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Ethnobotanical and Ethnopharmacological Study of Medicinal and Aromatic Plants Used in the Treatment of Neurological Disorders in the Moroccan Rif

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ABSTRACT

Background: The present study aimed to analyse and evaluate the ethnobotanical and ethnopharmacological information related to the use of plants for medicinal purposes by the native people of Moroccan Rif region. Material and Methods: An ethnobotanical and ethnopharmacological study was conducted in the Rif region (northern Morocco) for two campaigns (2016 and 2017), using 625 questionnaires to identify the various information concerning the therapeutic uses practiced by the population of the study area. Results: The Rif’s population that uses medicinal and aromatic plants in the treatment of neurological diseases includes 321 women and 304 men. The survey identified 31 plant species and subspecies divided into 14 families, 09 of which were Dicotyledonous and 04 of Monocotyledonous. The most important family is that of the Asteraceae and the Lamiaceae represented by 05 species, the leaves are the most used part and the majority of the remedies are prepared in the form of infusion. Conclusion: This study highlights the medicinal and aromatic plants used in the treatment of neurological diseases by the Moroccan Rif population. The results obtained constitute a very valuable database for the national medicinal flora. They could be a source of information to search for active ingredients in Rif plants.

1. Introduction

Humans have always used medicinal and aromatic plants (MAPs) to treat themselves and fight against diseases. In all ancient civilizations and in all continents, one finds traces of this use. Today, plant-based treatments are coming back to the fore as the effectiveness of drugs such as antibiotics (considered as the near-universal solution to serious infections) is decreasing, bacteria and viruses have gradually adapted to drugs and resist them more and more.

In the Moroccan Rif, like all the other regions of developing countries, MAPs occupy a very important place in traditional medicine, which itself is widely used for their subsistence and health problems. Remedies using MAPs are considered: less expensive, with no side effects and tend to be more used in diseases such as Epilepsy, Psychic disorders, etc. This use may be largely related to

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socio-cultural, economic, religious factors and ease of acquisition.

The World Health Organization (WHO) \[^{1,2}\] estimates that nearly 80% of the world’s inhabitants rely primarily on traditional medicines to cope with health problems. As a result, WHO has developed a strategy for traditional medicine that aims to maximize the possibilities of this form of medicine as a source of health care, and to protect the raw material especially in the case of plants (OMS 2002).

The objective of our work is to promote the richness of the Moroccan Rif by MAPs and to collect a maximum of information on these MAPs used by the population to treat neurological disorders, the species used, their vernacular names, their geographical distributions, their methods of conservation, their modes of administration, their methods of preparation, their parts used, their harvesting technique, their forms of use, etc.

2. Material and Methods

2.1 Study Area

The Moroccan Rif is part of the region of Tangier-Tetouan-Al Hoceima which is one of the twelve regions of Morocco established by the territorial division of 2015 \[^{8}\]. It consists of the former Tangier-Tetouan region and the province of Al Hoceima of the former Taza Taounate Al Hoceima region.

It is located in the extreme north-west of Morocco; it is limited to the North by the Strait of Gibraltar and the Mediterranean, to the West by the Atlantic Ocean, to the South-West by the Rabat-Sale-Kenitra region, to Southeast by region Fes-Meknes and east by the region of Oriental. The region has two Tangier-Asilah and M’Diq-Fnideq prefectures and six provinces: Al Hoceima, Chefchaouen, Fahs-Anjra, Larache, Ouezzane and Tetouan. Its main town is Tangier-Asilah (Figure 1).

![Figure 1. Map of the geographical location of the study area](image1)

According to the last census of the population of 2014, the region of Tangier-Tetouan-Al Hoceima is ranked the fifth of the regions with a population of 3,549,512 inhabitants, or a share of 10.49% of the total population of the country \[^{17}\]. In general, people live mainly from agriculture, livestock and, to a different extent, forest resources.

The climate of the region is Mediterranean on the coasts and the surroundings, rather continental and with abundant snow on the interior areas of the region. Thanks to its altitude and its triple maritime façade (+ 1000 mm), the region is one of the most watered areas in Morocco \[^{12}\].

From a geological point of view, the Rif region is part of the alpine chains, and is characterized by cartons which have determined its structure. The Rif’s chain is the frame of the Rif’s geological domain with an exceptional situation with two maritime façades: the Mediterranean Sea in the North and the Atlantic Ocean in the West.

2.2 Methodology

The survey based on this study was carried out from 30 June 2016 to 01 June 2018, using 625 questionnaires, in hospitals, pharmacies, houses, mosques, villages and weekly souks with pharmacists, herbalists, traditional doctors, practitioners, believers, spiritualists and therapists met who were informed about the purpose of this study and are regularly interviewed in Amazigh or Arabic depending on the case in order to earn their Trust. They are people reputedly experienced, serious and aged between 17-80 years.

The questionnaire used consists of two parts: the first relates to the informant and the second relates to the plants used in the treatment of the disease. The sample is made up of men and women from different socio-economic strata, chosen at random from the Rif’s population.

In this study, the sample is developed using a proportional random probabilistic sampling method. According to this sampling method, we have divided our study area into sites (Sn), so we have 28 sites that correspond to the number of divisions in the study area (Figure 2).

![Figure 2. Distribution of survey points at the study area level](image2)
The data collected are recorded to be analyzed, studied, and confirmed or reversed at the end. Then these data were captured and analyzed by IBM-SPSS Statistics Base 21 (statistical analysis software providing the basic functions, to control the analytical process).

3. Results and Discussion

3.1 Informant Profile

3.1.1 Use of Medicinal and Aromatic Plants by Age

The use of MAPs in the study area is widespread in all age groups with predominance of people from 40 to 60 years of age (41.3%). Respondents aged over 60 and 20 to 40 years, then come with 35.2% and 22.5% respectively (Figure 3). These elderly people provide more reliable information because they hold much of the ancestral knowledge that is part of the oral tradition. The transmission of this knowledge is in danger now because it is not always assured [20]. However, people under the age of 20 (1%) do not use much traditional medicine. These values confirm the results obtained in other regions of Morocco [3,4,5,6,7,24]. Which actually show that the lack of interest for herbal medicine in people under 20 years is explained by the mistrust of young people who tend to no longer believe in this herbal medicine.

3.1.2 Use of Medicinal and Aromatic Plants by Sex

The survey of the local population in the region of Rif revealed that both women and men all practice traditional medicine. They use herbs to heal neurological disorders. However, we note a slight predominance of women, 51.3% of the total population studied compared to men (49.7%) (Figure 4). The predominance of women can be explained by the vigilance of women for the balance of the disease, their responsibilities, and their attachment to all that is traditional. These results confirm the results of other ethnobotanical work done nationally in the province of Essaouira [19,21] and at the level of the prefecture of Agadir-Ida-Outanane [14].

3.1.3 Use of Medicinal Plants According to the Family Situation

The analysis of the collected data shows that, medicinal and Aromatic plants are much more used by married people (80.6%) than by divorced (10.7%), knowing that widowers people have a percentage of 5.7% and 3% for singles. These results coincide with those obtained in the central plateau of Morocco [15] (Figure 5).

3.1.4 Use of Medicinal and Aromatic Plants According to the Level of Education

For the level of education, 65.4% of the surveyed population was not in school, However, people who have a primary level, have a significant (27%) followed by those of secondary level (6.8%). Finally the University level

Figure 3. Frequency of use of medicinal and aromatic plants according to age groups

Figure 4. Use of medicinal and aromatic plants according to sex

Figure 5. Use of medicinal and aromatic plants according to the family situation
(0.8%). This is similar to the results of other studies\textsuperscript{[15,20]}. We can therefore see that the use of MAPs decreases as the level of study increases (Figure 6).

**Figure 6.** Use of medicinal and aromatic plants according to socio-economic level

### 3.1.5 Use of Medicinal and Aromatic Plants by Income/month

The survey of the local population in the Rif Moroccan revealed that, 31.4% of the surveyed populations are unemployed, 45.1% belong to a low level, 21.5% of the respondents have an average socio-economic level and only 2% have a high level (Figure 7). These results are similar to those obtained in Moyen Moulouya\textsuperscript{[13]}. We can therefore see that the use of MAPs increases as the income per month for these informants increases.

**Figure 7.** Use of medicinal and aromatic plants according to socio-economic level

### 3.2 Floristic Analysis

#### 3.2.1 Most Represented Botanical Families

The ethnobotanical and ethnopharmacological survey, based on the 625 questionnaires developed in the Moroccan Rif, made it possible to inventory 31 species and sub-species of MAPs belonging to 14 families, including: 09 from Dicotyledons and 04 from Monocotyledons and only one species belongs to the Branch of the Gymnosperms represented by the family Cupressaceae.

The Asteraceae and Lamiaceae are the most important family with 05 species. The other most represented families were: Cucurbitaceae (04 species), and Solanaceae (04 species) (Figure 8).

**Figure 8.** Frequency of botanical families

#### 3.2.2 Medicinal and Aromatic Plants with Very Frequent Uses

According to the results presented in Figure 9, six medicinal and aromatic plants are relatively more used in traditional herbal medicine by the Rif’s population. The species *Marrubium echinatum* \(L\) was reported by 134 respondents, followed by *Allium cepa* \(L\) (123), *Aloysia citrodora* \(L\) (105), *Myristica fragrans* \(L\) (68), *Artemisia herba alba* \(L\) (95) and *Tetraclinis articulata* \(L\) (8).

**Figure 9.** Frequency of the most commonly used botanical species and sub-species

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3.3 Ethnobotanical and Pharmacological Aspect

3.3.1 Choice between Phytotherapy and Modern Medicine

The results of our study show that according to the care systems, the Rif’s population can be divided into 3 classes. Out of 625 people interviewed, one distinguishes:

(1) 26.7% use herbal medicine alone.
(2) 25.6% use modern medicine alone.
(3) 47.7% use herbal medicine and modern medicine.

The respondents who use phytotherapy are therefore 465 (74.4%). This is justified by the fact that the local population is interested in traditional remedies to relieve their daily ills (Figure 10).

![Figure 10. Choice of the population between herbal medicine and modern medicine](image1)

3.3.2 Plant Type

At the Rif’s region level, spontaneous MAPs are widely used with 83.2% of the total species, it comes in 2nd class plants Cultivated with a percentage of 14.5% while the use of introduced plants is a minority (2.3%). These results are different from those obtained in the Zerhoun region [25] (Figure 11).

![Figure 11. Use of medicinal and aromatic plants according to type](image2)

3.3.3 Preparation of the Drug

The ethnomedicinal and ethnopharmacological survey revealed that most preparations were drawn from single plant (65.2%), but their mixtures with other plant, animal or mineral were also commonly used (34.8%) (Figure 12). These results corroborate those found by El-Rhaffari (El Rhaffari and Zaid 2002).

![Figure 12. Proportion of species used alone or mixed](image3)

3.3.4 Use of the Plant

The parts of the plant are mostly used in fresh (58.2%) or desiccated (36%); however, the use of the plant after treatment is the least with a percentage of 5.8%. Because they are not available all year round drying, and then conservation are protected from light, this allows the preservation of the majority of the active principles of plants (Figure 13).

![Figure 13. Use of medicinal and aromatic plants according to their condition](image4)
3.3.5 Used Part
The survey conducted in the Rif region revealed that the leaf is the most used part with a percentage of (38%), followed by the bulb (15.3%), the other combination (12.95%), the whole plant (8.8%), the seed (8.7%), the flower (8.3%), the root (4%), the stem (3.2%) and the fruit (0.75%) (Figure 14). These results are comparable to those reported nationally [13] or in Africa [11,23] which indicate that the leaf is the most used medical organ.

3.3.6 Form of Employment
The analysis of the results shows that Herbal tea is the most used form of employment with a rate of 48.2%, Powder 43%, essential oils 05%. Tincture and Oily oils come in last position with a rate of 2% and 1.8% respectively (Figure 15). This situation is not different from what has been reported in studies in other parts of the country [19,21] or the world (Srithi et al. 2009).

3.3.7 Method of Preparation
In the study area, the most frequent method of preparation (Figure 16) for the treatment of neurological infections is infusion (41.6%), followed by cataplasm (30.36%), the decoction (27.6). Finally the other forms of employment (0.44%). Similar results were also obtained at the national level [15,24,25] and at the continental level [9,10].

3.3.8 Administration Mode
The modes of administration used by the local population are classified in order of decreasing importance (Figure 17): the oral (83%), the massage (6%), other modes of administration (5.9%) the swabbing (3%), and the rinsing (2.1%). These results confirm the ethnobotanical study carried nationwide by El Hafian [14].

Figure 14. Frequency of use of different parts of aromatic and medicinal plants

Figure 15. Percentage of forms of use of medicinal and aromatic plants

Figure 16. Proportion of different methods of preparations for aromatic and medicinal plants

Figure 17. Frequency of different methods of administration of plant-based remedies
3.3.9 Conservation Method

The most used method of preserving MAPs is protected from light with a percentage of 71.3% (Figure 18). Our result coincides with those of (Parfait et al. 2015) who found that the preparations of the various extracts are mostly kept away from light (90.91%).

Figure 18. Proportion of methods of conservation of aromatic and medicinal plants

3.3.10 Origin of Information

Concerning the source of information by which respondents were aware of the plant used, 68% of respondents said they followed the advice and experiences of the direct entourage, 15.3% of respondents their information is reflected in Ahab the rate of respondents who reported the pharmacist as a source of information is 12.7%. Finally 4.2% of respondents acquire information through reading (Figure 19). These results are consistent with those obtained in the region of Mechraa Bel Ksiri and at the province of Laayoune.

Figure 19. Frequency of origin of information according to the profile of the respondent.

3.3.11 Toxicity of Aromatic and Medicinal Plants

The results of our investigations show that only 11% of the population studied knows toxic MAPs, especially respondents with secondary education. The assessment of the knowledge of the subjects interviewed shows that the majority of the population (89%) declares their ignorance of toxic MAPs in the Rif region (Figure 20) this joins a study by (Hamouchi 1997).

Figure 20. Percentage of medicinal and aromatic plants used as a function of intoxication

4. Conclusion

The Moroccan Rif is characterized by climatic and edaphic diversity favorable to the growth and development of MPAs. These plants are currently used in the field of herbal medicine which remains a practice still widely used by the human population for the treatment of many diseases.

Like other populations of the terrestrial globe, the population of northern Morocco has always used medicinal and aromatic plants to treat neurological diseases. Throughout the kingdom of Morocco, ethnobotanical and ethnomedical studies have been carried out. However, very little information is available on the medicinal and aromatic plants of Rif’s Moroccan, despite its floristic diversity and its cultural, climatic and ethnic specificity.

This work enabled us to carry out a more complete inventory of the MPAs most used in the treatment of neurological diseases in the Moroccan Rif. The series of surveys revealed a multitude of results. The species *Marrubium echinatum* L is a medicinal plant more used in traditional herbal medicine by the Rif’s population. From an ethnobotanical point of view, the distribution of respondents by sex showed overall a slight predominance of women. The leaf is the most used part; the infusion is the most practiced form.

On the other hand, the collection and analysis of the collected information has made it possible to transform the popular oral know-how in this region by transcribing the establishment of a catalog of medicinal and aromatic plants used, thus highlighting advantage, the wealth of this know-how, because the practice of phytotherapy is left to popularization and forgetting scientific, academic and legislative.
Indeed, it is necessary and important to safeguard the phytotherapeutic knowledge of the Rif’s population because they are part of the Moroccan national empirical heritage that deserves to be valued and highlighted. Moreover, these results are very motivating. They can be considered as a source of information to search for the active ingredients in medicinal and aromatic plants of Moroccan Rif.

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APPENDIX

The ethnobotanical and ethnopharmacological survey has made it possible to list the medicinal and aromatic plants used in the treatment of neurological diseases (Table 1). The families are presented in alphabetical order. For each plant listed, we give the scientific name, the family, the local name, the part used, the method of preparation adopted by the local population, as well as the frequency of use.

| Family          | Frequency | Local name          | French name                  | Scientific name of the species | Parts used | Preparation |
|-----------------|-----------|---------------------|------------------------------|-------------------------------|------------|-------------|
| Agavaceae       | 01        | Aloe Vera           | Agave Bullian                | Prochnyanthes mexicana L.     | Leaf       | Cataplasm   |
|                 | 01        | Sabra               | Agave                        | Agave karatto L.              | Leaf       | Cataplasm   |
| Asteraceae      | 01        | Chih, Izri          | Armoise                      | Artemisia afra L.             | Leaf       | Decoction   |
|                 | 01        | Lzik Chouki         | lampourdé épineuse           | Xanthium spinosum L.          | Leaf       | Decoction   |
|                 | 95        | Chih, Izri          | Armoise blanche              | Artemisia herba alba L.       | Leaf       | Decoction   |
|                 | 63        | Lghawân, Lgentus    | Marguerite sauvage           | Chrysanthemum coronarium L.   | Flower     | Infusion    |
|                 | 01        | Far Dahabya         | Anacyle radié                | Anacyclus radiatus L.         | Whole plant| Infusion    |
| Cucurbitaceae   | 02        | Faggous El Hemar    | Concombre d’âne              | Ecballium elaterium L.        | Fruit      | Other       |
|                 | 13        | Btikh               | Melon                        | Cucumis melo L.               | Leaf       | Infusion    |
|                 | 09        | Dlíah               | Pastèque                     | Citrullus lanatus L.          | Leaf       | Decoction   |
|                 | 05        | El garía-sláwiya    | Courgette de Salé            | Lagenaria sicalera L.         | Fruit      | Cataplasm   |
| Cupressaceae    | 81        | El A’râr            | Thuya de berbère             | Tetraclinis articulata L.     | Leaf       | Infusion    |
| Fabaceae        | 32        | Rtem                | Retam                        | Retama monosperma L. Boiss    | Stem       | Decoction   |
|                 | 41        | Rtem                | Retam                        | Retama raetam L.              | Root       | Decoction   |
| Lamiaceae       | 134       | Mrywt, Ifzi         | Marrube blanc                | Marrubium echinatum L.        | Other combination | Cataplasm   |
|                 | 23        | Na’a Na’a           | Menthe verte                 | Mentha spicata L.             | Whole plant| Infusion    |
|                 | 06        | Na’na El-Aabdi      | Menthe poivrée               | Mentha x piperita L.          | Leaf       | Infusion    |
|                 | 67        | Fliyou              | Menthe pouliot               | Mentha pulgium L.             | Whole plant| Infusion    |
|                 | 15        | Kharwae             | Gattilier                    | Vitex agnus castus L.         | Seed       | Infusion    |
| Liliaceae       | 36        | Lberwag, Inghri     | Asphodèle                    | Asphodelus microcarpus L.     | Bulb       | Decoction   |
|                 | 123       | Bassla, Azalim      | Oignon                       | Allium cepa L.                | Bulb       | Cataplasm   |
| Myristiceae     | 96        | El Goza             | Muscadier                    | Myristica fragrans L.         | Seed       | Infusion    |
| Nyctaginaceae   | 01        | Chob Ellayl         | Belle de nuit                | Mirabilis jalapa L.           | Root       | Decoction   |
| Poaceae         | 08        | Njem Rjel Djaja     | Chiendent pied de poule      | dactyloctenium aegyptium L.   | Seed       | Decoction   |
| Rubiaceae       | 65        | Qahwa               | Café                         | Coffea arbica L.              | Seed       | Decoction   |
| Solanaceae      | 02        | Chedak Jmal         | Datura officinal             | Datura stramonium L.          | Seed       | Other       |
|                 | 01        | Haded Europa        | Lyciet d’Europe              | Lycium europaeum L.           | Leaf       | Cataplasm   |
|                 | 23        | Tembak Berri        | Tabac glauque                | Nicotiana glauca L.           | Flower     | Decoction   |
|                 | 78        | Batâta              | Pomme de terre               | Solanum tuberosum L.          | Leaf       | Cataplasm   |
| Verbenaceae     | 01        | Bot, Kseb           | Masette à large feuilles     | Typha domingensis L.          | Stem       | Other       |
|                 | 105       | Lwiza               | Verveine                     | Alosyia citrodora L.          | Leaf       | Infusion    |
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