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Original Article

Inventorization of ethnobotanical use of some medicinal halophytes plants in the Algerian arid zone (Biskra)

[Inventario del uso etnobotánico de algunas plantas halófitas medicinales en la zona árida de Argelia (Biskra)]

Zohra F. Behaz[1,2*], Fatma Demnati Allache[1,3], Naima Mebrek[1,2], Amina Belhadj[4]

[1]Department of Agricultural Sciences, University of Biskra, Algeria.
[2]Laboratory; Ecosystem Diversity and Production Systems Dynamics in Drylands (DEDSPAZA), Algeria.
[3]Development of Automatic and Intelligent Control Systems in Agriculture in Arid Regions (DAICSAAR), Algeria.
[4]Higher School of Saharan Agriculture, El Oued, Algeria.
*E-mail: fatimazohra.behaz@univ-biskra.dz, fatima_agro@hotmail.com

Abstract

Context: The population's use of halophyte plants in traditional medicine is a fundamental component of the exploration of natural remedies.

Aims: To analyze a list of halophyte plants and their ethnobotanical characteristics, with a focus on those most commonly used in traditional medicine in the southeast of Algeria (Biskra).

Methods: The ethnobotanical surveys were conducted between 2017 and 2019 by interviewing 120 informants using a questionnaire and applying a semi-structured interview methodology. The data was analyzed using ethnobotanical statistical tools, including the informant consensus factor (ICF), citation frequency (CF), use value (UV), family importance value (FIV), relative frequency of citation (RFC), plant part value (PPV), and relative importance (RI), as well as statistics analysis (ANOVA) to compare the use of medicinal plants according to age, gender, and education level.

Results: The results of the survey enabled us to identify 12 species distributed across eight different families. The most common family was that of the *Amaranthaceae* (four species), while the most frequently utilized parts of plants were leaves (PPV = 0.4). Furthermore, decoctions were the most commonly prepared form (33.39%). The highest ICF values were observed for the endocrinological and digestive disease groups (ICF = 0.97). The statistical analysis (ANOVA) revealed a significant difference in the knowledge of the use of halophyte plants in traditional medicine according to age and level of education.

Conclusions: The findings of this research suggest that the halophyte flora in our arid study area may offer a promising source for the discovery of new drugs, a prospect that requires further investigation and exploration.

Keywords: Biskra; diseases; ethnobotanical survey; halophyte plants; traditional medicine.

Resumen

Contexto: El uso de plantas halófitas por parte de la población en la medicina tradicional es un componente fundamental en la exploración de remedios naturales.

Objetivos: Analizar una lista de plantas halófitas y sus características etnobotánicas, centrándose en las más utilizadas en la medicina tradicional en el sureste de Argelia (Biskra).

Métodos: Las encuestas etnobotánicas se realizaron entre 2017 y 2019 entrevistando a 120 informantes mediante un cuestionario y aplicando una metodología de entrevista semiestructurada. Los datos se analizaron utilizando herramientas estadísticas etnobotánicas, incluido el factor de consenso del informante (ICF), frecuencia de citación (CF), valor de uso (UV), valor de importancia familiar (FIV), frecuencia relativa de citación (RFC), valor de parte de la planta (PPV), e importancia relativa (RI), así como análisis estadístico (ANOVA) para comparar el uso de plantas medicinales según edad, sexo y nivel educativo.

Resultados: Los resultados del estudio nos permitieron identificar 12 especies distribuidas en ocho familias diferentes. La familia más común fue la de *Amaranthaceae* (cuatro especies), mientras que las partes de las plantas más utilizadas fueron las hojas (PPV = 0,4). Además, las decocciones fueron la forma más comúnmente preparada (33,39%). Los valores más altos de LIC se observaron para los grupos de enfermedades endocrinológicas y digestivas (ICF = 0,97). El análisis estadístico (ANOVA) reveló diferencia significativa en el conocimiento sobre el uso de plantas halófitas en la medicina tradicional según edad y nivel de escolaridad.

Conclusiones: Los hallazgos de esta investigación sugieren que la flora halófita en nuestra árida área de estudio puede ofrecer una fuente prometedora para el descubrimiento de nuevos fármacos, una perspectiva que requiere más investigación y exploración.

Palabras Clave: Biskra; enfermedades; estudio etnobotánico; medicina tradicional; plantas halófitas.

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AUTHOR INFO
ORCID: 0000-0001-9232-0498 (ZFB)
0000-0002-6793-5041 (FDA)
0000-0003-3436-3478 (AB)

INTRODUCTION

For several decades, plants have served as valuable sources of medicinal substances, with the transmission of traditional knowledge occurring across generations and among communities. (Cox and Balik, 1994**;** Vitalini et al., 2013). Algeria, characterized by its large area and varying climatic conditions, has a vast range of flora, which serves as a valuable and plentiful source of medicinal resources (Chériti et al.,1995). The plants found in the Sahara region are well recognized for their remarkable capacity to endure and adapt to various environmental factors (Bouaziz et al., 2009). The vegetation of drylands, particularly that of the Sahara, is very remarkable for its adaptation to a dry climate and salty soil (Ozenda, 1991). Diverse salty ecosystems, such as salt marshes along the coast and salt deserts and flats inland, support the growth of halophytes (Qasim et al., 2014). The capacity of halophytes to mitigate oxidative stress induced by salinity is regulated by many adaptation mechanisms. These mechanisms mostly include the production of osmolytes and antioxidants, which explains the historical utilization of halophytes as therapeutic and dietary plants (Ksouri et al., 2008). Many halophytes have been used in traditional medicine for centuries (Ksouri et al., 2012). Various plant parts, such as leaves, roots, seeds, fruits, barks, latex, or whole plants, are employed in the form of juices, decoctions, or infusions. They may also be subjected to processes such as maceration, grinding into powder, crumpling into pastes or poultices, or incineration to obtain ashes (Petropoulos et al., 2018). Ethnobotany and ethnopharmacology bring together the ancestral knowledge of traditional healers and current scientific knowledge (Gurib Fakim, 2006). This knowledge is transmitted orally, and the risk of its disappearance is real (Sundara Rajoo et al., 2023). The data provided by ethnopharmacology frequently leads to the selection of plants with high pharmacological potential (Bouayyadi and Zidane, 2020; El Khomsi et al., 2022). Many desert plants have been employed in traditional medicine for centuries (Yaseen et al., 2015). Similarly, halophytic plants play a pivotal role in the maintenance of ecosystem services and serve as a vital resource for rural communities in the Saharan region (Demnati et al., 2020). However, the ethnobotanical research pertaining to the utilization of halophytic plants in phytotherapy is generally understudied, particularly in our study region. However, the local population of the area employs medicinal plants to treat a variety of ailments due to the remoteness of health centers and the transfer of indigenous knowledge about halophytic plants from generation to generation. The present study was initiated with the aim of listing the halophytic plants used by Saharan populations in traditional treatments in southeast Algeria and making significant contributions to this field.

MATERIAL AND METHODS

Presentation of the study area

The study area (34°48'33'' N, 06°44'05'' E) is situated in the middle eastern part of Algeria and the southern part of the Saharan Atlas, known as the gateway to the Sahara (Biskra). The desert bioclimatic zone, which includes Biskra, is characterized by intense light and irrigable rainfall. The average annual precipitation is about 152 mm per year. The average annual temperature varies from 40°C in July, which represents the warmest month, to 7°C in January, which represents the coldest month. (Belhadj et al., 2023). We selected six sites in the province of Biskra (Biskra, Loutaya, Elhadjeb, Sidi Okba, Oumach, and Elhaouch) for sampling due to their floristic diversity, ecological features, and climatic conditions. These sites provide the local population with a wealth of knowledge in traditional phytotherapy, thanks to the renowned expertise of traditional healers in using therapeutic plants. (Fig. 1).

Ethnobotanical survey and sampling

From 2017 to 2019, we collected data using the ethnobotanical interview. This survey is based on semi-structured questionnaires or a focused interview (Demnati, 2013), focusing on the utilization of halophytic plants cited in traditional pharmacology. We conducted the interview using a pre-designed questionnaire, randomly selecting traditional healers, herbalists, and local population participants from the various sampled sites. The age, gender, and education level of 120 informants were recorded (Table 1), asking them questions about plants, their scientific and common names, the parts they used, preparation methods and forms, pharmacological knowledge, and therapeutic indications. We conducted the interview in the local Arabic dialect spoken by the informants. Several plants were documented with the local names provided by the informants. A literature search was conducted to determine the scientific and common names associated with the local names provided by the informants. The names from the literature and the correct nomenclature of the taxa were validated in the plant list database.

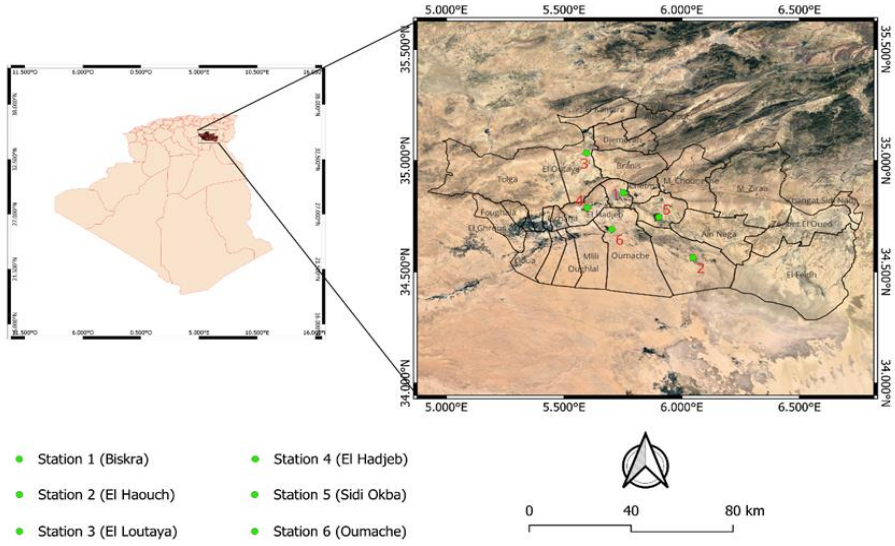

Figure 1. Map of the study area.

Table 1. The socio-demographic description of the informants.

Variable	Number	Percentage (%)
Distribution by gender		
Woman	72	60
Male	48	40
P-value	*<0.025*	
Age		
<20	3	2
20-40	51	43
40-50	43	36
> 60	23	19
P-value	*<0.005*	
Level of education		
Illiterate	18	15
Primary	21	18
Secondary	35	29
High school	23	19
University	23	19
P value	*<0.0001*	

Anthropological

The survey and data, established in the laboratory of Ecosystem Diversity and Production Systems Dynamics in Drylands (DEDSPAZA) and validated by experts in the field, were made available to respondents for completion. The survey provided information on the respondents, including age, sex, therapeutic practice, and other relevant details. It also collected data on the medicinal plants used, including their vernacular names, types of diseases treated, and parts used. Each informant was informed of the study's aims and objectives before being asked to participate. It was emphasized that the research was not for commercial purposes but for academic reasons. Ethical information was noted on cards bearing the number of the interviewee and in complete anonymity after respondents' consent was obtained.

Data analysis

A quantitative ethnobotanical method was used to examine the acquired data as Informant Consensus Factor (ICF), Citation Frequency (CF), Use Value (UV), and Relative Importance (RI).

Informant Consensus Factor

The informant consensus factor (ICF) reflects the consensus of informants on the use of plant species in the treatment of different disease categories (Heinrich et al., 1998). This variable was calculated following the formula [1].

$$ICF = \frac{Nur - Nt}{Nur - 1} \quad [1]$$

Where Nur is the number of uses reported (number of conditions within a disease category) for a disease category treated by a plant species, and Nt is the number of plant taxa used to treat this category of disease.

Frequency of citation

For each use category, the frequency of citation (Fc) was determined according to the formula [2] of Prance et al. (1987).

$$FC\ (\%) = \frac{n}{N} \times 100 \quad [2]$$

Where N is the number of citations of a species for all categories, and n is the number of citations of a species for a disease category.

Use value

Use value (UV) is an ethnobotanical index that shows the relative importance of locally known plant species based on the number of recorded uses for each species (Trotter and Logan, 1986). This variable was calculated following the formula [3].

$$UV = \frac{U}{n} \quad [3]$$

Where U represented the total number of uses per species while "n" was the number of informants who reported the plant species.

Relative Importance

Relative importance (RI) determines the importance of a plant species based on the number of uses of each plant species and the organic systems it addresses (Bennett and Prance, 2000). This variable was calculated following the formula [4].

$$RI = \frac{(R.\,Ph + R.\,BS)}{2} \times 100 \quad [4]$$

Where "R.Ph" was the relative pharmacological properties (relative use ratios) and "R.BS" was the relative body systems processed. The relative pharmacological properties (R.Ph) of a plant species convey its applications. The "R.Ph" was determined by dividing the number of uses (U) by the most used ratios in the entire study. The "R.BS" was determined by dividing the number of body systems treated by a plant species by the highest number of body systems treated per species throughout the entire study.

Relative Frequency of Citation

Relative Frequency of Citation (RFC) was calculated to appreciate the local importance of each species. The RFC was the result of the Citation Frequency (Fc), that was the number of informants who mentioned the use of the species, divided by the total number (N) of respondents, according to the formula [5], with ($0 < RFC < 1$) (Tardío and Pardo-de- Santayana, 2008).

$$RFC = \frac{Fc}{N} \quad [5]$$

Family Importance Value

The family Importance value (FIV) serves as a cultural significance indicator that ethnobotanists may use to determine the biological plant taxonomic value. It was calculated by the formula [6] (Cadena-González et al., 2013).

$$FIV = \frac{FCfamily}{Ns} \quad [6]$$

Where FCfamily was the RFC, the number of informants mentioning the family, and Ns was the total number of species in each family.

Plant Part Value

The Plant Part Value (PPV) was calculated to assess the importance of each part of the plant used by the respondents, and it was obtained by the following formula [7].

$$PPV = \frac{RUplant\ part}{RU} \quad [7]$$

Where RUplant part was the sum of reported uses per part of the plant, and RU was the number of reported uses of all plant parts.

Statistical analysis

Descriptive statistical analysis (ANOVA) was performed using XLSTAT (Version 2016.02.28451) to compare herbal medicine use by age, gender, and education level.

RESULTS

Diversity of medicinal plants

The survey made identifying twelve halophyte species with medicinal uses in phytotherapy easier. These species belong to eight botanical families. Based on the number of species and the FIV index, the *Amaranthaceae* were the leading family, represented by four species (FIV 0.7); the *Asteraceae*, represented by

two species (FIV 0.98), and there were six other families, each represented by one species only. (Fig. 2).

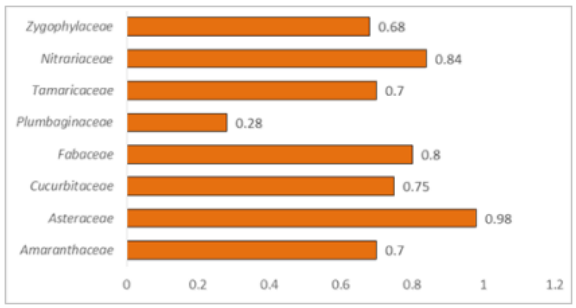

Figure 2. Distribution of the recorded plants according to the family importance value.

Table 2 summarizes the species of halophyte medicinal plants, their vernacular names (Fon local language), the parts of the plants used, the methods of preparation, and their therapeutic use.

Method of preparation

According to Fig. 3, of the six techniques for preparing medicinal plants, decoction (33.39%) was the form most used by the local population, followed by infusion (29%). The local applications that were less used were poultice (12%), paste and powder (10%), and essential oils (5%).

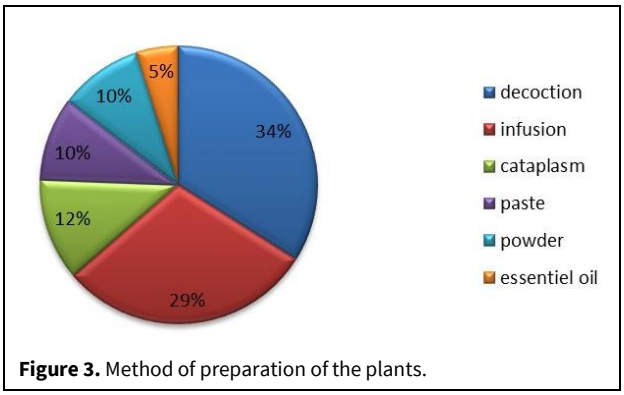

Figure 3. Method of preparation of the plants.

Plant Parts Value (PPV)

Different medicinal remedies used various parts of the plant (Fig. 4). According to the plant part value (PPV index), the leaves (PPV 0.4) remained the most used part for remedies, followed by the aerial part (PPV 0.29). The remaining plant parts, in decreasing order, continued to receive less use as the stem (PPV 0.25), the entire plant (PPV 0.12), the root (PPV 0.04), the seeds (PPV 0.046), the fruits (PPV 0.03), the bark (PPV 0.01), and the flowers (PPV 0.05). Different studies in Africa, Asia, and America prove the dominance of using leaves (Hadjaj et al., 2015).

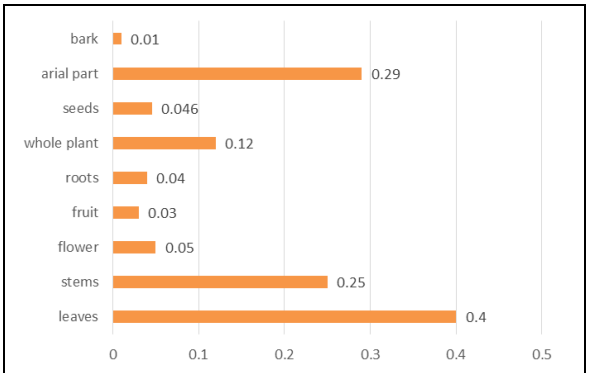

Figure 4. Plant parts used in phytotherapy according to the PPV index.

Demographic data

The present study interviewed 72 men and 48 women (Table 1). Only 2% of informants are under 20, 43% are 20–39, 36% are 40–59, and 19% are over 60. According to age, there was a significant difference in knowledge about the use of halophyte plants in traditional medicine ($p<0.0001$). The older ones reported several diseases compared to the younger ones. There was no significant difference in knowledge about halophyte plants across genders; respondents had similar awareness about halophyte plants used in traditional medicine.

Regarding the educational level of the informants, the results show that 19% (illiterate) have not attended school, while 29% have achieved a medium level (can read and write in Arabic). On the other hand, the primary, secondary, and university levels are 18% and 19%, respectively (Table 1). There was a significant difference ($p<0.0001$) in local knowledge about halophyte plants in traditional medicine according to education level. Participants with higher education levels (secondary school and university education) had more plant usage knowledge than those with less formal education.

Quantitative analyses of ethnomedicinal data

The Informant Consensus Factor (ICF) and Frequency of Citation (Fc) were used. Informant consensus was employed to bolster the ethnobotanical data and ascertain the extent of each plant's citation (Table 3). A quantitative analysis of the informants' consensus regarding the medicinal plants cited for the treatment of various diseases was performed. All diseases treated into 15 groups were categorized to reach this consensus. In this study, the ICF for genital, endocrine, and cardiovascular diseases was high (0.97). Dermatological diseases and toxicological diseases came in third (0.95). Hearing diseases and ophthalmologic diseases presented with the lowest levels (0.5 and 0.00, respectively). The highest plant use citation (378) was for endocrine diseases, followed by

digestive problems (231), toxic disorders (173), dermatological diseases (164), genital diseases (155), and rheumatic diseases (100). According to Table 4, for endocrine diseases, we reported *S. fruticosa* (Fc = 91.66%), *C. colocynthis* (Fc = 63.1%), and *A. halimus* (Fc = 53.69%) as the most frequently used plants. However, for digestive disorders, *L. guyonianum* (Fc = 59.45%) and *A. campestris* (Fc = 44.56%) were the most frequently cited. The most commonly used medicinal species for poisoning was *A. herba alba* (Fc = 49%). In dermatology treatment, the species *R. retam* (Fc = 56.07%) and *T. gallica* (Fc = 36.49%) are the most commonly used. However, the population most frequently requests *H. scoparia* (Fc = 50.98%) and *P. harmala* (Fc = 31.54%) for genital diseases and *P. harmala* (Fc = 24.16%) for rheumatism. The use of medicinal plants in disease treatment showed a highly significant difference ($p<0.00001$), except for ophthalmological and otolaryngological diseases ($p<0.024$) (Table 4).

Use value (UV)

The results showed that the UV varied from 0.025 to 1.6, according to the calculated values. *Artemisia campestris* has the highest value (1.6), followed by *Artemisia herba-alba* (1.53), *Hammada scoparia* (1.25), *Atriplex halimus* (1.24), and *Limoniastrum guyonianum* (0.96). The lowest values were for *Retama reatam* (0.02), *Tetraena cornuta* (0.3), and *Tamarix gallica (0.3*).

Relative Importance (RI)

The RI range was from 13 to 100. *Citrullus colocynthis* had the highest RI, whereas *Suaeda vera* showed the lowest. *Atriplex halimus*, *Hammada scoparia,* and *Peganum harmala* were important plant species that showed versatility in treating many diseases of the human body.

Relative Frequency of Citation (RFC)

The quantitative ethnobotanical survey highlights the significance of traditional knowledge, as evidenced by the RFC values. Species with a substantial RFC indicate their extensive utility. It ranged from 0.25 to 1. Results of this study showed that *Artemisia herba-alba* exhibited the highest (1.00), followed by *Artemisia campestris* (0.97), *Peganum harmala* (0.84), and *Atriplex halimus* (0.81). *Nirosalsola vermaculata* exhibited the lowest RFC (0.25), followed by *Limoniastrum guyonianum* and *Suaeda vera* (0.29).

DISCUSSION

The dominance of *Amaranthaceae* and *Asteraceae* in this study aligns with the findings reported on halophytic plants in the Pakistani area (Bahdur et al., 2020; Demnati et al., 2020). Furthermore, Mechaala et al. (2021) inferred that *Asteraceae* and *Lamiaceae* have a prominent presence in the northern region of Biskra. *Amaranthaceae* dominance in arid environments is linked to certain environmental factors (Belhadj et al., 2023; Ghulam et al., 2015). The interaction between environmental circumstances and resource availability significantly influences the abundance and functional distinctive qualities of species within a certain area (Noman, 2013).

The ethnobotanical field survey interviewed 120 people, including 20 healers and 20 herbalists. The 20-39 age group had the highest user rate (43%), followed by the 40-59 age group (36%). This result confirms that obtained by several authors, such as Elhilah et al. (2015) and Kadri et al. (2018). 60% of the informants were men; these results are similar to those obtained (Mushtaq et al., 2018; Telli et al., 2016). Contradicting to many ethnobotanical studies, which indicate that traditional knowledge is always common among women (Lahsissene and Kahouadji, 2010; Negrelle et al., 2007), the sexes were equal (Lozada et al., 2006). Communities with limited education often possess traditional knowledge (Kayani et al., 2015; Mushtaq et al., 2018).

Leaves were the most often used part, confirming the convenience and efficiency of leaf collecting (Hadjaj et al., 2015; Ghulam et al., 2021; Kord et al., 2019). The process of gathering leaves and using them for medicinal purposes is comparatively simpler in contrast to the collection and use of roots, flowers, and fruits (Giday et al., 2009). People often prefer roots over leaves in various applications, possibly because they contain more bioactive chemicals than other plant components (Basualdo et al., 1995; Srithi et al., 2009). The extensive use of leaves is due to their dual role as the primary site for photochemical reactions as well as reservoirs of organic materials resulting from these processes. These specific parts of plants make and store many different kinds of alkaloids, heterosides, and essential oils (Ould El Hadj et al., 2003).

The method of preparing medicinal plants is contingent upon the intended mode of administration, which may include decoction, infusion, powder, poultice, oil, or paste. Nevertheless, decoction was the predominant preparation method, with infusion and powder being the next most commonly used techniques. These results are in agreement with Telli et al. (2016). This could explain the rationale for the preference for soft powder among several herbalists. According to the findings, a significant proportion of participants said that powder preparation is a straightforward process with a lower risk of contamination than juice or decoction preparation (Mushtaq et al., 2018).

Table 2. Use of the plants studied in traditional medicine in the region of Biskra.

Family/ species name	Vernacular name	FC	RFC	FIV	UV	IR%	Part used	Method of use	Traditional use
Amaranthaceae				0.70					
Atriplex halimus L	Gtaf, القطف	98	0.81		1.24	73.5	Leaves, aerial parts, stems, whole plants.	Infusion, decoction, cataplasm, powder.	Diabetes, weight loss, ovarian cysts, joint and muscle aches, fatigue, inflammation, drying wounds, infertility, thyroid, fibroids, flu, general weakness, indigestion, appetite, rheumatism, hypertension
Hammada scoparia Pomel.	Remth, رمث	91	0.75		1.25	57.5	Leaves, stems, aerial parts, whole plant.	Infusion, decoction.	Diabetes, stomach ulcer, sterility, rheumatism, indigestion, scorpion stings, snake bites, wounds and burns, for hair loss, fever, eczema, against fungus, weakness, infertility, herniated disc, and scabies.
Suaeda vera Forssk. ex J.F.Gmel.	Soauida, سويدة	35	0.29		0.85	13	Leaf, aerial parts.	Infusion, decoction, paste.	Diabetes, and injuries.
Nitrosalsola vermiculata (L.) Theodorova	Moulleyh, مليح	30	0.25		0.89	51	Leaf, aerial parts.	Infusion, decoction, paste.	Stomach aches, intoxication, wounds, and treatment of pimples.
Asteraceae				0.98					
Artemisia herba-alba Asso	Chih, الشيح	120	1		1.6	71	Leaves, stems, aerial parts.	Infusion, decoction, poultice, powder, essential oil.	Diabetes, urinary tract problems, gastric pain, deworming, weight loss, rheumatism, body cooling, intoxication, stomachache, flu, indigestion, colic, painful periods, nausea, and vomiting.
Artemisia campestris L.	Tgouft ,تقفت	117	0.97		1.53	57.5	Leaves, stems, whole plant.	Infusion, decoction, cataplasm, powder.	Diabetes, digestive disorders, stomachache, convulsions, urinary problems, weight loss, intoxication, painful periods, childbirth, diarrhea, and dental pain
Cucurbitaceae				0.75					
Citrullus colocynthis (L.) Schrad.	Hdaj, الحج	91	0.75		1.14	100	Fruits, roots.	Cataplasm, powder, essential oil.	Diabetes, rheumatism, fever, hemorrhoids, genital infection, indigestion, gonarthrosis, joint pain, dermatitis, scorpion stings, and inflammation.
Fabaceae				0.80					
Retama reatam (Forssk.) Webb	Rtam, رتم	96	0.80		0.025	60.5	Leaves, aerial parts, whole plant, roots.	Infusion, decoction	Diabetes, healing, rheumatism, wounds, scorpion stings, snake bites, burns, respiratory ailments, and stomach ulcers.

Table 2. Use of the plants studied in traditional medicine in the region of Biskra (continued...)

Family/ species name	Vernacular name	FC	RFC	FIV	UV	IR%	Part used	Method of use	Traditional use
Nitrariaceae				0.84					
Peganum harmala L.	Harmel, الحرمل	101	0.84		0.3	80	Leaves, seeds, flowers, roots.	Infusion, decoction, poultice, powder, essential oil	Diabetes, sterility and infertility, joint pains, rheumatism, fever, children's convulsions, insomnia, pain, deworming, and respiratory diseases.
Plumbaginaceae				0.28					
*Limoniastrum guyonianum Durieu ex*Boiss.	Zeyta, زيتة	34	0.28		0.96	92.5	Leaf, aerial parts, whole plant, bark.	Infusion, decoction, poultice, powder, essential oil	Inflammation of the intestines, depurative, vermifuge, intestinal pain, injuries, acute diarrhea, and indigestion.
Tamaricaceae				0.70					
Tamarix gallica L.	Tarfa, طرفة	85	0.70		0.3	34.5	Leaves, bark, aerial parts, roots.	Infusion, decoction, poultice, powder, essential oil	Diabetes, healing for acne marks, stomachache, stress and insomnia, hypotension, against lice, burns, dental pain, colon cancer, fever, stomachache, hemorrhoids, joint ache, flu, indigestion, migraine, skin lesions, and hemorrhage.
Zygophyllaceae				0.68					
Zygophyllum cornutum Coss.	Aggaya, Bougriba, العقاية بوقريبة	82	0.68		0.29	31	Leaves, aerial parts, whole plant, roots.	Infusion, decoction, cataplasm	Diabetes, healing, stomach aches, dental pain, burns and wounds, hypotensive, scorpion stings, dermatitis, indigestion, urinary problems, migraine, stomach ulcer, trachoma, earache, angina, diarrhea, and indigestion.

Table 3. Informant Consensus Factor (ICF) for different disease categories.

Ailment	Number of taxa (Nt)	Number of use reports (Nut)	ICF
Nervous disease	4	26	0.88
Skin disease	9	164	0.95
Urinary disease	3	15	0.85
Genital disease	5	155	0.97
Digestive disease	11	231	0.95
Respiratory disease	5	15	0.72
Visual disease	2	3	0.5
Endocrine disease	10	378	0.97
Cancerous disease	1	4	1
Poisonous disease	8	173	0.95
Rheumatic disease	8	100	0.93
Dental disease	3	17	0.87
Parasitic disease	7	36	0.83
Cardiology disease	3	31	0.97
Auditory disease	1	1	0

Table 4. Frequency of citation (Fc %) of the studied plants according to the treated diseases.

Ailment	*A. halimus*	*P. harmala*	*A. herba alba*	*A. campestris*	*H. scoparium*	*R. retam*	*T. gallica*	*C. colocynthis*	*T. cornuta*	*L. guyonianu m*	*S. vera*	*N. vermiculata*	P-value
Nervous disease	-	1.34	-	5.97	-	-	7.29	-	2.58	-	-	-	<0.0001
Skin disease	2.01	-	-	-	7.84	56.07	36.49	1.94	25.86	8.1	8.33	20	<0.0001
Urinary disease	-	-	4.95	2.17	-	-	-	-	0.86	-	-	-	<0.0001
Genital disease	29.53	31.54	0.99	5.43	50.98	-	-	-	-	-	-	-	<0.0001
Digestive disease	4.02	2.68	27.22	44.56	8.82	2.8	9.48	3.88	15.51	59.45	-	-	<0.0001
Respiratory disease	0.57	1.34	1.48	-	-	1.86	5.1	-	-	-	-	-	<0.004
Visual disease	-	-	-	-	-	-	0.72	-	1.72	-	-	-	<0.024
Endocrine disease	53.69	30.87	11.38	20.65	20.58	12.14	18.97	63.1	28.44	-	91.66	-	<0.0001
Cancerous disease	-	-	-	-	-	-	2.91	-	-	-	-	-	<0.0001
Poisonous disease	-	-	49	20.1	5.88	10.28	-	0.97	0.86	16.21	-	34.28	<0.0001
Rheumatic disease	5.36	24.16	4.95	-	1.96	16.82	0.72	23.3	0.86	-	-	-	<0.0001
Dental disease	-	-	-	1.08	-	-	1.45	-	11.2	-	-	-	<0.0001
Parasitic disease	4.69	8.05	-	-	3.92	-	2.18	2.91	-	16.21	-	2.85	<0.0001
Cardiology disease	-	-	-	-	-	-	10.21	3.88	11.2	-	-	-	<0.0001
Auditory disease	-	-	-	-	-	-	-	-	1	-	-	-	<0.024

The species with the highest use value were *Atremisia campestris*, *Artemisia herba-alba, Hammada scoparia, Atriplex halimus*, and *Limoniastrum guyonianum*. Other regions of Algeria frequently use these plants with high UV (Telli et al., 2016).

The RI of medicinal plants reflects their full application value (Albuquerque et al., 2006). The species *A. halimus*, *C. colocynthis*, and *S. fruticosa* were most effective in treating the endocrine disease. *L. guyonianum and A. campestris* were used to treat digestive pathologies. The most common species used to treat poisoning was *A. herba alba*. However, studies by Mushtaq et al. (2018) showed that the IR ranges from 18 to 100, and plants like *Berberis lyceum*, *Zingiber officinale*, *Fagonia cretica*, *Foeniculum vulgare*, and *Chlorophytum borivilianum* were also very important in disease treatments.

In their study, Wei et al. (2020) concluded that 15 medicinal plants showed high IRs, indicating that these plants have several medicinal uses.

In this study, 15 treatment categories based on IFC were identified. Endocrine diseases received the highest citation for herbal use, followed by digestive problems, toxic disorders, dermatological diseases, genital diseases, and rheumatic diseases. These results are similar to those of Hadjaj et al. (2015), who found a total of 15 disease categories where the number of citations for digestive diseases is the highest, followed by dermatological diseases and neurological diseases.

Local communities widely utilized and recognized the species of ethnomedicinal plants with high RFC values. The highest relative frequency was measured for *Asteraceae* family member *Artemisia herba-alba* (RFC = 1), and the lowest was measured for *Nirosalsola vermaculata* (RFC = 0.25). Similar research findings have been reported in previous studies, where *Artemisia herba-alba*, *Atriplex halimus,* and *Peganum harmala* were reported as potential medicinal plants for the cure of various diseases, of which the most cited were digestive disorders and influenza (Humaira et al., 2022; Tolbi, 2020). It is important to perform phytochemical and phytopharmaceutical analyses for plants that have a high citation value to determine the active compounds of each plant (Vitalini et al., 2013).

CONCLUSION

Despite the limited variety of plant life in dry areas, the local community in Algeria's southeastern region heavily relies on the flora as a valuable resource. This study demonstrates the importance of 12 species from 8 families, as evidenced by their presence in the flora data, utilization values, and frequency of citation indices. These species serve as a crucial medicinal resource within the primary healthcare system for the local populations residing in the study region. For pharmacology, high-value species like *Artemisia campestris* (1.60), *Artemisia herba-alba* (1.53), *Hammada scoparia* (1.25), *Atriplex halimus* (1.24), and *Limoniastrum guyonianum* (0.96) are thought to work well.

The trend toward knowledge loss is observable because the younger generation has a limited understanding of each plant used in traditional medicine. According to the International Classification of Diseases, we identified fifteen treatment categories, with endocrine disorders receiving the most mentions, followed by digestive disorders, toxic disorders, dermatological diseases, genital disorders, and rheumatic disorders. For the advancement of herbal medicine and the discovery of chemical molecules in medicine, the integration of local people through their traditional knowledge with the scientific community is essential.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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AUTHOR CONTRIBUTION:

Contribution	Behaz FZ	Demnati Allache F	Mebrek N	Belhadj A
Concepts or ideas	x	x		
Design	x	x		
Definition of intellectual content	x			
Literature search	x	x		
Experimental studies	x			
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Data analysis	x			
Statistical analysis	x		x	x
Manuscript preparation	x	x		
Manuscript editing	x	x		
Manuscript review	x	x	x	x

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