

PLANT SCIENCE

Relative importance of the exploitation of medicinal plants in traditional medicine in the Northeastern Sahara

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Abstract

The objective of this study was to highlight the relative importance related to the exploitation of medicinal plants in the South East of Algeria. For this reason, the ethnobotanical survey was conducted in a very systematic way, a record of 10 successive dwellings was collected within rural and urban areas in both Ouargla and Tougourt. This was followed by an analysis of results by the application of some ecological clues. The investigation led to the identification of 65 species covering 36 families that treat several diseases. On one hand, the centesimal frequency of use is the highest in the rural area of Ouargla (QRO) with 95.23% and in descending order for the species *Artemisia herba alba* Asso. (chih), *Mentha spicata* L. (naa naa), *Origanum vulgare* L. (zaatar) and *Juniperus communis* L. (aaraar), on the other hand. The four classes of constancy are present, but the accidental species are very important in the four (04) districts. The type of distribution calculated for all species of medicinal plants in different areas showed a contagious distribution. And the application of automatic classification showed that urban sites are very similar. In the end, this approach has identified the species and has reported the first results obtained by the ecological analysis to better understand the exploitation of species in the studied area.

Key words: Sahara, Medicinal plants, Ethno-botanical, Exploitation, Lifestyle, Ecological indices, Algeria

Introduction

About five hundred species of higher plants inventoried part is nowadays used by people as medicinal plants in the Sahara (Ozenda, 1983). Since herbal medicine offers natural remedies and well accepted by the body, is often associated with conventional treatments. Its exceptional revival, especially for chronic diseases, nowadays, is well marked (OSS " Observatoire du Sahara et du Sahel ", 2010;"Organisation Mondiale de la Santé" O.M.S., 2004; Tabuti et al., 2003). Indeed, the Algerian Sahara has a long tradition and expertise in traditional and herbal medicines. Previous studies were mainly qualitative in nature and related to the correlation between the rural and traditional medicine (Bounaga and Brac De La Perriere, 1988;

Benchellahetal, 2004; Maiza, 1993; Ould El Hadj et al., 2003; Chehma, 2006). Nevertheless, during the Anthropocene era, humans have really changed all ecosystems on the planet with an acceleration greater than in any comparable period in human history (Steffen et al., 2007). Indeed, the effects have been observed on the lifestyle of people in the study area, including education, agriculture, industry and especially on the natural environment, including plants. However, the evolution of ethnobotanical research led to the development of the methods of analysis, including various disciplines. Among others, ecological methods for determining the impact on the environment and the level of sustainability - plants - human relations in the past and present were reported (Cotton, 1996). Thus, we believe that the medicinal flora heritage requires monitoring and regular assessment in both qualitative and quantitative ways. That in turn will ensure its preservation and its current medicinal values. Therefore, we focused on the quantitative aspect at the end to identify the importance of the use of medicinal species and was based on a sampling method that seems suitable for our approach. The latter is based on two questions:

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- Is the lifestyles have an impact on the use of medicinal plants?
- What are the plant families and species most involved in regional pharmacopoeia whose use is based on ecological indices and automatic classification?

Materials and Methods

Description of the studied area

The study was conducted in South-eastern Algeria, in the province of Ouargla, which is located 790 km away from Algiers. It is characterized by several oases, the most important are those of Touggourt (X: 33° 07'; Y: 6° 04' and A: 70m (Le Houerou et al., 1995) and Ouargla (X: 31° 37'; Y: 5° 24' and A: 141m (Rouvilleis-Brigol, 1975; Cote, 1998) (Figure 1). The aridity is substantially attenuated in Touggourt; however, all the studied area belongs to the hyper-arid bioclimatic Mediterranean-continental (Rivas – martinez, 1996-2009; Chehma et al., 2005).

In addition to palm cultivation with crops underlying the studied area has a floristic heritage of various strains, Mediterranean and tropical species that have adapted to the desert. The inhabitants are ethnic- multiple, Berber, Arab, African and mestizo came from mixed marriages. Ouargla is as an administrative pole of southeastern Algeria, most commercial activities are concentrated in Touggourt. Also, most young people prefer to leave the oasis and go to the oil fields located nearby. However, small transactions that take a traditional aspect exist in Ksour and in the periphery of the two oases.

Sampling methodology

It aims to evaluate the use of plants by the traditional medical system in its present form and to compare the pharmacological research, agro-ecological and socio-economic development. Overall, our methodology consists of: An exploratory phase from October to December was conducted among the most skilled people in the subject at the studied area to make a first list of species and the development of the survey form. The choice of sites, guided by the characteristics of the studied area, was based on two modes of life, urban and rural areas that are the most representative (Anonym, 2008) (Figure of 2-4). The phase of the ethno-botanical survey itself was conducted during five months. To rationalize the sampling and to facilitate the quantitative study while getting as close as possible to the residents at the district level, we were constrained to be limited to 10% of houses. These were chosen in a systematic or a record of 10 successive dwellings. The duration of each conversation is about 1h30. In each one, any information was gathered on the profile of the questioned people and the medicinal plants they use.

Thus, the profile of everyone includes their age, sex, educational level, their job, their income and the medicinal plants they use. The gathered information on plants includes the scientific and common names, the parts used, the method of preparation and the disease being treated. All species have been authenticated through literature and through comparison with the herbarium specimens produced within the Faculty SNV (Sciences de la Nature et de la Vie) and S.T.U. (Sciences de la Terre et de l'Univers), University Kasdi Merbah, Ouargla. The data recorded on data sheets Gross.

The data recorded on the raw data sheets were analyzed through ecological indices and statistical method:

The frequency of use (Fc), the percentage of individuals of a species considered in relation to the total number of individuals of all species. It can be

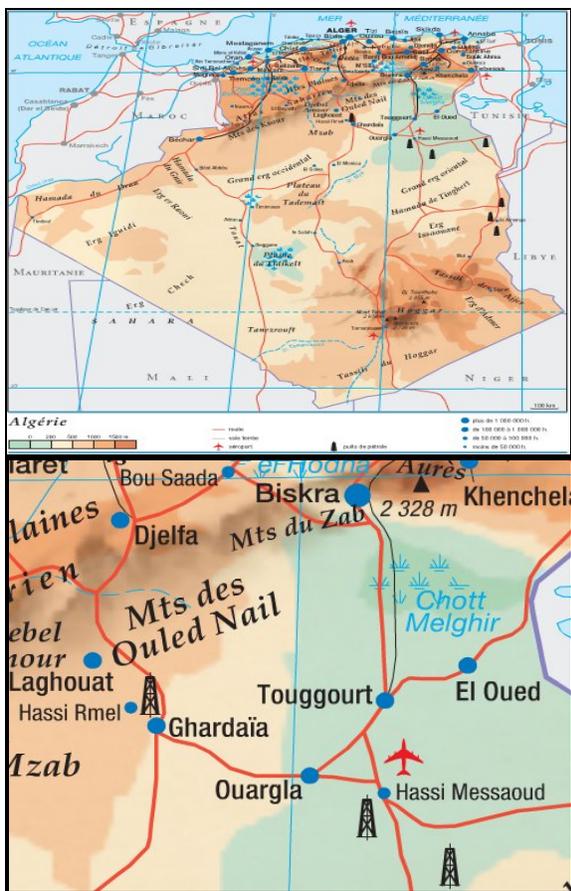


Figure 1. Geographic location of the study area.

calculated for a sample or for all concerned (Dajoz, 1971). It is calculated according to the formula:

$$F_c = (n_i / N) \times 100$$

Where, (n_i) - The number of individuals of a species

(N) - The total number of individuals of all species present

The consistency or frequency of occurrence (C) of a given species is the number of times it appears in the sample. It is calculated from the following formula:

$$C = (P_i / P) \times 100$$

Where, (i) - The number of records where species are present

(P) - The total number of records (P)

Thus, the constancy of a species is called accidental (C <25%), accessory (25% <C <50%), regular (50% <C <75%) or constant (75% <C <100%).

Analysis of Variance (O²) (Dagnelie, 1975): is obtained by using the formula:

O²=, with the number of squares to be studied (n), the number of individuals in each square (x) and the average individual in the set of squares (m);

-Type of distribution (TR) (Dagnelie, 1975): is given by following the formula: TR= O²/ m. The type of distribution is contagious if TR is greater than 1. It will be aleatory if this value is equal to 1, regular if it is less than 1 and uniform with a value equal to zero.

Automatic classification: is performed using the software STATISTICA.



Photo 1. Urban area of Ouargla (QUO): Chourfa.



Photo 2. Rural area of Ouargla (QRO): Hassi Miloud.



Photo 3. Urban district of Touggourt (QUT): Amir Abdelkader.



Photo 4. Rural district Touggourt (QRT): Sidi Mahdi.

Results and Discussion

The ethno-botanical survey

The analysis of 735 ethno-botanical investigations was completed by the distribution shown in Table 1. The latter shows the number of the questioned people by district and by gender. In fact, it is proportional to the number of inhabitants recorded by site.

Table 1. Distribution of data by sex and lifestyle.

Sites	Ouargla		Touggourt		Total interviews
	Urban district (QUO)	Rural district (QRO)	Urban district (QUT)	Rural district (QRT)	
Number of samples	Number	Number	Number	Number	
Male	155	8	130	9	302
Female	215	13	190	15	433
Total	370	21	320	24	735

Frequency of medicinal plants according to the profile and lifestyle of the questioned people

At both oases studied, those of age 20-40 have a high frequency of use of herbals, especially in Ouargla (57%). It is in order by age groups 41-60, [under 20] and finally the more than 61 years, these results show that there is a real return to traditional medicine, whatever the lifestyle and age. Among users, there is a preponderance of females where rates are between 62% and 65% compared to men whose rate is not more than 40% for all districts. What seems paradoxical with other ethno-botanical explorations (Hasnaoui et al., 2011; Gbolade, 2009) is that most users are not illiterate. The frequency recorded over 75%. Unemployment is a national problem and the study area is a part, especially in rural sites. In fact, the rate of users exceeds 50% in the districts studied, particularly in the QRO with 65% and rural district of Touggourt (QRT) with 63.2%. In terms, we find that the self-employed with a rate of over 50% remain dominant in spite the fact of what was cited earlier. In this socio-economic analysis plus the regional culture (tradition), health weakened by pollution, the resistance of certain organisms towards the chemical treatment, the ineffectiveness of the public health system that explains the return to phytotherapy. Apparently the knowledge of the users of medicinal plants and their properties grows more and more unlike what has been reported by other studies (Mehdioui and Kahouadji, 2007; Hasnaoui et al., 2011; Gbolade, 2009).

Inventory

In order to record the number of species according to their systematic entity, our results are presented in the Table 1. Upon completion of the investigation 65 plants were identified, distributed between 43 spontaneous and 22 cultivated. Their distribution is unequal between districts, similarly for the genera and families. However, the higher number has characterized the urban lifestyle especially in the urban district of Touggourt QUT, except for the entity of the genus where the urban

district of Ouargla QUO dominates with 56 (Table 2). Among the 36 families surveyed, only some are highly exploited in these oases, according to their species richness: Apiaceae (10), Labieae (10), Astéraceae (6), Myrtaceae (4), Fabaceae (3) and Zygophyllaceae (3). They are followed by the Lythraceae, Zingiberaceae, Rutaceae, Lauraceae and Alliaceae with 2 species each. According to many authors, such as Hernandez et al. (2012), the closely related families of Asteraceae, Myrtaceae, Fabaceae are considered among the largely exploited plants in traditional medicine.

Frequency of use of medicinal species identified in the oasis of Ouargla and Touggourt

The results are presented for some of the parameters transcribed in the survey form. From the Table 3, it is clear that the high frequencies involve twelve species whose use is common to all districts. In fact, the most common species is *Artemisia herba alba* Asso, with 16.85% in QRT, 15.74% in QUT, to 14.98% in QUO and 12.50% in QRO. These rates are explained by the therapeutic properties of the plant and also its availability. For the remaining species, the frequencies are relatively low overall. In total, we recorded 39 diseases treated by the listed plants but the most frequent ones were: digestive disorders (8 species, 12, 3%), pneumonia (7 species, 10, 8%), fever (6 species, 9, 2%) and influenza (5 species, 7, 8%). The recommended methods are the decoction (58.46%), powder (36.92%) and infusion (30.76%). The parts used are leaves (44.61%), seeds (29.23%), stems (27.69%), fruits (21.53%) and roots (1.53%). In literature, there are differences with our results (Maiza et al., 1993; Ould El Hadj et al., 2003).

In addition, the seven identified endemic plants are characterized by a low frequency of use. These plants treat sixteen diseases. They were mentioned by many authors in Traditional Saharian pharmacopoeia (Ozenda, 1983; Maiza et al., 1993; Chehma, 2005) (Table 4). According to these results, we record the use of aerial parts. This preserves the underground organs.

Table 2. Number of Family, Genus and species indicated according to the sites.

Sites Systematic entity	Ouargla		Touggourt		Totals
	QUO	QRO	QUT	QRT	
Family	23	14	25	14	31
Genus	56	28	49	22	60
Species	46	39	53	25	65

QUO: Urban area of Ouargla / QRO: Rural area of Ouargla / QUT: Urban district of Touggourt / QRT: Rural district of Touggourt

Table 3. Centesimal frequency (Fc.) of occurrence (C.) variance (O2) and type of distribution (TR) of common medicinal species and diseases treated in the district studied.

Species	QUO		QRO		QUT		QRT		Parameters		Treated diseases
	Fc (%)	C (%)	Fc (%)	C (%)	Fc (%)	C (%)	Fc (%)	C (%)	O2	TR	
<i>Artemisia herba alba</i> Asso.	14,98	52,6 3	12,5	60	15,77	52,40	16,88	78,94	3,41	0,22	Respiratory disease Diarrhea, cough, flu pneumonia, digestive disorders, gastritis
<i>Mentha spicata</i> L.	11,58	40,7 0	7,29	35	11,77	39,2	10,11	47,36	4,29	0,42	digestive disorders, gastric gas, headaches, hypertension Cough, flu, Menstrual Sore, Asthenia
<i>Origanum vulgare</i> L.	7,99	28,0 7	8,33	40	9,13	30,4	5,61	26,31	2,28	0,29	Weakness, disorders of the respiratory tract Rheumatism, menstrual disorders, digestive disorders, flu
<i>Juniperus communis</i> L.	6,49	22,8	5,20	25	6,49	21,6	4,49	21,05	0,98	0,17	Diarrhea, pneumonia Gastritis, Vomiting Digestion trouble
<i>Nigella damascena</i> * L.	3,29	11,5 7	3,12	15	2,64	8,80	3,37	15,78	0,10	0,03	Hypertension Stomach gas Headache, Asthma Nervous exhaustion
<i>Trigonilla foenum graecum</i> L.*	5,99	21,0 5	3,12	15	6	20	4,49	21,05	1,91	0,39	Sexual weakness Weakness, digestive disorders, Anemia, Glomerulonephritis Anorexia, Hypertension
<i>Rosmarinus officinalis</i> L.	4,09	28,0 7	7,29	35	1,44	4,80	4,49	21,31	5,73	1,32	Dehydration Stomach gas
<i>Cuminum cyminum</i> L.	5,39	18,9 4	5,20	25	5,16	17,20	1,12	5,26	4,28	1,01	Digestive disorders, Stomach gas, anemia
<i>Eugenia caryophylla</i> Thumb	0,69	2,45	3,12	15	0,24	0,80	1,12	5,26	1,61	1,24	Headache Sexual weakness Nervous exhaustion
<i>Myrtus communis</i> L. Herm.	-	-	2,08	10	0,48	2,40	-	-	0,97	1,52	Gastritis, Diarrhea Stomach gas, digestive disorders, Heart, menstrual disorders
<i>Lippia citriodora</i> L.	1,79	6,31	3,12	15	1,44	4,80	5,61	26,31	3,58	1,19	Digestive disorders Stomach gas
<i>Zingiber officinales rascoe</i> Var.	5,99	21,0 5	2,08	10	5,52	18,40	2,24	10,52	4,35	1,09	Hypercholesterolemia, Pneumonia, flu , hypertension, Sexual weakness, The human immunodeficiency, gastric gas, digestive disorders, constipation, diarrhea, cancer, diabetes, anemia

N: Number of species/ C: constancy/ QUO: Urban area of Ouargla / QRO : Rural area of Ouargla/ QUT: Urban district of Touggourt / QRT: Rural district of Touggourt/ Centesimal frequency (Fc.) of occurrence (C.) variance (O2) and type of distribution (TR)

Table 4. Endemic species used in the east of the northern Sahara.

Families	Scientific names	Names Vernacular	Parts used	Mode of preparation	Diseases treated	Biogéography
Apiaceae	<i>Ammodaucus leucotrichus</i> Coss. & Dur	Oum drayga	Leaves and Fruits	Decoction	Asthma Diarrhea, constipation	Endémic
	<i>Ferula Vesceritentis</i> Coss. & Dur.	Habet lehlaoua	Fruits	infusion	Angina, fevers and migraines	Endémic saharan
Asteraceae	<i>Anvillea radiata</i> L	Noug	whole plant	Infusion	Diabetes and indigestion	Endemic Saharan
	<i>Matricaria pubescens</i> (Desf.)Schultz	Garteufa	leaves	Decoction	Pain rules	North African endemic
Brassicaceae	<i>Oudneya africana</i> R. Br.	Hannet l'ibel	Leaves and Fruit	Mixture powder	Skin disease	Endémic
Euphorbiacées	<i>Euphorbia gyuoniana</i> Boiss. & Reut.	Oum el bina	Leaves	Decoction, mixture, powder	cataplasm Verrus, abscess	Endemic northern Sahara
Liliaceae	<i>Urginea noctiflora</i> Batt. & Trab.	Basl elfar	Bulbs	Decoction, Powder and cataplasm wounds	Verrus, Abcès wounds, ulcer, Inflammation of the throat and earaches	Endémic

Table 5. Toxic Species identified in the study area.

Families	Speices	toxic parts	Toxic	Authors
Asteraceae	<i>Anvillea radiata</i> L	whole plant	Highly glycosylated flavonol	Dendougui et al., 2006
	<i>Cotula cinerae</i> Del.	whole plant	Flavones	Benayache et al., 2000, Chehma, 2005
Apocynaceae	<i>Nerium oleander</i> L.	whole plant, especially the leaves	Glycoside	Bruneton (2001),
Chenopodiaceae	<i>Hammada scoparia</i> (Pomel) Iljin	Leaves	alkaloids	Chehma (2005)
Cucurbitaceae	<i>Colocynthis vulgaris</i> (L.) Schrader	Fruits	alkaloids	Bruneton (2001)
Euphorbiaceae	<i>Euphorbia gyoniana</i> Boiss. & Reut.	Leaves	Lactone euphorbe	The investigation Raouiha (tradipraticien)
Rutaceae	<i>Ruta tuberculata</i> Forssk.	Leaves	Essential oil, bitter substances	Passager (1957) Ozenda (1983)
Solanaceae	<i>Solanum nigrum</i>	Leaves, fruits	alkaloids	Ozenda (1983), Bruneton (2001), Ducerf (2010)
Liliaceae	<i>Urginea noctiflora</i> Batt. & Trab.	Bulbs	Glycoside	Baba aissa (1991)
Zygophyllaceae	<i>Peganum harmala</i> L.	whole plant	Alkaloids, harmaline, indole harmalol	UNESCO (1960) Bruneton (2001)
	<i>Zygophyllum album</i>	Fruits	Essential oil, bitter substances	Ozenda (1983)

Table 6. Number and constancy of medicinal species used in the four districts.

District Stances		QUO	QRO	QUT	QRT
Ubiquitous species	N	0	0	0	0
C=100%	%	0	0	0	0
Constant species	N	0	0	0	1
75% < C < 100%	%	0	0	0	4
Regular species	N	1	1	1	0
50 < C < 75%	%	2,22	3,44	1,88	0
Incidental species	N	2	7	2	6
25 < C < 50%	%	4,44	24,13	3,77	24
Accidental species	N	42	21	50	18
C < 25%	%	93,33	72,41	94,33	72
		45	29	53	25

N: Number of species/ C: constancy/ QUO: Urban area of Ouargla / QRO: Rural area of Ouargla / QUT: Urban district of Touggourt / QRT: Rural district of Touggourt

Table 7. Variance of use and type of species distribution in districts.

Settings	QUO	QRO	QUT	QRT
Variance	7,68	6,17	7,93	8,46
Type of distribution	5,02	4,03	5,18	5,53

QUO: Urban area of Ouargla / QRO: Rural area of Ouargla / QUT: Urban district of Touggourt / QRT: Rural district of Touggourt

Table 8. Number of medicinal species by types of distribution

Types of distribution	Contagious TR>1	Aleatory TR=1	Regular TR<1	Uniform TR=0
Number of species	22	0	41	2

TR: Types of distribution; Contagious if TR is greater than 1; Aleatory if this value is equal to 1; Regular if it is less than 1 and uniform with a value equal to zero.

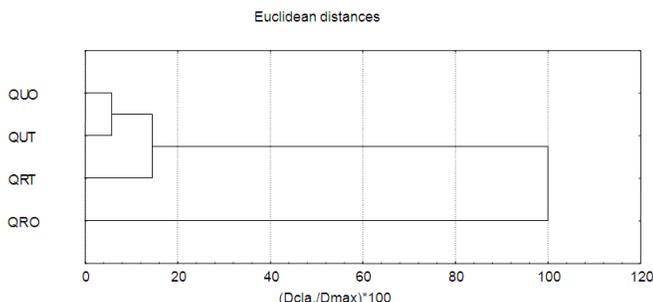


Figure 2. Dendrogram of similarity levels of the exploitation of medicinal species in the four sites.

Given the sample size, the study of the species' toxicity is limited to statements of the interviewed subjects and the necessary documentation. 11 species result from this sampling; they are classified as dangerous species which cover 9 families. They are clearly illustrated in Table 5.

Table 6 shows the prevalence of accidental species, especially in urban areas (93% and 94%). These rates are due to instability probably related to the socio-economic evolution and the revival of the herbal medicine. Incidental species occupy the second position; the constancy in the rural areas (24%) is higher than in urban areas (4%). In this category, we find the species *Origanum vulgare* L. and *Mentha spicata* L. in the two lifestyles. For this, the incidental species *Peganum harmala* L.,

Rosmarinus officinalis L., *Ajuga iva* (L.) Schreb. and *Mentha pelgium* L. are found exclusively in the QRT (Table 4).

The third position is occupied by the regular class with constancy ranging between 2% and 3% in urban and rural areas of Ouargla. *Artemisia herba alba* is the only species where the highest rate is maintained or the QRO (60%). The class of constant species is characterized by a single species which is sagebrush *Artemisia herba alba* with 78.4% in the QRT. It comes in the fourth position (Table 3).

Analysis of Variance applied to medicinal plants used in the districts

The analysis of variance allows us to know if there is a significant difference between species use

areas (lifestyle) and the difference between the species themselves. In fact, the results of the variance and the type of distribution are illuminated by Table 7.

In Table 7, it is clear that the variance values are quite closer between urban settlements than between rural sites. However, the type of distribution is greater than 1 in all areas, thus the distribution is contagious. In fact, this highlighted the relationship established between users.

Type of distribution of medicinal plants used in the studied area

From the obtained results, we noted that the distribution of medicinal species in common use is variable (Tables 3 and 8). The value of the type of distribution shows that the regular distribution "R" is well represented in the studied area. Thus, this type is used for 41 species. The contagious "C" is illustrated by 22 species. Species representing the uniform distribution "U" are 2, characterizing the QUO. By term, we emphasize the lack of randomization "A". According to ethnobotanical survey, this is due to the rate of mixed use more than that of single use of these species.

Automatic classification applied to medicinal plants used in the studied area

Examining the dendrogram (Figure 6), we distinguished three nodes; the first node is formed between the urban districts of Ouargla (QUO) and Touggourt (QUT). This is equivalent to the number of species (48) in common use which is very important. This was predictable, given the assumptions raised. The second node is located between the first node and the rural district of Touggourt (QRT). The similarity is relatively low because the number (20) of common species decreased. In the end, the third node is between the second node and the rural district of Ouargla (QRO). At this level, the similarity is the lowest, obviously because the number of species (14) in common use is reduced.

Conclusion

This study was focused on the importance of medicinal plants in two oases in northeastern Sahara. It has extended the list of medicinal flora where two-thirds of the species are spontaneous. In fact, it appears that the urban lifestyle is as much involved in herbal medicine as rural lifestyle. However, we noticed that the rural people preserve more of their tradition in using certain plant species. Thereby they escape the pressure of the most acclaimed species of the contemporary period. In summary, the analysis of the constancy showed

that the exploitation of medicinal plants was inversely proportional to the number of species transcribed in each lifestyle. The analysis of variance reveals a significant difference in use of species between the two lifestyles. The type of distribution has unveiled two main levels of use. The first group consists of species regularly distributed that express the homogeneous use. Thus, they can be described as the most popular species of the traditional medical system. This might be due to the rate of mixed use that is higher than the rate of single use of these species. In fact, the description of the hierarchy is divided into three classes. The first class is composed of the urban districts reflecting the importance of common species. The second class consists of urban and rural districts where the similarity is relatively low. The third class consists of the rural district of Ouargla that has few medicinal species in common with the other sites. We, therefore conclude that, apart from the interactions (land-use systems, tenure systems, human disturbance etc.) of local people (ethnic group, language, population size and distribution, migration, social groups, education etc.) with the natural environment (medicinal species, location, elevation, climate, geology, vegetation, types, species diversity etc.), we noted a much moderated exploitation of the endemic plants. Yet, the quantitative aspect deserves being dealt with subsequently. Likewise toxicity, doses and methods of the conservation of medicinal plants should make the object of deep researches to supply the ascendant needs of the population.

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