Table 4: Fidelity level values (FL) for the most medicinal plants used.

Aliment category	Plants	FL (%)
	Pistacia lentiscus	25.00
Skin diseases	*Anthemis arvensis*	10.00
	Laurus nobilis	16.67
	Punica granatum	16.67
Cancer	*Marrubium vulgare*	14.29
	Lavandula stoechas	10.00
Cardiovascular system diseases	*Marrubium vulgare*	14.29
	Laurus nobilis	83.33
	Titraclinis articula	41.18
Gastro-intestinal system diseases	*Pistacia lentiscus*	31.25
	Myrtus communis	78.57
	Thymus vulgaris	7.69
	Lavandula stoechas	40.00
	Quercus ilex	50.00
	Marrubium vulgare	28.57
	Avena sterilis	33.33
	Globularia alypum	16.67
	Mentha pulegium	50.00
	Punica granatum	66.67
	Titraclinis articula	11.76
	Thymus vulgaris	38.46
Genitourinary diseases	*Lavandula stoechas*	11.11
	Eucalyptus globulus	11.11
	Quercus ilex	37.50
	Marrubium vulgare	33.33
	Anthemis arvensis	10.00
	Quercus ilex	12.50
Metabolic diseases	*Avena sterilis*	66.67
	Globularia alypum	66.67
	Rhamnus alaternus	100.00
	Titraclinis articula	29.41
Neurological diseases	*Myrtus communis*	7.14
	Anthemis arvensis	30.00
	Lavandula stoechas	30.00
	Mentha pulegium	33.33
	Titraclinis articula	17.65
	Pistacia lentiscus	43.75
ENT and respiratory diseases	*Myrtus communis*	7.14
	Thymus vulgaris	46.15
	Anthemis arvensis	40.00
	Eucalyptus globulus	88.89
	Globularia alypum	16.67
	Mentha pulegium	16.67
	Punica granatum	16.67
Osteo-articular diseases	*Anthemis arvensis*	10.00
	Lavandula stoechas	10.00
	Myrtus communis	7.14
Teeth and gums	*Thymus vulgaris*	7.69
	Marrubium vulgare	14.29

the highest FL (88.89%) was shown for *Eucalyptus*, in this category of diseases the same finding was reported for *Eucalyptus globulus* by Gonzales-Terejo *et al.*[47] in Albania, Benarba *et al.*[23] in Mascara (FL = 100%), Ouelbani *et al.*[28] in Constantine and Mila (FL = 93.93%).

Laurus nobilis was the main species used by the local population against cardiovascular system diseases with a fidelity level of 83.33%. According to Ouelbani *et al.*[28] *Laurus nobilis* recorded in the east side of Algeria an FL of 54.54% for the treatment of cardiovascular diseases.

Finally, two species received the highest FL in the treatment of gastro-intestinal system diseases by the local population, namely *Myrtus communis* (FL = 78.57%) and *Punica granatum* (FL = 66.67%). In this context Ouelbani *et al.*[28] and Benarba *et al.*[23] reported the same high FL for the two species against gastro-intestinal diseases in Constantine and Mila (East Algeria) and Mascara (West of Algeria).

CONCLUSION

This first ethnobotanical study conducted in the region of Bissa revealed a very rich local knowledge in term of traditional herbal medicine; this fact was reflected by the high diversity of species used in the treatment of several diseases. The gastro-intestinal disorders, respiratory troubles, metabolic diseases and skin affections were respectively the most frequently treated ailments and Lamiaceae and Asteraceae were the most commonly used botanical families. In light of this, it is therefore very important to subject some of the major species to further phytochemical and pharmacological studies in order to validate their traditional use and to probably discover new bioactive molecules.

It was also possible through this ethnobotanical study to notice the possibility of using these medicinal plants in local socio-economic development while preserving the floristic richness of the region of Bissa, in the framework of valorization of the human and natural potential.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

ABBREVIATIONS

IFC: Informant Consensus Factor; **FL**: Fidelity Level; **ENT**: Ear, Nose and Throat; **Inf**: Infusion, **Dec**: Decoction; **Ckd**: Cooked; **Pou**: Poullice; **Oth**: Others; **Ora**: Oral; **Rin**: Rincing; **Mas**: Massage; **Whi**: Whitewashing; **A.pa**: Aerial parts; **St**: Stem; **Le**: Leaves; **Fl**: Flowers; **Fr**: Fruits; **Bu**: Bulbs; **Ro**: Roots; **Se**: Seeds; **Ba**: Barks.

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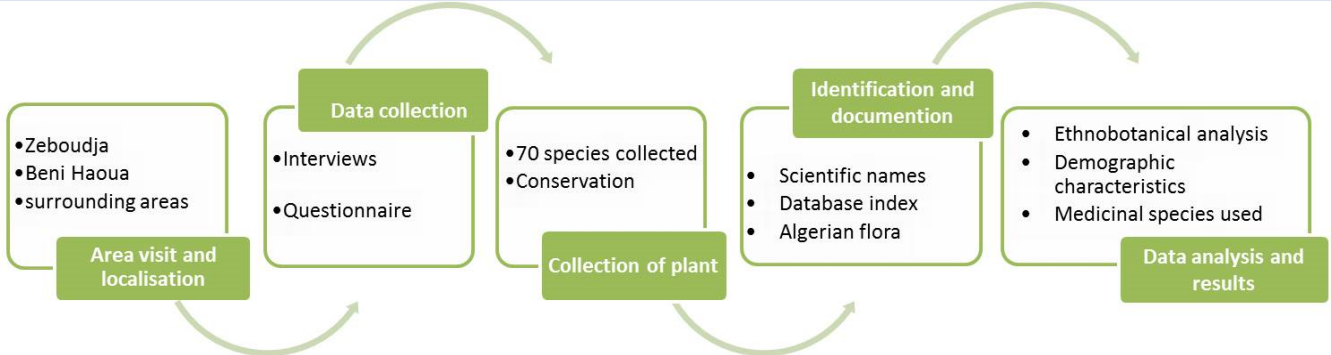
GRAPHICAL ABSTRACT



SUMMARY

This paper documented the results of ethnobotanical study carried out in the northeastern Dahra Mountains, Algeria. A total of 70 species belonging to 38 families. Lamiaceae and Asteraceae were the most used plant family by the local population. Leaves were the most used part, the majority of remedies were prepared as a decoction and gastro-intestinal system disorders were the most treated diseases. This first ethnobotanical study conducted in the region of Bissa revealed a very rich local knowledge in term of traditional herbal medicine.

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