

Natural riches of Al Hoceima: inventory of plants with medicinal and aromatic properties

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Abstract. This study on the Al Hoceima Province emphasizes its rich botanical diversity and significant ethnobotanical heritage. It catalogs 490 species, 108 of which are identified for medicinal and aromatic uses, including notable genera like *Lavandula*, *Thymus*, and *Allium*. The study highlights the presence of endemic species, illustrating the region's unique ecological value and the community's traditional practices in utilizing flora for health and culinary purposes. This research underscores the importance of conserving Al Hoceima's natural and cultural treasures to enhance appreciation for its role in local health and well-being. **Keywords:** Al Hoceima Province, botanical diversity, ethnobotanical heritage, medicinal plants, aromatic plants, ecological value, traditional practices, conservation, natural treasures, cultural heritage.

1 Introduction

Vegetation is a cornerstone of Earth's terrestrial landscapes and vital to human history and survival. The fusion of botany's ecological, genetic, and molecular breakthroughs has enriched disciplines like agronomy, horticulture, forestry, and pharmacology. The quest for natural health remedies has revitalized interest in medicinal plants, acknowledging their invaluable therapeutic potential. Even with synthetic pharmaceutical advancements, the intrinsic value of medicinal plants endures, underpinning critical applications in therapeutic practices and extending to the pharmaceutical and cosmetological arenas.

Phytotherapy, the ancient art of healing with plants, is experiencing a resurgence as modern populations integrate traditional medicine with contemporary healthcare practices. This enduring tradition, steeped in historical significance, has served as the wellspring for numerous botanical remedies. Morocco, renowned for its biodiversity and ecological variety, boasts a rich array of medicinal plants [1] integral to its cultural fabric. Al Hoceima, set within the northern Moroccan expanse, is a region that stands out for its scenic beauty and abundant biodiversity. The microclimates shaped by the unique topography of the Rif Mountains create a diverse ecosystem [2-3], facilitating the adaptation and blossoming of numerous endemic plant species. The Mediterranean Sea's proximity significantly influences local climatic conditions, contributing to various coastal and Mediterranean ecosystems. This ecological

diversity imparts a remarkable specificity to the flora of the Rif. In the region of Al Hoceima, medicinal and aromatic plants hold profound and multifaceted importance, playing an essential role in the health and well-being of inhabitants as well as in preserving cultural tradition. These plants have been traditionally used by local populations to treat a diverse range of ailments, from minor afflictions to more serious illnesses [4]. The importance of aromatic plants in the Al Hoceima region also cannot be underestimated. These plants are often used in local cuisine to add unique flavors and aromas to traditional dishes. Additionally, they have applications in the cosmetic and perfume industry, thereby contributing to the local economy [5-6]. This research aims to compile a comprehensive catalog of Moroccan flora, emphasizing medicinal plants utilized in traditional treatments, mainly herbal medicine. The study seeks to detail the distribution of various plant families, genera, and species, especially those in the Al Hoceima region of Morocco. By doing so, it aims to enhance the understanding of local biodiversity and reinforce the importance of these plants in traditional healthcare practices.

2 Methods

2.1 Study Area

The study area, referred to as Al-Hoceima, encompasses an expanse of approximately 3,555 km², situated within the central Rif. This mountainous region in northern

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Morocco is bordered by the Mediterranean Sea to the north, the province of Nador to the east, the provinces of Taza and Taounate to the south, and the province of Chefchaouen to the west. Al-Hoceima, located in the heart of the Central Rif as detailed in Figure 1, is characterized by a climate influenced by both the Atlantic and Mediterranean, resulting in hot, dry summers and mild, humid winters. This climatic variation, coupled with the region's fertile lands, especially notable in Igzannayen and among the Ait Ouriaghel in the Nekour plain, supports a diverse botanical landscape [7-8].

The botanical diversity in the Rif region of Morocco results from the complex interaction of geographical, climatic, and ecological factors. Microclimates created by the varied topography, from summits to valleys, foster the growth of diverse plant species. The proximity of the Mediterranean Sea influences local climatic conditions conducive to the presence of multiple ecosystems. The diversified soils, ranging from limestone to volcanic, provide unique habitats, allowing the coexistence of numerous species [9-10].

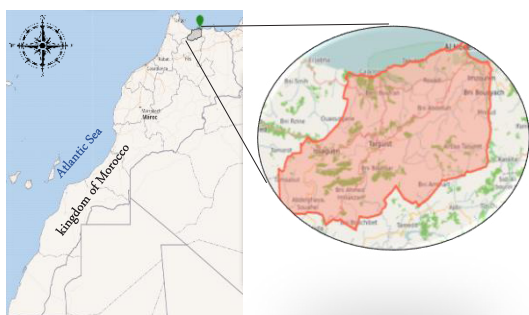


Fig. 1. Map of the study area.

2.2 Methodology

An exhaustive inventory of relevant botanical literature was compiled by systematically searching well-established databases such as 'Flora du Maroc' and 'Plantas y Hongos Plataforma.' The foundation of primary sources included the 'Flore Pratique du Maroc' series, spanning three volumes, the catalog of Morocco's vascular flora, and esteemed publications from Moroccan scholarly institutions. Several Moroccan universities have significantly contributed to botany and agri-food health research through their dedicated research teams [11-12]. Their collaborative effort has resulted in an extensive bibliography collection that will be crucial to advancing their research.

Additionally, a preliminary visit in December 2023 allowed the research team to gain direct insights into the geographical and ecological context of Al Hoceima. This initial survey was followed by field expeditions from January to February 2024, dedicated to the detailed exploration and documentation of the region's plant biodiversity. The methodology encompassed on-site observations, specimen collection, environmental condition assessments, and the photographic documentation of various plant species. This comprehensive approach ensures a thorough and

nanced examination of the medicinal and aromatic plants in Al Hoceima, combining visual documentation with factual data to enhance the study's depth and accuracy.

3 Results and Discussion

3.1 Floral Diversity of Al Hoceima

The study findings underscore the remarkable richness of vegetation in the province of Al Hoceima. The flora analysis revealed a vast diversity, with 76 families spread across 174 genera and 490 species, as depicted in Figure 2. This diverse distribution is influenced by the province's varied ecosystems, including forests, rivers, mountains, and water dams.

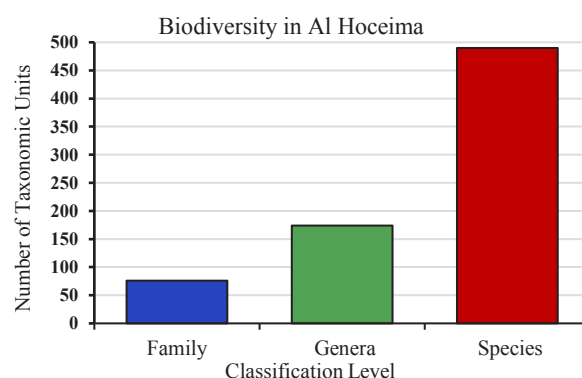


Fig. 2. Hierarchical Distribution of Biodiversity in Al Hoceima: Families, Genera, and Species.

Each bar corresponds to the number of taxonomic units at each classification level: families, genera, and species within the Al Hoceima region. This chart effectively illustrates the hierarchical structure of biodiversity, with an increasing number of units as the classification becomes more specific.

Figures 3 and 4 illustrate Al Hoceima's extensive biodiversity, highlighting the depth of plant variety across different orders and families. The first graph demonstrates the distribution of principal orders, emphasizing the dominance of angiosperms, both dicotyledons, and monocotyledons, which indicates the variety and complexity of flowering plants in the region. Notably, the presence of 368 species within the angiosperms is particularly significant.

Upon examining the number of species, the Asteraceae family emerges as the most abundant, with 142 species, followed by the Fabaceae with 71 species, Poaceae with 57 species, and Brassicaceae with 28 species. Close behind are the Lamiaceae with 27 species, Apiaceae with 24 species, and Caryophyllaceae and Scrophulariaceae with 21 species. The Rosaceae family includes 15 species, while the Papaveraceae family contains 17 species, Euphorbiaceae has 13, Rubiaceae boasts 19, and the Ranunculaceae family comprises 12 species. Other families in the region display at least 6 plant species each. This thorough insight into the province's botanical richness offers invaluable information for researchers and highlights the critical importance of conserving biodiversity in the region.

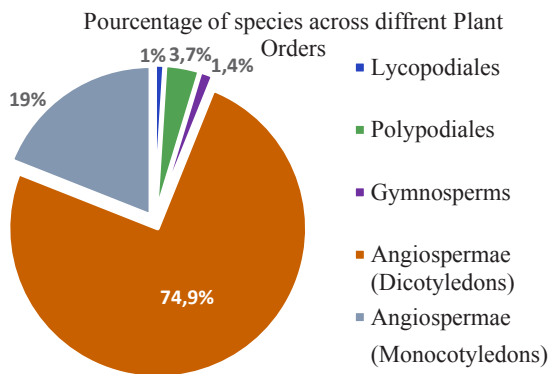


Fig. 3. Proportional Diversity of Plant Orders in Al Hoceima.

The circular chart illustrates species distribution across different plant orders in Al Hoceima, with a clear dominance of Angiospermae (Dicotyledons), which constitute the majority of species. They are followed by Angiospermae (Monocotyledons), with the remaining orders comprising a smaller proportion of the species diversity. This visual representation effectively highlights the proportional diversity within these major plant orders, offering immediate insight into the botanical composition of the region.

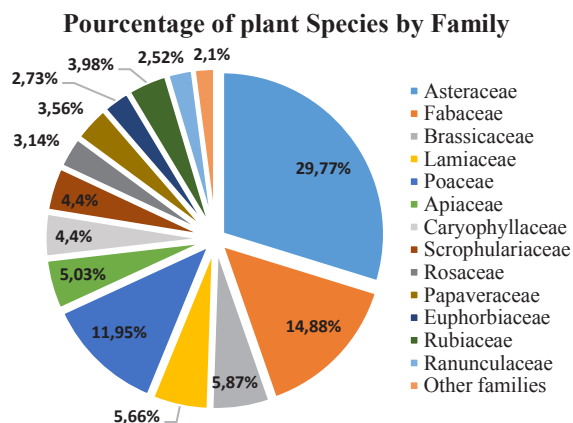


Fig. 4. Proportional Diversity of Plant Orders in Al Hoceima.

The circular chart shows the percentage of plant species by family in Al Hoceima. Each slice of the pie chart represents a plant family, with the size of the slice corresponding to its percentage of the total number of species. The chart illustrates species distribution among these families, with Asteraceae having the largest share. This vegetation biodiversity in Al Hoceima is a testament to the local population's deep understanding and application of plants in health, food, and agriculture. The diverse plant life enriches the ecological landscape and forms the foundation of the region's ethnobotanical knowledge. The inhabitants of Al Hoceima have developed a profound relationship with their environment, utilizing abundant plant resources for medicinal purposes, nutritional needs, and agricultural practices. This symbiotic interaction between humans and nature underscores the significance of preserving the rich biodiversity of Al Hoceima, as it plays a pivotal role in sustaining the community's cultural heritage, health, and livelihoods [13-14].

3.2 Geospatial Analysis of Plant Biodiversity in Al Hoceima

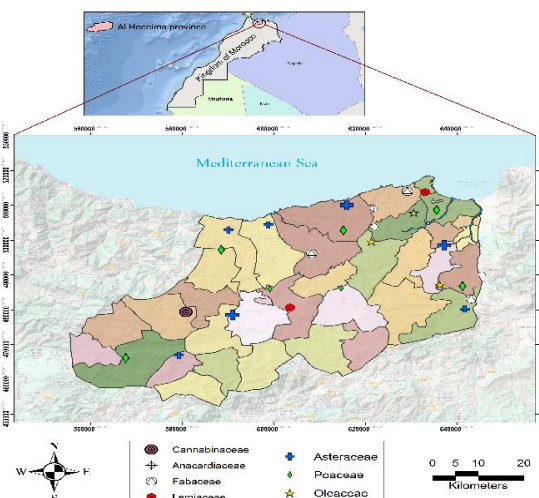


Fig. 5. Multiscale distribution of plant families biodiversity across Al Hoceima province.

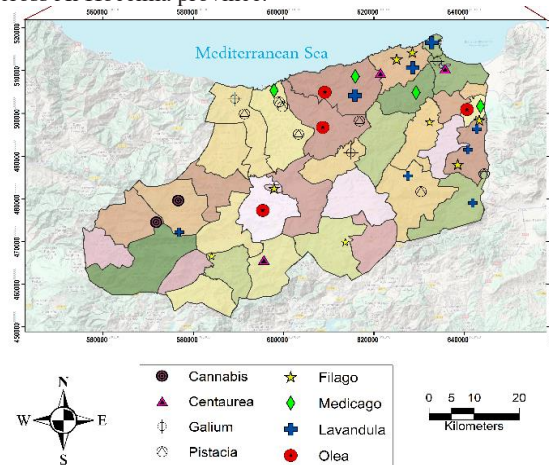


Fig. 6. Multiscale distribution of plant genera biodiversity across Al Hoceima province.

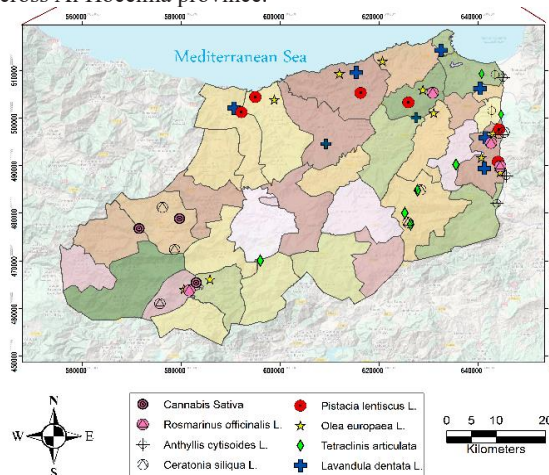


Fig. 7. Multiscale distribution of plant species biodiversity across Al Hoceima province.

Each map is accompanied by a legend that interprets the symbols representing different plant families, genera, and species. The symbols were chosen to provide clear visual differentiation and to facilitate a quick assessment of plant diversity and abundance across the region. The map in Figure 5 shows a detailed representation of plant family distribution within Al Hoceima province. The

family Asteraceae, marked by blue crosses, is the most prevalent, denoting its extensive presence and ecological importance, especially along the northern Mediterranean coast and adjacent mountainous regions. Cannabaceae is predominantly located around Tidghine, the highest mountain in the area, suggesting an affinity for high-altitude environments. Anacardiaceae and Oleaceae, depicted by green diamonds and yellow stars, respectively, show varied geographic occurrences, indicating a range of habitats from riverine areas to the Rif mountains in the west.

Filago and Centaurea are widely distributed across the province, as shown on the map in Figure 6. As a result, the local environment has been adapted to a vast extent. Lavandula, Pistacia, and Medicago are particularly abundant along the Mediterranean Sea's climatic zones and the Oued Nekor River basin, reflecting their preference for specific climatic or edaphic conditions. Olea is found in various locales, consistent with the olive tree's adaptability to the Mediterranean climate. Cannabis is less widespread, with a focused presence in the western region, nestled within the Rif mountains. In Figure 7, the locations of different species of plants within Al Hoceima are depicted in detail, showcasing the widespread distribution of *Lavandula dentata* L. and *Tetraclinis articulata*. These species are the most prevalent, followed by *Olea europaea* and *Pistacia lentiscus*, which also have a significant presence in the region. The map further identifies the locations of *Ceratonia siliqua*, *Anthyllis cytisoides* L., and *Rosmarinus officinalis* L., species renowned for their medicinal properties, pinpointing areas where they are either endemic or have been cultivated.

- *Cannabis sativa* has emerged as the most cultivated plant in the eastern part of the province following its legalization in 2021. The inhabitants of Al Hoceima province have shown increased interest in this crop, leading to numerous studies aiming to investigate the beneficial properties of the endemic strains of this species [15]. In brief, the distribution of these botanical elements is notably concentrated along the Oued Nekkour River and the Mediterranean coastline. These areas, rich in ecological variety, serve as prime habitats for a wide range of flora, fostering biodiversity hotspots within the province. The proximity to water bodies and the unique microclimates created by the interplay between marine and riverine environments appear to be critical factors in the thriving plant communities observed. The varied topography of Al Hoceima, including its river valleys and coastal zones, has proven to be instrumental in shaping plant distribution patterns, with particular genera and species demonstrating a preference for these ecologically vibrant locales. Al Hoceima province boasts an exceptional array of endemic flora, accounting for 10.2% of its total plant diversity. With 102 Ibero-Moroccan endemic taxa identified in the Rif region [16], the area surpasses all others in Morocco regarding endemic plant richness. This remarkable endemism is a direct result of the region's long geological history and the diverse ecological factors that have shaped its landscapes over millions of years.

3.3 Ethnobotanical Survey of Medicinal and Aromatic Plants in Al Hoceima Province

In the Al Hoceima Province, researchers have uncovered a vast array of medicinal and aromatic plants, spotlighting the region's affluent natural endowment. The flora of this area includes noteworthy species. These species are celebrated for contributing to traditional medicine and their roles in aromatherapy and culinary arts, underscoring the multifaceted utility of the region's plant life [17]. Our comprehensive inventory reveals that, of the 490 distinct species cataloged, a mere 108 are harnessed for their medicinal and aromatic virtues, constituting roughly 22.04% of the total species count. Genera such as *Lavandula* (encompassing *Lavandula dentata* and *Lavandula multifida*), *Thymus* (including *Thymus munbyanus*), and *Allium* (which covers various onion and garlic species) are distinguished for their significant medicinal and aromatic contributions. For example:

- *Olea europaea* (Olive) is celebrated for its cardiovascular advantages, primarily attributed to its rich content of oleuropein, hydroxytyrosol, and other phenolic compounds. These bioactive components have been shown to reduce blood pressure, inhibit LDL oxidation, and improve endothelial function, collectively contributing to lowering heart disease risk. Furthermore, olive leaves and olive oil are utilized in dietary applications to manage diabetes, showcasing their role in glycemic control by improving insulin sensitivity [18].

- *Thymus species* (Thyme) are well-known for their antiseptic, antimicrobial, and antiviral qualities, making them effective in treating various skin conditions, including fungal infections and dermatitis. Thymol and carvacrol, the primary volatile oil components, are responsible for these actions. Beyond their topical application, *Thymus* extracts have supported respiratory health, showcasing expectorant and cough-suppressant properties. Their ability to alleviate bronchitis and sore throat symptoms highlights their importance in traditional herbal medicine [19].

- *Pistacia lentiscus* (Mastic Tree): This evergreen shrub or small tree from the Mediterranean region is renowned for producing mastic gum, a resin with broad applications in medicine, culinary arts, and cosmetics. Medicinally, mastic gum has been used for its antimicrobial, anti-inflammatory, and antioxidant properties. It's traditionally used to treat gastrointestinal disorders, including ulcers and inflammatory bowel disease. The leaves and oil of *Pistacia lentiscus* also find use in traditional medicine for their antiseptic and wound-healing properties [20].

- *Ziziphus lotus* (Jujube): This small deciduous tree is native to the Mediterranean region. Like the date, its fruit is consumed fresh or dried and is known for its nutritional and health benefits. In traditional medicine, *Ziziphus lotus* is used for its soothing and analgesic effects, especially in managing insomnia and anxiety. The fruits are rich in vitamins and antioxidants, contributing to their anti-inflammatory and anticancer properties [21].

-*Lavandula species* (Lavender): The *Lavandula* genus encompasses a variety of species, all celebrated for their fragrant flowers and essential oils. Lavender oil is widely used in aromatherapy to alleviate stress, anxiety, and insomnia due to its calming and sedative effects. In topical applications, lavender oil promotes wound healing and reduces acne and other skin conditions by its antimicrobial properties. Culinary uses of lavender include flavoring for baked goods, teas, and other dishes, where it adds a distinctive floral note [22]. Utilizing these plants within the medicinal and aromatic properties domain underscores a holistic approach to health, emphasizing the prevention and natural management of conditions. Their diverse applications, from traditional remedies to modern-day health supplements and culinary uses, reflect a deep-rooted appreciation and reliance on natural resources for well-being. Furthermore, *Marrubium vulgare* is recognized for its significant ethnobotanical applications, primarily for its effectiveness in treating respiratory conditions and serving as a potent herbal remedy for various stomach-related issues. This underscores the community's reliance on natural remedies for sustaining health. *Rosmarinus officinalis* plays a crucial role in the production of essential oils, which are widely used in aromatherapy to alleviate stress and promote relaxation, relieve muscle pain, and support digestion. Cannabis sativa, employed with caution, is esteemed for its analgesic properties and versatility in addressing a range of ailments, notably in epilepsy treatment. Additionally, the Al Hoceima population frequently employs a combination of herbal decoctions, including *Marrubium vulgare*, *Rosmarinus officinalis*, and Thymus, to effectively manage pain, particularly dysmenorrhea. This practice showcasing the diverse applications of these plants in both medicinal and aromatic domains. This intricate tapestry of plant usage highlights the botanical wealth of Al Hoceima Province and emphasizes the enduring legacy of ethnomedicinal practices deeply embedded in the region's cultural heritage [23-25].

Our research conducted in the Al Hoceima region sheds light on the rich botanical diversity and the traditional use of plants by local communities, deepening our understanding of the interactions between humans and nature. Furthermore, the results of this study can serve as a catalyst for further exploration into the potential therapeutic power of medicinal plants in this region. By identifying plants with promising pharmacological potential, the knowledge held by the Al Hoceima communities can play a crucial role in refining and enhancing the utilization of plants, as well as enriching our understanding of ethnobotanical practices in the region. Future research endeavors could unlock new insights into the healing properties of these plants, potentially leading to the development of novel treatments and pharmaceutical products. Additionally, these findings may inspire increased efforts to document and preserve traditional knowledge about medicinal plants, ensuring that their benefits are not lost to future generations.

4 Conclusion

In conclusion, our research sheds light on the rich botanical diversity of the Al Hoceima Province, highlighting its vast array of species, including many endemic ones unique to the region. Through our exploration of traditional medicine, aromatherapy, and culinary arts, we have uncovered the profound ethnobotanical knowledge passed down through generations, illustrating the community's deep-rooted connection with their natural environment. By documenting the traditional uses of local flora for therapeutic and aromatic purposes, we contribute to a deeper understanding of the intricate relationship between humans and nature in Al Hoceima. Furthermore, our study emphasizes the importance of preserving these traditional practices and the unique species they rely on. The preservation of Al Hoceima's natural and cultural treasures is essential not only for safeguarding biodiversity but also for promoting the well-being of both the environment and its inhabitants. Through sustainable conservation efforts that prioritize the preservation of traditional knowledge and ecosystem integrity, we can ensure the continued harmony between humans and nature in this ecologically rich region.

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