Universal Journal of Plant Science 10(1): 1-25, 2023
DOI: 10.13189/ujps.2023.100101 http://www.hrpub.org

Qualitative and Quantitative Ethnobotanical Analysis of the Knowledge of Indigenous Populations on Medicinal Plants in the Meknes Region of Morocco

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Received November 8, 2022; Revised December 7, 2022; Accepted December 27, 2022

Cite This Paper in the Following Citation Styles

(a): *[1] Hamza Benyahya, Hicham Mohti, Lhoussaine El Rhaffari, Abdelhamid Zaid , "Qualitative and Quantitative Ethnobotanical Analysis of the Knowledge of Indigenous Populations on Medicinal Plants in the Meknes Region of Morocco," Universal Journal of Plant Science, Vol. 10, No. 1, pp. 1 - 25, 2023. DOI: 10.13189/ujps.2023.100101.*

(b): *Hamza Benyahya, Hicham Mohti, Lhoussaine El Rhaffari, Abdelhamid Zaid (2023). Qualitative and Quantitative Ethnobotanical Analysis of the Knowledge of Indigenous Populations on Medicinal Plants in the Meknes Region of Morocco. Universal Journal of Plant Science, 10(1), 1 - 25. DOI: 10.13189/ujps.2023.100101.*

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Abstract Plants constitute a major resource used for subsistence by people. Ethnobotany plays an important role in preserving plant diversity and in understanding and interpreting the knowledge that allows plants to be used effectively and sustainably to meet people's needs. Indeed, medicinal plants are a therapeutic resource that is frequently mobilized by populations for the treatment of various diseases in physiotherapy. In this study, based on 394 questionnaire forms, a series of ethnobotanical surveys were conducted in 2018. The surveys focused on the main medicinal plants used and their uses in traditional herbal medicine. Quantitative ethnobotanical indices were used to assess the importance of plants in traditional medicine and the relationships between populations and the natural systems that surround and support them. The analysis of the results allowed the inventory of 84 species and 44 families, the most represented in the region being the Lamiaceae, Asteraceae and Apiaceae. The species shown to be most used by the local population were: *Origanum compactum*, *Dysphania ambrosioides* and *Lavandula angustifolia*. In particular, the local population was found to make use of the plants to treat dermatological, metabolic, respiratory, rheumatological, urological, cardiovascular, nervous system, nephrological and ENT diseases. Moreover, plant foliage was the most used part and the majority of the remedies are prepared as infusion and decoction. This study reveals that the population of the prefecture of Meknes has a thorough knowledge of medicinal plants and uses them traditionally for the treatment of a variety of diseases.

Keywords Ethnobotanical Surveys, Medicinal Plants, Physiotherapy Meknes

1. Introduction

Plants are resources rich in ingredients, which can be used in therapy, based on the development of drugs. Herbal medicines are considered as home remedies in many parts of the world and a considerable increase in their use has been reported in the last two decades. In developing countries, an estimated 80% of the population relies on traditional herbal medicine for their primary health care system [1-2].

Although the idea of ethnobotany is longstanding, it is only recently that quantitative methods of data analysis in ethnobotany have received more attention from researchers. This attention has begun to grow in the last two decades [3]. However, the tools and methods used to collect data in ethnobotanical research on medicinal plants are not always appropriate and their use depends on the intended objectives.

The development of a number of quantitative tools, even for a well-defined study objective, may raise questions or

doubts at the student or researcher level at the beginning of their career. One of the most obvious concerns would be which tool to choose from a wide range of tools. This question has already attracted the attention of many researchers who have developed analytical reviews of indices used in quantitative ethnobotany [4-5]. On the other hand, other researchers have analyzed the strengths and weaknesses of some commonly used indices [6] in order to make recommendations. Moreover, the majority of indices used in quantitative ethnobotany aim to assess the relative importance of plants to a given community. Synthesizing the results of work on index synthesis and analysis [5-7], a few important indexes are suggested for use in ethnobotanical studies due to their apparent objectivity. Thus, these indices are widely used in quantitative ethnobotany. The most widely used indices and usually incorporate in their calculation other indices that are primary quantitative parameters or basic indices. The most commonly used indices include: cultural importance by species (CI), frequency of citation by species (FC), number of uses by species (NU), relative frequency of citation by species (FCR), relative importance by species (IR), use value by species (UV), cultural value for the ethnospecies (CVe), and level of fidelity by species (FL).

Quantitative indices offer great value in ethnobotany for assessing the relevance of plants in terms of subsistence relationships between people and the natural systems on which they depend [8-10]. Additionally, these indices enhance ethnobotanical research and promote more discussion among scientists.

Morocco constitutes an important region of plant diversity and speciation, harboring a great floristic diversity, which is explained by its geographical location, as well as its varied topography, geology, ecology and climate. Morocco's flora includes 4200 species of spontaneous plants, 600 of which possess aromatic or medicinal properties [11]. In this context, the Moroccan population retains significant knowledge of medicinal plants and ancestral know-how in traditional medicine [12]. Moreover, traditional medicine continues to be used by the local population even with the development of modern pharmacopoeia and medicine. Indeed, the low cost of medicinal plants further justifies their use as pharmaceutical or cosmetic products [13]. These factors make medicinal plants an ideal ally in the treatment of diseases by the inhabitants. However, these products continue to be poorly exploited on an industrial scale in Morocco, notwithstanding the significant lack of research data in this area [14].

The strategic geographical position of the prefecture of Meknes (between the Middle Atlas and the Pre-Rif) offers the ideal location to conduct studies on the relationship between medicinal plants and the local population. With an area of 117.5 km^2, it enjoys a remarkable geographical location due to its contact zone between two mountainous areas: Pre-Rif and Western Middle Atlas. It represents the second largest prefecture in the Fez-Meknes region of Morocco, in terms of population with 835,695 inhabitants [15]. Meknes has a historical reputation for having a rich heritage and culture of traditional herbal medicine practice [16].

The aim of this study is to identify the medicinal plants used by the local population to treat illnesses, as well as their preparation methods and possible undesirable side effects. In addition, we present indices and quantitative ethnobotanical data, using different tools and methods, which allow for the identification of the correlation between people and medicinal plants.

2. Materials and Methods

2.1. Study Area

The study was conducted in six districts surrounding the province: N'zalt Ben Amar and Moulay Driss Zarhoun in the north, Ain orma in the west, Ouisslane in the east, Mejjat in the south, and Meknes (Hamria and Lahdim) in the central region of Morocco (Figure 1).

Thanks to its strategic geographical location, in the center of northern Morocco, integrating on the one hand the plain of Saiss and bordering the mountains of Rif and Middle Atlas on the other hand, the region of Fez-Meknes is characterized by a climatic and environmental diversity and a great ecological and floristic wealth. It is also experiencing significant population flows, which have repercussions on the economy of the region. According to the general census of population and housing of 2014, the Region of Fez-Meknes has about 4.2 million inhabitants with an estimated 39.50% of rural population.

Figure 1. Map of the study area showing the main selected municipalities

2.2. Methodology

The ethnobotanical survey was conducted during the period between June and December in 2018 through population interviews, by means of survey forms. The interviews focused on the main medicinal plants used and their uses in traditional herbal medicine. The data collected allowed for the identification of the relationship between the local population and the use of the plants, including the side effects from use of these plants. Moreover, data on which part of the plant were used, and the method of preparation was also collected.

In each commune of the study area, a pre-survey was conducted to obtain a better understanding of the terrain, the practices of the population and the vocabulary, while preparing herbariums for the botanical identification of plant species. The identification was carried out with the help of several publications, particularly works by Benabid [17] and Fennane et al. [18].

In the following phase, we conducted the actual surveys using questionnaire forms. In these, a randomly drawn sample of 394 men and women living in the region (herbalists, traditional practitioners, nomads or other users of medicinal plants) were interviewed. The survey covered their personal information (gender, age, education, family status and occupation), and their connection to aromatic and medicinal plants, i.e., the plants used, the part of the plant, the method of preparation and the therapeutic use.

2.3. Data Analysis

All ethnobotanical indices are based on the basic structure of the ethnobotanical information on informant i which reports the use of species s in use category u. The event resulting from the combination of these three variables (i, s, and u) is defined as a reported use relationship (UR) [19].

In a particular survey that yields NS species (s1, s2, ... sNS), with a total number of use categories NC (u1, u2, ..., uNC) and N informants (i1, i2, ..., iN), URsui can take the value 1 when a combination exists or 0 if no combination exists. These ethnobotanical data can be grouped in different ways by fixing one or two of the variables. To study the cultural importance of plants, one of the most commonly used tools is the UR of each species. It can be expressed mathematically as shown in (1).

$$UR_s = \sum_{u=u_1}^{u_{NC}} \sum_{i=i_1}^{i_N} UR_{ui} \quad (1)$$

This corresponds to the sum of the RUs of all informants (i1 to iN) in each use category for that species (s), i.e., the number of informants who mention each use category for the species and all RUs in each use category (u1 to uNC).

In this study, eight indices drawn from quantitative ethnobotany were used to assess the importance of different species including: cultural importance by species (CIs), frequency of citation by species (CFs), number of uses by species (NUs), relative frequency of citation by species (RFCs), relative importance by species (RIs), use

value by species (UVs), cultural value to the ethnospecies (CVe), and level of fidelity by species (FLs).

2.3.1. Cultural Importance Index by Species (CIs)

CIs is essentially URs expressed as the number of informants divided by the number of informants to account for the diversity of uses of the species [6]. It is determined as shown in (2).

$$CI_s = \sum_{u=u_1}^{u_{NC}} \sum_{i=i_1}^{i_N} UR_{ui/N} \quad (2)$$

2.3.2. Frequency of Citation by Species (FCs)

FCs (3) is the sum of informants citing a use for the species [9].

$$FC_s = \sum_{i=i_1}^{i_N} UR_i \quad (3)$$

2.3.3. Number of Uses by Species (NUs)

NUs is the total number of all categories for which a species is considered useful [9] and is determined as shown in (4).

$$NU_s = \sum_{u=u_1}^{u_{NC}} UR_u \quad (4)$$

2.3.4. Relative Frequency of Citation by Species (RFCs)

This index is obtained by dividing the number of informants who mention the use of the species, also called frequency of citation (FC), and by the number of informants participating in the survey (N) as shown in (5). Using the same terminology, the numerator can be thought of as the sum of the RUs of all informants surveyed for the species regardless of use category.

$$RFC_s = \frac{FC_s}{N} = \frac{\sum_{i=i_1}^{i_N} UR_i}{N} \quad (5)$$

2.3.5. Relative Importance Index by Species (RIs)

This index was developed by Pardo-de-Santayana (2003). It considers only the use categories, not the subcategories, based on the formula in (6).

$$RI_s = \frac{RCF_{s(max)} + RNU_{s(max)}}{2} \quad (6)$$

where $RFC_{s(max)}$ represents the relative frequency of citation over the maximum, obtained by dividing the FC by the maximum value in all the species in the survey, as shown in (7).

$$RFC_{s(max)} = FC_s/\max(FC) \quad (7)$$

while $RNU_{s(max)}$, expressed in (8), is the relative number of use categories over the maximum, obtained by dividing the number of uses of species s by the maximum value in all species in the survey.

$$RN_{s(max)} = NU_s/\max(NU) \quad (8)$$

2.3.6. Use Value Index by Species (UVs)

UVs (9) is essentially the same as CIs except that it begins with the sum of the UR groupings by informants. Ui is the number of different uses mentioned by each informant i and N is the total number of informants interviewed in the survey [6].

$$UV_s = \sum_{i=i_1}^{i_N} \sum_{u=u_1}^{u_{NC}} UR_{ui/N} \quad (9)$$

2.3.7. Cultural Value for ethnospecies (CVe)

This index is one of the three proposed to assess the importance of cultural, practical and economic dimensions of species. Reyes-Garcia et al. [20] propose several other indices, but CVe is the most commonly used in this study and is expressed as shown in (10).

$$CV_e = U_{ce} * I_{ce} * \sum IU_{ce} \quad (10)$$

where U_{ce} represents the number of reported uses for ethnospecies e divided by all potential uses of an ethnospecies considered in the study. I_{ce} expresses the number of informants who mentioned ethnospecies e as useful, divided by the total number of informants. IU_{ce} expresses the number of informants who mentioned each use of ethnospecies e divided by the total number of informants [20].

2.3.8. Fidelity Level by Species (FLs)

We use the FLs index as shown in (11) to calculate the percentage of informants who use a plant for the same purpose compared to all uses of all plants.

$$FL_s = \frac{N_s * 100}{FC_s} \quad (11)$$

Ns represents the number of informants who use a particular plant for a specific purpose, and FCs is the total number of uses for the species [21].

The calculation of quantitative ethnobotanical indices and graphical representations were performed using the ethnobotany R package [22] in R.

3. Results and Discussion

In the present research, an inventory was made of the medicinal plants used by the local population in the prefecture of Meknes in Morocco. Along the same lines, data and insights on the manner in which these plants are used and their side effects were documented. Moreover, a presentation of quantitative ethnobotanical evidence and data, using different tools and methods, was presented, which allowed for the identification of the correlation

between the people and the medicinal plants.

3.1. Characteristics of Informants

In this study, 394 informants were interviewed, 43% of whom were men and 57% women (Figure 2). Moreover, 45% of the informants are over 50 years old, 43% are between 31-50 years old and 21% are under 30 years old. The informants were grouped into four categories, namely herbalists, researchers, traditional practitioners and others. Herbalists represented 45% of the informants, while researchers and traditional practitioners represented 8 and 14%, respectively.

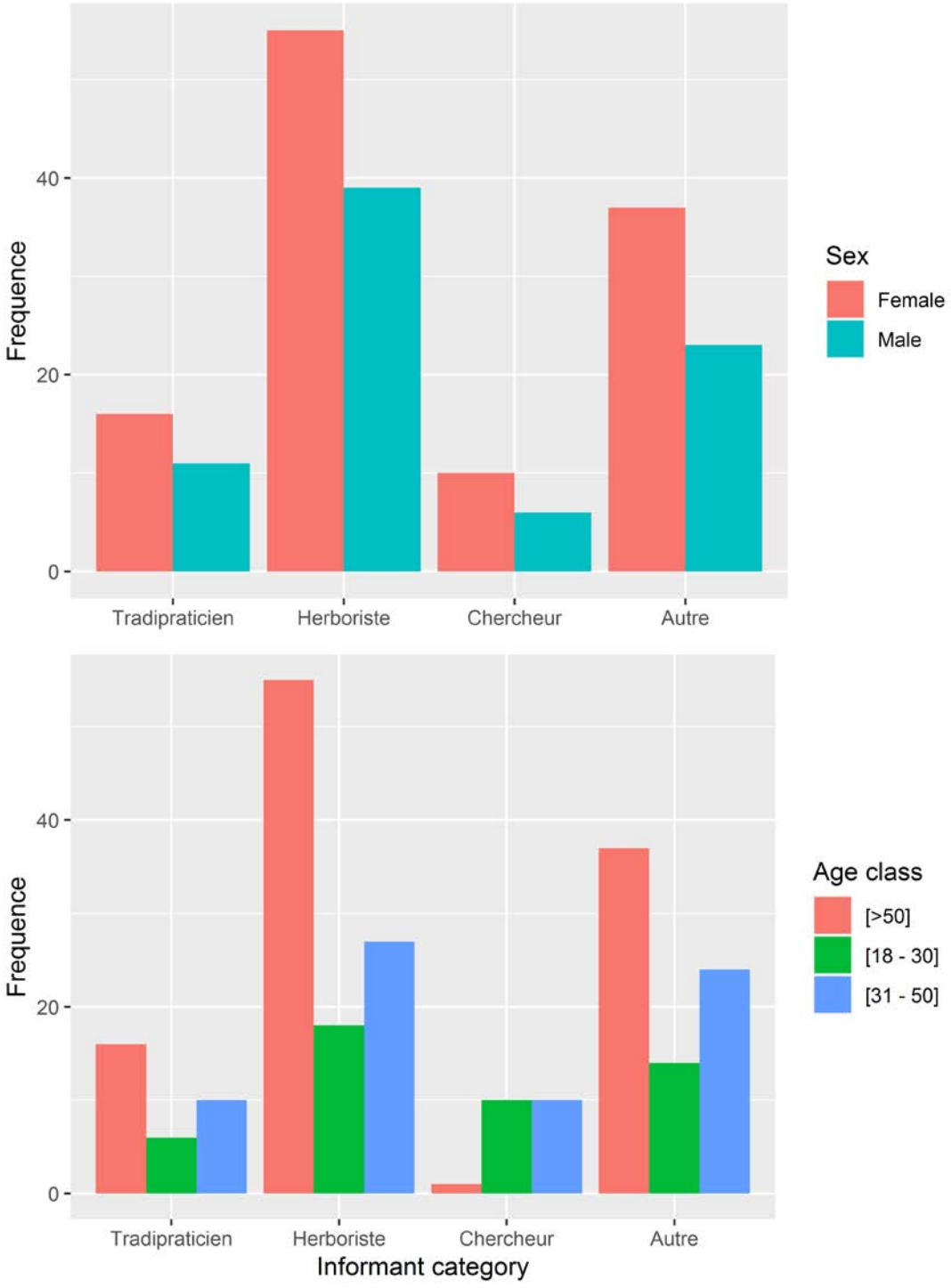


Figure 2. Sex and age class of informants

Among the plants used in traditional phytotherapy, 84 species divided into 44 families were identified (Appendix 1).

3.2. Characteristics of Informants

The ethobotanical indices for therapeutic uses for all species are presented in Appendix 2. The different therapeutic uses are: dermatological (DER), metabolic (MET), nervous system (SNE), gastrological (GAS), respiratory system (SRE), rheumatological (RHU), cardiovascular (CVA), urological (URO) and nephrological (NEP).

In the prefecture of Meknes, the use of plants by the local population for the treatment of diseases is as follows: dermatological (24%), metabolic (18.1%), respiratory (14.4%), rheumatological (10%), urological (9.8%), ear, nose and throat (ENT) (8.6%), cardiovascular (8.1%), nervous system diseases (6.5%), and nephrological diseases (0.5%).

Table 1 shows the ethnobotanical indices for the 20 species with the highest URs. Among the 84 species considered, these 20 species are the most used in therapy. The most used species for therapeutic purposes are *Origanum compactum*, *Dysphania ambrosioides* and *Lavandula angustifolia* with a use report greater than or equal to 30.

These species have a cultural importance index and use value index greater than or equal to 7.5. They also exhibit the highest cultural values, greater than 15, among the ethnospecies.

Table 1. Ethnobotanical indices for the 20 species with the highest URs

Species	Code	URs	CIs	FCs	NUs	RFCs	RIs	UVs	CVe
Dysphania ambrosioides	s24	32	8.0	13	6	3.3	0.9	8.0	15.6
Origanum compactum	s52	32	8.0	15	5	3.8	0.8	8.0	15.0
Lavandula angustifolia	s36	30	7.5	18	5	4.5	0.9	7.5	16.9
Matricaria chamola	s42	27	6.8	14	6	3.5	0.9	6.8	14.2
Thymus vulgaris	s78	21	5.3	16	4	4.0	0.8	5.3	8.4
Dittrichia viscosa	s23	20	5.0	7	6	1.8	0.7	5.0	5.3
Salvia officinalis	s74	19	4.8	10	6	2.5	0.8	4.8	7.1
Mentha pulegium	s44	17	4.3	8	5	2.0	0.6	4.3	4.3
Myrtus communis	s46	16	4.0	9	3	2.3	0.5	4.0	2.7
Opuntia ficus-indica	s51	16	4.0	6	4	1.5	0.5	4.0	2.4
Rosmarinus officinalis	s68	14	3.5	8	4	2.0	0.6	3.5	2.8
Artemisia herba-alba	s08	13	3.3	13	2	3.3	0.5	3.3	2.1
Calamintha officinalis	s14	13	3.3	8	4	2.0	0.6	3.3	2.6
Marrubium vulgare	s41	13	3.3	6	5	1.5	0.6	3.3	2.4
Olea europaea	s50	13	3.3	7	5	1.8	0.6	3.3	2.8
Aloysia citrodora	s04	12	3.0	6	2	1.5	0.3	3.0	0.9
Avena sativa	s12	12	3.0	7	3	1.8	0.4	3.0	1.6
Rhomnus aloternus	s66	11	2.8	7	4	1.8	0.5	2.8	1.9
Ajuga iva	s01	10	2.5	6	4	1.5	0.5	2.5	1.5
Atractylis gummifera	s11	10	2.5	9	3	2.3	0.5	2.5	1.7

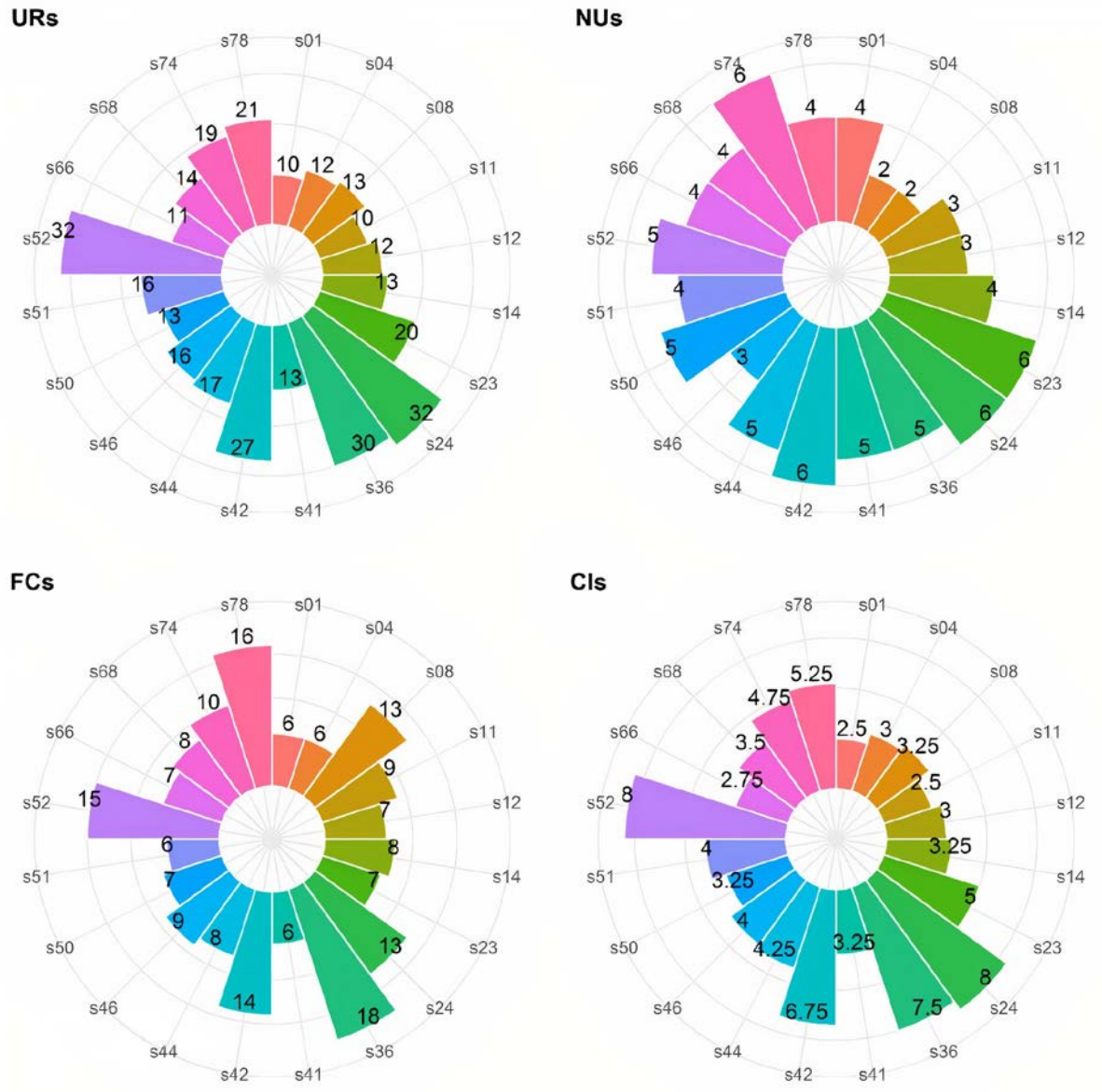
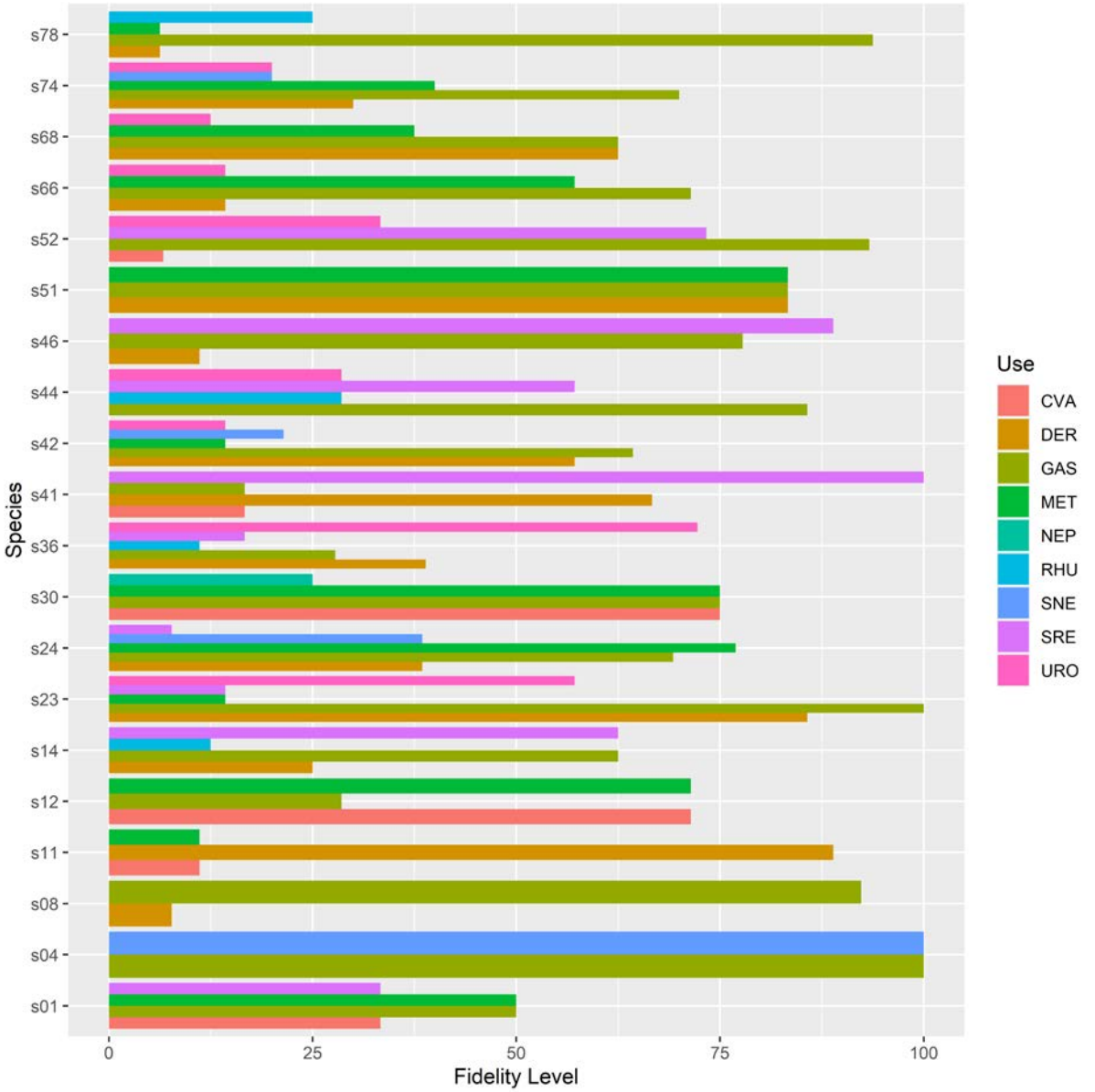


Figure 3. URs, FCs, NUs and CIs for the top 20 species with the highest URs for therapeutic uses

Citation frequency and relative citation frequency indices show that species such as *Lavandula angustifolia, Thymus vulgaris* and *Origanum compactum* are the most mentioned species by informants regardless of use category. Figure 3 graphically presents the RU, FC, Nus and CI for the 20 species with the highest RUs.

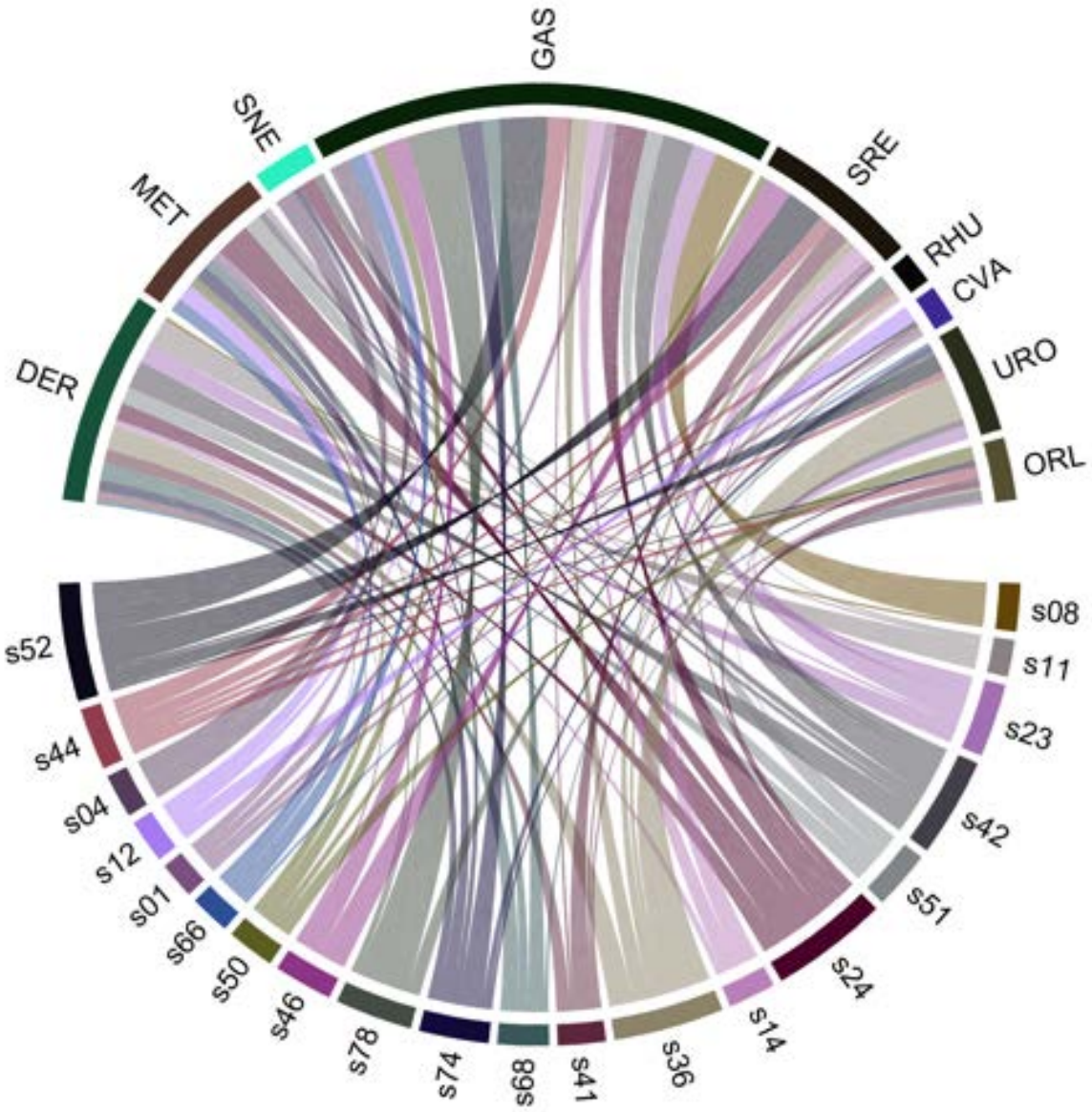


DER: dermatological, MET: metabolic, SNE: nervous system, GAS: gastrological, SRE: respiratory system, RHU: rheumatological, CVA: cardiovascular, URO: urological and NEP: nephrological.

Figure 4. Fidelity level for the top 20 species with the highest URs

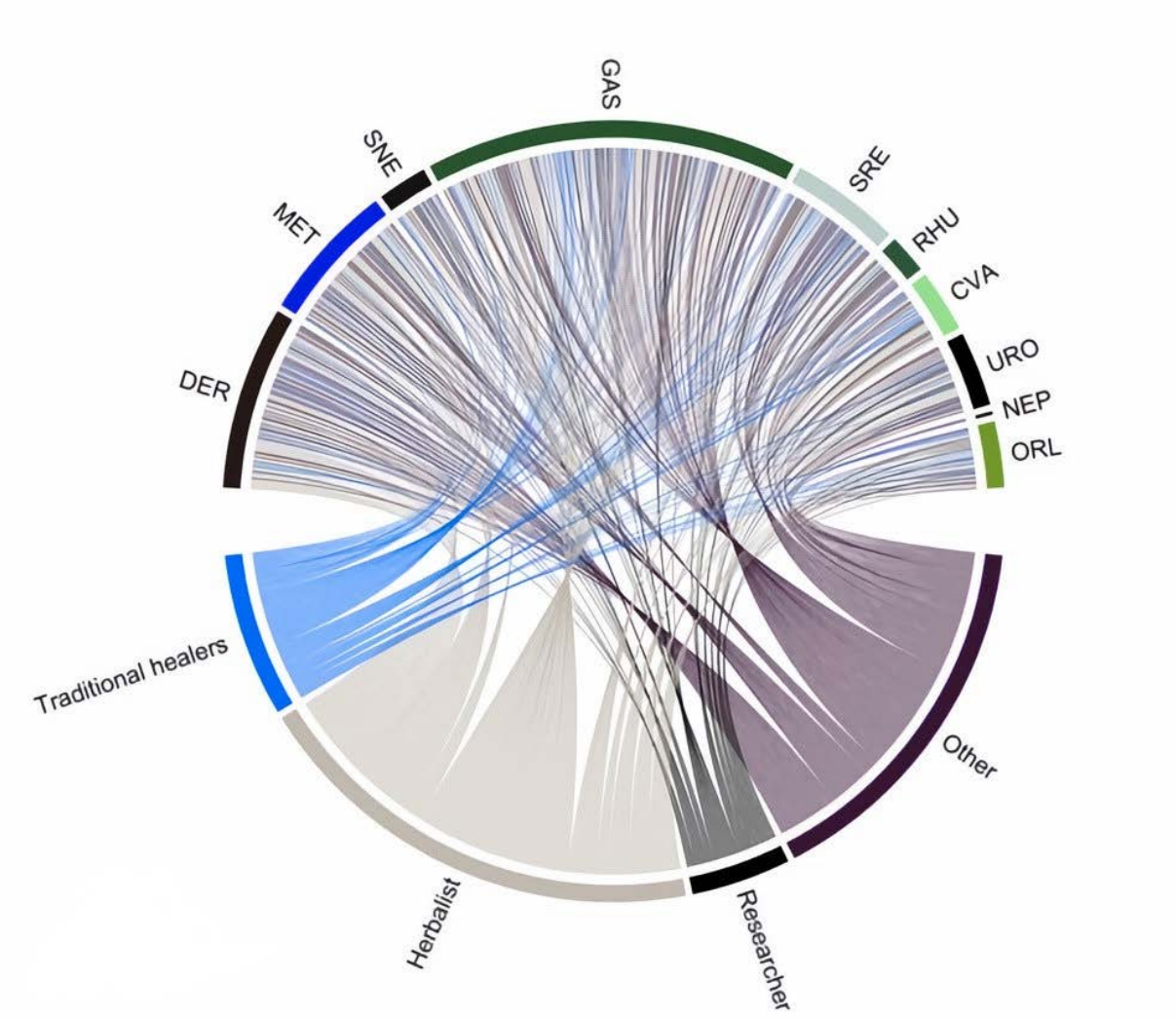
Figure 4 presents the percentage of informants who use a plant for the same purpose as compared to all uses of all plants for the top 20 species with the highest URs.

The FLs show that species S04, S23 and S41 are used by all informants for the treatment of gastrointestinal and nervous system disorders with a FL of 100%. Species s12 and s30 are used in cardiovascular treatment with a FLs of more than 70%. Species s11, s23 and s51 are mainly used for dermatological treatment with FLs above 80%. For gastrological treatments, the most used species are s78, s52, s08, s44 and s51 with a level of accuracy between 80 and 95%. For metabolic treatments, the most used species in the study area are s51, s24, s30 and s12 with an accuracy level between 70 and 85%. In the case of rheumatology, the most used species are s44 and s78 with a fidelity level between 25 and 30%. For the treatment of the respiratory system, the most used species are s41, s46 and s52 with a fidelity level between 70 and 100%. The most used species for urological treatment is s36, while s44 is the most used species for respiratory treatment. The species s44 is the most used for the treatment of ENT diseases with a fidelity level of 38%.



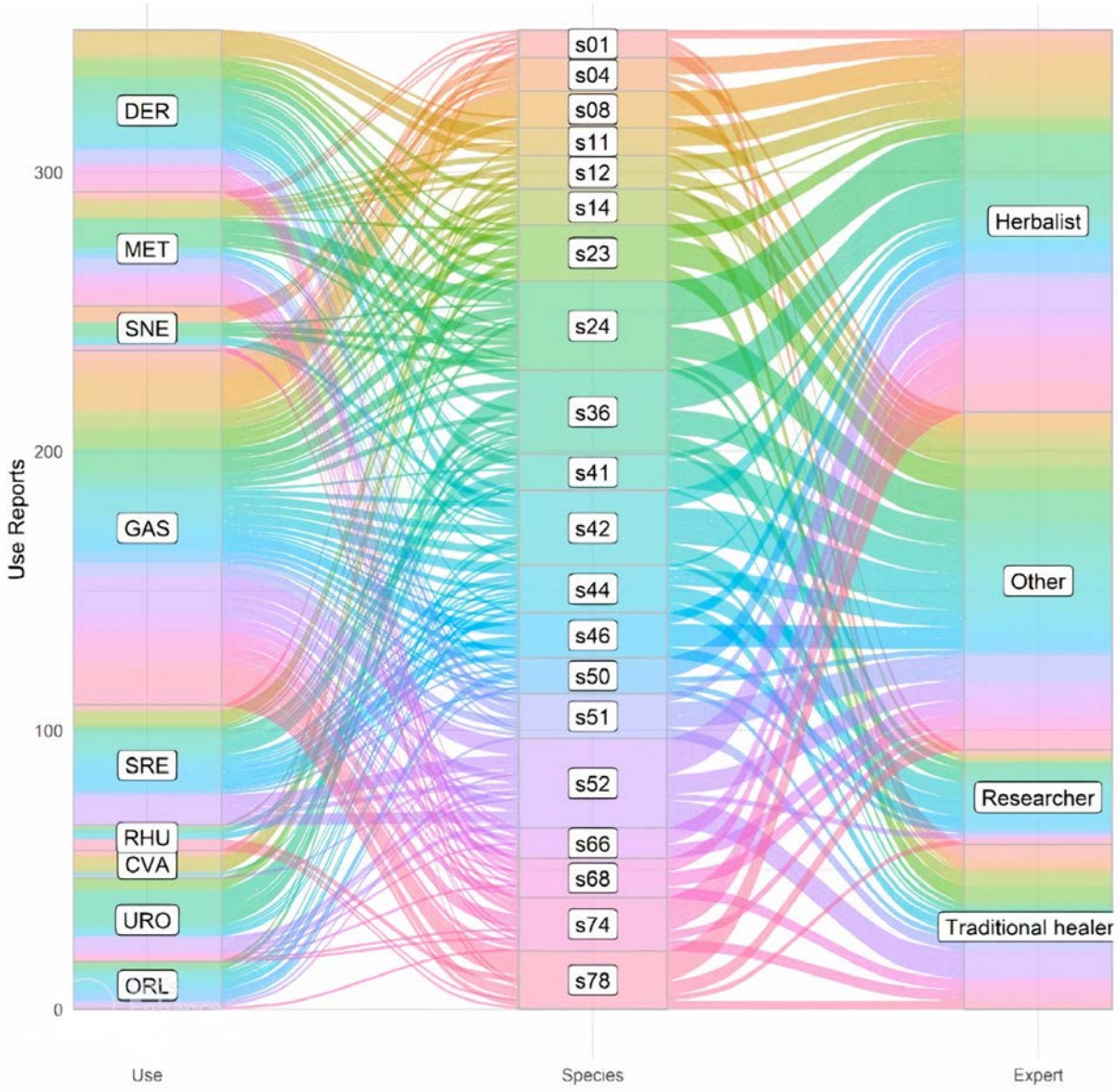
DER: dermatological, MET: metabolic, SNE: nervous system, GAS: gastrological, SRE: respiratory system, RHU: rheumatological, CVA: cardiovascular, URO: urological and NEP: nephrological.

Figure 5. Relationship between the top 20 species with the highest URs and therapeutic uses



DER: dermatological, MET: metabolic, SNE: nervous system, GAS: gastrological, SRE: respiratory system, RHU: rheumatological, CVA: cardiovascular, URO: urological and NEP: nephrological.

Figure 6. Relationship between informants and therapeutic uses



DER: dermatological, MET: metabolic, SNE: nervous system, GAS: gastrological, SRE: respiratory system, RHU: rheumatological, CVA: cardiovascular, URO: urological and NEP: nephrological.

Figure 7. Relationship between informants, species and therapeutic uses

Figure 5 shows the relationship between the 20 species with the highest RUs and therapeutic uses, while Figure 6 shows the relationship between informants and therapeutic uses. On the other hand, Figure 7 shows the relationship between informants, species and therapeutic uses. The relationship between informants and therapeutic uses of plants shows that traditional healers mainly use plants for gastrointestinal, respiratory and dermatological treatments at rates of 39, 16 and 13% respectively. Herbalists mainly use plants for gastrological, dermatological and metabolic treatments at 39, 20 and 15% respectively. Researchers, on the other hand, use plants mainly for gastrological and metabolic treatments at rates of 29 and 15% respectively.

Species s11 and s42 are the most used for the treatment of dermatological diseases (Figure 7), while s24 is the most used for the treatment of metabolic diseases. For treatment of diseases related to the nervous system, species s04 is the most widely used, while species s78, s52 and s08 are the most used to treat gastrological diseases. To treat species related to the respiratory system, informants mainly use species s52 and s46, while s36 is mainly used to treat urological diseases. Informants mainly use s81 species to treat ENT diseases, while s12 is mainly used to treat cardiovascular diseases.

Figure 8 presents the families of species used in traditional medicine in the region. The most used species are from the Lamiaceae, Asteraceae and Apiaceae families with respective URs of 192, 90 and 40.

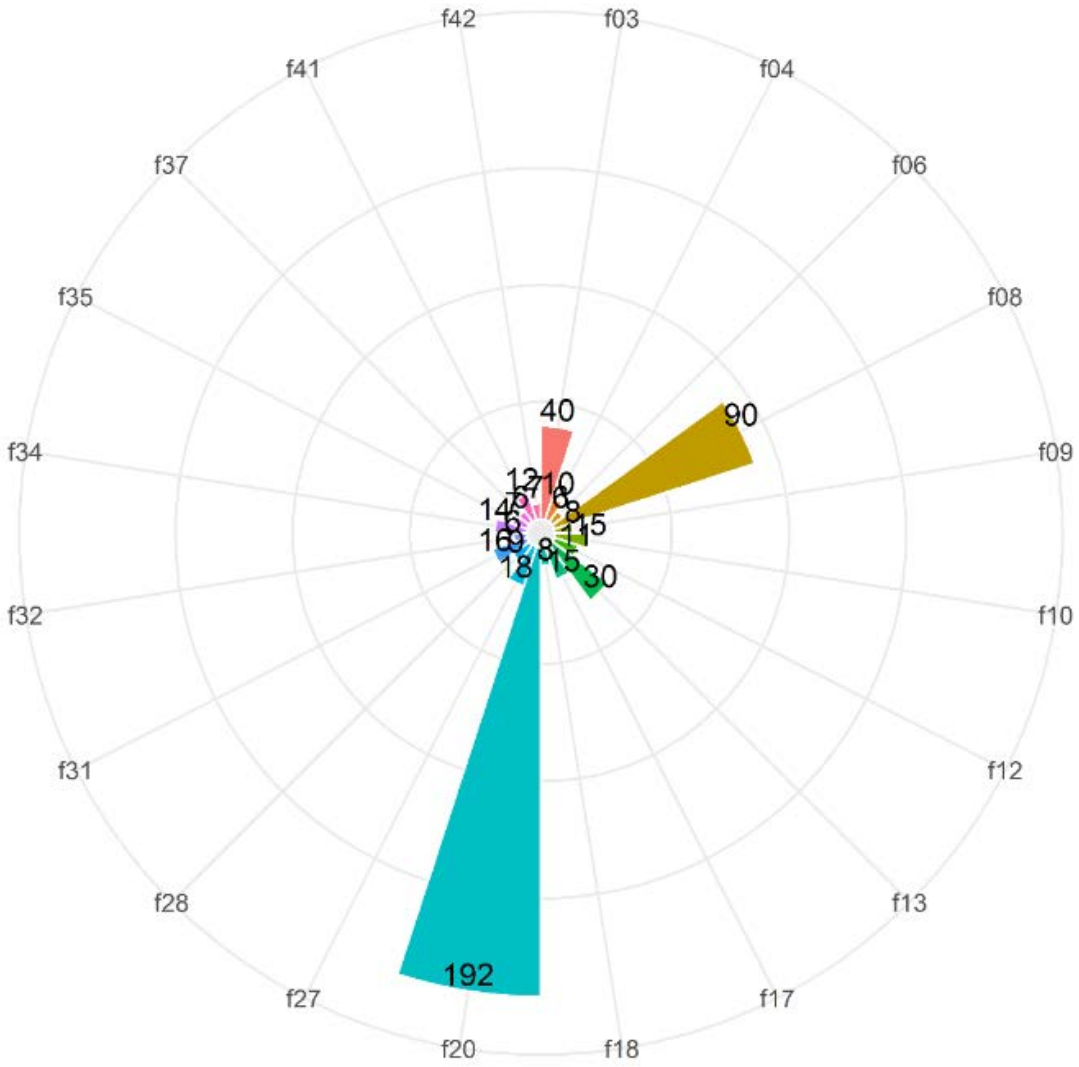
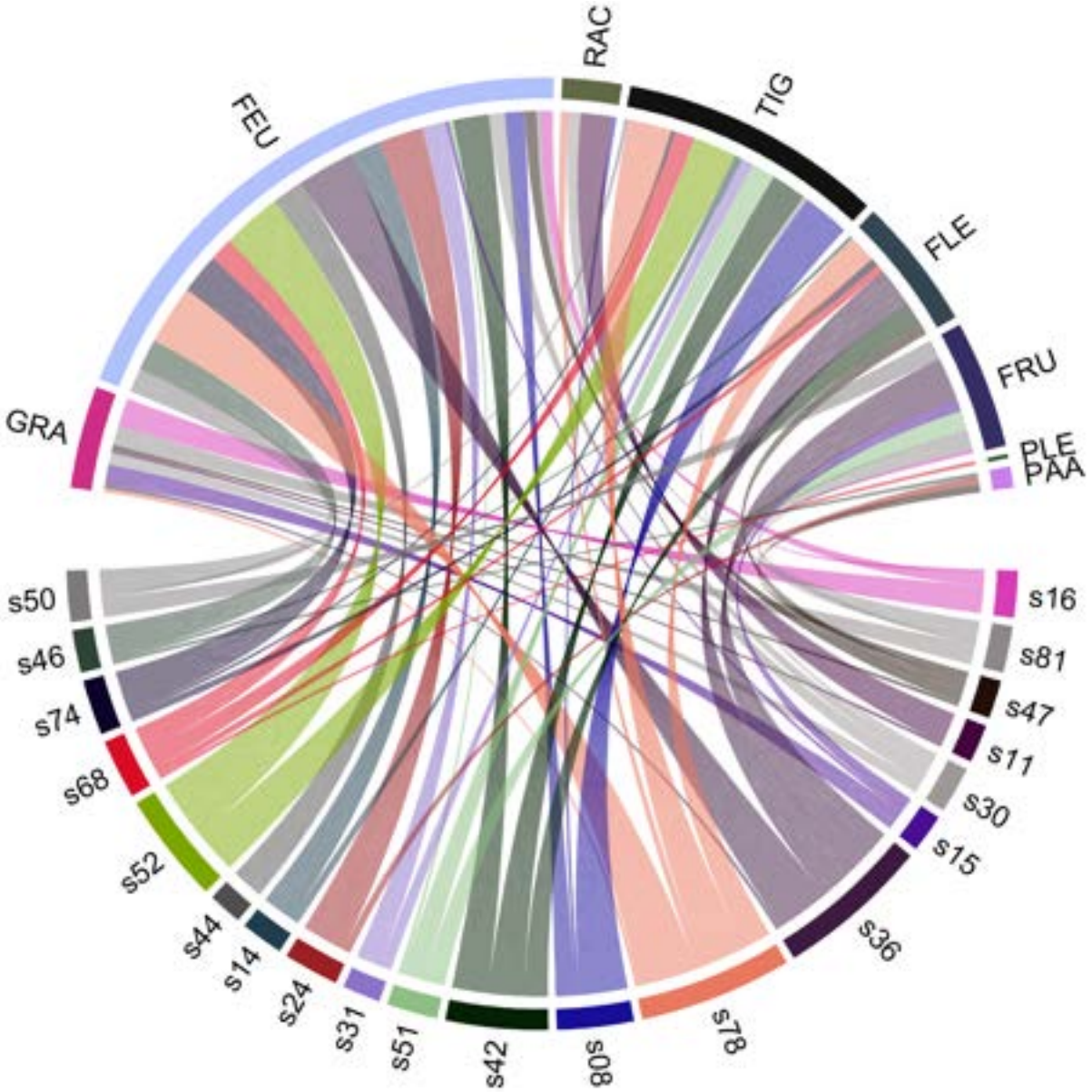


Figure 8. URs of the family of species used by informants

3.3. Relationship between the Part of the Plant Used, Species and Informants

The ethobotanical indices for the part of the plant used by informants for all species are presented in the appendix 3. The different parts of the plant used by informants are: seed (GRA), leaf (FEU), root (RAC), stem (TIG), flower (FLE), fruit (FRU), whole plant (PLE), aerial part (PAA) and buds (BOU).



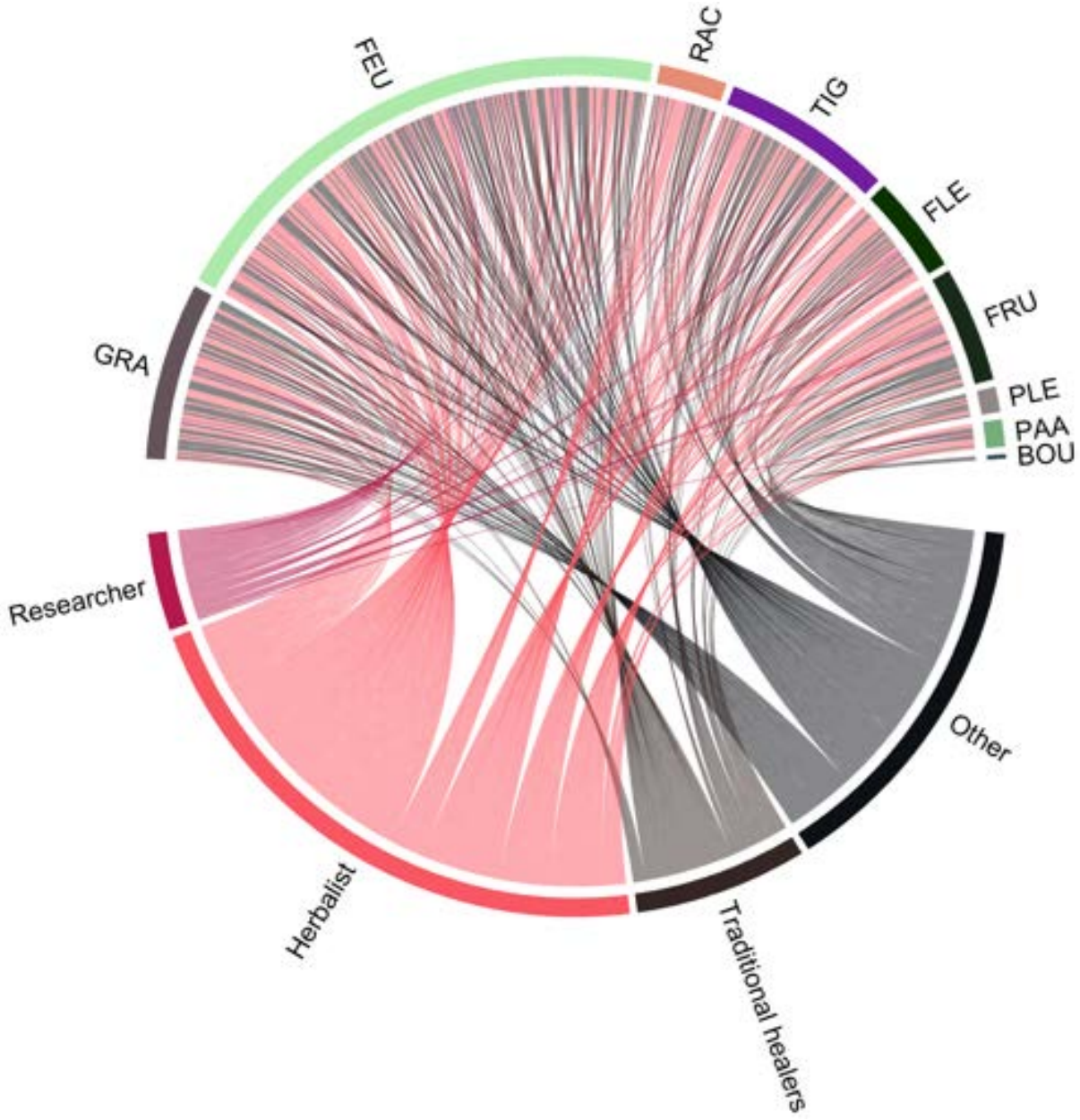
GRA: seed, FEU: leaf, RAC: root, TIG: stem, FLE: flower, FRU: fruit, PLE: whole plant, PAA: aerial part and BOU: buds

Figure 9. Relationship between the top 20 species with the highest URs and the part of the plant used by informants

Leaves are the most used part with a percentage of 43.45%, seeds 14.61%, stems 14.04%, fruits 9.55% and roots 5.62%. Indeed, the high frequency of use of leaves can be explained by the ease of harvesting [23].

The relationship between the part of the plant used and the species (Figure 9) shows that grains are used mainly for species s16 and leaves for species s78, s52, s36, s24, s74, s42, s14, s44, s46, s01, s04, s31, s50 and s68. The main use of the roots is for species s11 and the stems for species s08, s78, s52, s42 and s51. As for the flowers, they are used mainly for species s36, s78 and s42. For the fruits, it is mainly species s36 that is used. However, the whole plant, the whole aerial part and the buds are rarely used for the treatment of diseases in the region.

The relationship between the parts of the plants used and the categories of informants (Figure 10) shows that all the respondents use mainly the leaves for the traditional treatment of diseases at the rate of 55% for traditional practitioners, 49% for researchers and 41% for herbalists and the other category.



GRA: seed, FEU: leaf, RAC: root, TIG: stem, FLE: flower, FRU: fruit, PLE: whole plant, PAA: aerial part and BOU: buds

Figure 10. Relationship between informants and the part of the plant used by informants

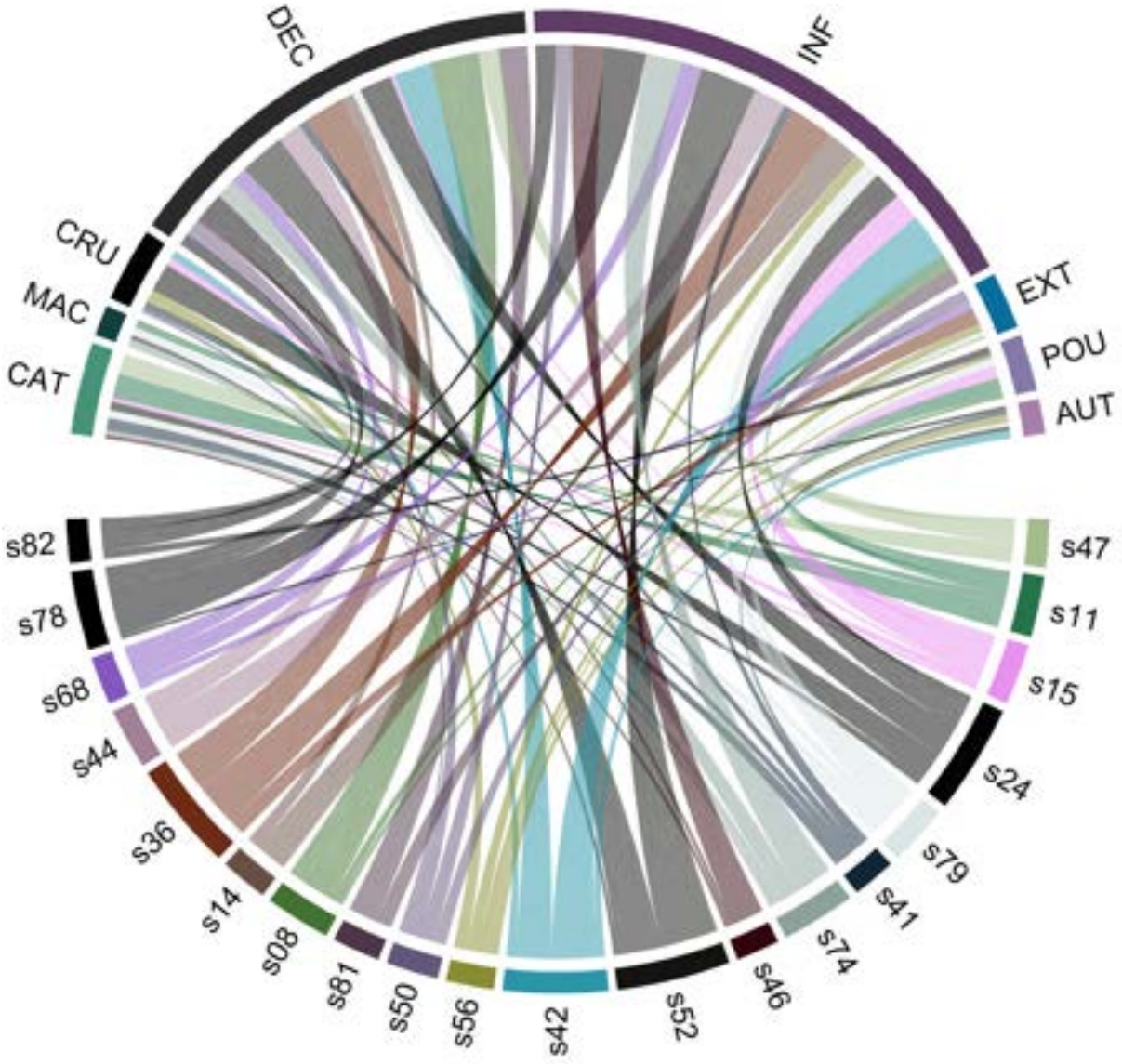
3.4. Relationship between the Method of Preparation of the Plant, Species and Informants

The ethobotanical indices of plant preparation mode used by the informants are presented in Appendix 4. The results show that the users adopt different modes of preparation of plants for their uses in traditional herbal medicine. Among these are infusion, decoction, extraction, poultice, powder, Bkhour and maceration. In the present study, infusion (44.56%), decoction (32.98%), extraction (5.7%) and cataplasm (4.99%) are the most used preparation methods. These results converge with several results obtained in other regions of Morocco including Essaouira [24] and Kenitra [25].

The relationship between the species and the method of preparation of the plant (Figure 11) shows that preparation by poultice is mainly used for species s11, while S24 is generally used raw. Decoction and infusion are widely used. Decoction is used mainly for species s08, s52, s36, s42, s24, s78 and s81, while for infusion, species s52, s36, s42, s78, s74, s44, s14, s46, s24, s15, s16, s12 and s04 are the most used.

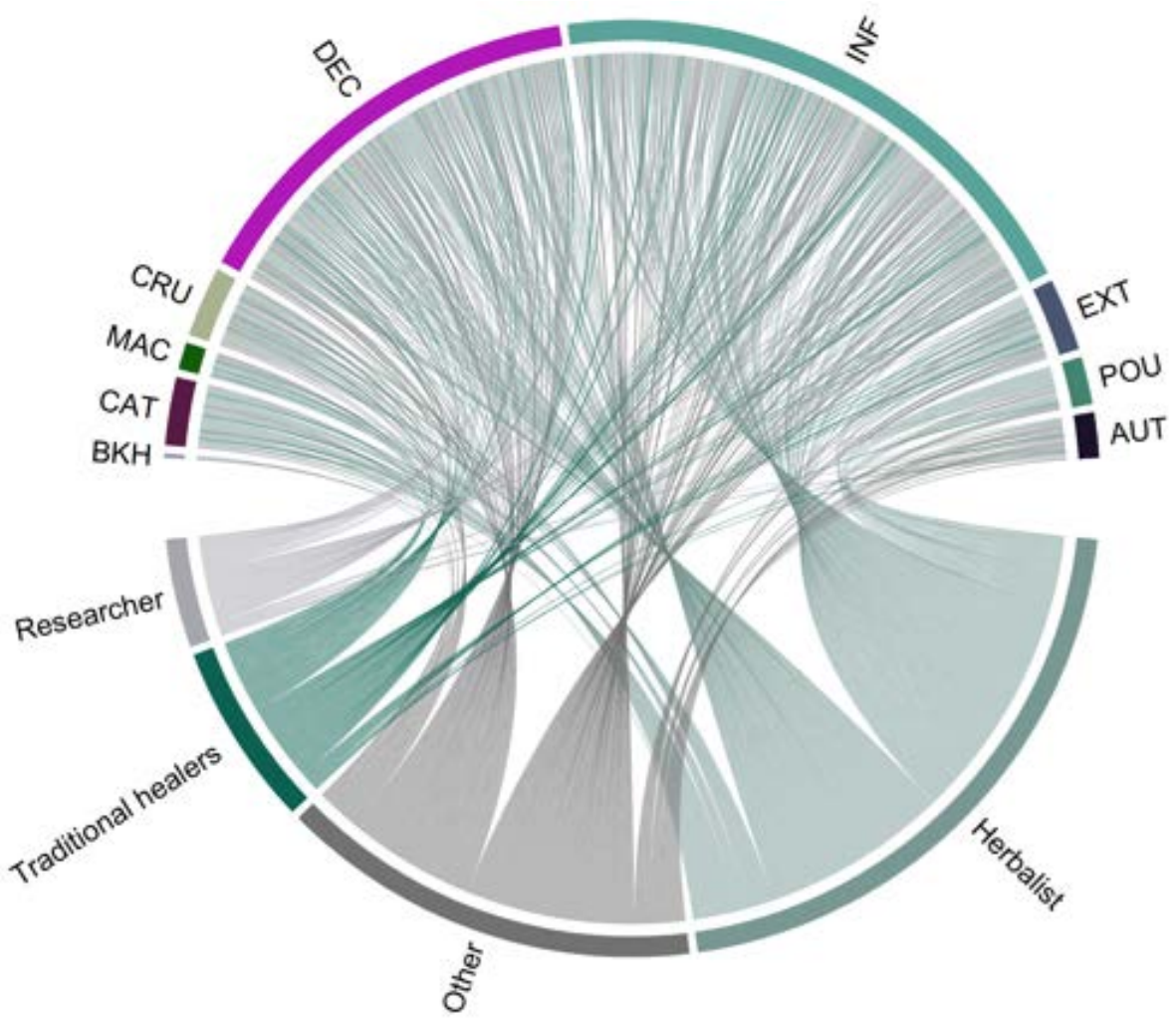
The relationship between informants and the method of plant preparation is presented in Figure 12. Among

traditional practitioners, 46% treat plants by infusion and 30% by decoction. Among herbalists, 40% use infusion and 33% decoction. Researchers mainly use infusion at 52% and decoction at 25%.



INF : infusion, DEC : decoction, EXT : extraction, CAT : poultice, POU : powder, MAC : maceration, CRU : raw, AUT : others

Figure 11. Relationship between the top 20 species with the highest URs and the method of preparation of the plant used by informants



INF: infusion, DEC: decoction, EXT: extraction, CAT: poultice, POU: powder, MAC: maceration, CRU: raw, BKH: incense of Arab culture, AUT: others

Figure 12. Relationship between informants and the method of preparation of the plant used by informants

4. Conclusions

The prefecture of Meknes is an important area of plant diversity, home to a wide variety of flora. The local population uses the plants to treat dermatological, metabolic and respiratory diseases. *Origanum compactum*, *Dysphania ambrosioides* and *Lavandula angustifolia*, belonging to Lamiaceae, Asteraceae and Apiaceae families, respectively, are the species most used for therapeutic purposes.

Quantitative indices in ethnobotany have been used to assess the importance of plants in traditional medicine and the relationships between people and the natural systems that surround and support them.

In our research, the local population primarily relies on plants to treat dermatological diseases (24%), metabolic diseases (18.1%), respiratory diseases (14.4%), rheumatological diseases (10%), urological diseases (9.8%), ENT diseases (8.6%), cardiovascular diseases (8.1%), diseases of the nervous system (6.5%) and nephrological diseases (0.5%).

The relationship between informants and the therapeutic uses of plants shows that traditional healers mainly rely on plants for gastrological, respiratory and dermatological treatments at rates of 39, 16 and 13%, respectively, while herbalists mainly use plants for gastrological, dermatological and metabolic treatments at respective rates of 39%, 20% and 15%. On the other hand, researchers use plants mainly for gastrological (29%) and metabolic (15%) treatments.

This study shows that the population of the region has a high awareness of the benefits of the most popular plants available for use.

Appendix

Appendix 1: Species and family code

Species	Code	Family	Code
Ajuga iva	s01	Amaryllidaceae	f01
Allium sativum	s02	Anacardiaceae	f02
Aloe vera	s03	Apiaceae	f03
Aloysia citrodora	s04	Apocynoceae	f04
Arbutus unedo	s05	Arecaceae	f05
Aristolochia longa	s06	Aristolochiaceae	f06
Artemisia absinthium	s07	Asphodelaceae	f07
Artemisia herba-alba	s08	Asteraceae	f08
Asphodelus albus	s09	Brassicaceae	f09
Asphodelus microcarpus	s10	Cactaceae	f10
Atractylis gummifera	s11	Capparaceae	f11
Avena sativa	s12	Caryophyllaceae	f12
Calendula officinalis	s13	Chénopodiaceae	f13
Calamintha officinalis	s14	Cupressaceae	f14
Capparis spinosa	s15	Ericaceae	f15
Carum carvi	s16	Euphorbiaceae	f16
Ceratonica siliqua	s17	Fabaceae	f17
Chamaerops huis	s18	Geraniaceae	f18
Citrus limonum	s19	Iridaceae	f19
Coriandrum sativum	s20	Lamiaceae	f20
Cuminum cymimum	s21	Lauraceae	f21
Cynara cardunculus	s22	Liliaceae	f22
Dittrichia viscosa	s23	Linaceae	f23
Dysphania ambrosioides	s24	Lythraceae	f24
Eucalyptus camaldulensis	s25	Molvaceae	f25
Eugenia caryophyllata	s26	Moraceae	f26
Euphorbia falcata	s27	Myrtaceae	f27
Ficus carica	s28	Oleaceae	f28
Foeniculum vulgare	s29	Papaveraceae	f29
Helianthus annuus	s30	Pinaceae	f30
Herniaria hirsuta	s31	Poaceae	f31
Hibiscus sabdariffa	s32	Polygonaceae	f32
Iris germanica	s33	Renonculaceae	f33
Juniperus sp	s34	Rhamnaceae	f34
Laurus nobilis	s35	Rosaceae	f35
Lavandula angustifolia	s36	Rubiaceae	f36
Lavandula multifida	s37	Rutaceae	f37
Lavandula stoechas	s38	Salicaceae	f38
Lepidium sativum	s39	Tamaricaceae	f39
Linum usitatissimum	s40	Urticaceae	f40

Appendix 1 Continued

Marrubium vulgare	s41	Verbénaceae	f41
Matricaria chamola	s42	Vitaceae	f42
Melissa officinalis	s43	Xanthorrhoéaceae	f43
Mentha pulegium	s44	Zygophyllaceae	f44
Mentha suaveolens	s45		
Myrtus communis	s46		
Nerium oleander	s47		
Nigella sativa	s48		
Ocimum basilicum	s49		
Olea europaea	s50		
Opuntia ficus-indica	s51		
Origanum compactum	s52		
Origanum majorana	s53		
Papaver rhoeas	s54		
Peganum harmala	s55		
Pelargonium graveolens	s56		
Pennisetum spicta	s57		
Petroselinum crispum	s58		
Pimpinella anisum	s59		
Pimpinella anisum	s59		
Pistacia lentiscus	s60		
Pinus halepensis	s61		
Populus nigra	s62		
Ptychotis verticillata	s63		
Punica granatum	s64		
Rhaponticum acaule	s65		
Rhomnus aloternus	s66		
Rosa × damascena	s67		
Rosmarinus officinalis	s68		
Rubia tinctorum	s69		
Rumex acetosa	s70		
Ruta chalepensis	s71		
Salvia officinalis	s72		
Salvia verbenaca	s73		
Saponaria officinalis	s75		
Tamarix aphylla	s76		
Taraxacum officinale	s77		
Thymus vulgaris	s78		
Trigonella foenumgraecum	s79		
Urtica urens	s80		
Visnaga daucoides	s81		
Vitis vinifera	s82		
Zeucrium polium	s83		
Ziziphus lotus	s84		

Appendix 2: Ethobotanical indices for therapeutic uses

Species code	URs	CIs	FCs	NUs	RFCs	RIs	UVs	CVe
s01	10	2.5	6	4	1.5	0.5	2.5	1.5
s02	4	1.0	2	2	0.5	0.2	1.0	0.1
s03	1	0.3	1	1	0.3	0.1	0.3	0.0
s04	12	3.0	6	2	1.5	0.3	3.0	0.9
s05	1	0.3	1	1	0.3	0.1	0.3	0.0
s06	6	1.5	2	3	0.5	0.3	1.5	0.2
s07	3	0.8	2	2	0.5	0.2	0.8	0.1
s08	13	3.3	13	2	3.3	0.5	3.3	2.1
s09	1	0.3	1	1	0.3	0.1	0.3	0.0
s10	2	0.5	2	2	0.5	0.2	0.5	0.1
s11	10	2.5	9	3	2.3	0.5	2.5	1.7
s12	12	3.0	7	3	1.8	0.4	3.0	1.6
s13	4	1.0	2	3	0.5	0.3	1.0	0.2
s14	13	3.3	8	4	2.0	0.6	3.3	2.6
s15	5	1.3	5	2	1.3	0.3	1.3	0.3
s16	9	2.3	8	2	2.0	0.4	2.3	0.9
s17	5	1.3	5	1	1.3	0.2	1.3	0.2
s18	2	0.5	2	2	0.5	0.2	0.5	0.1
s19	2	0.5	2	2	0.5	0.2	0.5	0.1
s20	4	1.0	4	1	1.0	0.2	1.0	0.1
s21	6	1.5	5	3	1.3	0.4	1.5	0.6
s22	3	0.8	1	3	0.3	0.3	0.8	0.1
s23	20	5.0	7	6	1.8	0.7	5.0	5.3
s24	32	8.0	13	6	3.3	0.9	8.0	15.6
s25	2	0.5	2	2	0.5	0.2	0.5	0.1
s26	2	0.5	2	2	0.5	0.2	0.5	0.1
s27	1	0.3	1	1	0.3	0.1	0.3	0.0
s28	3	0.8	2	2	0.5	0.2	0.8	0.1
s29	5	1.3	2	4	0.5	0.4	1.3	0.3
s30	10	2.5	4	4	1.0	0.4	2.5	1.0
s31	9	2.3	6	5	1.5	0.6	2.3	1.7
s32	1	0.3	1	1	0.3	0.1	0.3	0.0
s33	1	0.3	1	1	0.3	0.1	0.3	0.0
s34	1	0.3	1	1	0.3	0.1	0.3	0.0
s35	2	0.5	1	2	0.3	0.2	0.5	0.0
s36	30	7.5	18	5	4.5	0.9	7.5	16.9
s37	4	1.0	3	2	0.8	0.3	1.0	0.2
s38	5	1.3	4	3	1.0	0.4	1.3	0.4
s39	8	2.0	3	6	0.8	0.6	2.0	0.9
s40	8	2.0	3	6	0.8	0.6	2.0	0.9
s41	13	3.3	6	5	1.5	0.6	3.3	2.4

Appendix 2 Continued

s42	27	6.8	14	6	3.5	0.9	6.8	14.2
s43	1	0.3	1	1	0.3	0.1	0.3	0.0
s44	17	4.3	8	5	2.0	0.6	4.3	4.3
s45	3	0.8	3	2	0.8	0.3	0.8	0.1
s46	16	4.0	9	3	2.3	0.5	4.0	2.7
s47	10	2.5	6	4	1.5	0.5	2.5	1.5
s48	5	1.3	3	3	0.8	0.3	1.3	0.3
s49	3	0.8	3	2	0.8	0.3	0.8	0.1
s50	13	3.3	7	5	1.8	0.6	3.3	2.8
s51	16	4.0	6	4	1.5	0.5	4.0	2.4
s52	32	8.0	15	5	3.8	0.8	8.0	15.0
s53	5	1.3	4	3	1.0	0.4	1.3	0.4
s54	5	1.3	3	3	0.8	0.3	1.3	0.3
s55	2	0.5	2	1	0.5	0.1	0.5	0.0
s56	8	2.0	8	4	2.0	0.6	2.0	1.6
s57	2	0.5	1	2	0.3	0.2	0.5	0.0
s58	7	1.8	4	3	1.0	0.4	1.8	0.5
s59	6	1.5	4	3	1.0	0.4	1.5	0.5
s60	4	1.0	3	3	0.8	0.3	1.0	0.2
s61	3	0.8	2	3	0.5	0.3	0.8	0.1
s62	3	0.8	2	3	0.5	0.3	0.8	0.1
s63	2	0.5	1	2	0.3	0.2	0.5	0.0
s64	3	0.8	2	3	0.5	0.3	0.8	0.1
s65	3	0.8	3	2	0.8	0.3	0.8	0.1
s66	11	2.8	7	4	1.8	0.5	2.8	1.9
s67	7	1.8	4	3	1.0	0.4	1.8	0.5
s68	14	3.5	8	4	2.0	0.6	3.5	2.8
s69	4	1.0	4	2	1.0	0.3	1.0	0.2
s70	6	1.5	5	2	1.3	0.3	1.5	0.4
s71	4	1.0	3	4	0.8	0.4	1.0	0.3
s72	2	0.5	2	1	0.5	0.1	0.5	0.0
s73	6	1.5	5	2	1.3	0.3	1.5	0.4
s74	19	4.8	10	6	2.5	0.8	4.8	7.1
s75	2	0.5	2	2	0.5	0.2	0.5	0.1
s76	4	1.0	2	4	0.5	0.4	1.0	0.2
s77	1	0.3	1	1	0.3	0.1	0.3	0.0
s78	21	5.3	16	4	4.0	0.8	5.3	8.4
s79	10	2.5	6	3	1.5	0.4	2.5	1.1
s80	4	1.0	3	4	0.8	0.4	1.0	0.3
s81	8	2.0	7	4	1.8	0.5	2.0	1.4
s82	8	2.0	5	4	1.3	0.5	2.0	1.0
s83	3	0.8	2	2	0.5	0.2	0.8	0.1
s84	3	0.8	3	1	0.8	0.2	0.8	0.1

Appendix 3: Ethobotanical indices for the part of the plant used by informants

Species code	URs	CIs	FCs	NUs	RFCs	RIs	UVs	CVe
s01	10	2.5	6	4	1.5	0.5	2.5	1.7
s02	4	1.0	2	2	0.5	0.2	1.0	0.1
s03	1	0.3	1	1	0.3	0.1	0.3	0.0
s04	12	3.0	6	2	1.5	0.3	3.0	1.0
s05	1	0.3	1	1	0.3	0.1	0.3	0.0
s06	6	1.5	2	3	0.5	0.3	1.5	0.3
s07	3	0.8	2	2	0.5	0.2	0.8	0.1
s08	13	3.3	13	2	3.3	0.5	3.3	2.3
s09	0	0.0	0	0	0.0	0.0	0.0	0.0
s10	1	0.3	1	1	0.3	0.1	0.3	0.0
s11	10	2.5	9	3	2.3	0.5	2.5	1.9
s12	12	3.0	7	3	1.8	0.4	3.0	1.8
s13	4	1.0	2	3	0.5	0.3	1.0	0.2
s14	13	3.3	8	4	2.0	0.6	3.3	2.9
s15	5	1.3	5	2	1.3	0.3	1.3	0.3
s16	9	2.3	8	2	2.0	0.4	2.3	1.0
s17	5	1.3	5	1	1.3	0.2	1.3	0.2
s18	2	0.5	2	2	0.5	0.2	0.5	0.1
s19	2	0.5	2	2	0.5	0.2	0.5	0.1
s20	4	1.0	4	1	1.0	0.2	1.0	0.1
s21	6	1.5	5	3	1.3	0.4	1.5	0.6
s22	3	0.8	1	3	0.3	0.3	0.8	0.1
s23	19	4.8	7	5	1.8	0.6	4.8	4.6
s24	30	7.5	13	5	3.3	0.8	7.5	13.5
s25	1	0.3	1	1	0.3	0.1	0.3	0.0
s26	1	0.3	1	1	0.3	0.1	0.3	0.0
s27	1	0.3	1	1	0.3	0.1	0.3	0.0
s28	2	0.5	2	1	0.5	0.1	0.5	0.0
s29	4	1.0	2	3	0.5	0.3	1.0	0.2
s30	10	2.5	4	4	1.0	0.4	2.5	1.1
s31	9	2.3	6	5	1.5	0.6	2.3	1.9
s32	1	0.3	1	1	0.3	0.1	0.3	0.0
s33	1	0.3	1	1	0.3	0.1	0.3	0.0
s34	1	0.3	1	1	0.3	0.1	0.3	0.0
s35	2	0.5	1	2	0.3	0.2	0.5	0.0
s36	30	7.5	18	5	4.5	0.9	7.5	18.8
s37	4	1.0	3	2	0.8	0.3	1.0	0.2
s38	5	1.3	4	3	1.0	0.4	1.3	0.4
s39	8	2.0	3	6	0.8	0.6	2.0	1.0
s40	7	1.8	3	5	0.8	0.5	1.8	0.7
s41	12	3.0	6	4	1.5	0.5	3.0	2.0

Appendix 3 continued

s42	24	6.0	14	5	3.5	0.8	6.0	11.7
s43	0	0.0	0	0	0.0	0.0	0.0	0.0
s44	14	3.5	7	4	1.8	0.5	3.5	2.7
s45	3	0.8	3	2	0.8	0.3	0.8	0.1
s46	16	4.0	9	3	2.3	0.5	4.0	3.0
s47	10	2.5	6	4	1.5	0.5	2.5	1.7
s48	3	0.8	3	2	0.8	0.3	0.8	0.1
s49	2	0.5	2	1	0.5	0.1	0.5	0.0
s50	9	2.3	6	4	1.5	0.5	2.3	1.5
s51	15	3.8	6	3	1.5	0.4	3.8	1.9
s52	31	7.8	15	4	3.8	0.8	7.8	12.9
s53	5	1.3	4	3	1.0	0.4	1.3	0.4
s54	5	1.3	3	3	0.8	0.3	1.3	0.3
s55	2	0.5	2	1	0.5	0.1	0.5	0.0
s56	8	2.0	8	4	2.0	0.6	2.0	1.8
s57	2	0.5	1	2	0.3	0.2	0.5	0.0
s58	7	1.8	4	3	1.0	0.4	1.8	0.6
s59	6	1.5	4	3	1.0	0.4	1.5	0.5
s60	4	1.0	3	3	0.8	0.3	1.0	0.3
s61	3	0.8	2	3	0.5	0.3	0.8	0.1
s62	3	0.8	2	3	0.5	0.3	0.8	0.1
s63	1	0.3	1	1	0.3	0.1	0.3	0.0
s64	2	0.5	2	2	0.5	0.2	0.5	0.1
s65	3	0.8	3	2	0.8	0.3	0.8	0.1
s66	11	2.8	7	4	1.8	0.5	2.8	2.1
s67	7	1.8	4	3	1.0	0.4	1.8	0.6
s68	14	3.5	8	4	2.0	0.6	3.5	3.1
s69	4	1.0	4	2	1.0	0.3	1.0	0.2
s70	6	1.5	5	2	1.3	0.3	1.5	0.4
s71	4	1.0	3	4	0.8	0.4	1.0	0.3
s72	2	0.5	2	1	0.5	0.1	0.5	0.0
s73	6	1.5	5	2	1.3	0.3	1.5	0.4
s74	18	4.5	10	5	2.5	0.7	4.5	6.3
s75	2	0.5	2	2	0.5	0.2	0.5	0.1
s76	4	1.0	2	4	0.5	0.4	1.0	0.2
s77	1	0.3	1	1	0.3	0.1	0.3	0.0
s78	21	5.3	16	4	4.0	0.8	5.3	9.3
s79	10	2.5	6	3	1.5	0.4	2.5	1.3
s80	4	1.0	3	4	0.8	0.4	1.0	0.3
s81	3	0.8	3	3	0.8	0.3	0.8	0.2
s82	7	1.8	5	3	1.3	0.4	1.8	0.7
s83	2	0.5	2	1	0.5	0.1	0.5	0.0
s84	3	0.8	3	1	0.8	0.2	0.8	0.1

Appendix 4: Ethobotanical indices for the method of preparation of the plant used by informants

Species code	URs	CIs	FCs	NUs	RFCs	RIs	UVs	CVe
s01	6	1.5	6	2	1.5	0.3	1.5	0.5
s02	2	0.5	2	1	0.5	0.1	0.5	0.0
s03	1	0.3	1	1	0.3	0.1	0.3	0.0
s04	7	1.8	6	2	1.5	0.3	1.8	0.6
s05	1	0.3	1	1	0.3	0.1	0.3	0.0
s06	2	0.5	2	1	0.5	0.1	0.5	0.0
s07	4	1.0	2	2	0.5	0.2	1.0	0.1
s08	15	3.8	13	3	3.3	0.6	3.8	4.1
s09	1	0.3	1	1	0.3	0.1	0.3	0.0
s10	2	0.5	2	2	0.5	0.2	0.5	0.1
s11	14	3.5	9	4	2.3	0.5	3.5	3.5
s12	8	2.0	7	2	1.8	0.3	2.0	0.8
s13	4	1.0	2	3	0.5	0.3	1.0	0.2
s14	11	2.8	8	2	2.0	0.4	2.8	1.2
s15	14	3.5	8	5	2.0	0.6	3.5	3.9
s16	8	2.0	8	2	2.0	0.4	2.0	0.9
s17	8	2.0	5	3	1.3	0.4	2.0	0.8
s18	2	0.5	2	2	0.5	0.2	0.5	0.1
s19	3	0.8	2	2	0.5	0.2	0.8	0.1
s20	7	1.8	4	3	1.0	0.3	1.8	0.6
s21	6	1.5	5	2	1.3	0.3	1.5	0.4
s22	1	0.3	1	1	0.3	0.1	0.3	0.0
s23	8	2.0	7	3	1.8	0.4	2.0	1.2
s24	25	6.3	13	5	3.3	0.7	6.3	11.3
s25	2	0.5	2	1	0.5	0.1	0.5	0.0
s26	3	0.8	2	3	0.5	0.3	0.8	0.1
s27	1	0.3	1	1	0.3	0.1	0.3	0.0
s28	3	0.8	2	3	0.5	0.3	0.8	0.1
s29	4	1.0	2	2	0.5	0.2	1.0	0.1
s30	8	2.0	4	2	1.0	0.3	2.0	0.4
s31	7	1.8	6	3	1.5	0.4	1.8	0.9
s32	2	0.5	1	2	0.3	0.2	0.5	0.0
s33	1	0.3	1	1	0.3	0.1	0.3	0.0
s34	3	0.8	2	3	0.5	0.3	0.8	0.1
s35	4	1.0	2	3	0.5	0.3	1.0	0.2
s36	25	6.3	18	3	4.5	0.7	6.3	9.4
s37	4	1.0	3	2	0.8	0.2	1.0	0.2
s38	5	1.3	4	3	1.0	0.3	1.3	0.4
s39	4	1.0	3	3	0.8	0.3	1.0	0.3
s40	5	1.3	3	2	0.8	0.2	1.3	0.2
s41	10	2.5	6	5	1.5	0.5	2.5	2.1

Appendix 4 continued

s42	24	6.0	14	4	3.5	0.7	6.0	9.3
s43	1	0.3	1	1	0.3	0.1	0.3	0.0
s44	14	3.5	8	2	2.0	0.4	3.5	1.6
s45	4	1.0	3	2	0.8	0.2	1.0	0.2
s46	10	2.5	9	3	2.3	0.5	2.5	1.9
s47	11	2.8	6	3	1.5	0.4	2.8	1.4
s48	9	2.3	6	4	1.5	0.5	2.3	1.5
s49	3	0.8	3	2	0.8	0.2	0.8	0.1
s50	12	3.0	7	4	1.8	0.5	3.0	2.3
s51	7	1.8	6	4	1.5	0.5	1.8	1.2
s52	26	6.5	15	3	3.8	0.6	6.5	8.1
s53	7	1.8	5	2	1.3	0.3	1.8	0.5
s54	5	1.3	3	2	0.8	0.2	1.3	0.2
s55	2	0.5	2	2	0.5	0.2	0.5	0.1
s56	11	2.8	8	5	2.0	0.6	2.8	3.1
s57	8	2.0	3	4	0.8	0.4	2.0	0.7
s58	9	2.3	4	4	1.0	0.4	2.3	1.0
s59	4	1.0	4	3	1.0	0.3	1.0	0.3
s60	5	1.3	3	2	0.8	0.2	1.3	0.2
s61	4	1.0	2	2	0.5	0.2	1.0	0.1
s62	3	0.8	2	2	0.5	0.2	0.8	0.1
s63	1	0.3	1	1	0.3	0.1	0.3	0.0
s64	2	0.5	2	2	0.5	0.2	0.5	0.1
s65	4	1.0	3	3	0.8	0.3	1.0	0.3
s66	8	2.0	7	3	1.8	0.4	2.0	1.2
s67	7	1.8	4	3	1.0	0.3	1.8	0.6
s68	11	2.8	8	3	2.0	0.4	2.8	1.8
s69	6	1.5	4	3	1.0	0.3	1.5	0.5
s70	7	1.8	5	3	1.3	0.4	1.8	0.7
s71	8	2.0	3	4	0.8	0.4	2.0	0.7
s72	3	0.8	2	3	0.5	0.3	0.8	0.1
s73	5	1.3	5	4	1.3	0.4	1.3	0.7
s74	17	4.3	10	4	2.5	0.6	4.3	4.7
s75	3	0.8	2	2	0.5	0.2	0.8	0.1
s76	4	1.0	2	2	0.5	0.2	1.0	0.1
s77	1	0.3	1	1	0.3	0.1	0.3	0.0
s78	18	4.5	16	3	4.0	0.7	4.5	6.0
s79	14	3.5	6	7	1.5	0.7	3.5	4.1
s80	5	1.3	3	3	0.8	0.3	1.3	0.3
s81	11	2.8	7	2	1.8	0.3	2.8	1.1
s82	10	2.5	5	3	1.3	0.4	2.5	1.0
s83	3	0.8	2	2	0.5	0.2	0.8	0.1
s84	5	1.3	3	3	0.8	0.3	1.3	0.3

REFERENCES

[1] Jiofack T., Ayissi I., Fokunang C., Guedje N., Kemeuze V. Etnobotany and phytomedicine of the upper Nyong Valley forest in Cameroon. African Journal of Pharmacy and Pharmacology, 3(4): 144-150, 2009

[2] Jiofack T., Fokunang C., Guedje N., Kemeuze V., Fongnzossie E., Nkongmeneck B. A., Mapongmetsem P. M., Tsabang N. Ethnobotanical uses of medicinals plants of two ethnoecological regions of Cameroon. International Journal of Medicine and Medical Sciences, 2(3): 60-79, 2010

[3] Albuquerque U. P. Quantitative Ethnobotany or Quantification in Ethnobotany? Ethnobotany Research & Applications, 7: 1–3, 2009

[4] Hoffman B., Gallaher T. Importance indices in ethnobotany. Ethnobotany Research & applications, 5:201-218, 2007

[5] Medeiros M. F. T., Silva V. A., Albuquerque U. P. Quantification in research: an overview of indices used from 1995 to 2009. Sitientibus série Ciências Biológicas, 11(2): 211–230, 2011

[6] Tardio J., Pardo-de-santayana M. Cultural importance indices: a comparative analysis based on the useful wild plants of southern Cantabria (Northern Spain). Economic Botany, 62(1): 24–39, 2008

[7] Albuquerque U. P., Lucena R. F. P., Cunha L. V. F. C., Alve R. R. N. Methods and Techniques in Ethnobiology and Ethnoecology, Springer Protocols Handbooks, Humana Press, 2014

[8] Ahoyo C. C., Houehanou T. D., Yaoitcha A. S., Prinz K., Assogbadjo A. E., Adjahossou C. S. G., Hellwig F., Houinato M. R. B. A Quantitative Ethnobotanical Approach toward Biodiversity Conservation of Useful Woody Species in Wari-Maro Forest Reserve (Benin, West Africa). Environment, Development and Sustainability 1–20, 2017

[9] Prance G. T., Baleé W., Boom B. M., Carneiro R. L. Quantitative Ethnobotany and the Case for Conservation in Amazonia. Conservation Biology 1:296–310, 1987

[10] Whitney C. W., Vang Sin M. M. V., Le Hong G., Vu Van C., Barber K., Tran Thi L. Conservation and Ethnobotanical Knowledge of a Hmong Community in Long Lan, Luang Prabang, Lao People's Democratic Republic. Ethnobotany Research and Applications 12:643–658, 2014

[11] Haut-Commissariat aux Eaux et Forêts et à la Lutte Contre la Désertification (HCEFLCD). Ten-Year Plan 2015-2024, 2015

[12] Scherrer A. M., Motti R., Weckerle C. S. Traditional plant use in the areas of Monte Vesole and Ascea, Cilento National Park (Campania, Southern Italy), J. Ethnopharmacol. 97: 129-143, 2005

[13] Neffati M., Sghaier M. Développement et valorisation des plantes aromatiques et médicinales (PAM) au niveau des zones désertiques de la région MENA (Algérie, Egypte, Jordanie, Maroc et Tunisie). Projet MENA-DELP, Observatoire du Sahara et du Sahel. 152p., 2014

[14] Bourkhiss, M., Hnach, M., Bourkhiss, B., Ouhssine, M., Chaouch, A. Composition chimique et propriétés antimicrobiennes de l'huile essentielle extraite des feuilles de Tetraclinis articulata (Vahl) du Maroc. Afrique Science: Revue Internationale des Sciences et Technologie. 3. 10.4314/afsci.v3i2.61267, 2010

[15] RGPH. Recensement Général de la Population et de l'Habitat 2014. Recuperado de https://rgph2014. hcp. ma/downloads/Publications-RGPH-2014_t18649. html., 2014

[16] Haut-Commissariat au Plan. Recensement Général de la Population et de l'Habitat. Direction Régionale Fès – Meknès. https://www.hcp.ma/region-fes/?start=44, 2017

[17] Benabid A. Flore et écosystème du Maroc : évaluation et préservation de la biodiversité. Ibis Press, Paris, 357 p., 2000

[18] Fennane M., Ibn Tattou M., Mathez J., Ouyahya A., El Oualidi J. Flore pratique du Maroc, Vol. I. Trav. Inst. Sci. Rabat, série botanique 36. 558 p, 1999.

[19] Kufer J., Förther H., Pöll E Heinrich M. Historical and Modern Medicinal Plant Uses-The Example of the Ch'orti' Maya and Ladinos in Eastern Guatemala. Journal of Pharmacy and Pharmacology 57(9):1127–1152, 2005

[20] Reyes-Garcia, V., Huanca T., Vadez V., Leonard W. Cultural, Practical, and Economic Value of Wild Plants: A Quantitative Study in the Bolivian Amazon Economic botany, 60(1), 62-74, 2006

[21] Friedman J., Yaniv Z., Dafni A., Palewitch D. A preliminary classification of the healing potential of medicinal plants, based on a rational analysis of an ethnopharmacological field survey among Bedouins in the Negev desert, Israel. Journal of ethnopharmacology, 16(2-3), 275–287. https://doi.org/10.1016/0378-8741(86)90094-2, 1986

[22] Whitney C. Package 'ethnobotanyR', CRAN, 23p., 2021

[23] Bitsindou M. Enquête sur la phytothérapie traditionnelle à Kindamba et Odzala (Congo) et analyse de convergence d'usage des plantes médicinale en Afrique centrale Mem. Doc (inéd.). Univ. Libre de Bruxelles. 482 pp., 1986

[24] Mehdioui R., Kahouadji A. Etude ethnobotanique auprès de la population riveraine de la forêt d'Amsittène: cas de la Commune d'Imi n'Tlit (Province d'Essaouira), Bulletin de l'Institut Scientifique, Rabat, section Sciences de la Vie, n°29, 11-20, 2007

[25] Salhi S., Fadli M., Zidane L., Douira A. Etudes floristique et ethnobotanique des plantes médicinales de la ville de Kénitra (Maroc). Lazaroa, 31: 133-146, 2010