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Original Article

Ethnomedicinal and traditional phytotherapeutic plants used in Bouhachem Natural Regional Park (Rif of Morocco): Case of Bni-Leit and Al-Oued districts

[Plantas etnomedicinales y fitoterapéuticas tradicionales utilizadas en el Parque Regional Natural de Bouhachem (Rif de Marruecos): El caso de las comunas rurales de Bni-Leit y Al-Oued]

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Abstract

Context: The flora of the Bouhachem Regional Natural Park has been studied by many botanists and ecologists, but the analysis of the medicinal and economic values of these plants is still weak and poorly documented. Within the framework of this study, further investigations will be carried out into the value of indigenous medicinal plants and the documentation of their ethnopharmacological knowledge. In addition, due to their important socio-economic role as a second source of income after agriculture, the evaluation of the commercial activity of aromatic and medicinal plants (AMP) will also be taken into account.

Aims: To evaluate the ethnobotanical and commercialized medicinal plants in north region of Morocco in which traditional medicine is widespread.

Methods: The uses of medicinal plants in traditional phytotherapy were researched through 700 question cards, in Bni-Leit and Al-Oued districts, which are a part of the Naturel Regional Park of Bouhachem. A series of ethnobotanical, economic and sociocultural surveys/interviews were conducted among the local population in the study area, between March 2014 and July 2016.

Results: This Ethnobotanical study identified 101 medicinal plant species belonging to 46 families, of which the most abundant are *Lamiaceae* (FUV: 1.87). This study also revealed that the leaves are the most used parts of the plant (26%) and that the most remedies are prepared as decoction (27%). Digestive disorders rank first among the diseases treated by these plants with a rate of 21%.

Conclusions: The present study shows that the traditional use of medicinal plants still persists and constitutes a very rich heritage in the northern of Morocco. Therefore, this important indigenous knowledge of medicinal plants would be exploited in pharmaceutical research. It reveals that urgent action is needed to promote a sustainable and best practices to reduce the increasing scale of exploitation of AMPs for commercial use and to draw the attention of Park managers to the preservation of these plants from genetic erosion by a rational management.

Keywords: Bouhachem Park; ethnobotanical; medicinal plants; Moroccan Rif; phytotherapy; Tetouan.

Resumen

Contexto: La flora del Parque Regional Natural de Bouhachem ha sido estudiada por muchos botánicos y ecologistas, pero el análisis de los valores medicinales y económicos de estas plantas es todavía débil y poco registrado. En el presente estudio, las investigaciones ulteriores se centrarán en el valor de las plantas medicinales autóctonas, la documentación de sus conocimientos etnofarmacológicos y la evaluación de la actividad comercial de las plantas aromáticas y medicinales (AMP) en las dos comunas estudiadas.

Objetivos: Evaluar las plantas medicinales etnobotánicas y comercializadas en la región septentrional de Marruecos, en la que la medicina tradicional está muy extendida.

Métodos: Los usos de las plantas medicinales en la fitoterapia tradicional se investigaron mediante 700 tarjetas de preguntas, en los distritos de Bni-Leit y Al-Oued que forman parte del Parque Regional Natural de Bouhachem. Entre marzo de 2014 y julio de 2016 se realizó una serie de encuestas/entrevistas etnobotánicas, económicas y socioculturales entre la población local de la zona de estudio.

Resultados: En este estudio etnobotánico se identificaron 101 especies de plantas medicinales pertenecientes a 46 familias, de las cuales las más abundantes son las *Lamiaceae* (FUV: 1,87). Este estudio también reveló que las hojas son las partes más utilizadas de la planta (26%) y que la mayoría de los remedios se preparan en forma de decocción (27%). Los trastornos digestivos ocupan el primer lugar entre las enfermedades tratadas por estas plantas con una tasa del 21%.

Conclusiones: El presente estudio muestra que el uso tradicional de las plantas medicinales aún persiste y constituye un patrimonio muy rico en el norte de Marruecos. Por lo tanto, este importante conocimiento indígena de las plantas medicinales sería explotado en la investigación farmacéutica. Revela que es necesario adoptar medidas urgentes para promover prácticas sostenibles y óptimas a fin de reducir la escala cada vez mayor de la explotación de las AMP para uso comercial y señalar a la atención de los administradores de los parques la preservación de esas plantas de la erosión genética mediante una ordenación racional.

Palabras Clave: etnobotánico; fitoterapia; Parque Bouhachem; plantas medicinales; Rif marroquí; Tetuán.

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INTRODUCTION

The Moroccan flora has about 7000 known species. The vascular flora has about 4500 species, belonging to 940 genera and 135 families (Benabid, 2000), of which about 1/4 are endemic species, the main centers of which are the high mountain peaks. It is massively represented in forest ecosystems, where almost 2/3 of the species live; the remaining third is mainly shared between steppe formations and wetland biotopes. The mountainous regions of the Rif and Atlas Mountains are the most important areas for endemism.

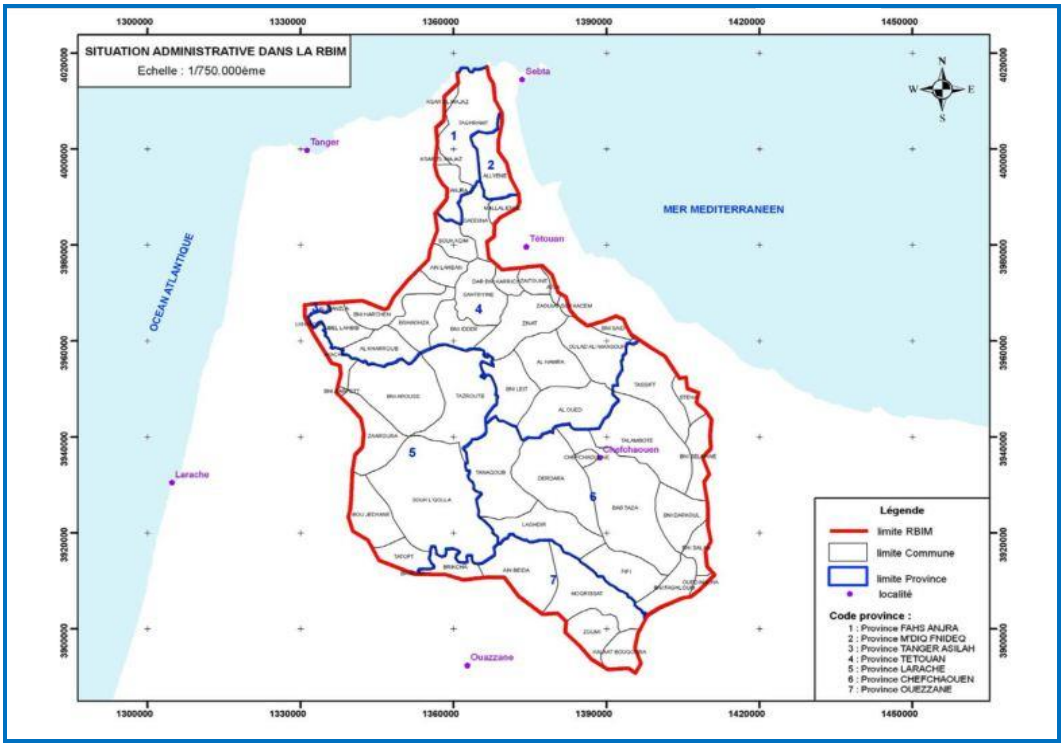
The Western Rif, thanks to its geographical location, orographic, lithological, and bioclimatic characteristics, stands out for its natural wealth, which is particularly similar to that of southern Andalusia (Valdes, 1991).

The vegetation is very diversified, the phytocenoses are luxuriant and offer the greatest forest potential in Morocco (Benabid, 2002). The traditional use of medicinal plants forms the basis of curative medicine for low-income populations.

The "Mediterranean Intercontinental Biosphere Reserve" (MIBR) located in the north of Morocco is considered as a reservoir of biodiversity in Morocco, covering a total area of 479 618 ha (Map 1).

In the MIBR, biological diversity is an important opportunity for the local population. Several forest and non-forest species have historically been used by endogenous populations.

In fact, the total planimetric area of the different facies of aromatic and medicinal plants (AMP), amounts to 470 613 ha; i.e. 98% of the total area of the MIBR zone (APDN, 2012). This figure truly reflects the great richness of this zone in AMP. Being an integral part of the MIBR, the "Bouhachem Regional Natural Park" in general and the province of Tetouan, in particular, is both rich and diversified in aromatic and medicinal plants (Fig. 1).



Map 1. Administrative situation in the Mediterranean Intercontinental Biosphere Reserve integrating the Regional Natural Park of Bouhachem (RNPB).

Source: APDN, 2012.

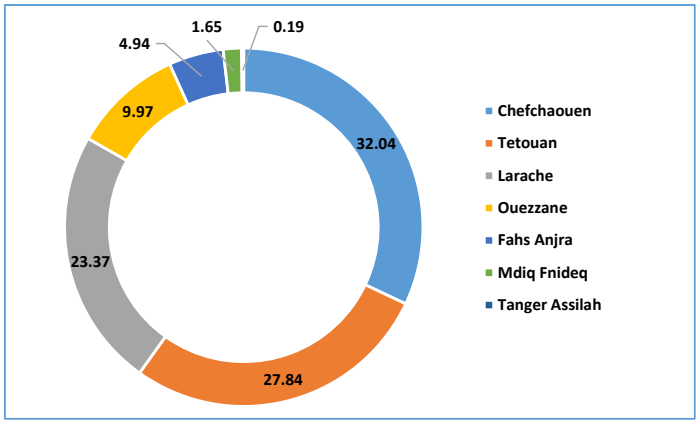


Fig. 1. Distribution of the surface area in ha and in (%) of aromatic and medicinal plants in the MIBR of Northern Morocco (APDN, 2012).

The objective of this research paper is to capitalize all the information concerning the indigenous knowledge on the main medicinal plants present in the area of the communes of Bni Leit and Al Oued of our study in order to: (i) document its ancestral practices; (ii) draw attention to the important medicinal values of these plants and to consider them as a basis for pharmaceutical research; (iii) highlight the commercial collection activity, which is beginning to take on considerable and worrying importance; and (iv) attract the attention of the public authorities in order to raise the awareness of the local population and to draw up a forest management plan for the rational management and conservation of the biodiversity of the Bouhachem's Park ecosystem against the genetic erosion of the species most coveted by the population.

The ethno-scientific approach is an incomparable tool for accessing a population's knowledge of its environment. The use of ethnobotanical surveys will enable us to inventory the resource plants of plant products exploited by traditional medicine in the two communes studied.

MATERIAL AND METHODS

Description of the study area

The rural communes (RC) targeted by this study are located in northwest Morocco (Rif), in the RNPB. The latter is part of the "Mediterranean Intercontinental Biosphere Reserve" considered as a biodiversity reservoir in Morocco, and which covers a total area of 479 618 ha. The RNPB is entirely within the Tangier-Tetouan-Al Hoceima region, but extends over three provinces, six rural communes (RC) and 159 villages. The entire territory covers an area of about 90 000 ha (Map 2). The study area covered by this article concerns two rural communes in the province of Tetouan, namely Bni Leit and Al Oued (Map 3).

The general data relating to the study area for the rural communes of Bni Leit and Al Oued are shown in Table 1.

Geology

Geologically, the study area is an integral part of the Rif. The Rif is subdivided into three domains: external, median, and internal. Our study area is concerned only with the internal and median domains, each of which has different characteristics.

Mountains (forest) make up 59% while plateaux and plains represent 39% and 2% of the total area of the two communes respectively (Table 2).

From a topographical side, the study area presents a rugged relief with significant slopes, cliffs, and altitudes.

Climate

According to the climatic variation, the areas of Bni Leit and Al Oued are located in a subhumid to humid bioclimatic environment with a temperate variation. This climate is characterized by a clear contrast between the seasons, both in terms of

temperature and rainfall (Table 3). The number of dry months varies between 3 and 5 months. Rainfall can exceed 1100 mm/year in Bouhachem mountain.

During the summer period, the dominant winds are easterly or chergui winds at around 60 km/h. Frost is rare and there is no snow cover.

Hydrology

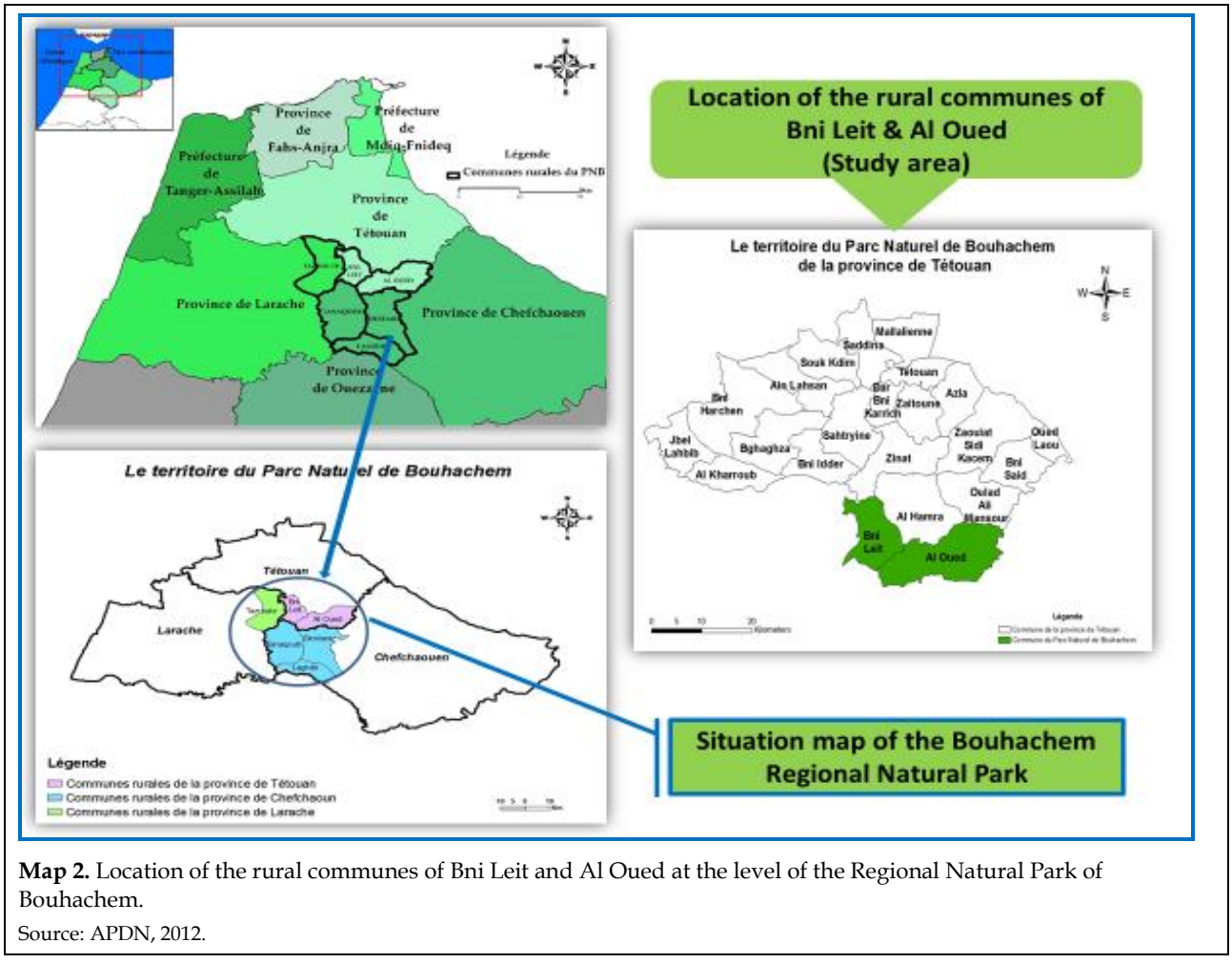
The hydrology of the study area is particularly related to its geology and topography. Indeed, the nature of the rocks and the slopes of the landforms where the watercourses meander potentially affect the size and flow rates of the watercourses.

First, in areas characterized by rocks of a nature where clay and marl predominate, with steep slopes, the watercourses are of a rather torrential and rainy regime. This means that there are abundant wells and water sources in the study area. The effect of frequent and strong winds is remarkable in both communities.

The study area is an integral part of the MIBR, the only one in the world that links two continents: Africa and Europe.

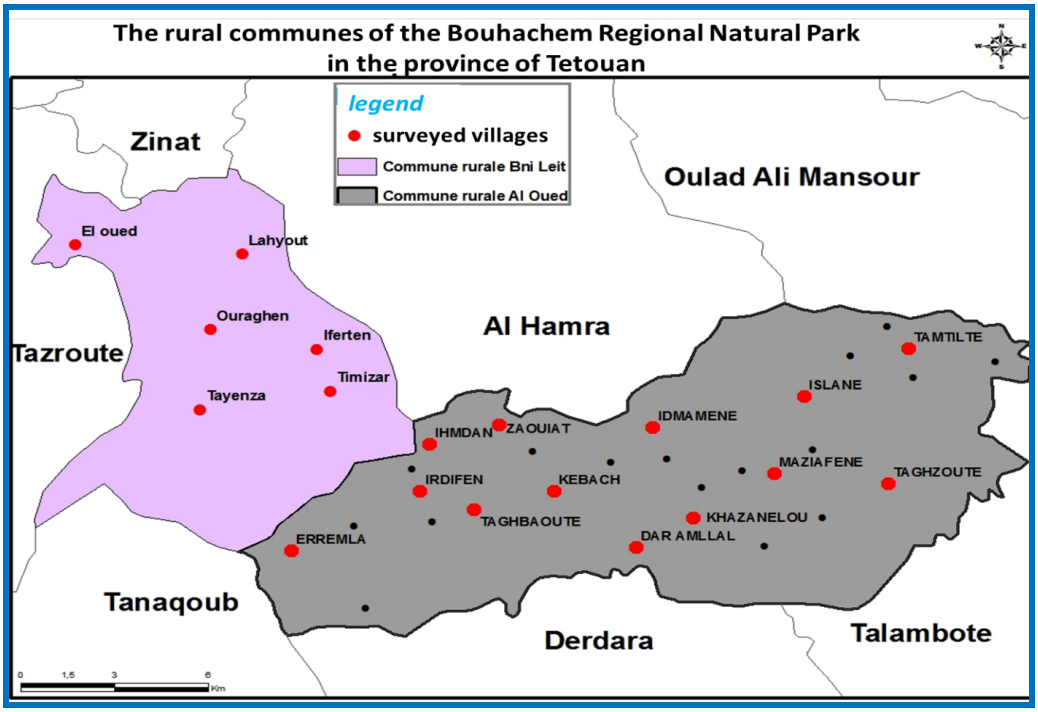
The MIBR area, due to its geographical position, exceptional climatology, and geology, occupies a major position in the biodiversity in Morocco, and even on a Mediterranean scale.

This area has the particularity of being recognized by a high rate of endemism, both for animal and plant species. The spontaneous aromatic and medicinal plants of the two rural communes are mainly under the forest domain of the State.



Map 2. Location of the rural communes of Bni Leit and Al Oued at the level of the Regional Natural Park of Bouhachem.

Source: APDN, 2012.



Map 3. Douars or villages surveyed in the communes of Bni Leit and Al Oued.
Source: APDN, 2012.

Table 1. General data about rural communes of Bni Leit et Al Oued (RGPH, 2014).

Rural Commune	Surface in km²	Inception date	Number of inhabitants	Number of households	Number of villages
Bni Leit	111.06	1992	5324	889	06
Al Oued	352.93	1977	11 288	1918	29
Total	**463.99**	**-**	**16 612**	**2807**	**35**

Table 2. Reliefs of rural communes of Bni Leit et Al Oued (HCP, 2015).

Rural commune	Bni Leit	Al Oued	Total	
Plains (ha)	865	0.00	865	2%
Mountains (ha)	8965	18 330	27 295	59%
Plateaux (ha)	1276	16 963	18 239	39%
Total (ha)	**11 106**	**35 293**	**46 399**	**100%**

Table 3. Climatic data of the two communes (HCP, 2015).

Rural commune		Minima	Maxima	Average
Bni Leit	Rainfull (mm)	412	1248	607
	Temperature (°C)	14.5	28.5	18.3
Al Oued	Rainfull (mm)	900	1200	650
	Temperature (°C)	4	40	22

Methodology

General methodological information

The ethnobotanical study of medicinal plants was carried out according to the semi-structured and open-ended interview technique (Weller and Romney, 1998) and with the help of a questionnaire sheet (Appendix 1) distributed in villages in the two rural communes (Map 3) in order to have an overview of the local traditional uses and the floristic diversity of the pharmacopoeia of this area.

Questionnaire sheets (700) were used to carry out our ethnobotanical field surveys, which were conducted between March 2014 and July 2016 during six field missions (March-April and June-July) at the rate of two missions per year. This survey was carried out among the local population of the two communes in order to define the plants marketed and used in traditional medicine. We also interviewed two herbalists and five MAP traders, as well as the president of a cooperative that exports MAP.

Informants were briefed on the purpose of this study after gaining their confidence/agreement and were interviewed in Arabic dialect.

The data collected contains detailed information on the respondents (age, education, family situation and income) and on the plant used (vernacular name, parts used, quantity sold and selling price, medicinal uses, and method of preparation).

Botanical identification

The plants indicated by the informants were systematically photographed for each species, and botanical samples were collected and placed in the perforated plastic bag with a label indicating its vernacular name for all unrecognized species.

On the other hand, the taxonomic identification of the listed species was made according to the latest phylogenetic classification of angiosperms elaborated by the APG III team (2009). Furthermore, we identified species not recognized in the field under a botanist control of Professor Zidane of the University IBN Tofail (Kenitra) in order to compile a complete list of medicinal species reported by respondents in the study area.

Anthropological approach

A questionnaire was drawn up on the basis of preliminary surveys in the study area and validated by the team of the Natural Resources and Sustainable Development Laboratory of the Faculty of Sciences at the University Ibn Tofail (Morocco).

This survey was carried out in 5 steps (Fig. 2). The third stage involved carrying out preliminary surveys among a limited number of people to validate the survey form (blank test). After making the necessary adjustments and validating the questionnaire, the 4th stage consisted of conducting the surveys properly.

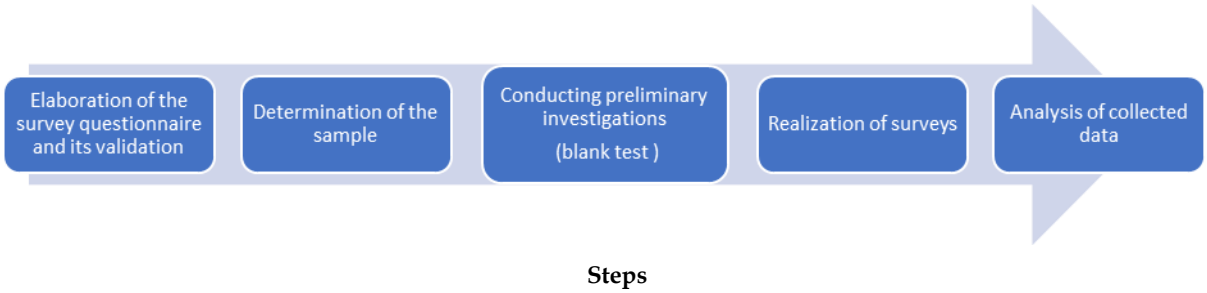


Figure 2. Survey process.

In the last step, the questionnaires were duly instructed and processed. Quantitative data were entered, analyzed and graphs were prepared using Excel software.

Ethical consent

Letters of consent were taken from department of biology, Ibn Tofail University and an agreement with the local authorities of Tetouan. All data collections were done with special care on the base of the cultural view of the local villages in the study area. Informants were also informed that the objectives of the research were not for commercial purposes but for academic reasons. Participants provided verbal informed consent to participate in this study. They were free to withdraw their information at any point of time. Finally, informants were accepted the idea and they have clearly agreed to have their personal data to be published.

Statistical analysis

The data collected through interviews of the informants was analyzed using different statistical quantitative tools (Bouayyadi and Zidane, 2020; Orch et al., 2020); i.e., Medicinal Use Value (MUV), Family use value (FUV), Use Value Index (UV), and Relative Frequency of citation (RFC) to determine the importance of medicinal plant resources.

1. Medicinal Use Value (MUV): The Medicinal Use Value indicates the relative medicinal importance of plants known locally. MUV ranges from 0-1. MUVs are high when there are many use-reports for a plant making the sense that the plant is important and approaches zero (0) when there are a few use reports related to its use.

2. Family Use Value (FUV): The Family use value (FUV) determines the importance of a family reporting various plants/animals for their therapeutic potential.

FUV = ∑UVs/Ns. Where UVs is the number of informants mentioning the family and Ns is the total number of species within each family.

3. Use Value (UV): The use value of species is a quantitative method that demonstrates the relative importance of species known locally.

UV = ∑Ui/N. Where Ui is the number of use reports mentioned by each informant (i) and N is the total number informants interviewed for a given plant species.

4. Relative Frequency Citation (RFC): The Relative Frequency Citation is an index that is used to demonstrate the local importance of each plant species. It is calculated based on the frequency of citation divided by the total number of informants: RFC = FC/N. Where FC is the number of informants in relation to the use of plant species and N indicates the total number of informants participated in the study without used categories for consideration.

RESULTS AND DISCUSSION

Characteristics of study population

Analysis of the data collected showed that the respondents were between 19 and 73 years of age, with an average age of 43. This average age is much lower than that recorded in the commune of Tazroute (Western Rif of Morocco), which is about 53 years old (Bachar et al., 2016). This average age is similar to that reported in the region of Taza (Pre-Rif of Morocco), which is about 45 years old (Khabbach et al., 2012).

Older people (over 40 years of age) have more information than their younger counterparts; the knowledge of younger people is limited to the most common species. The surveys showed that women represent 39% and men 61% of the respondents. The large category of people with a high frequency of medicinal plant use is the married with 68%, followed by singles and widows with 21% and 11% of cases respectively (Fig. 3). Our sample was also marked by a high illiteracy rate (53%) (Fig. 3). This rate remains lower than that declared for the region of "Oulad Daoud Zkhanine" in the province of Nador in the north of Morocco (Jaadan et al., 2020).

Medicinal and family use-value (MUV and FUV)

The analysis of the survey sheets of our study area (Rural communes of Bni Leit and Al Oued) allowed us to list 101 species belonging to 46 fami-

lies (Table 4). The study conducted between 2009 and 2010 by Chambouleyron throughout the Regional Natural Park of Bouhachem, which includes the communes of Bni Leit and Al Oued, resulted in an inventory of 1124 taxa (species and subspecies) including 113 medicinal species (Chambouleyron, 2012).

The families most represented and most used by the population studied are respectively *Lamiaceae* (FUV: 1.87), *Apiaceae* (0.46), followed by *Asteraceae* (0.42), then *Amaryllidaceae* (0.34), *Myrtaceae* (0.32), *Lauraceae* (0.30), and *Fabaceae* (0.27). Fennane and Ibn Tattou (2012), inventory of the vascular flora of Morocco, concluded in their catalogue that the first three families of the Moroccan vascular flora are always the same and in the same order *Asteraceae*, *Fabaceae* and *Poaceae* and total 1329 species, i.e., more than a third of the national specific inventory; whereas our result showed that the two families *Asteraceae* and *Fabaceae* represent only 10.29% in the two rural communes under Tetouan of the Bouhachem park (Table 5).

In order to situate our results with other work realized in the north of morocco, we adapted our data (MUV) to the used method by the other authors. Regarding to MUV, the news values founded are *Lamiaceae* (27.02% equivalent to FUV: 1.87), *Apiaceae* (6.59%), *Asteraceae* (6%), *Amaryllidaceae* (4.86%), *Myrtaceae* (4.57%), *Lauraceae* (4.29%), and *Fabaceae* (3.86). In this case, the five botanical families most represented at the scale of the same park in the Tazroute RC revealed that the highest represented families are *Lamiaceae* (24%), *Asteraceae* (7%), *Lauraceae* (5.5%), *Fabaceae* (5.5%), *Myrtaceae* (5%) and *Apiaceae* (4.5%) (Bachar et al., 2016). Similarly, the study conducted at the Pre-rif of Morocco led to the same findings and noted that the botanical families most used in traditional medicine in Taza are dominated by *Lamiaceae* (15%), *Asteraceae* (10.9%), *Fabaceae* (6.84%), *Myrtaceae* (5.47%) and *Rosaceae* (5.47%) (Khabbach et al., 2012).

The highest number of species were possessed by *Lamiaceae* (18), following by three families (*Apiaceae*, *Asteraceae* and *Fabaceae*) with 7 species and *Poaceae* with 6 species (Table 5). Twenty-five families were composed of one species only.

Concerning the Medicinal Use-Value, the MUV coincides with the FUV for the family with one species recorder (Table 4). For the other, it ranges from 0.01 to 0.32. The highest value was observed for *Mentha pulegium* and the lowest for four species (*Anthyllis cytisoides, Pelargunium Capitatum, Origanum grosii* and *Mentha viridis)*.

Relative Frequency citation (RFC)

Analyzing of the information collected shows that *Mentha pulegium* was reported by 84% of respondents, followed by *Origanum compactum* (71%) and *Myrtus communis* (66%). In addition, *Rosmarinus officinalis* was used by 58% of the informants, followed by *Cistus villosus* (55% of citations), *Artemisia absinthium* (47%), *Calamintha officinalis* (47%), *Allium cepa* (45%), *Allium sativum* (45%) and *Salvia officinalis* (42%) (Fig. 4).

The result shows that seven volunteer species top the list of species used by the local population in the two communities studied. This shows the respondent's dependence on their natural environment and also implies a mastery and richness of local popular know-how in terms of the multiple use of medicinal plants in their forest ecosystem.

In addition, it should be noted that medicinal plants, not presented below, were used by interviewees with varying frequencies between 5% and 26%. On the other hand, it should be mentioned that six species, namely *Artemisia herba-alba*, *Herniaria hirsuta*, *Anthyllis cytisoides*, *Pelargunium capitatum, Origanum grosii* and *Mentha viridis* were only mentioned once.

Table 4. Information on medicinal uses and quantitative values of the medicinal taxa of Bni Leit and Al Oued rural communes (Tetouan province).

N°	Family	FUV	Scientific specie name	Local name (English name)	Freq. (%)	MUV	RFC	Part used/ type of plants	Preparation mode	Administration mode	Phyto-therapeutic actions
	1. *Amaryllidaceae*	**0.34**			**4.86**						
1			*Allium cepa* L.	L'bssale (onion)	2.43	0.17	0.45	Bulb/ cultivated plant	Decoction/ cataplasm	Oral or local application	Gastritis, against dermatological affections, cold, against eye and ear pain
2			*Allium sativum* L.	Toum (garlic)	2.43	0.17	0.45	Bulb/ cultivated plant	Prepared with olive oil/ decoction	Oral or local application	Cold, enteritis, anti-rheumatism, antimicrobial, blood pressure regulation, against respiratory disorders, treatment of hair affections
	2. *Anacardiaceae*	**0.13**			**1.86**						
3			*Pistacia lentiscus* L.	Drou (masticum)	1.86	0.13	0.34	Leaves or gum/ wild plant	Infusion/ cataplasm	Oral or local application (to cover fracture)	Ear pain, against anorexia, against fractures, headaches
	3. *Apiaceae*	**0.46**			**6.59**						
4			*Petroselinum crispum* (Mill.) Fuss	Maadnousse (parsley)	2.14	0.15	0.39	Leaves and stem/ cultivated plant	Decoction/ mixed with *Allium cepa*	Oral	Calming and against insect bites
5			*Pimpinella anisum* L.	Habbat ehlaoua (anise)	0.43	0.03	0.08	Seeds/ wild plant	Decoction	Oral	For abdominal pain
6			*Coriandrum sativum* L.	Kozbor (coriander)	1.43	0.16	0.26	Seeds/ cultivated plant	Decoction	Oral	Against kidney stones and protects the bladder, against hardening of the arteries
7			*Apium graveolens* L.	Krafesse (ache)	0.87	0.06	0.16	Seeds/ cultivated plant	Decoction	Oral	Countercooling of the body, calming of the nervous system, eliminates gases
8			*Ammi visnaga* (L.) Lam.	Bouchnikha (false fennel)	0.29	0.02	0.05	Seeds/ wild plant	Decoction	Oral	Against diarrhea, gastritis, eczema, wounds, mouthwash, and toothache
9			*Cuminum cyminum* L.	Kamoune (cumin)	1.14	0.08	0.21	Fruit/ seeds/ cultivated plant	Infusion or mixed with oregano or thyme	Oral	Against diseases of the digestive system, against stomach pains
10			*Carum carvi* L.	Karouiya (caraway)	0.29	0.02	0.05	Seeds/ cultivated plant	Infusion or mixed with *Foeniculum vulgare*	Oral	For abdominal pain, bowel pain and gas

Table 4. Information on medicinal uses and quantitative values of the medicinal taxa of Bni Leit and Al Oued rural communes (Tetouan province) (continued…)

N°	Family	FUV	Scientific specie name	Local name (English name)	Freq. (%)	MUV	RFC	Part used/ type of plants	Preparation mode	Administration mode	Phyto-therapeutic actions
	4. *Apocynaceae*	**0.06**			**0.87**						
11			*Nerium oleander* L.	Defla (laurel)	0.87	0.06	0.16	Roots or leaves/ wild plant	Infusion/ cataplasm	Oral/ local application	For headaches, wounds and pain in the teeth and throat
	5. *Aristolochiaceae*	**0.04**			**0.57**						
12			*Aristolochia baetica* L.	Berez'tem (aristoloche)	0.57	0.04	0.11	Aerial parts/ wild plant	Powder mixed with honey	Oral	Against cancer and ulcer
	6. *Arecaceae*	**0.02**			**0.29**						
13			*Chamaerops humilis* L.	Doum (saw palmetto)	0.29	0.02	0.05	Roots/ wild plant	Powder or raw	Oral	Aphrodisiac, for stomach cancer and anemia
	7. *Asteraceae (Compositae)*	**0.42**			**6.00**						
14			*Matricaria chamomilla* L.	Amellal/ babounje (chamomile)	1.29	0.09	0.24	Flower or fruit/ wild plant	Decoction or mixed with henna/ cataplasm	Oral or local application	Against toothache, for hair coloring, calming of the nervous system and against intestinal gas
15			*Artemisia absinthium* L.	Chayba (absinthe)	2.57	0.18	0.47	Aerial parts/ wild plant	Infusion/ cataplasm	Oral or local application (ears)	Against otitis, vertigo, intoxication, facilitates digestion
16			*Calendula arvensis* M.Bieb.	Jamra (marigold)	0.43	0.03	0.08	Roots/ wild plant	Decoction	Oral	Against intestinal pain, calming during menstruation cycle
17			*Artemisia herba-alba* Asso	Chih (mugwort)	0.14	0.01	0.05	Leaves/ wild plant	Infusion/ decoction or mixed with thyme	Oral	Against rheumatism, cold, stomach ulcer, tooth pain, hemorrhoids, gastrointestinal and constipation, menstrual pain
18			*Cynara humilis* L.	Tamaite (artichoke white)	0.57	0.04	0.11	Roots/ wild plant	Powder	Local application	Against burns and injuries
19			*Dittrichia viscosa* (L.) Greuter	Bayramane terrehlâ, bagraman (slimy inule)	0.71	0.05	0.13	Whole plant/ wild plant	Decoction	Oral	Against allergy, stomach, and carminative pains
20			*Scolymus hispanicus* L.	Guernina (scolyme plant from Spain)	0.29	0.02	0.05	Rhizome or leaves/ wild plant	Infusion or raw	Oral	Against gastritis (infusion) or cold (leaves)

Table 4. Information on medicinal uses and quantitative values of the medicinal taxa of Bni Leit and Al Oued rural communes (Tetouan province) (continued…)

N°	Family	FUV	Scientific specie name	Local name (English name)	Freq. (%)	MUV	RFC	Part used/ type of plants	Preparation mode	Administration mode	Phyto-therapeutic actions
	8. *Brassicaceae*	**0.06**			**0.86**						
21			*Brassica rapa* L.	L'efft (turnip)	0.29	0.02	0.05	Leaves or roots/ cultivated plant	Infusion or decoction	Oral	Against weight loss, sore throat, and diabetes
22			*Brassica oleracea* L.	Kroumb (cabbage)	0.57	0.04	0.11	Leaves/ cultivated plant	Cataplasm or decoction	Local application or for cleaning face	Against burns
	9. *Cactaceae*	**0.05**			**0.71**						
23			*Opuntia ficus-indica* (L.) Mill.	El Hendia (cactus)	0.71	0.05	0.13	Whole plant or fruit or flower/ wild plant	Cataplasm or decoction	Oral or local application	Cold, rheumatism and prostate and dandruff
	10. *Cannabaceae*	**0.02**			**0.29**						
24			*Cannabis sativa* L.	Kif (Indian hemp)	0.29	0.02	0.05	Seeds/ cultivated plant	Powder mixed with oil olive	Local application on hair	Calming of the nervous system and softening
	11. *Caryophyllaceae*	**0.01**			**0.14**						
25			*Herniaria hirsute* L.	Harasse ihajer (herniary)	0.14	0.01	0.03	Aerial parts/ wild plant	Decoction	Oral	Against pain in the urinary tract and the cold
	12. *Cistaceae*	**0.21**			**3.00**						
26			*Cistus villosus* L.	Tirguelt (cistus)	3.00	0.21	0.55	Seeds/ wild plant	Decoction or powder mixed with honey	Local application or oral	For dermal diseases and hemorrhoids, menstrual pain, constipation
	13. *Cucurbitaceae*	**0.02**			**0.29**						
27			*Cucurbita pepo* L.	Krae hmar (red courgette)	0.29	0.02	0.05	Seeds or fruit/ cultivated plant	Decoction or cataplasm	Oral or local Application	Against the glasses of the intestines and against wounds

Table 4. Information on medicinal uses and quantitative values of the medicinal taxa of Bni Leit and Al Oued rural communes (Tetouan province) (continued…)

N°	Family	FUV	Scientific specie name	Local name (English name)	Freq. (%)	MUV	RFC	Part used/ type of plants	Preparation mode	Administration mode	Phyto-therapeutic actions
	14. *Cupressaceae*	**0.13**			**1.86**						
28			*Tetraclinis articulata* (Vahl) Mast.	L'arâar (thuya)	1.86	0.13	0.34	Leaves/ wild plant	Cataplasm mixed with *Lepidium sativum*	Local application	Treat hair problems and facial skin conditions
	15. *Ericaceae*	**0.07**			**1.00**						
29			*Arbutus unedo* L.	Boukhanou or bakhanou or sassnou (arbutus)	0.71	0.05	0.13	Roots/ wild plant	Decoction or powder mixed with honey	Oral	Asthma and stomach problems
30			*Erica arborea* L.	Khlenj (heather plant)	0.29	0.02	0.05	Seeds/ wild plant	Decoction or powder	Oral or local application	Against sexual diseases and headaches and against injuries
	16. *Fabaceae (Leguminosae)*	**0.27**			**3.86**						
31			*Trigonella foenum-graecum* L.	Halba (trigonal fenugreek)	1.29	0.09	0.24	Seeds or fruit/ cultivated plant	Decoction, infusion, maceration, or cataplasm	Oral or application on hair	Bronchitis, sedative of cough, chest, eye and fall diseases and stimulates the appetite
32			*Anthyllis cytisoides* L.	Chtappa (anthyllis)	0.14	0.01	0.03	Roots/ wild plant	Decoction	Oral (mouth brush)	For toothache
33			*Cicer arietinum* L.	Hommosse (chickpea)	0.29	0.02	0.05	Seeds/ cultivated plant	Powder or cataplasm	Oral or local application	Against pain in the urinary tract, stimulates sexual potency, stimulates the brain and against facial tasks
34			*Phaseolus vulgaris* L.	Loubiya (dry bean)	0.43	0.03	0.05	Seeds/ cultivated plant	Powder/ cataplasm	Local application	Against skin diseases (eczema) and hemorrhoids
35			*Vigna sinensis* (L.) Savi ex Hausskn.	Foul gnaoua (lupin)	0.57	0.04	0.08	Seeds/ cultivated plant	Powder mixed with hot milk	Oral	Anti-diabetic and energetic
36			*Ceratonia siliqua* L.	Kharroub/ slaghwa (carob tree)	0.43	0.03	0.11	Pods/ wild plant	Powder With honey	Oral	Anti-diarrhea and stomachic
37			*Ononis natrix* L.	Afzaz (bugrane, ononis)	0.71	0.05	0.13	Aerial parts/ wild plant	Decoction	Oral	Sedative and stomatic

Table 4. Information on medicinal uses and quantitative values of the medicinal taxa of Bni Leit and Al Oued rural communes (Tetouan province) (continued…)

N°	Family	FUV	Scientific specie name	Local name (English name)	Freq. (%)	MUV	RFC	Part used/ type of plants	Preparation mode	Administration mode	Phyto-therapeutic actions
	17. *Fagaceae*	**0.06**			**0.87**						
38			*Quercus rotundifolia* Lam.	Bellout kerrouch (holm oak)	0.87	0.06	0.16	Fruits/ wild plant	Decoction	Oral	Stomachic (used by women after childbirth)
	18. *Gentianaceae*	**0.02**			**0.29**						
39			*Centaurium erythraea* Rafn	Kossat el hayya (little knapweed)	0.29	0.02	0.05	Leaves/ wild plant	Decoction or powder or cataplasm	Oral or local application	Against gastric pain and fever and against deep burns
	19. *Geraniaceae*	**0.09**			**1.28**						
40			*Pelargonium graveolens* L'Hér.	Atarcha (strong smelling pelargonium)	1.14	0.08	0.21	Leaves/ wild plant	-	-	Use to repel insects (avoid bites) and to perfume homes
41			*Pelargonium capitatum* (L.) L'Hér.	Atarcha (rose geranium)	0.14	0.01	0.03	Leaves/ wild plant	Decoction	Oral	Against intestinal pain and stress
	20. *Juncaceae*	**0.07**			**1.00**						
42			*Juncus acutus* L.	Azraf	1.00	0.07	0.18	Flowers/ wild plant	Powder/ consumed honey	Oral	For stomach pains
	21. *Lamiaceae*	**1.87**			**27.01**						
43			*Mentha pulegium* L.	Fliou or flayou (mint chickweed)	4.57	0.32	0.84	Stems and leaves/ wild plant	Infusion/ powder/ decoction/ essential oil	Oral or local application	Against body coldness and respiratory diseases (flu, colds, and bronchitis)
44			*Rosmarinus officinalis* L.	Azir (rosemary)	3.14	0.22	0.58	Stems and leaves/ wild plant	Infusion/ decoction/ essential oil/ cataplasm	Oral or local application	Against the cooling of the body, against skin diseases (eczema of the feet), antiseptic and anti-cold
45			*Mentha suaveolens* Ehrh.	Abchichtrou or m'chichtrou (mint with round leaves)	1.43	0.13	0.26	Stems and leaves/ wild plant	Decoction	Oral	Against body coldness, respiratory (flu, colds, and bronchitis) and stomach ailments.
46			*Mentha rotundifolia* (L.) Huds.	Marseta or timijja	0.29	0.02	0.05	Stems and leaves/ wild plant	Decoction	Oral	Against body coldness, respiratory (flu, colds and bronchitis) and stomach ailments

Table 4. Information on medicinal uses and quantitative values of the medicinal taxa of Bni Leit and Al Oued rural communes (Tetouan province) (continued…)

N°	Family	FUV	Scientific specie name	Local name (English name)	Freq. (%)	MUV	RFC	Part used/ type of plants	Preparation mode	Administration mode	Phyto-therapeutic actions
47			*Origanum compactum* Benth.	Sahtar (oregano)	3.86	0.27	0.71	Stems and leaves/ wild plant	Decoction/ infusion (with honey) or powder or essential oil on cataplasm	Oral	Against the cooling of the body, respiratory ailments (flu, colds, and bronchitis), against poisoning, stomach, lightens menstruation, softening and anti-dandruff
48			*Origanum grosii* Pau & Font Quer	Sahtar jebel (oregano)	0.14	0.01	0.03	Stems and leaves/ wild plant	Decoction/ infusion (with honey) or powder with essential oil on cataplasm	Oral or local application	Against the cooling of the body, respiratory ailments (flu, colds, and bronchitis), against poisoning, stomach, lightens menstruation, softening and anti-dandruff
49			*Calamintha officinalis*	Menta (calament)	2.57	0.18	0.47	Stems and leaves/ wild plant	Decoction with hot milk/ essential oil	Oral	Anti-cold, antitussive, and stomachic
50			*Origanum majorana* L.	Merdadouch (marjoram)	1.29	0.09	0.24	Stems and leaves/ wild plant	Decoction	Oral	Anti-cooling
51			*Lavandula stoechas* L.	Lhalhal (lavender stoechade)	1.57	0.11	0.29	Leaves/ wild plant	Decoction	Oral	Against anemia, anti-diarrhea for children
52			*Lavandula multifida* L.	Lakhzama (lavender plant with divided leave)	1.57	0.11	0.29	Leaves/ wild plant	Decoction or cataplasm with henna	Oral or local application (on hair)	Anti-cold and stimulator and hair treatment
53			*Lavandula dentata* L.	Lakhzama (lavender)	0.43	0.03	0.08	Leaves/ wild plant	Decoction	Oral	For urinary tract disorders
54			*Mentha spicata* L.	Na'nae (spearmint)	2.00	0.14	0.37	Stems and leaves/ cultivated plant	Decoction	Oral	Stomachic
55			*Mentha viridis* (L.) L. (synonyms of *M. spicata*)	Na'nae g'naou i (mint)	0.14	0.01	0.03	Stems and leaves/ cultivated plant	Decoction	Oral	Antitussive and hypotensor
56			*Salvia officinalis* L.	Salmia (officinal sage)	2.29	0.16	0.42	Leaves/ wild plant	Decoction	Oral	Anti-diabetic, abdominal pain, cold and toothache

Table 4. Information on medicinal uses and quantitative values of the medicinal taxa of Bni Leit and Al Oued rural communes (Tetouan province) (continued…)

N°	Family	FUV	Scientific specie name	Local name (English name)	Freq. (%)	MUV	RFC	Part used/ type of plants	Preparation mode	Administration mode	Phyto-therapeutic actions
57			*Ajuga iva* (L.) Schreb.	Chendgoura (musk ivette)	0.43	0.03	0.08	Leaves/ wild plant	Decoction or inhalation	Oral	Anti-diabetic and cold, anti-rheumatic and stomachic
58			*Marrubium vulgare* L.	Meriouate (marrubus)	0.57	0.04	0.11	Stems and leaves/ wild plant	Powder	Oral	Against headaches (insomnia) and ear diseases
59			*Thymus capitatus* (L.) Hoffmanns. & Link	Zaïtra (thyme)	0.29	0.02	0.05	Stems and leaves/ wild plant	Decoction (mixed with honey)	Oral	Against the cold of the body, respiratory (flu, colds, and bronchitis) and stomach ailments
60			*Ocimum basilicum* L.	Lahbak (basil plant)	0.43	0.03	0.08	Leaves/ cultivated plant	Juice/ decoction/ infusion	Oral or local application (hair and eyes)	Against eye irritation (eye drops) and against hair-loss.
	22. *Lauraceae*	**0.30**			**4.29**						
61			*Cinnamomum verum* J.Presl	L'Karfa (cinnamon)	2.29	0.06	0.42	Bark/ cultivated plant	Infusion	Oral	Against nausea, improves intestinal transit, against dental and childbirth pain, antidiabetic and alleviates fatigue
62			*Laurus nobilis* L.	Ouarket sidna moussa (laurel sauce)	2.00	0.14	0.37	Leaves/ wild plant	Decoction	Oral	For Genito-urinary diseases
	23. *Linaceae*	**0.04**			**0.57**						
63			*Linum usitatissimum* L.	Zariate Al Kattane (linen)	0.57	0.04	0.11	Seeds/ cultivated plant	Powder only or with honey	Oral	Stomachic and use in case of bone fracture
	24. *Lythraceae*	**0.08**			**1.16**						
64			*Lawsonia inermis* L.	L'hanna (henna)	0.29	0.02	0.05	Leaves/ cultivated plant	Powder	Local application (mask)	Against skin diseases (eczema), softening and anti-dandruff
65			*Punica granatum* L.	Rommane (pomegranate)	0.87	0.06	0.16	Fruit and bark/ cultivated plant	Decoction/ powder or juice (fresh) (sometime mixed with honey)	Oral	Against ulcers and stomachic
	25. *Malvaceae*	**0.10**			**1.42**						
66			*Malva sylvestris* L.	Bakkoul or bakkoula or imezgouar (mallow)	1.42	0.10	0.26	Leaves/ wild plant	Preparation with *Portulaca oleracea* and olive oil	Oral	Against cold

Table 4. Information on medicinal uses and quantitative values of the medicinal taxa of Bni Leit and Al Oued rural communes (Tetouan province) (continued…)

N°	Family	FUV	Scientific specie name	Local name (English name)	Freq. (%)	MUV	RFC	Part used/ type of plants	Preparation mode	Administration mode	Phyto-therapeutic actions
	26. *Molluginaceae*	**0.05**			**0.71**						
67			*Corrigiola telephiifolia* Pourr.	Serghine or sarghina (sarghine)	0.71	0.05	0.13	Roots/ wild plant	Only powder or cataplasm or mixed with nigella	Local application/ oral	Treatment of wounds, burns and allergies
	27. *Moraceae*	**0.06**			**0.87**						
68			*Ficus carica* L.	Chriha or karmousse or bakour (figtree)	0.87	0.06	0.16	Fruit/ cultivated plant	Boiled then mixed with olive oil	Oral	Against cough when mixed with olive oil, against the cooling of the body
	28. *Myristicaceae*	**0.03**			**0.43**						
69			*Myristica fragrans* Houtt.	L'gouza (muscadier)	0.43	0.03	0.08	Teguments/ cultivated plant	Mixed with milk or tea	Oral	Antitussive and sleeping pill and against abdominal gas
	29. *Myrtaceae*	**0.32**			**4.57**						
70			*Myrtus communis* L.	Rihane or rayhane (myrtle)	3.57	0.25	0.66	Leaves/ wild plant	Powder	Oral	Anti-fall and hair detangler
71			*Syzygium aromaticum* (L.) Merr. & L.M.Perry	K'ronfol (clove)	1.00	0.07	0.18	Clous/ cultivated plant	Powder/ decoction	Oral or application on chair	Against toothache, menstrual pain, anti-fall, analgesic and soothing
	30. *Oleaceae*	**0.17**			**2.43**						
72			*Olea europaea* L.	Zaitoune (olive tree)	2.00	0.14	0.37	Leaves or olives/ cultivated plant	Infusion or direct consumption	Oral	Against asthma, against tension and sedative for respiratory diseases and antidiabetic
73			*Fraxinus excelsior* L.	Dardar (ash)	0.43	0.03	0.08	Leaves/ wild plant	Decoction	Oral	Reduces attacks of gout, used against rheumatism and joint pain
	31. *Piperaceae*	**0.02**			**0.29**						
74			*Piper nigrum* L.	Ibzar (pepper)	0.29	0.02	0.05	Seeds/ cultivated plant	Powder mixed with *Zingiber officinalis* and hot milk	Oral	Relieves acute cough, sore throat, and flu

Table 4. Information on medicinal uses and quantitative values of the medicinal taxa of Bni Leit and Al Oued rural communes (Tetouan province) (continued…)

N°	Family	FUV	Scientific specie name	Local name (English name)	Freq. (%)	MUV	RFC	Part used/ type of plants	Preparation mode	Administration mode	Phyto-therapeutic actions
	32. *Poaceae*	**0.23**			**3.30**						
75			*Avena sativa* L.	Khortal (vesce oats)	0.43	0.03	0.26	Seeds/ cultivated plant	Decoction	Oral	Calm acute and stomach cough
76			*Zea mays* L.	Torkiya or kbal or dra (corn)	1.43	0.10	0.26	Stigma/ cultivated plant	Decoction	Oral	Against constipation and energetic
77			*Saccharum officinarum* L.	Kassab lahlou or kassab assokar (sugar cane)	0.43	0.03	0.08	Stems/ cultivated plant	Pressing	Oral	Energetic and against gastritis
78			*Triticum durum* Desf.	Kam'h salb (durum wheat)	0.29	0.02	0.05	Bran/ cultivated plant	Decoction	Oral or local application	Stomachic, against menstrual pain, anemia, stimulates bone growth and cleanses the skin
79			*Hordeum vulgare* L.	Z'rae or chair (barley)	0.43	0.03	0.08	Bran/ cultivated plant	Decoction or cataplasm	Oral	Energetic and against gastritis and diarrhea
80			*Pennisetum glaucum* (L.) R.Br.	Illane (mil candle)	0.29	0.02	0.05	Seeds/ cultivated plant	Cooking (seeds or powder) mixed with honey or milk	Oral	Use in case of fracture, promotes bone development
	33. *Polygonaceae*	**0.04**			**0.57**						
81			*Rumex acetosa* L.	Hommaida (wild oscilla)	0.57	0.04	0.11	Stems, seeds/ wild plant	Infusion mixed with milk	Oral	Antidiabetic, against constipation, anti-insomnia
	34. *Portulacaceae*	**0.06**			**0.87**						
82			*Portulaca oleracea* L.	Rejla (pourpier)	0.87	0.06	0.16	Stems and leaves/ wild plant	Preparation with *Malva sylvestris*	Oral	Energetic and stomachic
	35. *Ranunculaceae*	**0.05**			**0.72**						
83			*Nigella sativa* L.	Sanouj (nigelle)	0.43	0.03	0.08	Seeds/ cultivated plant	Powder or mixed with honey and olive oil	Oral	Stomachic, against cold, against respiratory diseases, against sexual impotence
84			*Delphinium staphisagria* L.	Habbat rass (*Staphylococcus aureus* dolphin)	0.29	0.02	0.05	Seeds/ wilt plant	Powder with henna	Local application	Used for hair care

Table 4. Information on medicinal uses and quantitative values of the medicinal taxa of Bni Leit and Al Oued rural communes (Tetouan province) (continued…)

N°	Family	FUV	Scientific specie name	Local name (English name)	Freq. (%)	MUV	RFC	Part used/ type of plants	Preparation mode	Administration mode	Phyto-therapeutic actions
	36. *Rosaceae*	**0.14**			**1.85**						
85			*Crataegus monogyna* Jacq.	Adamâm (monogynous hawthorn)	0.43	0.04	0.08	Stems and leaves/ wild plant	Decoction	Oral	Anti-diarrhea and blood pressure drop
86			*Prunus amygdalus* Stokes	Louz (almonds)	0.71	0.05	0.13	Fruit/ cultivated plant	Powder mixed with hot milk	Oral	Antidiabetic, anti-constipation, nourishes the hair
87			*Rosa damascena* Herrm.	Ward beldi (rose)	0.71	0.05	0.13	Leaves/ cultivated plant	Distillation	Local application	Treats facial skin and reduces pride
	37. *Rutaceae*	**0.17**			**2.43**						
88			*Citrus limon* (L.) Osbeck	Laymoune or l'hamed (lemon)	1.43	0.10	0.26	Fruit/ cultivated plant	Juice or mixed with honey	Oral	Against respiratory and heart diseases, sore throat, and angina
89			*Citrus aurantium* L.	Ranje or T'runje (bitter orange tree)	1.00	0.07	0.18	Fruit/ wilt plant	Juice or mixed with honey or coffee	Oral	Against sore throat and angina
	38. *Sapotaceae*	**0.03**			**0.43**						
90			*Argania spinosa* (L.) Skeels	Argane (argan)	0.43	0.03	0.08	Amanda or oil/ wild plant	Fresh kernel or cataplasm	Oral or local application	Antidiabetic and for skin care
	39. *Solanaceae*	**0.10**			**1.43**						
91			*Nicotiana rustica* L.	Taba baldiya (tobacco)	0.43	0.03	0.08	Leaves/ cultivated plant	Powder with henna	Local application	For hair-loss
92			*Solanum tuberosum* L.	Btata (potato)	0.57	0.04	0.11	Bulb/ cultivated plant	Boiled and mixed with an egg/ rhizome slice	Local application (mask)	Used as a facial mask or directly on the skin in case of burns
93			*Capsicum frutescens* L.	Folfol har (hot pepper)	0.43	0.03	0.08	Fruits/ cultivated plant	Condiment	Oral	Stimulates the appetite

Table 4. Information on medicinal uses and quantitative values of the medicinal taxa of Bni Leit and Al Oued rural communes (Tetouan province) (continued…)

N°	Family	FUV	Scientific specie name	Local name (English name)	Freq. (%)	MUV	RFC	Part used/ type of plants	Preparation mode	Administration mode	Phyto-therapeutic actions
	40. *Theaceae*	**0.04**			**0.57**						
94			*Camellia sinensis* (L.) Kuntze	Ataye (tea)	0.57	0.04	0.11	Leaves/ cultivated plant	Decoction mixed with *Crocus sativus*	Oral	Against kidney stones, and toothache
	41. *Thymelaeaceae*	**0.14**			**2.00**						
95			*Daphne gnidium* L.	Metnane (garou)	2.00	0.14	0.37	Leaves/ wild plant	Powder cataplasm mixed with olive oil	Local application	Headaches, with henna protects the hair
	42. *Urticaceae*	**0.08**			**1.14**						
96			*Urtica dioica* L.	Horriga (nettle)	1.14	0.08	0.21	Leaves/ wild plant	Decoction with olive oil	Local application	Against foot eczema
	43. *Verbenaceae*	**0.11**			**1.57**						
97			*Aloysia citriodora* Palau	Louiza (verbena)	1.57	0.11	0.29	Leaves/ cultivated plant	Infusion	Oral	Against insomnia, difficult digestion, stomach aches, anxiety, dizziness, and pain
	44. *Vitaceae*	**0.05**			**0.72**						
98			*Vitis vinifera* L.	Inab (grape)	0.43	0.03	0.08	Leaves/ cultivated plant	Powder	Local application on the head	Against febrile states.
				Sammite (grape juice)	0.29	0.02	0.05	Fruit/ cultivated plant	Juice	Oral	Against cold
	45. *Xanthorrhoeaceae*	**0.02**			**0.29**						
99			*Asphodelus ramosus* L.	Berouag (asphodel)	0.29	0.02	0.05	Flowers/ wild plant	Infusion	Inhalation	Against bronchitis
	46. *Zingiberaceae*	**0.13**			**1.86**						
100			*Curcuma zanthorrhiza* Roxb.	Kharkoum (turmeric)	0.43	0.03	0.08	Rhizome/ cultivated plant	Cataplasm with honey and *Crocus sativus*	Local application	Against facial stains that appear after childbirth for women
101			*Zingiber officinale* Roscoe	Sikkinjbir (ginger)	1.43	0.10	0.26	Rhizome/ cultivated plant	Powder, maceration, decoction	Local application or oral	Against cold, flu and cough, and urinary tract stimulant

MUV: Medicinal use value; FUV: Family use value; Freq.: Frequency; RFC: Relative frequency citation; FL: Fidelity level; RI: Relative importance index. The scientific names were proposed according to Theplantlist.org (http://www.theplantlist.org/)

Table 5. Dominant medicinal plants families used in the rural communes of Bni Leit and Al Oued.

Family	Genera	Species
Amaryllidaceae	1	2
Anacardiaceae	1	1
Apiaceae	7	7
Asteraceae	7	7
Cistaceae	1	1
Cupressaceae	1	1
Fabaceae	7	7
Lamiaceae	10	18
Lauraceae	2	2
Malvaceae	1	1
Molluginaceae	1	1
Myrtaceae	2	2
Oleaceae	2	2
Poaceae	6	6
Rosaceae	3	3
Rutaceae	1	2
Solanaceae	3	3
Thymelaceae	1	1
Verbenaceae	1	1
Zingiberaceae	2	2

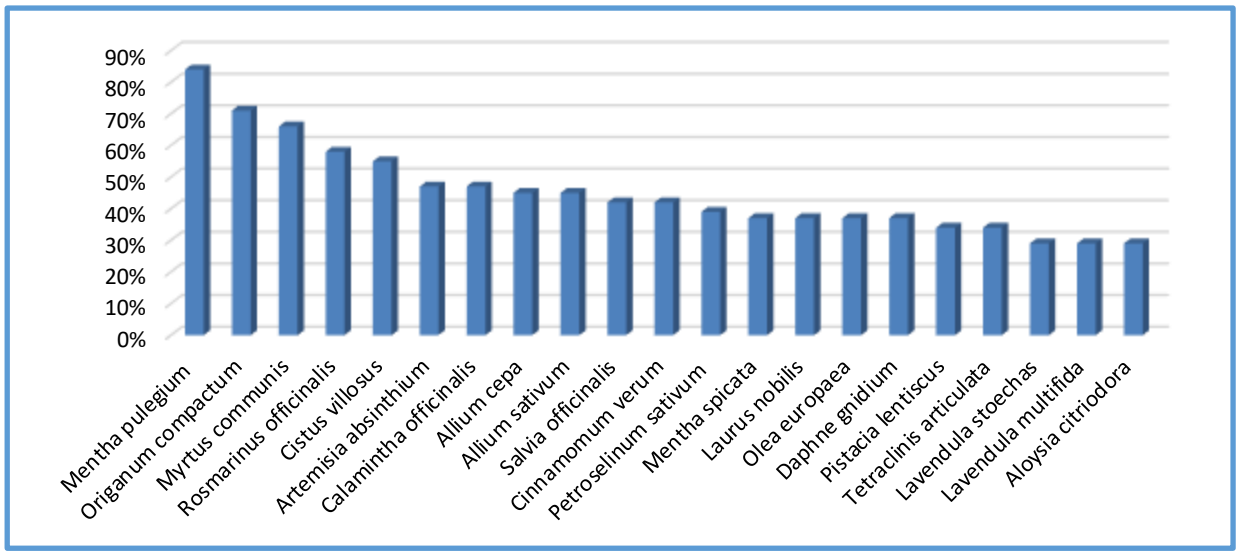


Figure 4. Main medicinal species used at RC level of Bni Leit and Al Oued.

Used parts of medicinal plants

Various organs of medicinal plants are used by the local population to meet their medication needs. They range from fruits, leaves, roots, bark and sometimes even flowers and seeds. In the study area, leaves, seeds, aerial parts, and fruits are the most commonly used organs. They account for 72% of the species encountered. Roots and flowers represent 8% and 5% respectively. As for the other organs (bark, bulbs, stems, etc.), they interest 15% of the species used (Fig. 5).

The organ removed from a species is a function of the utility sought by the population as well as the endogenous knowledge related to the use of the organ. Organs are removed either by complete uprooting of the plant (in the case of *Origanum compactum*, *Mentha pulegium*, *Origanum grosii*), or by debarking, digging out the root, picking the fruit or harvesting the leaves. Knowing that there is a clear relationship between the part of the plant exploited and the regeneration of the species on the one hand, and on the other hand, the method of harvesting and the intensity of harvesting on the regeneration of the species, it is important to raise awareness on rational techniques or good practices for harvesting plant organs in order to preserve the sustainability of ecosystem services.

While it was recognized some decades ago that cases of overexploitation of medicinal plants were rare, today there is reason to fear that the destruction and alteration of the natural environment may become a concern in the near future because of overexploitation leading to the degradation of ecosystems for economic purposes.

Methods of preparation and administration of medicinal plants

Different methods of preparation and administration are used: decoction (27%) and powder (16%) are the most commonly used methods of preparation, followed by cataplasm (14%) and infusion (10%). Oral administration (68%) is the most common, followed by mask (13%) and dressing (8%) (Fig. 6).

Distribution of the use of medicinal plants according to the group of care and diseases treated

The properties of aromatic and medicinal plants are numerous, including their stimulating, calming, emmenagogue, hypotensive, hypoglycemic, diuretic, exciting, treating digestive disorders, rheumatism, intestinal infections, tuberculosis, intestinal parasites, fever, bronchitis, asthma, etc. All these properties make medicinal plants have several uses.

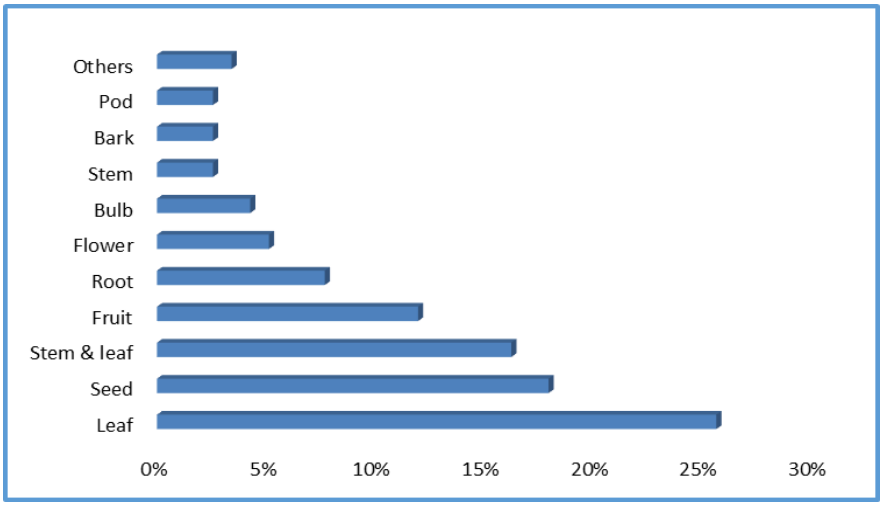


Figure 5. Breakdown of the use of medicinal plants according to the part used.

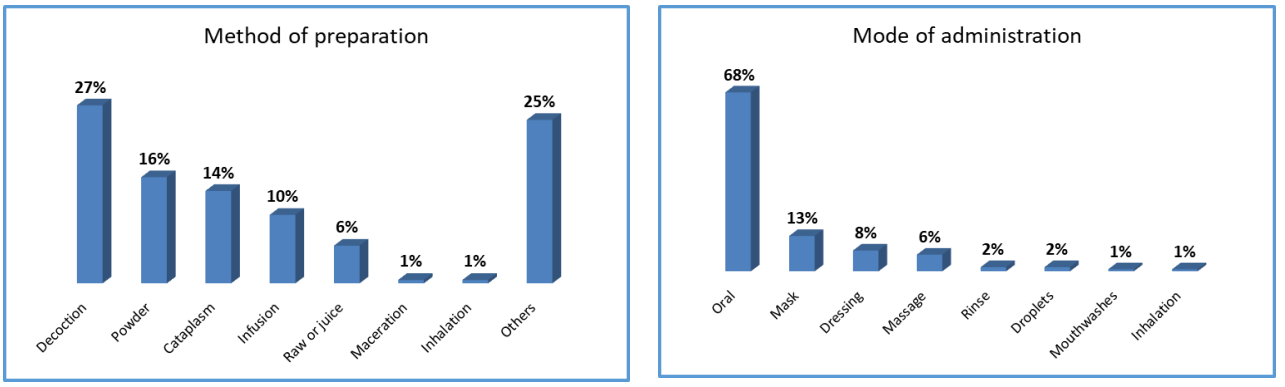


Figure 6. Distribution of the use of medicinal plants according to methods of preparation and administration.

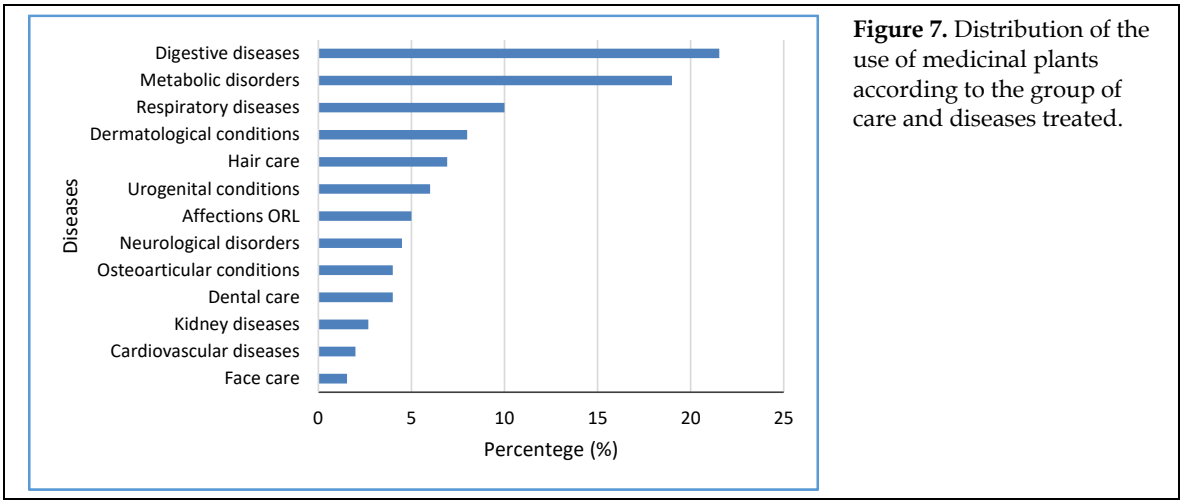


Figure 7. Distribution of the use of medicinal plants according to the group of care and diseases treated.

The ethnobotanical survey revealed that the majority of medicinal species are used mainly against diseases of the digestive disorders, with a percentage of 21% (Fig. 7), followed by metabolic diseases (19%), respiratory affection (10%), skin (9%), hair (8%) and urogenital diseases (7%). The remaining diseases (visual, bone, urinary, auditory, nervous system, and dental) are represented by less than 26%.

The same findings have been published in other studies carried out in northern Morocco (Rif) in the Tazroute RC of the same Bouhachem Park (Bachar et al., 2016). Indeed, the distribution of the use of medicinal plants according to the diseases treated shows that four groups of treated pathologies dominate and represent more than 61% (digestive, metabolic, respiratory, and cutaneous diseases) against 59% in the present study.

Some species are used for several diseases. *Perganum harmala* is used against epileptic seizures, headache, hair loss and abdominal pain.

Economics of medicinal plants at the RC level of Bni Leit and Al Oued

In Morocco, aromatic, and medicinal plants have enormous potential to improve the incomes of rural and peri-urban populations who are dedicated to exploiting natural resources from forest areas and working in agriculture. Indeed, the majority of these plants grow spontaneously in forest estates and collective lands, which generally requires a very close link between the rural population and forest products (APDN, 2012).

Analysis of the surveys in this study revealed that AMP collection activity in the two communes is highly developed. It does not only concern the collection of medicinal plants for medical purpos-

es, but the attractions of a value chain that is itself a promising sector are beginning to take hold. Indeed, the activity increased after the years following the cannabis eradication operations started in 2005 in the provinces of Larache, Tetouan and Chefchaouen (HCEFLCD, 2012). We found that 60% of the households in the two communes have at least one collector. This dynamic has given rise to the creation and emergence of about ten cooperatives in the province of Tetouan specializing in the production, collection, valorization, and marketing of AMP, two of which have managed to secure regular foreign orders (export to Europe from 2011). In 2011, one cooperative was able to market 20 tons, of which myrtle holds first place with 22% of the AMP recovered (APDN, 2012). In addition, the province of Tetouan has seen the installation of a modern unit for the distillation and valorization of AMP since 2012 (located at the Hamra RC, 25 km from the capitals of the two communes studied). Since then, the exploitation of medicinal and aromatic plants has been an important source of life for a large local population. In general, it is the women who hold the knowledge of prospecting, harvesting, and packaging.

The study showed that despite the late knowledge of the possible added values of AMP, which were often underestimated by rural populations who, however, were not unaware of their intrinsic natural properties (traditional herbal medicine).

The income generated by the sale of the valued cash varies from 575 MAD/month to 1000 MAD/month with a monthly average of 760 MAD. The average annual income generated by the collection and marketing of AMP amounts to about 9114 MAD. The main medicinal species most sold quantitatively in these two communes are respectively *Mentha pulegium* (Mint Chickweed), *Calamintha officinalis* (calamant), *Cistus villosus* (cistus), *Lavendula stoechas* (lavender), *Myrtus communis* (myrtle), *Rosmarinus officinalis* (rosemary), *Origanum compactum* (oregano), *Pistacia lentiscus* (masticum), *Centaurium erythraea* (knapweed) and *Laurus nobilis* (laurel) (Fig. 8).

Similar income from AMP operations has been reported in the neighboring commune of Tazroute (Larache province). Income varied between 400 MAD/month and 892 MAD/month with a monthly average of 665 MAD. The average annual income is 7975 MAD (Bachar et al., 2016).

A comparable study carried out in 2006 (Ennabili et al., 2006) estimated revenues from the exploitation of medicinal plants (spontaneous and cultivated) at 500 MAD/ha/year for *Origanum compactum* (spontaneous species - whose price quadrupled between 2006 and 2014: high demand and low supply) and 105 000 MAD/ha/year for *Cannabis sativa* (cultivated species).

On the other hand, this ethnobotanical survey revealed that the marketing of these natural resources is the weak point of the province's AMP cooperatives. Almost all of the cooperatives do not have a sales outlet. They are therefore obliged to sell on an occasional basis at national, regional and fair trade fairs, which further benefits the intermediaries in this sector.

In addition, the collection and marketing of AMP remains a seasonal activity. It is carried out over 4 to 5 months. It is subject to strong interannual variations, with an overall decline in supply in recent years due to the disruption of climate change.

Limitations

Some difficulties, such as the reticent attitude of herbalists and local population to collaborate, were encountered during the survey (plants price, quantity, and destination). Moreover, this study concerned only two rural communes among the six constituting the regional natural park of Bouhachem.

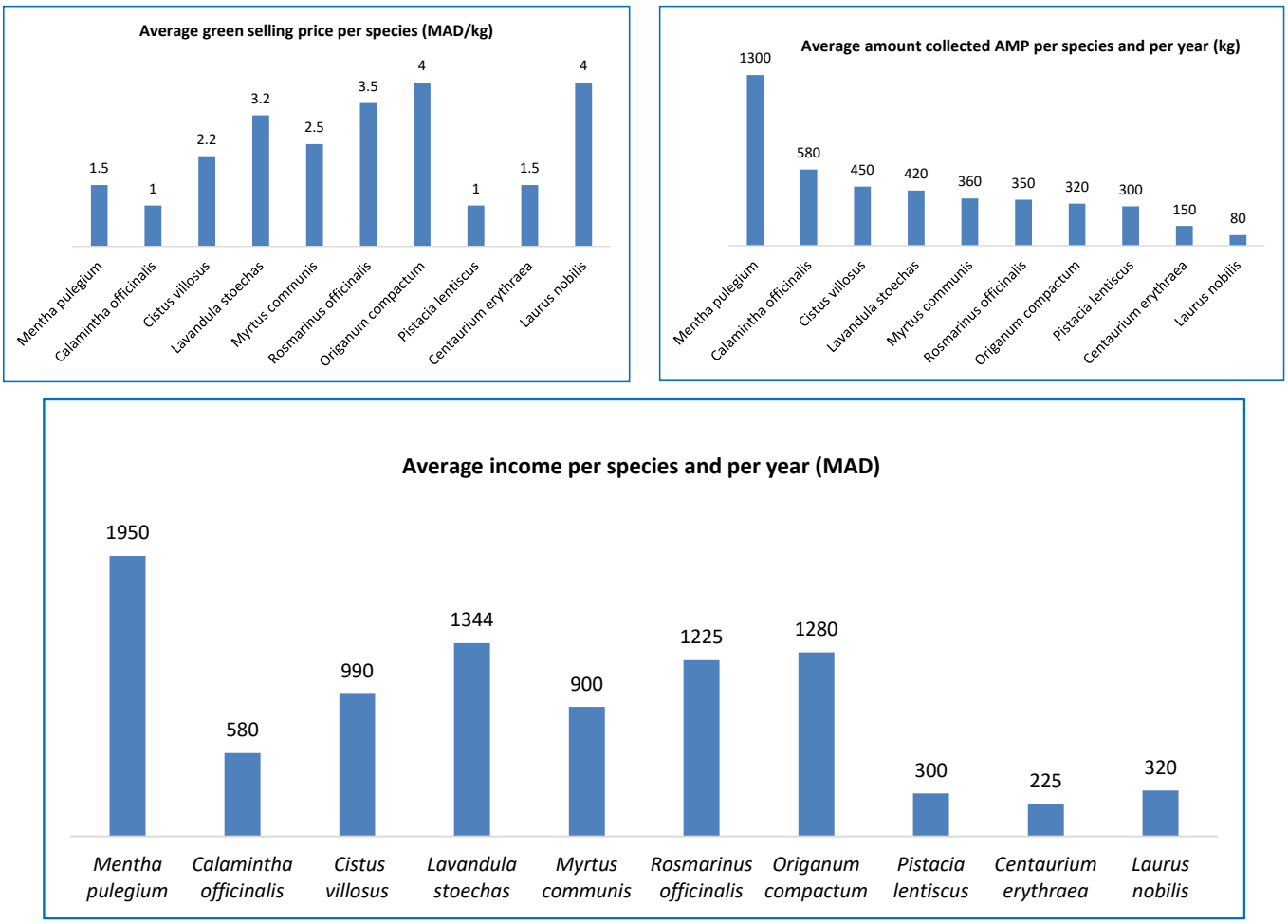


Figure 8. Income generated by the sale of medicinal plants at the level of Bni Leit and Al Oued RC (data extracted from surveys carried out in 2015 and 2016).

CONCLUSIONS

This study allowed us to identify and inventory the medicinal species used for therapeutic purposes by the local population of the Bni Leit and Al Oued rural communes belonging to the province of Tetouan, Morocco, as well as those exploited for commercial purposes. The ethnobotanical and economical survey revealed that, the study area has a rich biodiversity with a variety of medicinal and aromatic plants and still needs more explorations. Regarding to the exploited species in traditional medicine, we inventoried 101 species in 46 families, which the most represented family and most used by the population studied is *Lamiaceae* (FUV: 1.87). The most common and important used plants of the study area were demonstrated by MUV and RFC (*Mentha pulegium*, *Origanum compactum*, *Myrtus communis, Rosmarinus officinalis*, *Cistus villosus*, *Artemisia absinthium*, *Calamintha officinalis, Allium cepa* and *Allium sativum*). Furthermore, this survey ensures that many spontaneous species are recognized with high added value and with vast expanses (Bouhachem forest): little knapweed, myrtle, rosemary, oregano, mint, lavender, mastic, carob, and noble laurel. The income generated (760 MAD/month) despite its seasonality can be a sure way towards the empowerment of rural women from the Rif. The results of ethnobotanical survey can be considered as a source of information for scientific research in the field of phytochemistry and pharmacology however these uses could be confirmed with rigorous scientific protocols (active ingredients). In terms of economics, the development of the AMP

chain must be accompanied by a rational management of natural resources guaranteeing their preservation and use in a sustainable manner for the benefit of future generations, especially with the challenges of climate change and galloping anthropic pressure. The information (ethnobotanical and economic) has been compared to other studies and, for some important plants, has referred to corresponding pharmacological validations and similar levels of revenue.

CONFLICT OF INTEREST

The authors declare no conflicts of interests.

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AUTHOR CONTRIBUTION:

Contribution	Bachar M	ElYacoubi H	Zidane L	Rochdi A
Concepts or ideas	x			
Design	x			
Definition of intellectual content	x			
Literature search	x			
Experimental studies	x			
Data acquisition	x			
Data analysis	x			
Statistical analysis	x			
Manuscript preparation	x			
Manuscript editing	x			
Manuscript review	x	x	x	x

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Annex 1. Questionnaire sheets: Ethnobotanical and economic study of medicinal plant.

Ethnobotanical study of medicinal plants at the level of:

Commune: _____ **DISTRICT**: _____

Survey **N°**____/____ Date: __/__/____

Informant: Name: _____ Age: _____ Village: _____

– Sex: Male □ Female □

– Family situation: Single □ Married □ Divorced □

– Level of study: Illiterate □ Koranic school □ Primary □ Secondary □ University □

– Income/year (MAD): Unemployed □ [< 1500 DH] □ [1500-3000] □ [3000-6000] □ [6000-10000] □ [>10000] □

Material vegetal:

– When you feel sick, you address:

Experiences of others □ Herbalist □ Pharmacy □ Books □ Others □ _____

– Vernacular name: _____

- Spontaneous □ or Cultivated □ / - Local □ or Introduced from other regions □ _____

– Scientific name: _____

– **Use of the plant**: Therapeutic □ Cosmetic □ Aromatic □ Others □ _____

– Used part: Stem □ Flower □ Fruit □ Seed □ Bark □ Rhizome □

Bulb □ Leaf □ Whole plant □ Root □

– Only plant □ Other combination (with plants) □: _____

– Use of the plant: + Fresh □ + Desiccated □

+ Raw □ + Cooked □

+ After traditional treatment □ (*which treatment is undergone by the plant before its use* _____

– **Form of employment**: Tisane □ Powder □ Essential oil □ Oily oil □ Extract (juices, tincture, solution, capsule) □: _____

– **Method of preparation:** Infusion □ Decoction □ Maceration □ Cataplasm □ Fumigation □ Friction □

Injection □ Powder □ Raw □ Cooked □ Others: _____

– **Administration mode**: Oral □ Inhalation □ Massage □ Rinse □ Bain □ Swabbing □ Others □: _____

– **Dose used**:

- Do you use the plants with precise doses? Yes □ No □

* If yes: Pinch □ Handle □ Spoonful □ Others □: _____

Other specific dose: Quantity in g/cup: _____ or in g/liter: _____

– Dosage:

+ Number of catches per day:

- Dosage for children: 1 time/day □ 2 times/day □ 3 times/day □ Others □: _____

- Dosage for adults: 1 time/day □ 2 times/day □ 3 times/day □ Others □: _____

- Dosage for older people: 1 time/day □ 2 times/day □ 3 times/day □ Others □: _____

+ Time of use: Morning (before □; or at time □); Lunch □; Evening (with dinner □; or at bedtime □)

+ Length of Use: One day □ One week □ One month □ Until healing □

- Uses:

– Types of diseases:

- Dermatological conditions □
- Respiratory diseases □
- Cardiovascular diseases □
- Urogenital and urinary disorders □
- Osteoarticular affections □
- Metabolic disorders □
- Digestive tract disorders □
- Neurological disorders □
- Dental care □
- Kidney diseases □
- **Diagnosis By**: Himself □ Doctor □ Herbalist □ Others □: _____
- **Results**: Healing □ Improvement □ Ineffective □

- Side Effects □ *If yes, then* _____

- *Just undesirable* □: _____

- Toxic □: _____

- **Precaution of use**: _____
- **Harvest place**: _____
- **Harvest time**: _____
- **Technique of conservation**: _____
- **Price per kg fresh**:
- **Price per kg dry**:
- How the plant is collected: Whole □ Root □ Branches □ Leaf □ Flower □
- In which form the plant is sold: Whole □ Root □ Branches □ Leaf □ Flower □
- Who buys: Local customers □ Foreign customers □ Intermediaries □
  Transformers □ Cooperatives □ Exporter □
- Quantity sold per year and per species: _____

- List of best-selling species in order of importance:

Species name	Cultivated or Collected	Quantity sold annually (Kg)	Selling price per kg fresh (Dh)	Selling price per dry kg (Dh)	Place of sale (souk, on site, fair)