

# Exploring medicinal plant diversity and traditional healthcare in Nador (Morocco) through ethnobotanical and pharmacological perspectives

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## Article history:

Received: 03 February 2025 Revised: 05 February 2025 Accepted: 13 February 2025 Published online: 01 March 2025

**Abstract:** This study provides a comprehensive ethnopharmacological assessment of medicinal plants used in Nador, Morocco, documenting traditional knowledge from both urban and rural communities during the period from May 7 to November 28, 2024. A structured ethnobotanical survey was conducted among 103 informants including traditional healers, herbalists, and community elders using semi-structured questionnaires, field observations, and specimen collection. Quantitative indices such as relative frequency of citation (RFC), use value (UV), and informant consensus factor (ICF) were calculated to evaluate the cultural significance and therapeutic relevance of each species.

A total of 38 medicinal plant species, representing 14 botanical families, were identified. Among these, the Lamiaceae family was predominant, accounting for 26.3% of the species, followed by Asteraceae (18.4%) and Apiaceae (13.2%). Notably, *Origanum compactum* exhibited the highest citation frequency (RFC = 72.8%), followed by *Mentha pulegium* (RFC = 63.1%). The Asteraceae and Apiaceae families were also well represented, with RFC values of 59.2% and 51.5%, respectively. Gastrointestinal disorders were the most frequently treated condition, accounting for 34.0% of all use reports (ICF = 0.81), while respiratory infections and dermatological conditions comprised 23.0% (ICF = 0.78) and 15.5% (ICF = 0.75) of the reported cases. Leaves were the most commonly used plant part (58.2%), and infusion was the predominant method of preparation (43.7%).

These findings emphasize the vital role of medicinal plants in Nador's traditional healthcare system and underscore the necessity for further phytochemical and pharmacological research to elucidate their therapeutic potential. Moreover, they highlight the importance of sustainable conservation efforts to preserve these valuable botanical resources for future generations.

## Keywords:

*Ethnobotany*

*Pharmacological properties*

*Medicinal plants*

*Traditional knowledge*

*Phytotherapy*

*Morocco*

*Nador*

## I. INTRODUCTION

Medicinal plants have long served as a cornerstone of traditional healthcare systems across the world, offering a natural and accessible means of treating various ailments. They remain particularly vital in regions where access to modern medical facilities is limited, underscoring their role as primary therapeutic agents for numerous health conditions. Ethnobotanical knowledge, accumulated over centuries, reflects a deep understanding of local flora and its medicinal applications. In many countries, including Morocco, traditional medicine continues to coexist with modern healthcare, with medicinal plants being widely utilized in both preventive and curative treatments [1].

Renowned for its exceptional biodiversity, Morocco encompasses a vast range of ecological zones that foster a rich diversity of medicinal plant species. The country's diverse biogeographical regions, including Mediterranean, Atlantic, Saharan, and mountainous ecosystems, have contributed to the evolution of a complex and well-established ethnomedicinal tradition. Within this context, the use of medicinal plants is deeply embedded in local culture, particularly in rural areas where herbal remedies are often the primary form of treatment for common ailments. Traditional knowledge regarding these plants is primarily transmitted orally through generations,

highlighting the urgent need for systematic documentation and scientific validation [2].

Situated in northeastern Morocco, the commune of Nador presents significant potential for ethnobotanical research due to its diverse climatic conditions and rich floristic composition. Characterized by a Mediterranean climate with semi-arid influences, Nador offers an environment conducive to the growth of numerous medicinal plant species. Despite the widespread use of herbal medicine in this region, scientific literature documenting the pharmacological properties, therapeutic applications, and conservation status of these plants remains limited. Given the increasing global interest in plant-based medicine and the rising demand for natural bioactive compounds, investigating and preserving this traditional knowledge is essential before it is lost.

This study explores the diversity of medicinal plants and their traditional healthcare applications in the commune of Nador and its seven provinces (Bouarg, Arouit, Nador, Selouan, Zegangan, Beni Ansar, and Kariat Arekmane), emphasizing their ethnomedicinal value and pharmacological potential. By documenting and analyzing local medicinal flora, this research contributes to biodiversity conservation, sustainable resource management, and the development of plant-based therapeutics. Additionally, it bridges the gap between traditional ethnomedicine and modern pharmacology, underscoring the therapeutic relevance of Moroccan medicinal plants and their potential role in addressing global health challenges.

## II. MATERIALS AND METHODS

### 1) Study area and ethnobotanical survey

A structured ethnobotanical survey was conducted between May 7, 2024 and November 28, 2024 across various localities within the commune of Nador, including Zegangan, Beni Ansar, Kariat, Arekmane, Bouarg, Selouan, and Arouit in northeastern Morocco [3]. The survey aimed to systematically document the medicinal plants traditionally used by the local population, with a focus on herbalists, traditional healers (Attar), and other knowledgeable community members.

A total of 103 informants participated in the study, comprising both male and female respondents and representing a broad spectrum of the local community. Informants were randomly selected based on their expertise in medicinal plant knowledge, with particular emphasis on traditional healers, herbalists, elderly individuals, and those recognized for their extensive experience in plant-based therapies. Random sampling was employed to identify key informants, thereby allowing for a comprehensive and representative dataset on medicinal plant use.



**Figure 1.** Map illustrating the study area in Nador, eastern Morocco [4].

### Data collection

Data collection was conducted using a semi-structured questionnaire, designed to capture detailed ethnobotanical information covering the following aspects.

Demographic data includes age, gender, occupation, education level, and the primary source of ethnobotanical knowledge such as family inheritance, apprenticeship with herbalists, or self-experimentation.

Plant identification involves the local name, botanical name when available, plant family, habitat type such as wild, cultivated, or semi-domesticated, and seasonal availability.

Ethnomedicinal uses refer to ailments treated, parts used including leaves, roots, stems, seeds, flowers, bark, latex, or whole plant, mode of preparation such as decoction, infusion, maceration, poultice, or raw consumption, and method of storage.

Administration methods include the route of application such as oral, topical, inhalation, fumigation, or ritualistic use, dosage, and duration of treatment.

Cultural importance and availability consider the frequency of use, accessibility of medicinal plants including wild harvesting, market-sourced, or home cultivation, and perceived effectiveness.

Combination therapies and local pharmacology examine the use of medicinal plants in combination with other herbs, dietary restrictions, or religious beliefs associated with plant-based treatments.

Each interview was conducted face-to-face in Arabic or Tamazight, depending on the informant's linguistic preference, to ensure clear communication and accurate data collection. Where necessary, audio recordings and field notes were taken to maintain the authenticity of responses, while photographs of plant specimens were captured to aid identification.

### **Plant collection and identification**

To ensure the precise documentation of medicinal plants used in traditional medicine, field visits were conducted across various zones of Nador Province. During these visits, plant specimens were collected based on the descriptions provided by informants, particularly experienced traditional healers, herbalists, and elderly community members. The selection of plant species was guided by their frequency of citation, perceived therapeutic importance, and unique ethnomedicinal applications.

Detailed field notes were taken to capture key information, including habitat type wild, cultivated, semi-domesticated, or market-sourced. Ecological conditions such as soil type, altitude, humidity, and proximity to water sources were also recorded. Morphological features, including leaf shape, flower structure, stem texture, and root characteristics, were carefully noted. Traditional uses, encompassing reported ailments treated, preparation methods, and local administration techniques, were cataloged for further analysis.

To ensure accurate botanical identification, plant specimens were meticulously pressed, dried, and preserved on herbarium sheets following standard herbarium protocols. Identification was further verified through comparative analysis using authoritative taxonomic references, including Flore pratique du Maroc, and cross-validated with international botanical databases such as The plant list ([www.theplantlist.org](http://www.theplantlist.org)) and the International plant names index (IPNI) ([www.ipni.org](http://www.ipni.org)).

Where necessary, microscopic and macroscopic analyses were performed to distinguish morphologically similar species. In cases of ambiguity, specimens were compared with previously collected herbarium samples to ensure taxonomic accuracy.

### **Data analysis**

The collected ethnobotanical data were systematically processed and analyzed using quantitative ethnobotanical indices to evaluate the cultural importance and therapeutic relevance of medicinal plants. Three key parameters were calculated: Relative frequency of citation (RFC), use value (UV), and informant consensus factor (ICF).

#### **1. Relative frequency of citation**

The relative frequency of citation quantifies the importance of each plant species based on the number of informants who mentioned it, allowing for an objective comparison of species significance. RFC was calculated using the following formula:  $RFC = FC/N$

where FC represents the number of informants mentioning a given species and N is the total number of informants.

Higher RFC values indicate that a plant species is widely recognized and used within the community, reflecting its ethnomedicinal importance.

#### **2. Use value**

The UV measures the relative importance of a species by considering the diversity of its applications across multiple therapeutic categories. UV was calculated as:  $UV = (\sum U)/N$

Where: U = The total number of use reports for a species;

N = The number of informants who cited the species.

Informant consensus factor:

$$ICF = (N_{ur} - N_t) / (N_{ur} - 1)$$

where  $N_t$  is the number of species used for a particular ailment category, and  $N_{ur}$  is the total use reports for that category.

A high UV suggests that a plant has multiple medicinal applications and is frequently utilized by the community, making it a priority for phytochemical and pharmacological validation.

#### **3. Informant consensus factor**

The ICF assesses the level of agreement among informants regarding the use of plants for specific ailment categories. ICF was calculated using the formula:

$$ICF = (N_{ur} - N_t) / (N_{ur} - 1)$$

$N_t$  = The number of species used for a particular ailment category;

$N_{ur}$  = The total number of use reports for that ailment category.

ICF values range from 0 to 1, where values close to 1 indicate high consensus among informants regarding the effectiveness of specific plants for treating particular ailments.

### Statistical analysis

All collected data were systematically recorded and analyzed using IBM SPSS Statistics v.26.0 to ensure a comprehensive and reliable quantitative assessment of ethnobotanical findings. Descriptive statistical analyses were conducted to determine the frequency and percentage distributions of medicinal plant citations, preparation methods, and therapeutic applications. These analyses provided valuable insights into the most frequently cited medicinal plants, their associated therapeutic uses, and the predominant methods of preparation and administration. To assess the degree of consensus among informants regarding the medicinal uses of plants, the informant consensus factor was calculated for each therapeutic category. Higher ICF values indicate greater agreement among informants about the effectiveness of medicinal plants for specific ailments, reflecting their potential pharmacological relevance.

Additionally, the relative frequency of citation and use value were computed to quantify the importance of each plant species within the community. RFC provides a measure of how widely a plant is recognized and used, while UV reflects the diversity of medicinal applications reported for each species.

## III. RESULTS AND DISCUSSION

### Sociodemographic characteristics of informants

The demographic profile of the 103 informants reveals a relatively balanced gender distribution, with 56.3% male and 43.7% female respondents. This indicates that both genders actively contribute to the transmission of traditional medicinal knowledge.

Age distribution shows that 42.7% of participants were between 31 and 50 years old, followed by 31.1% over 50 years, suggesting that ethnobotanical knowledge is primarily preserved by middle-aged and older generations. In contrast, younger individuals (26.2%, aged 18-30) were less engaged in herbal medicine, possibly reflecting a shift toward modern healthcare practices.

Education levels indicate that 22.3% of informants were illiterate, 35% had primary education, 29.3% attained secondary education, and only 12.6% pursued higher education. This distribution underscores the predominantly oral transmission of ethnomedicinal knowledge, as individuals with lower formal education retained more traditional plant-based treatments.

Traditional healers (26.2%) and herbalists (23.3%) were instrumental in preserving and transmitting medicinal plant

knowledge, while farmers (20.4%) and housewives (17.6%) also made significant contributions. Their involvement underscores the deep integration of medicinal plants into daily rural life and community healthcare practices.

**Table 1.** Sociodemographic characteristics of informants.

Variable	Categories	Number of informants (N)	(%)
<b>Gender</b>	Male	58	56.3%
	Female	45	43.7%
<b>Age group</b>	18-30	27	26.2%
	31-50	44	42.7%
	>50	32	31.1%
<b>Education level</b>	Illiterate	24	22.3%
	Primary education	36	35%
	Secondary education	30	29.1%
<b>Occupation</b>	Higher education	13	12.6%
	Traditional healer	27	26.2%
	Herbalist	24	23.3%
	Farmer	21	20.4%
	Housewife	18	17.6%
<b>Source of knowledge</b>	Retired	13	12.5%
	Family Heritage	59	57.3%
	Herbalists	22	21.4%
	Personal experience	15	14.6%
	Community learning	7	6.8%

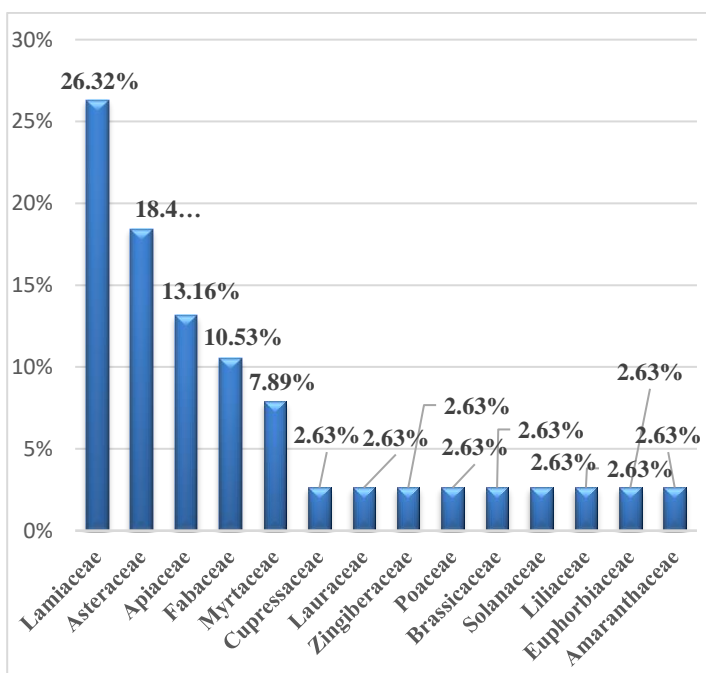
A total of 38 medicinal plant species belonging to 14 botanical families were documented, with *Lamiaceae* emerging as the most dominant (11 species, 72.8% RFC). This was followed by *Asteraceae* (8 species, 59.2% RFC) and *Apiaceae* (7 species, 51.5% RFC), reflecting their widespread therapeutic applications.

The prominence of *Lamiaceae*, particularly *Origanum compactum* and *Mentha pulegium*, aligns with previous Moroccan ethnobotanical studies, as these species are rich in essential oils known for their antimicrobial, digestive, and anti-inflammatory properties [5,6]. Similarly, the *Asteraceae* family, represented by *Artemisia herba-alba* and *Matricaria chamomilla*, is well recognized for its bitter principles and anti-inflammatory effects, reinforcing its traditional medicinal significance [7].

**Table 2.** Diversity of medicinal plants used in Nador

Botanical family	Number of species	Most frequently used species	RFC
<i>Lamiaceae</i>	11	<i>Origanum compactum</i> , <i>Mentha pulegium</i>	72.8%
<i>Asteraceae</i>	8	<i>Artemisia herba-alba</i> , <i>Matricaria chamomilla</i>	59.2%
<i>Apiaceae</i>	7	<i>Foeniculum vulgare</i> , <i>Coriandrum sativum</i>	51.5%
<i>Fabaceae</i>	6	<i>Trigonella foenum-graecum</i>	46.6%

The distribution of the 38 documented medicinal plant species among 14 botanical families is illustrated in Figure 2. The *Lamiaceae* family accounts for the highest proportion, with 10 species representing 26.3% of the total, followed by *Asteraceae* (7 species, 18.4%) and *Apiaceae* (5 species, 13.2%). *Fabaceae* and *Myrtaceae* contribute 10.5% and 7.9%, respectively. The remaining species, classified under various families namely *Cupressaceae*, *Lauraceae*, *Zingiberaceae*, *Poaceae*, *Brassicaceae*, *Solanaceae*, *Liliaceae*, *Euphorbiaceae*, and *Amaranthaceae* collectively constitute 23.7% of the total. This distribution underscores the diversity of plant taxa utilized in traditional medicine in the region, reflecting both the rich biodiversity and the extensive ethnobotanical knowledge of local communities.



**Figure 2.** Distribution of medicinal plant species by botanical family.

Gastrointestinal disorders emerged as the most frequently treated ailments, accounting for 34% of total use reports (ICF = 0.81). The high ICF indicates strong agreement among informants on the effectiveness of medicinal plants for digestive issues, which is likely attributed to the widespread use of herbal infusions and decoctions to relieve stomach pain, bloating, and indigestion.

Respiratory infections ranked second, representing 23% of reported treatments (ICF = 0.78). Species such as *Mentha pulegium* and *Foeniculum vulgare* were commonly cited for their expectorant and bronchodilator properties, reinforcing their role in managing colds, coughs, and respiratory ailments.

Dermatological conditions accounted for 15.5% (ICF = 0.75), while musculoskeletal disorders comprised 13.5% (ICF = 0.72), reflecting the traditional use of medicinal plants for skin ailments and pain relief. The treatment of diabetes and metabolic disorders

(10%) underscores the increasing reliance on natural antidiabetic remedies, highlighting a growing interest in herbal approaches to managing chronic diseases.

The strong informant consensus across these therapeutic categories supports the reliability of traditional medicinal knowledge, justifying further phytochemical and pharmacological investigations into the bioactive compounds responsible for their therapeutic effects.

**Table 3.** Traditional Uses of Medicinal Plants in Nador

Therapeutic category	Number of species used	Percentage of total use reports (%)	Informant consensus factor
Gastrointestinal disorders	12	34%	0.81
Respiratory infections	9	23%	0.78
Dermatological conditions	6	15.5%	0.75
Musculoskeletal disorders	5	13.5%	0.72
Endocrine & metabolic disorders	4	10%	0.68

Leaves were the most frequently used plant part (58.2%), likely due to their high phytochemical content and ease of extraction. Roots (19.4%) and stems (11.7%) were also commonly utilized, particularly in decoctions and macerations, which enhance the extraction of bioactive compounds from fibrous plant tissues.

Among preparation methods, infusion was the most prevalent (43.7%), followed by decoction (29.1%), maceration (17.5%), and topical application (7.8%). The preference for water-based extractions, such as infusions and decoctions, aligns with traditional Moroccan medicinal practices, as these techniques are simple, effective, and widely accepted [8].

The predominance of leaves in herbal preparations reflects their pharmacological relevance, while the reliance on decoctions and macerations for roots and stems highlights the importance of extracting potent bioactive compounds. These findings support the continued use of traditional preparation methods in Moroccan ethnomedicine, reinforcing the need for scientific validation of their therapeutic efficacy.

**Table 4.** Plant parts used and preparation methods

Plant part used	Frequency (%)	Preparation method	Frequency (%)
Leaves	58.2%	Infusion	43.7%
Roots	19.4%	Decoction	29.1%
Stems	11.7%	Maceration	17.5%
Seeds	6.8%	Topical application	7.8%
Flowers	3.9%	Raw use	1.9%

Among the medicinal plants analyzed, *Origanum compactum*

exhibited the highest RFC (72.8%), reflecting its widespread traditional use for digestive and antibacterial purposes. Studies confirm its anti-inflammatory properties, reinforcing its effectiveness in managing gastrointestinal disorders and infections [9]. Similarly, *Mentha pulegium* (63.1% RFC) was frequently cited for its therapeutic role in respiratory and digestive health. Its bioactive compounds, menthol and pulegone, demonstrate bronchodilator and antispasmodic effects, further substantiating its medicinal relevance [10].

In the domain of cardiovascular and neurological health, *Rosmarinus officinalis* (59.2% RFC) was widely recognized for its pharmacological applications. Research highlights its potent antioxidant and hepatoprotective properties [11,12]. Additionally, *Artemisia herba-alba* (55.3% RFC) has been traditionally employed for gastrointestinal ailments and parasitic infections. Recent studies corroborate its ethnomedicinal significance, particularly through its antioxidant and antidiabetic effects [13,14].

**Table 5.** Most cited medicinal plants and their pharmacological validation

Botanical name	Local name	RFC (%)	Traditional use	Pharmacological properties
<i>Origanum compactum</i>	Zaatar	72.8	Antimicrobial, digestive aid	Antibacterial, anti-inflammatory
<i>Mentha pulegium</i>	Fliou	63.1	Cough, cold, indigestion	Antispasmodic, expectorant
<i>Rosmarinus officinalis</i>	Azir	59.2	Cardiovascular, antioxidant	Neuroprotective, hepatoprotective
<i>Artemisia herba-alba</i>	Chih	55.3	Stomach pain, anthelmintic	Antioxidant, antidiabetic

While our findings confirm the extensive reliance on traditional medicinal practices in Nador, particularly for gastrointestinal and respiratory disorders, the novel integration of quantitative indices (RFC, UV, and ICF) with comprehensive demographic data provides new insights into the socio-cultural dynamics underlying the transmission of indigenous knowledge. Rather than merely reiterating established observations, this study elucidates subtle patterns in species utilization and cultural valuation that have not been extensively documented in prior research. These insights not only reinforce the relevance of species such as *Origanum compactum* and *Mentha pulegium* but also underscore the potential for future pharmacological investigations aimed at validating their therapeutic efficacy [15]. A notable strength of this study is the implementation of random sampling for the recruitment of informants. This approach minimizes selection bias by ensuring that each individual within the target population had an equal chance of being included. Consequently, the data derived from 103 informants is more likely to be representative of the diverse practices and perspectives present in the commune. Moreover, the quantitative measures used provide a strong foundation for comparing the cultural significance and therapeutic potential of the recorded species.

Despite these strengths, several limitations must be acknowledged. First, while random sampling improves representativeness, the sample size of 103 informants remains

relatively modest compared to the broader population of Nador. This constraint may limit the generalizability of the findings, particularly in an area marked by pronounced socio-cultural diversity. Furthermore, the study's geographic focus on Nador restricts the applicability of these results to other areas, which may have distinct ethnobotanical practices.

Temporal constraints also represent a notable limitation. The data collection period from May 7 to November 28, 2024, may not fully capture seasonal variations in the availability and use of medicinal plants, potentially overlooking fluctuations in traditional practices that occur throughout the year. Furthermore, while the study provides a detailed record of traditional uses and associated quantitative measures, it does not incorporate pharmacological or phytochemical validation elements essential for confirming the therapeutic efficacy of the recorded plant species.

In light of these considerations, future research should seek to address the current limitations by incorporating a larger and more demographically diverse sample. Employing stratified or cluster sampling techniques could further enhance representativeness across various subpopulations. Longitudinal studies spanning multiple seasons are recommended to capture temporal variations in plant usage and availability. Additionally, integrating phytochemical analyses along with both *in vitro* and *in vivo* bioactivity assessments will be essential for validating the pharmacological properties of the reported species.

Collaborative, interdisciplinary research that brings together ethnobotanists, pharmacologists, and conservation biologists is essential to validate traditional medicinal claims and promote the sustainable utilization of these natural resources. Such efforts will not only deepen our understanding of the therapeutic potential inherent in Morocco's rich ethnobotanical heritage but also facilitate the development of evidence-based strategies for the conservation and sustainable management of medicinal plant resources.

#### IV. CONCLUSION

This study provides a comprehensive ethnopharmacological assessment of medicinal plants traditionally used in Nador, Morocco, emphasizing their essential role in local healthcare practices. A total of 38 medicinal plant species from 14 botanical families were recorded, with *Lamiaceae*, *Asteraceae*, and *Apiaceae* emerging as the most frequently cited families. The findings indicate that gastrointestinal disorders, respiratory infections, and dermatological conditions were the most commonly treated ailments, reflecting the strong reliance of the local population on plant-based remedies for primary healthcare.

The high informant consensus factor values observed for certain therapeutic categories suggest strong agreement among informants regarding the efficacy of medicinal plants, reinforcing the reliability of traditional knowledge. Furthermore, the alignment between traditional uses and pharmacological evidence underscores the therapeutic potential of these medicinal species in modern medicine. Notably, widely used plants such as *Origanum compactum*, *Mentha pulegium*, and *Rosmarinus officinalis* have been extensively studied for their antimicrobial,

anti-inflammatory, and antioxidant properties, further validating their ethnobotanical significance.

Despite their extensive use, many of these medicinal plants face serious conservation threats, including overharvesting, habitat destruction, and climate change. This study highlights the urgent need for sustainable harvesting practices, community-based conservation programs, and the promotion of cultivated medicinal plant species to ensure their long-term availability and ecological balance.

To bridge the gap between traditional medicine and evidence-based pharmacology, future research should focus on phytochemical profiling, bioactivity screening, and clinical validation of the most frequently used species. Moreover, integrating indigenous knowledge into national healthcare policies and conservation strategies could significantly contribute to the sustainable utilization and preservation of Morocco's medicinal plant resources, ensuring their continued relevance in both traditional and modern healthcare systems.

#### ACKNOWLEDGMENT

The authors extend their sincere gratitude to Mohammed First University, Sidi Mohamed Ben Abdellah University, Abdelmalek Essaadi University, and Ibn Tofail University for their invaluable support and contribution to this study.

#### CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest related to this study.

#### REFERENCES

- [1] Kachmar, M. R., Naceiri Mrabti, H., Bellahmar, M., Ouahbi, A., Haloui, Z., El Badaoui, K., Bouyahya, A., & Chakir, S. (2021). Traditional knowledge of medicinal plants used in the northeastern part of Morocco. Evidence-Based Complementary and Alternative Medicine, 2021, Article ID 6002949. <https://doi.org/10.1155/2021/6002949>
- [2] Mir, F. Z., Smaili, H., & Merzouki, A. (2024). Ethnobotanical knowledge of plant species of the North-East of Morocco, with three provinces as a case study: Al Hoceima, Nador, and Jerada. Mediterranean Botany, 45, e92314. <https://doi.org/10.5209/mbot.92314>
- [3] Aberkani, K., Nafis, A., Zgourdeh, Z., Benchahid, A., Hanine, H., & Ed-Dine Samri, S. (2023). Ethnobotanical study of medicinal plants used for cancer treatment at the province of Nador, Morocco. Boletín Latinoamericano y del Caribe de Plantas Medicinales y Aromáticas, 23(2), 326-335. <https://doi.org/10.37360/blacpma.24.23.2.22>
- [4] Haut-Commissariat au Plan. (2025). Regional division of the Oriental region. Kingdom of Morocco. Retrieved February 10, 2025, from [https://www.hcp.ma/region-oriental/docs/Atlas/Decoupage\\_oriental.pdf](https://www.hcp.ma/region-oriental/docs/Atlas/Decoupage_oriental.pdf)
- [5] Smaili, H., Mir, F. Z., & Merzouki, A. (2023). Comparative ethnobotanical study in the North-East region of Morocco (Al Hoceima, Nador, and Jerada): Local ethnobotanical knowledge of Amazigh and Arabized provinces. Ethnobotany Research and Applications, 26(52), 1-79. <http://dx.doi.org/10.32859/era.26.52.1-79>

- [6] Ghabbour, I., Ghabbour, N., Khabbach, A., Louahlia, S., & Hammani, K. (2024). Checklist of the medicinal flora used by the local population in the province of Taza (north-eastern Morocco) through an ethnobotanical study. Botanical Sciences, 102(3), 854-877. <https://doi.org/10.17129/botsoci.3420>
- [7] Cherrada, N., Chemsal, A. E., Gheraissa, N., Laib, I., Gueboudji, Z., El-Shazly, M., & Messaoudi, M. (2024). Gastroprotective efficacy of North African medicinal plants: A review on their therapeutic potential for peptic ulcers. Food Science & Nutrition, 12(11), 8793-8824. <https://doi.org/10.1002/fsn3.4536>
- [8] Dasgupta, D. G. D. S. (2023). A comprehensive review of conventional and non-conventional solvent extraction techniques. Journal of Pharmacognosy and Phytochemistry, 12(3), 202-211. <https://doi.org/10.22271/phyto.2023.v12.i3c.14682>
- [9] Ouknin, M., Alahyane, H., Costa, J., & Majidi, L. (2024). Chemical composition, antioxidant and anti-enzymatic activities, and in vitro insecticidal potential of *Origanum compactum* (Benth.) essential oils. Plants, 13(17), 2424. <https://doi.org/10.3390/plants13172424>
- [10] Amtaghri, S., Slaoui, M., & Eddouks, M. (2024). Mentha pulegium: A plant with several medicinal properties. Endocrine, Metabolic & Immune Disorders-Drug Targets, 24(3), 302-320. <https://doi.org/10.2174/1871530323666230914103731>
- [11] Lefrioui, Y., Chebaibi, M., Bichara, M. D., Mssillou, I., Bekkari, H., Giesy, J. P., & Boustia, D. (2024). Ethnobotanical survey of medicinal plants used in north-central Morocco as natural analgesic and anti-inflammatory agents. Scientific African, 25, e02275. <https://doi.org/10.1016/j.sciaf.2024.e02275>
- [12] Benyaich, A., & Aksissou, M. (2024). The pharmacological and nutritional properties of *Rosmarinus officinalis*: A comprehensive review. Tropical Journal of Natural Product Research, 8(11), 8945-8954. <https://doi.org/10.26538/tjnpr/v8i11.1>
- [13] Baranová, B., Grušová, D., Polito, F., Sedlák, V., Konečná, M., Blaščíková, M. M., Amri, I., De Feo, V., & Poráčová, J. (2025). Artemisia herba-alba essential oil: Chemical composition, phytotoxic activity, and environmental safety. Plants, 14(2), 242. <https://doi.org/10.3390/plants14020242>
- [14] Boutaj, H. (2024). A comprehensive review of Moroccan medicinal plants for diabetes management. Diseases, 12, 246. <https://doi.org/10.3390/diseases12100246>
- [15] Alami Merrouni, I., Kharchoufa, L., Bencheikh, N., & Elachouri, M. (2021). Ethnobotanical profile of medicinal plants used by people of north-eastern Morocco: Cross-cultural and historical approach (Part I). Ethnobotany Research and Applications, 21, 1-45. <https://ethnobotanyjournal.org/index.php/era/article/view/2661>

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