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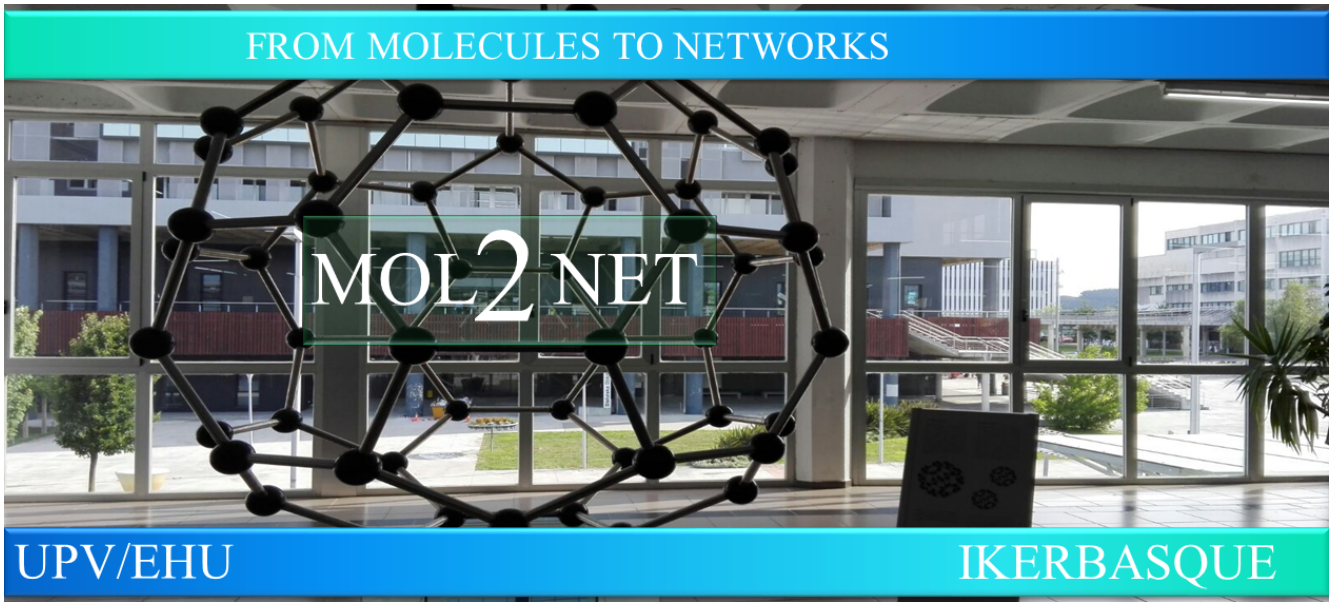

Floristic and Ethnopharmacological Investigation of Aromatic and Medicinal Plants Used by indigenous communities of the Rif, Morocco.

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Abstract.

Background: Since the beginning of time, the Moroccan people have used medicinal plants as a popular medicine to cure many human and livestock health problems. Studies have yet to be carried out to document and promote traditional ethnomedicinal knowledge properly.

Aim of the study: This study was conducted from July 1st, 2016, to July 30th, 2018, in the Rif; it aimed to establish the list of medicinal plants, together with the associated ethnomedicinal knowledge.

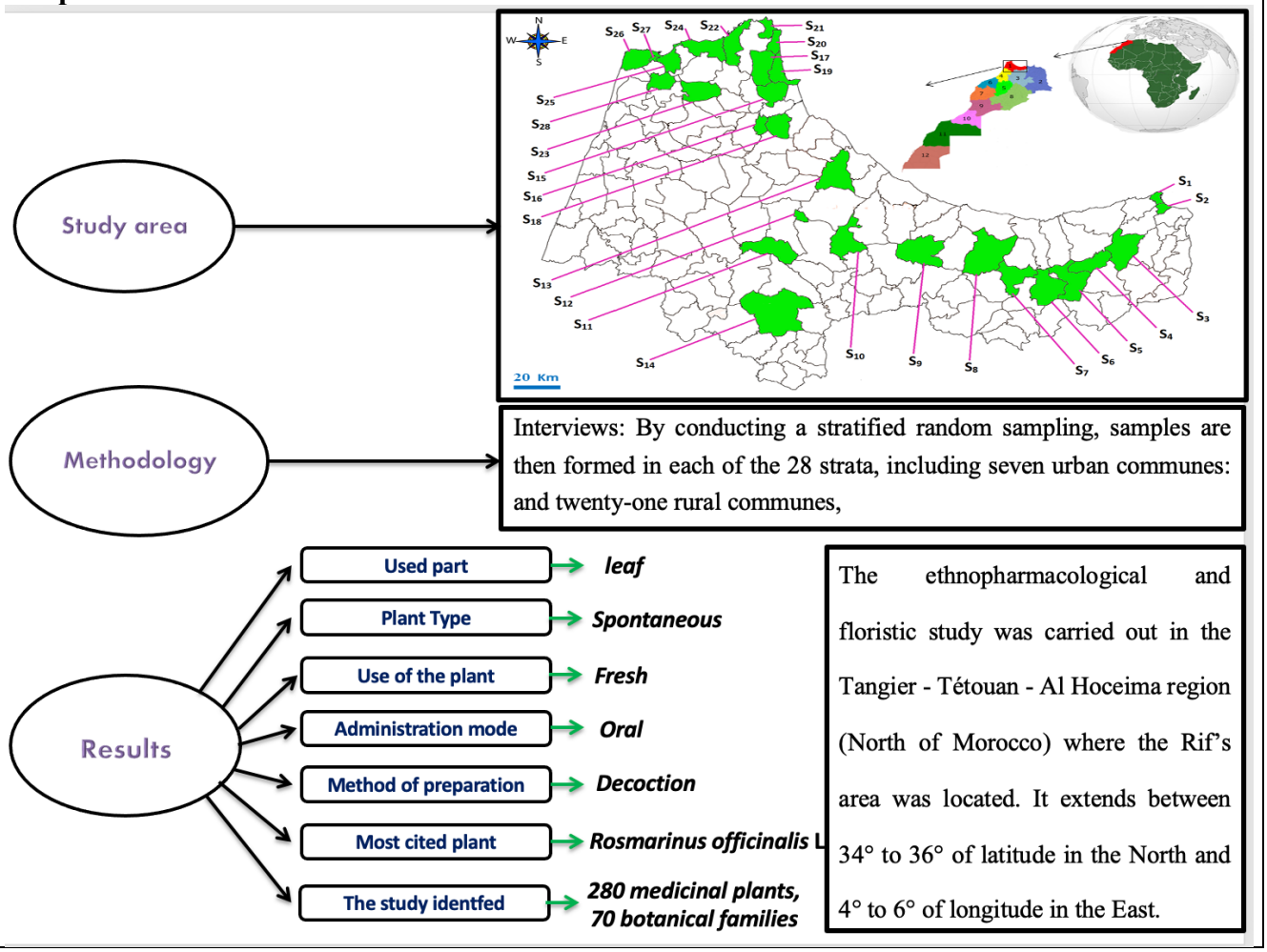
Materials and Methods: The ethnomedicinal data obtained was from 1 000 traditional healers using semi-structured discussions, free listing, and focus groups. Family importance value, plant part value, fidelity level, relative citation frequency, and informant consensus factor were applied to data interpretation. Plant species were accumulated, recognized, and deposited at the nutrition, health, and environment laboratory at Ibn Tofail University.

Results: 208 medicinal plants belonging to 204 genera and 70 families were documented. Asteraceae, with 29 species, was the most used family in this study area. Rosmarinus officinalis L. (RFC=0.189) was the most commonly prescribed by local traditional healers. Similarly, the leaf was the most used part of the plant (PPV=0.364), the most frequent affections were osteoarticular affections (ICF=0.983), and the majority of herbal remedies were prepared from a decoction (38.6%).

Conclusions: The results of the present investigation confirmed the presence of indigenous ethnomedicinal information on plant species in the Rif area to treat various disorders. More phytochemical, pharmacological, and toxicological studies should be considered to determine new drugs from these reported plants.

Keywords: Floristic, Ethnobotany, Ethnopharmacology, Traditional medicine, Medicinal plants, Diseases.

Graphical Abstract



1. Introduction

Medicinal plants have been prescribed and used extensively for thousands of years to treat various disorders and ailments in traditional herbal medicine systems worldwide (1). We find traces of this use in all ancient civilizations and on all continents. Thus, despite advances in pharmacology, the therapeutic use of plants is very present in some countries, especially in developing countries. The World Health Organization (WHO) estimates that unevenly, 80% of the people from developed and developing nations depend on traditional medicines, especially plant-based medicine in primary healthcare (2).

The Rif region is one of the most biologically diverse regions in the Mediterranean, with some of the rarest biogeographical areas in the world and biodiversity of primary importance, with many plants of therapeutic interest. For this reason, this region is the source of many medicinal plants marketed throughout Morocco and abroad, and the use of plants in herbal medicine is still very present. Conversely, data on medicinal plants in this region are rare and insufficient. To complete partial and fragmentary studies that have been carried out throughout the Rif: Talassemtane National Park (3) and

Tingitane Peninsula (4). It is, therefore, necessary to undertake them to identify the local uses of plant species. It is in this context that an ethnopharmacological study was carried out in the Rif, which has a lithological diversity, structural and floristic plants important enough to establish the catalog of medicinal plants used in the traditional treatment of diseases, especially herbal medicine, as an alternative to enhance, preserve and rationally use them.

2. Materials and Methods

2.1. Study area

The study was carried out in the Tangier-Tetouan-Al Hoceima region, situated in the northern part of Morocco, specifically in the area known as Rif. The geographical coordinates of this region span from 34° to 36° latitude in the North and 4° to 6° longitude in the East. It is bordered by the Strait of Gibraltar and the Mediterranean Sea to the North, the Rabat-Sale-Kenitra region and Fez-Meknes region to the South, the Eastern Region to the East, and the Atlantic Ocean to the West. The Rif covers a total area of 11,570 square kilometers and has a population of approximately 3,549,512 inhabitants, with an average population density of 222.2 individuals per square kilometer (5). The people of the region are a mix of Arabic and Amazigh ethnicities. The Rif experiences a Mediterranean climate characterized by hot temperatures reaching up to 45°C during the summer months of July and August, while winter temperatures can drop below 0°C in December and January. The average annual rainfall ranges from 700 to 1,300 millimeters, with the most precipitation occurring between October and February (6). The region is mountainous, with elevations ranging from 145 to 2,456 meters above sea level, with Jbel Tidirhine being the highest point. The local population of the Rif relies heavily on subsistence farming, livestock rearing, and, to a lesser extent, forest resources for their livelihoods.

2.2. Methodology

From July 2016 to July 2018, investigations were conducted in the Rif region to explore the traditional use of medicinal plants for treating various human ailments. The study employed a probabilistic sampling method, specifically a random stratified (7,8) non-proportional sampling technique. The sample was divided into 28 strata, encompassing cities, villages, douars, and souks, and was surveyed weekly throughout the study area. The sampling process considered environmental factors such as climate, soil, altitude, vegetation, and population distribution. Data collection involved several techniques, including semi-structured interviews (9), open-ended discussions, group sessions, free listing exercises, and digital voice recorder information recording. Using the ethnopharmacological knowledge shared by our informants, we organized plant specimens alphabetically according to their ethnomedicinal uses, vernacular names, and family names. The identification and nomenclature of the collected plant material were initially conducted in the field and further completed at the Laboratory for Nutrition, health, and Environment. The data gathered through ethnopharmacological research is documented on questionnaire sheets, which are later analyzed, studied, validated, or refuted. Subsequently, this data is inputted and interpreted using Microsoft Excel 2010 and IBM-SPSS Statistics Base 21. Representative and quantitative scientific approaches were employed to analyze the socio-demographic information of the participants, utilizing ANOVA One-way and Independent Samples T-Test.

3. Results

3.1. Demographic characteristics

One thousand individuals were surveyed and classified based on their socio-demographic characteristics. Among the participants, 52.7% were females, and the remaining 47.3% were males, resulting in a female-to-male ratio 1.11. Regarding marital status, 76% of the respondents were married, 10.8% were divorced, 9.2% were widowed, and 4% were unmarried. In terms of age, the age group between 40 and 60 years old was the largest, accounting for 47.6% of the total respondents. Individuals above 60 constituted 30.6%, those between 20 and 40 accounted for 21.4%, and those under 20 years old represented only 0.4% of the participants. Concerning educational background, most respondents (69.1%) were illiterate, while 23% had attended primary school and 6.7% had attended secondary school. Only 1.2% of the respondents had received higher education. Regarding monthly income, a significant portion of the participants (41.6%) were unemployed. Among the employed participants, 38.6% had a low monthly payment, 17% had an average income level, and 2.8% had a higher income level.

3.2. The botanical family

The analysis of the flora results revealed the presence of 280 medicinal species and subspecies belonging to 204 genera and 70 plant families, which were reported to have significant ethnopharmacological uses in the Rif region for treating various human ailments. When considering the number of species, the Asteraceae family is the most abundant, with 29 species accounting for 10.36% of the compiled catalog. Lamiaceae follows it with 22 species, Fabaceae and Poaceae with 21 species each, Apiaceae with 17 species, Solanaceae with 12 species, Brassicaceae with 11 species, and Asparagaaceae with ten species. Amaranthaceae and Cucurbitaceae have eight species, Rutaceae has six, and Myrtaceae and Rosaceae have five species. Furthermore, four plant species each represent Anacardiaceae, Caryophyllaceae, Cupressaceae, Euphorbiaceae, Lauraceae, and Zingiberaceae. The Apocynaceae, Malvaceae, Moraceae, Oleaceae, Papaveraceae, Pinaceae, Rubiaceae, and Tamaricaceae each have three medicinal species, whereas the remaining families have at most one or two medicinal plant species.

3.3. Most documented plant species

To evaluate the significance of the mentioned plant species, their relative importance was determined using the relative frequency of citation (RFC) based on information provided by the participants. Tables 2-9 give the RFC values for each species, with the highest value recorded as 0.189 and the lowest value as 0.001. In this study, the plants with the highest RFC values were *Rosmarinus officinalis* L. (RFC=0.189), *Thymus satureioides* Coss. (RFC=0.176), *Dittrichia viscosa* (L.) Greuter. (RFC=0.165), *Lawsonia inermis* L. (RFC=0.154), *Arenaria rubra* L. (RFC=0.153), and *Nerium oleander* L. (RFC=0.146). Conversely, 60 medicinal plant species had the lowest RFC value of 0.001.

3.4. FL of medicinal plants reported

Medicinal plants' reported fidelity level (FL) refers to their effectiveness compared to other species in treating specific ailments. Medicinal plants widely utilized by indigenous communities possess higher FL values than less popular ones. In this research, the FL values for the use of medicinal plants ranged from 45.5% to 100%. The study identified that 240 plant species (85.71%) achieved the highest fidelity level (FL=100%), while the remaining 40 had a reasonable FL.

3.5. Disease categories

The ICF values were calculated to assess the effectiveness of disease treatments. Our study's ICF values ranged from 0.944 to 0.983 across different disease categories (refer to Table 10). The highest ICF value (0.983) was observed for osteoarticular diseases, with 867 reported uses for 16 plant species. Dermatological conditions had the second highest ICF value (0.981), followed by neurological diseases (ICF=0.974), genitourinary diseases (ICF=0.973), metabolic diseases (ICF=0.972), cardiovascular diseases (ICF=0.968), digestive system diseases (ICF=0.945), and respiratory system diseases (ICF=0.944).

3.6. Plant parts used as a remedy

The study area focused on utilizing different parts of plants within the classical pharmacopoeia. The indigenous people of Rif employ various plant parts such as seeds, leaves, flowers, fruits, roots, and sometimes the entire plant. According to the plant structure value (PPV) index, the leaf has been identified as the primary component used in herbal preparations in the study area (PPV=0.364). This is followed by the seed (PPV=0.226), whole plant (PPV=0.097), flower (PPV=0.073), fruit (PPV=0.060), root (PPV=0.051), bulb (PPV=0.044), other combinations (PPV=0.034), rhizome (PPV=0.026), bark (PPV=0.021), and stem (PPV=0.006), respectively.

3.7. Preparation and Administration Methods of Medicinal Plants

Various methods were employed by the indigenous people in the study area to prepare medicinal plants. The findings indicated that the majority of remedies were made through decoction (38.6%) and infusion (34%), with cataplasm (11.3%), cooked (7.6%), and raw (2.3%) methods following suit. The combined percentage of other preparation techniques, such as maceration, inhalation, and fumigation, did not exceed 6.2%. While water was the primary solvent used with the plants, ingredients like milk, butter, tea, honey, and cereal oils were also commonly used.

The route of administration in this study varied depending on the type of disease being treated and the affected areas. The results demonstrated that herbal medicine was administered through diverse routes. Overall, the majority of participants prepared remedies primarily for oral consumption (82.4%), followed by massage (6.3%), swabbing (5.2%), other methods of administration (3.4%), and rinsing (2.7%).

4. Discussion

As part of this investigation, we identified 280 species and subspecies utilized for medicinal purposes. These medicinal species belong to 204 different genera and 70 botanical families, and they have been traditionally used to treat various ailments in the study area. Among the plant families, Asteraceae had the highest number of 29 species, followed by Lamiaceae (22 species), Fabaceae, and Poaceae (22 species each). These findings align with previous ethnobotanical inventories, highlighting the prominence of the Asteraceae and Lamiaceae families (21–27 species). The dominance of these families may be attributed to the wide range of active ingredients found in their species and their widespread distribution, abundance, and richness in the study area **(10–15)**.

The quantitative analysis calculated the Relative Frequency of Citation (RFC) for different plant species. The highest RFC values were found for *Rosmarinus officinalis* L. (RFC=0.189), *Thymus satureioides* Coss. (RFC=0.176), and *Dittrichia viscosa* (L.) Greuter. (RFC=0.165). Based on these results, we recommend further screening medicinal species with high RFC values to explore their

potential pharmacological, toxicological, phytochemical, and biological activities to discover novel molecules or chemicals for treating various ailments (16–20). Moreover, the ethnopharmacological plants with higher RFC values confirm their wide acceptance among the local population. Among the 280 medicinal plants identified, 86 species were explicitly used for digestive system diseases. In contrast, 41 species were employed for respiratory system diseases, 30 for neurological illnesses, 29 for cardiovascular illnesses, 29 for metabolic disorders, 27 for genitourinary disorders, 22 for dermatological conditions, and 16 for osteoarticular diseases.

Our study's FL (Fidelity Level) values ranged from 45.5% to 100%. To ensure better accuracy, we found 240 plant species with an FL value of 100%, even after excluding plants mentioned only once. Plant species with lower FL values were associated with multiple uses. This indicates that indigenous people tended to rely on specific medicinal plants for treating certain diseases rather than using them for a wide range of illnesses. Therefore, we recommend further investigation of plant species not previously studied but with maximum FL values, particularly in clinical practice (21–26).

The diseases treated in the Rif region were categorized into eight ailment categories. The highest Index of Cultural Significance (ICF) values were recorded for osteoarticular conditions (ICF=0.983), followed by dermatological diseases (ICF=0.981) and neurological diseases (ICF=0.974). The lowest ICF value (0.944) was associated with respiratory system diseases. Higher ICF values indicate that the local population uses only a few medicinal plants to treat a specific condition, reflecting a solid consensus between medicinal plants and the treatment of osteoarticular diseases in this case (27–29). Therefore, species with high ICF values are worth exploring for their bioactive compounds (30).

The local people of Rif employed a variety of plant parts for preparing medicinal remedies. Our investigation found that leaves were the most commonly used plant part, accounting for 36.4% of the applications in traditional medicine. This was followed by seeds (22.63%) and the whole plant (9.7%). Similar studies conducted in other countries also highlighted the prevalence of leaf usage in medicinal preparations (31–37). The popularity of leaves and aerial parts may be attributed to their easy accessibility and the presence of abundant secondary metabolites produced through photosynthesis. Additionally, the collection of leaves has a lesser detrimental impact on plants than harvesting roots and stem barks, particularly in the absence of sustainable harvesting strategies (38). Moreover, the collection of leaves is more convenient and sustainable than roots or flowers (39).

Regarding preparation methods, the indigenous people of Rif primarily rely on decoction (38.6%) and infusion (34%) techniques. These methods hold significant value and are preferred by traditional healers in Africa. The dominance of decoction in the Rif region aligns with numerous ethnobotanical studies (40–44). A decoction is commonly employed in indigenous herbal practices due to its simple preparation by mixing with water or tea (45). In general, oral administration accounted for the majority (82.4%) of herbal therapies. This preference for oral treatment can be attributed to a high incidence of internal illnesses in the Rif region. It is worth noting that oral administration is widely favored worldwide (46–52).

5. Conclusions

This investigation has uncovered the significant role of plant species in meeting the primary healthcare needs of the indigenous population living in the Rif region of northern Morocco. Through this study, we compiled an ethnopharmacological catalog of 280 plant species, representing 204 genera from 70 families. These findings highlight the abundant presence of medicinal plants in the area. The number

of medicinal plants identified for preventing and treating human ailments is a valuable indicator of the local potential, provided that scientific methods are combined with indigenous knowledge of traditional herbal medicine. The present research has identified medicinal plants with high Relative Frequency of Citation (RFC) and Fidelity Level (FL) values. These plants hold significant promise and should be further investigated through phytochemical, pharmacological, and clinical studies. Such research would enable the development of new herbal preparations or the formulation of novel drugs to improve the quality of life and treat various human diseases.

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