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Therapeutic use of spontaneous medicinal flora from an extreme environment (dune cordon) in Djelfa region, Algeria

[Uso terapéutico de la flora medicinal espontánea de un entorno extremo (cordón dunar) en la región de Djelfa, Argelia]

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Abstract

Context: In some extreme environments such as dune cordon in the region of Djelfa, the ability of species to adapt to extreme conditions, especially climatic stresses, appears to be highly developed. Notwithstanding this importance from an ecophysiological point of view, the plant genetic resources of the Algerian steppe are very little known and especially poorly valued.

Aims: To inventorying the spontaneous species in an extreme "dune cordon" environment of the Algerian steppe and to collect information on the ancestral know-how of the local populations in terms of therapeutic use of these species.

Methods: Foremost, a herbarium has been made which includes all species inventoried in dune cordon, then an ethnobotanical survey materialized by a direct questionnaire was conducted with different actors involved in the field of medicinal plants. It concerns the traditional use of these species.

Results: Seventeen plants (20%) of the listed plant species have been recognized and identified as medicinal species. These plants belong to 13 families of which the *Lamiaceae* family is the most represented, followed by *Asteraceae* and *Poaceae*. Several diseases are treated by these species by local populations, some have a definite therapeutic use while others are used in the treatment of several diseases. The most incriminated pathologies concern rheumatism, diabetes, dental pain, fever and renal function. Leaves are most used with decoction as the most used mode.

Conclusions: Results of the study showed that dune cordon contains a wide variety of spontaneous plants, which have a beneficial interest. It also indicated the link between natural resources and humans and the therapeutic use of these species for profit by local population. The rich ethno-pharmacological knowledge of this population must be preserved and valued. A phytochemical screening and biological investigation are needed to test this ancestral know-how.

Keywords: Algerian steppe; ancestral know-how; ethnobotany survey; remedy.

Resumen

Contexto: En algunos entornos extremos, como el cordón de dunas en la región de Djelfa, la capacidad de las especies para adaptarse a condiciones extremas, especialmente las tensiones climáticas, parece estar muy desarrollada. A pesar de esta importancia desde un punto de vista ecofisiológico, los recursos fitogenéticos de la estepa argelina son muy poco conocidos y especialmente poco valorados.

Objetivos: Hacer un inventario de las especies espontáneas en un entorno extremo del "cordón dunar" de la estepa argelina y recopilar información sobre los conocimientos ancestrales de las poblaciones locales en términos del uso terapéutico de estas especies.

Métodos: En primer lugar, se ha hecho un herbario que incluye todas las especies inventariadas en el cordón dunar, luego se realizó una encuesta etnobotánica materializada mediante un cuestionario directo con diferentes actores involucrados en el campo de las plantas medicinales. Se declarael uso tradicional de estas especies.

Resultados: Diecisiete plantas (20%) de las especies de plantas listadas han sido identificadas e identificadas como especies medicinales. Estas plantas pertenecen a 13 familias de las cuales *Lamiaceae* es la más representada, seguida por *Asteraceae* y *Poaceae*. Estas especies son utilizadas por poblaciones locales en el tratamiento de varias enfermedades como reumatismo, diabetes, dolor dental, fiebre y función renal. Las hojas son las partes más utilizadas y la decocción como el modo de preparación más utilizado.

Conclusiones: Los resultados del estudio mostraron que el cordón dunar contiene una amplia variedad de plantas espontáneas que tienen un interés beneficioso. También indicó el vínculo entre los recursos naturales y los humanos y el uso terapéutico de estas especies para beneficio de la población local. El rico conocimiento etno-farmacológico de esta población debe ser preservado y valorado. Se necesita de investigaciones fitoquímica y biológica para probar este conocimiento ancestral.

Palabras Clave: conocimiento ancestral; encuesta etnobotánica; estepa argelina; remedio.

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INTRODUCTION

Synthetic products widely used, both in medication and in the food industry, currently raise several questions as to their efficiency and safety. The return to nature is necessary then. Thus, medicinal plants are starting to gain interest as a potential source of bioactive natural molecules. They are being studied for their possible use as an alternative for the treatment of several diseases. In addition, the search for plants of therapeutic interest is seen to take several general paths, among others the empirical method (use of plants in folk medicine, observation of certain ancestral practices) (Paris and Hurabielle, 1981). So, ethnobotany is based on fundamental knowledge of plants and human societies (Mousnier, 2013).

The medicinal and aromatic plants that are the vectors of these substances are widespread in nature. Algeria, with its different bioclimatic stages and the nature of its soils, shelters a whole range of natural species with a large and varied phytogenetic range and thus testifies to an undeniable floristic richness. The Algerian flora contains many economically important species. It has more than 1000 species, subspecies and varieties with medicinal properties (Chenouf, 2009). Among the Algerian geographical areas, the Algerian steppe is of particular importance both ecologically and economically. Enjoying its privileged geographical position and immense space (9% of the total area of the country), it is characterized by an appreciable biological diversity. This is the result of an age-old adaptation to particularly difficult agro-climatic conditions (Chenouf, 2009) especially in some extreme environments such as sebkhas and the dune cordon.

In these areas, the ability of species and genes to adapt to extreme conditions, especially climatic stresses, appears to be highly developed (Mélanie and Marc, 2002). Notwithstanding this importance from an eco-physiological point of view, the plant genetic resources of the Algerian steppe are very little known and especially poorly valued, if not threatened by human uses and practices (Snoussi et al., 2003).

Although the region is mainly pastoral, the ancestral knowledge of local populations attests to the importance and efficiency of use of local plant genetic resources for various purposes (food, condiments, aromatics, medicinal, among others). Therefore, the know-how of local population, will be considered as a starter for the pharmacological and phytochemical investigation of medicinal plants. Thus, the best use of a plant would be one that preserves all its properties while allowing the extraction and assimilation of active ingredients (Dextreit, 1984)

Several ethnobotanical studies were carried out according to various aims, some of them targeting a specific pathology treated by the medicinal plants of the study area (El Rhaffari et al., 2002), others aimed at the inventory and therapeutic use of medicinal plants by indigenous populations in the investigation areas (Salhi et al., 2010; Benkhnigue et al., 2011; Tahri et al., 2012; Daoudi et al., 2015; El Yahyaoui et al., 2015; Béné et al., 2016; Mikou et al., 2016; Rhattas et al., 2016; Slimani et al., 2016). The Algerian pharmacopoeia is no exception to this rule (Maiza et al., 1993; Hammiche and Maiza, 2006; Bouallala et al., 2014; Sarri et al., 2014). To our knowledge no ethnobotanical study on the use of spontaneous plants of the dune cord in traditional therapy has been conducted before. In this sense, this work is part of a research-valorization and the objectives are to make an inventory of the spontaneous species that shelters the dune environment of the Algerian steppe and then collect information on the know-how ancestral populations of local populations in the use of plant species of the region in the treatment of various pathologies.

MATERIAL AND METHODS

Study area

The study area is located in the dune cordon at 270 kilometers south of the capital Algiers at a place called El-Mesrane (region of Djelfa) whose geographical coordinates are Longitude: 3° 03′ E. Latitude: 34° 36′ N. The dune cord is inserted between the depressions of Zahrez (Gharbi and Chergui) and the piedmont of the Saharan Atlas in a south-west to north-east orientation about 150 km long and 2 to 3 km wide on average (Fig. 1). Located at an altitude of 870 m, this area belongs to the superior arid bioclimatic stage with cold winter and average annual rainfall of 315 mm. According to Pouget (1971), the dune soil is classified as a crude mineral soil. The rate of organic matter is relatively low as well as the content of mineral elements.

Floristic inventory and botanical

To carry out the floristic inventory of dune zone three phases were followed: preliminary recognition of the environment, location and size of the surveys (position of transects) and execution of the quantitative statement. The sampling device was formed by two transects North-East, South-West and from the bottom to the top of the dune. This transect device crossed all the plant groups in the study area. The vegetation of the station was sampled by floristic survey, through the linear statement technique, still called technique of the quadrats points, described by Gounot (1969), and well adapted to steppe ecosystems.

Collection, preservation, processing and storage of botanical specimens were as described by British Columbia Ministry of Forests (1996). Samples of plants were collected from the dune cordon, an extreme environment from Algerian central steppe area in arid region of Djelfa.

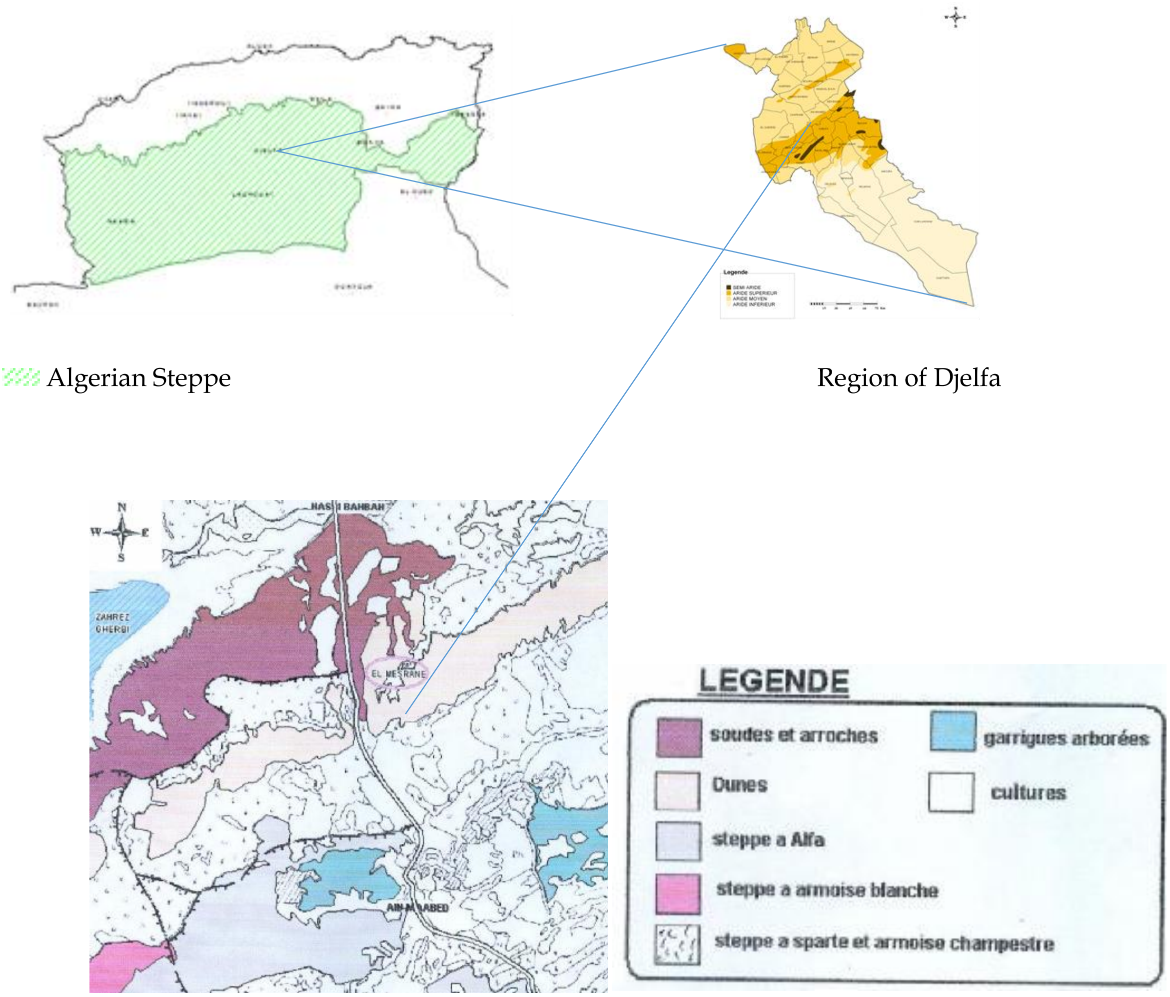

Figure 1. Geo-botanical situation of the study area (Ozenda and Keraudren, 1960).

Specimens that were representative of the existing population were collected by cleanly cutting of the stem and dried fairly quickly by placing them in presses once in laboratory. The damp papers were replaced every three days and packed again in the press. Each sample was associated with label, which included information as well as description of site and date of collection. Plants were identified by their vernacular names by healers and the scientific nomenclature was recorded according to the new flora of Algeria and southern desert regions (Quezel and Santa, 1963), Flora of the Sahara (Ozenda, 1991). The nomenclature retained for writing of taxa was that of The Plant List (2013) and African Plant Database (2012). For every plant identified, an herbarium specimen collected was deposited at the botany laboratory, Djelfa University, Algeria.

Survey and data collection

Ethnobotanical survey was carried out from February to July 2017 and conducted in several places of Djelfa region (markets, shops, home of healers) where all person interviewed were contacted by using semi-structured interviews (Hoffman and Gallaher, 2007). Arabic local language was used during anthropological interviews. Before the beginning of interview, oral consent was sought from each informant. The survey was conducted by training interviewers who had a course in ethnobotanical techniques and supervised by authors. For collecting survey questionnaire data, face-to-face interviews method was used.

The survey was established according the directive of Soundy et al. (2016), which include three stages namely a review of the literature, exploratory investigations and an online questionnaire and used to assess the content validity of the selected questions. It was validated by piloting system (pilot interview). One hundred three informants were interviewed in this study, in which seventeen key informants were selected rigorously and systematically according to trade ministry (who's with business register) and sanitary direction (traditional practitioner doctor) and on the knowledgeable elders. Key informants were identified according their traditional knowledge of medicinal plants and their use for the treatment of many illness. All respondents were native from the region. Respondents were chosen according the "snowball" method, which led to most informants (Russel Bernard, 2006). So, all the informants were known as expert in medicinal plants by local population. According Lawshe (1975), those who "know the job" are normally competent to make the required judgments

The validated ethnobotanical survey was materialized by a direct questionnaire (Annex 1). It included nineteen questions divided into two volts. One containing general information about the interviewee (sex, age, educational level, family situation, seniority in the field, and acquisition of knowledge), the other relating to the plant (vernacular name, part(s) used, mode of use, therapeutic use and duration of treatment).

This survey was conducted in the region of Djelfa with different actors (traditional practitioners, herbalists and users) involved in the field of medicinal plants. It was carried out in two phases: the first was to get in touch with the various actors in the sector, by asking a key question: what were the medicinal plants of the region used by the interviewers and which they know? The second phase was a second visit of the same people but this time holding in hand the herbarium already made, by asking the following question: do you know this plant (species by species, turning each time the sheets of the binder). If the answer was negative we moved on to the next species; if the answer was positive, the questionnaire was continued. The ultimate step of this phase was the recognition of the plant. The duration of the interview lasted between 40 to 90 minutes.

Statistical analysis

Data collected were subjected to analysis. Firstly, descriptive statistics were undertaken, then different quantitative indices were calculated including relative frequency citation (RFC), medicinal use value, and family use value, informant consensus factor (ICF) and fidelity level (FL). The meaning of each index was adapted from Hoffman and Gallaher (2007).

Relative frequency citation (RFC) was calculated by the following formula: RFC = FC/N ($0 < RFC < 1$), where FC (also known as frequency of citation) was the number of informants who mentioned the use of the species and N was the total number of informants participating in the survey (Tardio and Pardo de Santayana, 2008). This index estimated the local importance of each species.

Use-Value (UV) was calculated using the formula $UV = \sum Ui / N$, where: Ui = the number of uses mentioned by each informant for a given species, N = the total number of informants (Rossato et al. 1999). The Use Value was calculated to demonstrate the relative importance of the species known locally. According this, medicinal use-value (MUV) and family use-value (FUV) were recorded for each category.

Informant consensus factor (ICF) was calculated with the following formula: $IFC = (Nur - Nt)/(Nur - 1)$, where Nur refered to the total number of use reports for each ailment category and Nt was the number of taxa used in that category (adapted by Heinrich et al., 1998). This value was used to analysis the use of the medicinal plants against specific diseases i.e. estimate user variability of medicinal plants.

Fidelity level (FL) was calculated using the following formula: $FL(\%) = (Ip/Iu) \times 100$, where Ip refers to the number of informants who independently suggested the use of a species for the same major purposes and Iu the total number of informants who mentioned the plant for any use (Friedman et al., 1986). The FL quantified the importance of a species for a given purpose.

RESULTS AND DISCUSSION

Floristic list of the study area

In total eighty-four species distributed in twenty-six families were enumerated (Fig. 2). The *Asteraceae* family is the most represented (17 species), followed by *Poaceae* (11 species), *Fabaceae* (7 species), *Caryophylaceae* and *Brassicaceae* (6 species each), *Amaranthaceae* (5 species), *Boraginaceae* (4 species) *Lamiaceae* and *Geraniaceae* (3 species each), whereas *Plantaginaceae*, *Thymeliaceae*, *Ramunculaceae*, *Fumariaceae* and *Scrophulariaceae* contain only two species each. The other families (12 families) are represented by one species each. This variability of plant species is evidence of the floristic wealth of this area, which is a resource whose value and maintenance must be the concern of all. These species adapt better to climate and edaphic environmental conditions. According to Duvignaud (1980), populations and biocenoses depend on factors in their environment, the main ones being precipitation and temperature. These species have different uses, some are used in traditional medicine as a source of cure for certain diseases (Maiza et al., 1993; Hammiche and Maiza, 2006). Other have a fodder interest, especially annual plants “laacheb”, and therefore constitute an important food intake for domestic animals and whose palatability varies from one plant to another (ITMA, 1973; Nedjraoui, 2001).

General information about surveyed

The most people surveyed were potential users of medicinal plants in the treatment of various diseases while herbalists represented one third (Table 1).

The practice of herbal medicine remains the spell of men rarely for women (Table 1). All herbalists were men, there was never a woman who trades medicinal plants in the region of Djelfa, and this could be explained by the traditions of the region where women were not encouraged to work outside home (Boudjelal et al., 2013) by cons women used more herbal than men (63% against 37%); whereas traditional healers were mainly men than women (73% *versus* 33%). The use of medicinal plants by women much more than men was also confirmed by other studies (Benkhnigue et al., 2011; Bouallala et al., 2014).

Educational level varied from one category to another, only 20% of those surveyed were illiterate. The others can read and write with different levels (Table 1). The present results coincide with those of Boudjelal et al. (2013); Sarri et al. (2014)

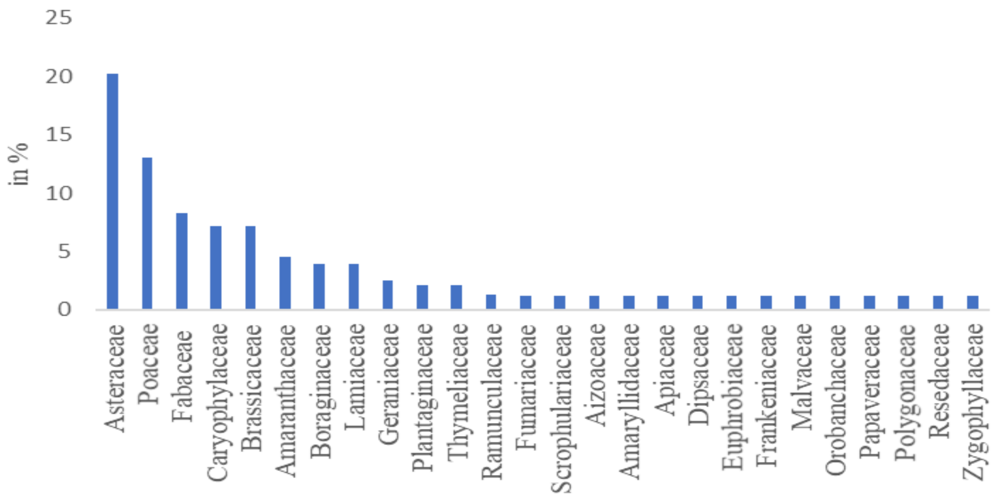

Figure 2. Distribution of species by family.

Table 1. Information about surveyed people.

Indicator	Description	Frequency (%)
Profile	Herbalist	31
	Traditional healer	12
	Doctor	8
	User	49
Gender	Male	61
	Female	39
Education	University	23
	Secondary	26
	Medium	21
	Elementary	10
	Illiterate	20
Family situation	Married	72
	Single	28
Age	< 35 years	38
	35 to 50 years	34
	> 50 years	28
Seniority in the field	< 5 years	29
	5-10 years	35
	> 10 years	36
Acquisition of knowledge	Ancestral know-how	36
	Self-training	49
	Specialized training	15

and Daoudi et al. (2015) while El-Yahyaoui et al. (2015) reported an illiteracy rate of around 53% among those surveyed in Morocco. The relatively high illiteracy rate can be a real obstacle to the development of the practice of traditional medicine (Daoudi et al., 2015).

Concerning the family situation, most of surveyed were married (Table 1). Among them, 47% were users of medicinal plants while 32% were herbalists. In Morocco, Benkhnigue et al. (2011) point out that medicinal plants were much used by married people (80.80%) than singles (19.20%) and justify this rate by material costs required by doctors and pharmacist.

Almost all age groups used traditional medicine as users, herbalists, traditional healers or doctors (Table 1). In Morocco, the use of medicinal plants was widespread among all age groups, with a predominance among people aged 30 to 45 years (Benkhnigue et al., 2011) although this predominance remains to be discussed and verified according to the study area.

Practice of phytotherapy

Seventy one percent of respondents had more than 5 years in the field of medicinal plants, while the rest has just integrated if not interested in herbal medicine (Table 1). Seniority in the field of medicinal plants varies according to the profile of those interviewed. The majority of surveyed were trained by themselves, others have acquired knowledge in the field of phytotherapy through the experiences of their ancestors (Table 1). The knowledge of the informants and their level of schooling is a variant to be taken into account because, in traditional medicine, the statements of an illiterate or an expert intertwine (El Rhaffari et al., 2002). The transmission of know-how from father to son plays a major role in this field. This mode of knowledge transfer concerns specially users. To this, it must be added that a satisfied user contributes enormously to the propagation of the information of mouths to ears. These results show the importance of the transmission of ancestral know-how from one generation to another (El-Yahyaoui et al., 2015). However, the transmission of this knowledge is in danger now because it is not always assured (Anyinam, 1995).

Use of medicinal plants and therapeutic indications

Among the plant species recorded in the dune, only 20.24% have been recognized and identified as medicinal species (Table 2). The *Lamiaceae* family was the most represented, followed by *Asteraceae* and *Poaceae*. The same observation was observed in a neighboring region (Boudjelal et al., 2013; Sarri et al., 2014). These species were used alone or in combination by binomial, trinomial or mixture (Table 3). In this sense Béné et al. (2016) speak of monospecific recipes that were predominant according to the survey conducted by his team in the Transua Department of Côte d'Ivoire. According to the same authors this preponderance is to the advantage of the patients because, associations of plants, badly matched, are sometimes dangerous. Thus, about 30% of fatal accidents are due to the use of mixtures in Africa (El-Said et al., 1969).

Several diseases can be treated by the medicinal plants identified in this study area according to our survey. Some species were indicated for a definite therapeutic use (*Cynodon dactylon, Atriplex halimus, Plantago albicans, Saccocalyx satureioides, Salvia verbenaca, Marrubium deserti, Artemisia campestris, Onopordon arenarium, Lygeum spartum, Thapsia garganica, Thymelaea microphyla*), others can be used in several treatments (*Allium flavum, Malva aegyptica, Peganum harmala, Echium trigorrhizum, Herniaria hirsuta, Euphrobia guyoniana*). These plants are used alone or in combination. Finally, some diseases are treated by several medicinal plant species taken separately (*Thapsia garganica* and *Peganum harmala* "antirheumatic", *Echium trigorrhizum* and *Peganum harmala* "anti-diabetes", *Onopordon arenarium* and *Euphrobia guyoniana* "against dental pain", *Marrubium deserti* and *Artemisia campestris* and *Malva aegyptica* "against fever", *Cynodon dactylon* and *Herniaria hirsuta* "renal function").

Most of the medicinal plants mentioned above or a part of them are used in the treatment of various diseases and ailments throughout the Algerian regions, in the Algerian steppe (Boudjelal et al., 2013; Sarri et al., 2014), in the Algerian Sahara (Hammiche and Maiza, 2006; Bouallala et al., 2014) or in Africa (Daoudi et al., 2015; El Yahyaoui et al., 2015). These species are used in traditional medicine in the treatment of various ailments according to the regions (Maiza et al., 1993); because the pathologies can be, too, the reflection of a particular biotope (Mousnier, 2013).

Used plant organs

All plant parts were used alone or in combination with each other (Table 3). Among the plant organs used alone, the aerial part represented by the leaves dominates followed by that of the stems. While among the combinations, the whole aerial part (leaf, stem and flower) or the whole plant predominated. The roots were rarely.

In Algeria, Sarri et al. (2014) and in Morocco, Tahri et al. (2012) and Mikou et al. (2016) reported that leaves were the most used plant organ. While Boudjelal et al. (2013) and Slimani et al. (2016) noted a high frequency of use of the entire aerial part (69% and 43.60% respectively). The use of the aerial part of the plant can be explained by the ease and speed of the harvest (Bitsindou, 1986) but also because the leaves are the seat of photosynthesis and sometimes storage of secondary metabolites responsible for the biological properties of the plant (Bigendako-Polygenis and Lejoly, 1990). According to Senator (1996) quoted by Djibo et al. (2004) the presence or absence of certain constituents in the plant depends on one or the combination of three factors, which are the genetic makeup, the age and the environment of the plant. However, it should be noted that different parts of the plant contain substances that differ chemically from one organ to another (Bruneton, 1999).

Table 2. Medicinal plants of the dune cord recognized for traditional use.

N°	Family	Scientific name	Local name	Part used	Mode of preparation	Therapeutic use	RFC
1	*Amaranthaceae*	*Atriplex halimus* L.	G'taf	Leaves, stems	Cooked, powder	Hydatid cyst	0.54
2	*Amaryllidaceae*	*Allium flavum* L.	El koureth	Fruits	Powder	Insect bites, anti-ringworm	0.14
3	*Apiaceae*	*Thapsia garganica* L.	Bounafaa or deriasse	Whole plant	Decoction	Antirheumatic Sprain	0.17
4	*Asteraceae*	*Artemisia campestris* L.	Dgouft	Leaves, stems	Decoction powder	Poisoning, fever	0.72
		Onopordon arenarium (Desf.) Pomel	Feries	Roots	Powder	Dental pains	0.17
5	*Boraginaceae*	*Echium trygorrhizum* Pomel	Hmimech	Leaves, whole plant, aerial part, roots	Decoction powder	Icterus, diabetes, angina	0.71
6	*Caryophyllaceae*	*Herniaria hirsuta* L.	Fetat elh'jar	Leaves	Decoction	Kidney stones, diuretic, renal lithiasis, biliary lithiasis	0.91
7	*Euphrobiaceae*	*Euphrobia guyoniana* Boiss. & Reut.	Lebbine	Aerial part, stems, juice	Friction, in-kind	Eczema, fungal, warts, dental pains	0.15
8	*Lamiaceae*	*Marrubium deserti* de Noé	Temiriouet er'rmel	Whole plant	Decoction	Fever	0.81
		Saccocalyx satureioides Coss. & Durieu	Zaatar er'rmel (or Zaatar elkhil)	Young twigs	Decoction	Common cold	0.85
		Salvia verbenaca L.	Zargtoun	Leaves	Powder	Wounds	0.19
9	*Malvaceae*	*Malva aegyptiaca* L.	Khobbeiz	Leaves	Maceration, poultice	Constipation, fever, wounds	0.36
10	*Plantaginaceae*	*Plantago albicans* L.	Lelma	Leaves	Decoction	Prostate	0.16
11	*Poaceae*	*Cynodon dactylon* (L.) Pers.	Nedjem	Leaves	Decoction	Anuria	0.14
		Lygeum spartum Loefl. ex L.	Sennagh	Leaves	Pomade, friction	Mycosis of the face	0.15
12	*Thymelaeaceae*	*Thymelaea microphylla* Coss. & Durieu ex.Meisn	Methnane	Aerial part	Decoction	Hemorrhoidal crisis	0.14
13	*Zygophyllaceae*	*Peganum harmala* L.	Harmel	Seeds	Powder	Antirheumatic, diarrhea, diabetes	0.63

Concerning the writing of taxa, the nomenclature retained was that of The Plant List (2013) and African Plant Database (2012). RFC: Relative frequency citation.

Table 3. Distribution of medicinal plants according to different criteria.

Indicator	Description	Frequency (%)
Use of plants	Alone	71
	In combination	29
Used plant organs	Whole plant	12.5
	Aerial part	12.5
	Root	8.3
	Seed	4.2
	Stem	12.5
	Leave	37.5
	Fruits	4.0
	Young twigs	4.2
	Juice	4.2
Mode of preparation	Decoction	39
	Powder	31
	Friction	9
	Pomade	5
	Maceration	4
	Poultice	4
	Cooked	4
	In-kind	4
Duration of treatment	One day	20
	One week	20
	One month	15
	Until healing	45

Preparation mode

Generally, several modes of preparation of medicinal plants were adopted (Table 3), nevertheless the decoction remained the most used mode in this study area followed by the use in powder form. Maceration, cooking or in-kind were rarely used. It should be noted that the method of preparation is closely related to the type of pathology to be treated. These results coincided with those obtained by Bouallala et al. (2014) in the South region of Algeria (32.73% for the decoction and 29.09 for the powder); Boudjelal et al. (2013) and Sarri et al. (2014) in the region of M'sila in Algeria (36% and 44.7% for the decoction, respectively); Slimani et al. (2016) in the region of Zerhoun in Morocco (48% for the decoction); Béné et al. (2016) in the Gontougo Region of Côte d'Ivoire (36% for the decoction). While Mikou et al. (2016) reported that the infusion had the highest frequency of preparation followed by decoction (more than 40% for infusion and less than 35% for decoction). For El Yahyaoui et al. (2015), powder was the most common method of preparation (36%) followed by the infusion preparation (29%). Tahri et al. (2012) reported that aqueous decoction (29.13%), infusion (28.87%) and poultice (20.40%) remain the most commonly used methods of preparation. The decoction mode collects the maximum of active ingredient and reduces or cancels the toxic effect of other substances (Salhi et al., 2010). According to Dextreit (1984), it is with the infusion and the decoction that most of the principles are properly dissolved, but some are destroyed while the cold maceration preserves these principles but does not allow the complete extraction.

In general, medicinal plants were administered orally (over 65%). The rest was shared between rinsing (16%) and poultice (13%). Lotions and compresses only represented 6%. For Slimani et al. (2016), the plants were administered mainly orally (75%). On the other hand, our result is controversial by that of Béné et al. (2016) where the cutaneous route was the most requested (35%) by the Brongs of the Department of Transua in Côte d'Ivoire, while the oral route represented only 30%. Similar results were observed, compared to the poultice mode: 20.40% for Tahri et al. (2012), 19% for Daoudi et al. (2015) and were slightly higher than those found by Bouallala et al. (2014) 9%, Rhattas et al. (2016) 10.32%, and Slimani et al. (2016) 11%.

Duration of treatment

The duration of treatment varied according to the disease treated and the plant species used (Table 3). This duration can be indeterminate and will continue until healing as it may be time limited (55%). The survey conducted by Slimani et al. (2016) in the region of Zerhoun in Morocco indicated that treatment with medicinal plants continued until healing for 97% of those surveyed and note the lack of concept of dosage in 73% of users whose handle was the most used dose. This dose, random as it is, is manifested by adverse effects on health (Benkhnigue et al., 2011). In addition, medicinal plants have adverse effects when improperly performed by patients (Rhattas et al., 2016).

Ethnobotanical indices analysis

Description of the quantitative techniques used in ethnobotanical publications in the period from 1995 to 2009 with their respective formulas and references were summarized in the overview of Medeiros et al. (2011) and importance indices in Ethnobotany were established by Hoffman and Gallaher (2007).

Consensus Statement on Ethnopharmacological Field Studies – ConSEFS for a best practice in research is available from 2018 and it is essential that the authors must be fully aware of the best practice in the field prior to starting ethnopharmacological field research (Heinrich et al., 2018)

Relative frequency citation

The local importance of each species was estimated by its relative frequency citation. This index varied from 0.14% to 0.91% (Table 2). The most species cited were *Herniaria hirsuta* (0.91%) followed by *Saccocalyx satureioides* (0.85) and *Marrubium deserti* (0.81%). These species were mentioned elsewhere for their use in different illness by local population. *Herniaria hirsuta* is a Mediterranean traditional medicinal plant widely used in Morocco to treat lithiasis patients (Atmani et al., 2004). In Showbak region from Jordan, this species is used as bronchodilator and for bladder disorders (Al-Qura'n, 2009). According to Grases et al. (1995), Folk medicine has attributed some beneficial effects for a variety of kidney disorders to *Herniaria hirsuta* L. (lithotriptic, urinary inflammations, kidney inflammations, renal calculi formation and renal sands). The two later plants are endemic to North Africa. In Algerian traditional folk medicine, *M. deserti* is used against respiratory diseases, fever, diabetes, jaundice and hypertension (Hammiche and Maiza, 2006) and it is frequently used for treating cough, dysmenorrhea, and as local treatment against scorpion stings and allergy (Ould El Hadj et al., 2003). In Tunisia *M. deserti* and is used in traditional medicine in the form of a decoction as a remedy for asthma, diabetes and as a diuretic (Edziri et al., 2012). According to Biondi et al. (2006), no particular traditional usage of *Saccocalyx satureioides* is reported, although it is supposed that it is treated like oregano, which is considered an essentially medicinal plant. But Bendahou et al. (2008) reported that the aerial parts of this species are used in folk medicine as condiment, for gastric disorders and spasms; while Allali et al. (2008) indicated that this plant was the most used in Tlemcen's region (Algeria) as antidiabetic.

Medicinal and family use-value (MUV and FUV)

Regarding family use-value, the highest levels were found in: *Caryophyllaceae* (3.01), *Boraginaceae* (1.84), *Zygophyllaceae* (1.82), *Malvaceae* (0.86), *Amaranthaceae* (0.71) (Table 4). These finding disagree with this obtained by Bonet et al. (1999) for which *Asteraceae*, *Lamiaceae*, *Fabaceae* and *Rosaceae* were the predominate families and authors were not surprise because these families are well represented in Mediterranean flora and contain some very common plants. In the present study it will be noted that all predominated families were represented by one species each one and the area of the study is an extreme environment (dune cordon) characterized by its aridity. Johns et al. (1990) confirmed that there is greater probability of a common plant being reported to treat a common disease than a rare plant to treat a disease of limited occurrence. *Poaceae* and *Thymelaeaceae* (0.14), *Plantaginaceae* (0.16), *Amaryllidaceae* (0.25) and *Apiaceae* (0.26) had the lowest values of FUV among the recorded families, however *Lamiaceae* and *Asteraceae* had FUV ranging from 0.62 to 0.66. Bibi et al. (2014) attribute the difference between the UV reported in their ethnobotany survey conducted in district Mastung of Balochistan province, Pakistan to the variation in vegetation and geo-climate of the area.

Concerning the medicinal use-value, the MUV coincides with the FUV for the family with one species recorded (Table 4). For the other, it ranges from 0.14 to 1.15. The highest value was observed for *Artemisia campestris* and the lowest for *Cynodon* *dactylon*. *Artemisia campestris* is used to treat goiter, cough and bronchitis (Benarba et al., 2015); as antidiabetic and antihypertensive (Boudjelal et al., 2013). This value was used to analysis the use of the medicinal plants against specific diseases i.e. estimate user variability of medicinal plants. Agelet and Vallès (2001) enumerate various factors that are responsible for the differences between various use-values around the world to socioecological reason (high number of the species of the predominant families are favored by human activity or cultivated for food, medicinal or ornamental purposes) and ecological conditions (some families include many species with a large distribution area, because they can grow in quite different ecological conditions, particularly in dry or poor soils).

Table 4. Medicinal and family use-values.

Family	Plant	MUV	FUV
Lamiaceae	*Saccocalyx satureioides*	0.85	0.62
	Salvia verbenaca	0.19	
	Marrubium deserti	0.81	
Asteraceae	*Artemisia campestris*	1.15	0.66
	Onopordon arenarium	0.17	
Poaceae	*Cynodon dactylon*	0.14	0.14
	Lygeum spartum	0.15	
Amaranthaceae	*Atriplex halimus*	0.71	0.71
Amaryllidaceae	*Allium flavum*	0.25	0.25
Apiaceae	*Thapsia garganica*	0.26	0.26
Boraginaceae	*Echium trigorrhizum*	1.84	1.84
Caryophyllaceae	*Herniaria hirsuta*	3.01	3.01
Euphrobiaceae	*Euphrobia guyoniana*	0.55	0.55
Malvaceae	*Malva aegyptica*	0.86	0.86
Plantaginaceae	*Plantago albicans*	0.16	0.16
Thymelaeaceae	*Thymelaea microphyla*	0.14	0.14
Zygophyllaceae	*Peganum harmala*	1.82	1.82

Informant consensus factor (ICF)

The informant consensus factor for eleven ailment categories are provided in Table 5. The present study showed that the value of ICF ranged between 0.96 and 1.00.

Table 5. Informant consensus factor (ICF).

Diseases category*	Number of use reports	Number of taxa	ICF
Respiratory system diseases	161	2	0.99
Digestive system diseases	176	3	0.99
Circulatory system diseases	14	1	1.00
Genital apparatus diseases	16	1	1.00
Urinary system diseases	108	2	0.99
Accessory glands diseases	167	2	0.99
Metabolic disorders	138	2	0.99
Microbial and parasitic diseases	250	4	0.99
Skeleton diseases	83	2	0.99
Skin diseases	101	5	0.96
Teeth and gums diseases	32	2	0.97

Respiratory system diseases: Common cold, angina. Digestive system diseases: Poisoning, constipation, diarrhea. Circulatory system diseases: Hemorrhoidal crisis. Genital apparatus diseases: Prostate. Urinary system diseases: Anuria, kidney stones, diuretic, renal lithiasis. Accessory glands diseases: Icterus, biliary lithiasis. Metabolic disorders: Diabetes. Microbial and parasitic diseases: Fever, hydatid cyst. Skeleton: Antirheumatic, sprain. Skin diseases: Wounds, mycosis of the face, insect bites, anti-ringworm, eczema, fungal, warts. Teeth and gums: Dental pains.

The highest was recorded for circulatory system and genital apparatus diseases. These levels were high regarding literature data, this is can be explained by the agreement of the majority of informants about species used for treatment of various illness group's, especially if we take into account the number of taxa for each category of disease and the number of ailment by category considered. So, for each disease category, there were in general, one or two species reported to be a remedy of the indicated problem. Highest values of ICF was observed for pathologies of the digestive system (0.92) by Jamila and Mostafa (2014) in Morocco, urinary system diseases (0.96) by Tuttolomondo et al. (2014) in Italy. However, cuts and wounds had the highest ICF score (0.85) in Turkey (Polat and Cakilcioglu, 2018). In Algeria, Bouasla and Bouasla (2017) reported highest ICF (0.66) for digestive system diseases, followed by nervous system diseases (0.62). Gastro-intestinal diseases, which had the highest ICF (0.658) was also observed in Algeria by Benarba et al. (2015). In their study, Tuttolomondo et al. (2014) found an ICF values close to 1 for several categories with an average value, for all categories, of 0.87 and they attribute this finding to the fact that there is a high homogeneity of consensus among informants about the therapeutic use of a set of species and about their efficacy.

Fidelity level (FL)

Seen as the preference of local population to use some plants more than other in healing different ailment categories (Bouasla and Bouasla, 2017), the fidelity level in this study range between 10.96 and 100% (Table 6). Species with high level (100%) were *Saccocalyx satureioides* for respiratory system diseases, *Thymelaea microphyla* for circulatory system diseases, *Plantago albicans* for genital apparatus diseases, *Cynodon dactylon* for urinary system diseases, *Marrubium deserti* and *Atriplex halimus* for microbial and parasitic diseases, *Thapsia garganica* for skeleton diseases, *Salvia verbenaca, Lygeum spartum* and *Allium flavum* for skin diseases and *Onopordon arenarium* for teeth and gums diseases. According to Shil et al. (2014), increasing values of FL for a species authenticate its uniqueness to treat a particular illness; while plant with low FL% should not be neglected as there is risk of loss of their information and they could be also important to the future generation (Malik et al., 2018). Generally, plants which are used in some repetitive fashion are more likely to be biologically active (Cheikhyoussef et al., 2011).

CONCLUSIONS

This first study conducted about spontaneous species growing in a hostile environment "dune cordon" in the region of Djelfa "arid zone" in Algerian steppe, shows the variability of plant species, which is a resource whose value and maintenance must be the concern of all. Beside this information concerning the traditional use of some of these species, a phytochemical screening and biological investigation is needed to test this ancestral know-how. And in other hand, culture is the only way to obtain the necessary plant material without further compromising the survival of these species in their natural environment, knowing in advance that we are facing an expanding market. For this, germination tests are necessary and studies on the behavior of these plants under conditions of saline and hydric stress are required.

Table 6. Fidelity level of medicinal species (FL).

Diseases category	Species	FL (%)
Respiratory system diseases	*Saccocalyx satureioides*	100.00
Digestive system diseases	*Echium trigorrhizum*	10.96
	Artemisia campestris	63.51
	Malva aegyptica	16.22
	Peganum harmala	16.92
Circulatory system diseases	*Thymelaea microphyla*	100.00
Genital apparatus diseases	*Plantago albicans*	100.00
Urinary system diseases	*Cynodon dactylon*	100.00
	Herniaria hirsuta	75.53
Accessory glands diseases	*Echium trigorrhizum*	63.01
	Herniaria hirsuta	24.47
Metabolic disorders	*Echium trigorrhizum*	26.03
	Peganum harmala	35.38
Microbial and parasitic diseases	*Marrubium deserti*	100.00
	Artemisia campestris	36.49
	Atriplex halimus	100.00
	Malva aegyptica	48.65
Skeleton diseases	*Thapsia garganica*	100.00
	Peganum harmala	47.69
Skin diseases	*Salvia verbenaca*	100.00
	Lygeum spartum	100.00
	Allium flavum	100.00
	Euphrobia guyoniana	60.00
	Malva aegyptica	35.14
Teeth and gums diseases	*Onopordon arenarium*	100.00
	Euphrobia guyoniana	40.00

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHOR CONTRIBUTION:

Contribution	Yabrir B	Touati M	Adli B	Bezini E	Ghafoul M	Khalifa S	Guit B
Concepts or ideas	x	x	x	x	x		
Design	x	x	x	x	x		
Definition of intellectual content	x	x	x	x	x		
Literature search	x	x	x	x	x	x	x
Experimental studies	x	x	x	x	x	x	x
Data acquisition	x	x	x	x	x	x	x
Data analysis	x		x				x
Statistical analysis	x						
Manuscript preparation	x						
Manuscript editing	x	x					
Manuscript review	x	x	x	x	x	x	x

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Annex 1. Semi-structured questionnaire corresponding to ethnobotanical survey of spontaneous medicinal flora from an extreme environment (dune cordon) in Djelfa region, Algeria.

Date:											
Locality:											
Informant reference (if possible):											
Questionnaire											
1. Profile of the people surveyed											
Herbal-ist		Traditional healer			Doctor		User				
Age:	<35 years		35 to 50 years			>50 years					
Sex:	Male		Female								
Level of education:		Illiterate		Elementary		Medium		Secondary		University	
Family situation:			Single		Married						
Seniority in the field:			<5 years		5-10 years			>10 tears			
Acquisition of knowledge:			Ancestral know-how			Specialized training				Self-training	
2. information related to the plant and its use (this section is repeat for each species recognized by the same informant)											
Recognition of the plant:			Yes		No						
Scientific name:											
Vernacular name:											
Use:	Therapeutics		Cosmetics		Food		Other				
Used plant organs:	Leaves		Roots		Aerial parts			Fruits		Twigs	
	Stem		Flowers		Whole plant			Seeds		Juice	
Mode of preparation:		Decoction		Infusion		Maceration		Powder			
		Poultice		In-kind		Cooked		Lotion and compress			
Route of administration:		Oral		Spray		Pomade		Massage		Rinsing	
Collection period:		Autumn		Winter		Spring		Summer		All year	
Type of plant:		Spontaneous		Cultivated							
Disease(s) treated:											
Duration of treatment:		One year		One week		One month			Until healing		
Use of plants:		Alone				In combination with others					