



## **Biodiversity and Utilization Patterns of Medicinal and Aromatic Plants in Africa**

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### **Anahtar Kelimeler**

Tıbbi ve aromatik bitkiler, Bitki çeşitliliği odak noktaları, Geleneksel iyileştirici tıp, Etobotanik araştırmalar

### **Keywords**

Medicinal and aromatic plants, Plant biodiversity hotspots, Traditional healing medicine, Ethnobotanical surveys

### **Özet**

Tıbbi ve aromatik bitkiler, tedavi edici özellikleri ve hoş kokulu bileşenleri için yetiştirilen veya toplanan çeşitli bitki türlerini içerir. Bu çalışma, Afrika'daki tıbbi ve aromatik bitkilerin çeşitliliğini ve kullanım şekillerini inceleyerek, kıtanın zengin doğal kaynaklarını kapsamlı bir şekilde keşfetmektedir. Araştırma, farklı bitki türlerinin dikkatli bir şekilde incelenmesiyle, bu bitkilerin geleneksel tıp ve yerel uygulamalardaki tarihsel, kültürel ve ekolojik önemini ortaya koymaktadır. Çalışmanın hedefleri, Afrika'da bulunan tıbbi ve aromatik bitkilerin çeşitliliğini değerlendirmek ve bunların kullanımını geleneksel ve modern yöntemleri içeren bir şekilde incelemektir. Bu çalışmanın bulguları, sürdürülebilir biyolojik çeşitlilik yönetimi konusundaki tartışmalara katkıda bulunmakta ve bu bitkilerin hem geleneksel hem de modern bağlamlardaki önemini vurgulamaktadır.

### **Biodiversity and Utilization Patterns of Medicinal and Aromatic Plants in Africa**

### **Abstract**

Medicinal and aromatic plants (MAPs) constitute a diverse array of botanical taxa cultivated or wild-collected primarily for their therapeutic properties and, or aromatic compounds. This study describes the biodiversity and usage patterns of medicinal and aromatic plants in Africa, offering a comprehensive exploration of the continent's rich natural resources. Through a meticulous examination of the diverse flora, the research sheds light on the historical, cultural, and ecological significance of these plants in traditional medicine and local practices. The objectives of the study include the evaluation of the diversity of medicinal and aromatic plants present in Africa, as well as the examination of their utilization, encompassing both traditional methodologies and modern applications. The findings of this study contribute to the ongoing discourse on sustainable biodiversity management and underscore the significance of these plants in both traditional and modern contexts.

## 1. INTRODUCTION

A medicinal plant, also known as medicinal herbs, is any botanical species containing substances suitable for therapeutic purposes or serving as precursors for semi-synthetic pharmaceuticals within one or more of its components. These plants contain the oldest form of medicine, having been utilized for millennia in traditional medical practices across various regions worldwide (Marrelli, 2021). In non-industrialized and developing countries in Africa, Asia, and Southern America, their prevalence is particularly notable, attributed primarily to their perceived effectiveness, cost efficiency relative to modern medications, and ready accessibility (Awuchi, 2019). The renowned pharmaceutical history of Egypt is epitomized by the Ebers papyrus, which dates back to 1500 BC and catalogues approximately 700 remedies, mostly derived from plants (Sahoo, 2022).

Africa boasts a vast array of plant species, estimated at about 68,000, with approximately 35,000 being unique to the continent. Key regions, including the lowlands of Cameroon, Gabon, Liberia, and Nigeria; the montane forests of Congo, Rwanda, and western Uganda; the coastal areas of Kenya and Tanzania; as well as the Horn of Africa, such as Ethiopia and Somalia, together with the arid lands of Namibia, are acknowledged as significant centers of endemic plant diversity (Vasisht and Kumar, 2004).

Most medicinal aromatic plants and herbs are typically gathered from wild sources. To enhance the understanding of their genetic make-up and prevalence, it is advisable to create a list of frequently utilized aromatic plant species. This compilation would aid in their categorization, and the data gathered would be instrumental in addressing conservation concerns, particularly for endangered species (Haslett et al., 2010).

The study aims to investigate the diversity of medicinal and aromatic plants in Africa, thereby exploring the continent's abundant natural resources. Additionally, the research seeks to comprehend the traditional uses of these plants, contributing to the preservation of indigenous knowledge and the sustainable management of plant resource.

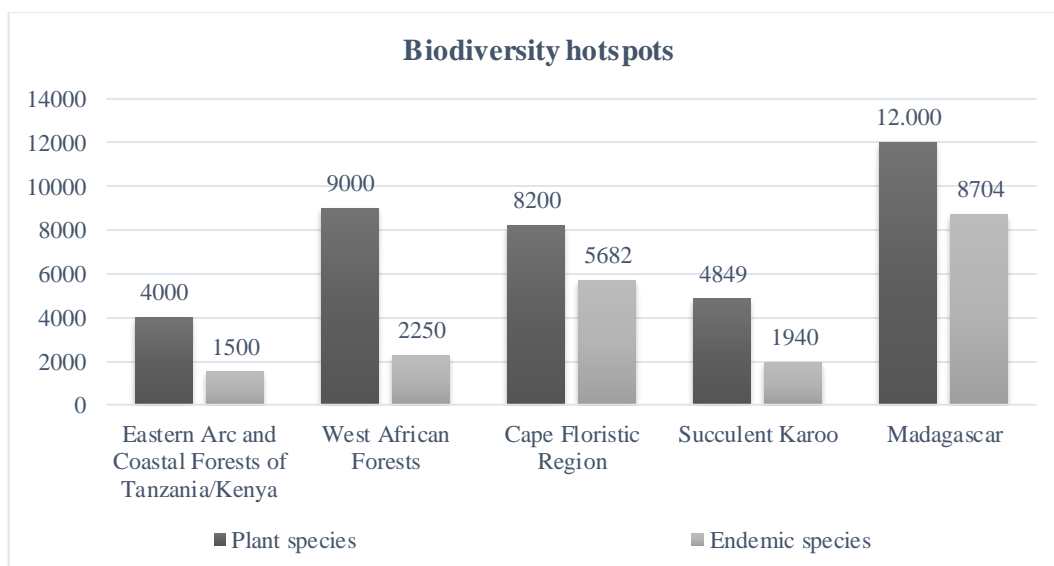
## 2. MATERIAL AND METHODS

### 2.1. Search Strategy

The literature search was conducted during the years 2023-2024, using various scientific databases such as Scopus, Science Direct, PubMed, MDPI, and Google Scholar. A broad spectrum of scientifically published content, including journals, patents, theses, books, and book chapters, was scrutinized, spanning the period from 1990 to 2023. Search engine queries were guided by specific keywords, such as "traditional medicine," "medicinal plants," "Biodiversity of Medicinal aromatic plants," "Africa," "indigenous," "traditional usage," and "ethnobotanical."

### 2.2. Biodiversity of Medicinal and Aromatic Plants in Africa

Medicinal and aromatic plants represent a significant part of the natural biodiversity present of various countries globally, with Africa being one of them. Although there have been developments in pharmacognosy, there has been uneven progress in comprehending the distribution, genetic variation, ecology, and conservation of these plants. These plants play crucial roles in primary healthcare for both humans and livestock. In Africa alone, more than 5,000 species are utilized for healing purposes. (Padulosi et al., 2002). Several indigenous medicinal and aromatic plants in Africa include *Azadirachta indica* A. Juss, *Zingiber officinale* Rosc, *Bridelia ferruginea* Benth, *Allium sativum* L., *Cassia alata* L., *Moringa oleifera*, *Cymbopogon citratus* (DC.) Stapf, *Aloe macrocarpa*, *Aloe vera* (L) Burm.f., *Aloe monticola* Reynolds, *Aloe halophila*, *Aloe Scandiflora*, *Hydnora sinandevu* Beentje & Q. Luke, *Hydnora abyssinica* (known as 'mavumbule'), *Carica papaya* L., *Securidaca longipedunculata*, *Alchornea laxiflora*, *R. serpentina* (L.), and *Ocimum gratissimum* (L.) (Okigbo et al., 2009). The data on plant species and endemic species across biodiversity hotspots are presented in the Figure below, with Madagascar exhibiting the highest total and endemic plant species, while the Cape Floristic Region is noted for having the highest proportion of endemism (Figure 1).



**Figure 1.** General biodiversity hotspots in Africa (Máthé et al., 2017).

Various and unique characteristics of several biodiversity nexus worldwide are observed around the world. Areas such as the Horn of Africa and Madagascar have extraordinary levels of endemism, underscoring the critical role of these areas in conserving global biodiversity. Madagascar and the Indian Ocean Islands stand out with 13,000 plant species, 89% of which are endemic, emphasizing their ecological significance. The Cape Floristic Region also shines with 9,000 species, boasting a high endemism rate of 69%, underscoring its importance in global biodiversity conservation. The Horn of Africa region of Somalia, Djibouti, Ethiopia, and Eritrea boasts 5,000 plant species, with an exceptionally high endemism rate of 55%, underscoring its ecological distinctiveness. These statistics underline the urgent need for conservation efforts to protect these unique ecosystems and their invaluable plant diversity (Moyo et al., 2015; CEPF, 2015).

Biodiversity encompasses the range and variability of living organisms and the ecological and evolutionary processes that sustain their existence. Traditionally, the discovery of plant medicines occurred through trial and error, paralleling the way people have learned to use plants for sustenance. Traditional medicine, deeply rooted in African socio-cultural heritage, has persisted for centuries, with populations in developing countries worldwide heavily reliant on it as their primary healthcare source (Okigbo and Ogbogu, 2008).

At the same time, there is a transition in many developing nations from subsistence to commercial use of medicinal plants (Solomou et al., 2016). The use of botanicals raises concerns about the environmental impacts on wild populations, species, and ecosystems. However, it's acknowledged that the use as well as the trade of wild plant resources are not inherently harmful (Lange, 2002). Therefore, Africa boasts abundant medicinal and aromatic plant species across diverse environmental conditions, providing ample opportunities for cultivation (Kumar and Jnanesha, 2016).

### **2.2.1 Families Associated with Agricultural Studies of Some Important Medicinal and Aromatic Plants of Africa**

Various sizable plants indigenous to Africa, each hailing from local plant families, serve diverse therapeutic roles. Species including, Aloe vera, a member of the Asphodelaceae family, and Artemisia afra of the Asteraceae family are renowned for their medicinal attributes, with Aloe vera also utilized in essential oil extraction. Plants like Hoodia gordonii and Aspalathus linearis, originating from the Apocynaceae and Fabaceae families respectively, find use as dietary supplements. Conversely, species such as Harpagophytum procumbens and Pelargonium sidoides are tailored for phytomedicine. Warburgia salutaris and Sutherlandia frutescens embody a fusion of traditional and phytomedicinal practices in African herbal medicine. From the nutritional benefits of Adansonia digitata's fruit to the digestive aid

properties of *Zingiber officinale*, and the versatile applications of *Nigella sativa* in both traditional and phytomedicinal contexts, these plants epitomize the diverse health advantages stemming from Africa's botanical abundance (Quattrocchi, U., 2016; Khalid et al., 2012).

Mengistu et al. (2019) conducted research in Eastern Hararge across three districts, focusing on the diversity and use of MAPs. They cataloged 87 plant species from 50 families in diverse environments like wild areas, farmlands, home gardens, and roadsides. Among these, 72 species were noted for medicinal benefits and 15 for both medicinal and aromatic uses. The Fabaceae family was particularly notable in medicinal categories, while Lamiaceae and Rutaceae were prominent among both medicinal and aromatic plants. The study found a higher diversity index for medicinal plants than for those also used aromatically. Leaves were the most used part of the plants, primarily consumed orally or applied externally. Trees dominated the growth forms, followed by herbs, shrubs, and climbers. The decline in these plant populations was attributed to human activities and natural factors.

An ethnobotanical study was conducted in Casablanca, Morocco's principal commercial center, utilizing semi-structured interviews to collect data from a selection of traditional herbalists. The study applied quantitative measures such as the informant consensus factor (ICF), fidelity level, use value, and family use value to assess the significance of various plant species. In total, 46 plant species across 22 families were identified for their practical uses. Notably, the Juglandaceae family exhibited the highest family use value at 0.75. The investigation revealed that thirteen species were primarily used to alleviate dental pain including toothaches and sensitivity, twelve species were used for oral ulcer treatments such as mouth ulcers and herpes, three were identified for their efficacy in addressing dental stains including whitening and bleaching, and only two species were noted for treating gum diseases (Zougagh et al., 2019).

A thorough and extensive inventory, it was found that the Ketama region hosts 81 plant species across 40 families and 65 genera, primarily used for medicinal purposes. The prevalent health conditions addressed were digestive diseases, with an Informant Consensus Factor (ICF) of 0.618. Notably, *Thymus serpyllum* L., *Origanum compactum* Benth, and *Rosmarinus officinalis* L. were identified as having the

highest use value among the medicinal herbs. The most frequently utilized plant part was leaves (50.28%), and the preferred method of preparation was decoction, typically administered orally. Overall, the region demonstrates a rich diversity of aromatic and medicinal plants, with significant local reliance on species such as *Rosmarinus officinalis* L., *Thymus serpyllum* L., and *Origanum compactum* Benth for therapeutic purposes (El-Memissi et al., 2023).

Recent research including online databases and reviews, has compiled an inventory of vascular plant families, emphasizing their use in Traditional African Medicine (TAM). The study identifies at least 4,576 vascular plant species from 1,518 genera in sub-Saharan Africa, spanning 192 of the 254 African plant families. It highlights the prevalence of families such as Fabaceae, Rubiaceae, and Asteraceae in TAM, while noting that others are less utilized. Through regression analysis, patterns of usage are analyzed, indicating trends of overuse and underuse within these families, which shed light on the selection dynamics of TAM plants. Additionally, the study reviews the international trade of African medicinal plants, revealing distinct trade patterns where families like Fabaceae and Apocynaceae are significantly represented, differing from global medicinal plant trade patterns (Van Wyk, 2020).

### 2.3. Utilization Patterns of MAPs

In the Central and Eastern regions of Africa, MAPs are crucial to meeting the health needs of millions of communities. As the population growth rate increases day by day, there is a surge in the demand for these plants (El-Kamali, 2009). Also, it's imperative to promote sustainable practices in the application of these species, along with the establishment of effective harvesting methods (Chen et al., 2016). Medicinal and Aromatic are used as spices and additives for aromatic, coloring, preservative, and antioxidative purposes. These plants are utilized in both fresh and dried forms, offering various methods of application (Kaptan and Sivri, 2018).

Most conservation efforts regarding medicinal plants should involve collaboration with individuals who own, manage, or utilize these species, or who are responsible for the land where they are grown. Herbal medicines gain popularity in wealthier nations, with this market segment has been expanding at a rate of 10–20% annually in Africa in recent years (Hamilton, 2004). Ethnobotanical research conducted across

Africa underscores the predominant use of indigenous plants in traditional African medicine (Cunningham, 1993). However, the documentation of the medicinal properties of African species is increasingly deemed urgent as their natural habitats are rapidly depleted due to human activities. One of the highest rates of deforestation globally is being experienced in Africa (Gurib-Fakim, 2006). In many developing countries with limited healthcare access, a substantial portion of the population turns to traditional practitioners or folk medicine, heavily dependent on medicinal plants. (Akerle et al., 1988).

#### **2.4. Ethnobotanical Surveys of MAPs**

Traditional medicine, deeply embedded in African medical traditions, serves as a prime illustration of this practice (Chaachouay et al., 2020). In Africa, traditional medicine remains the primary resource for a considerable portion of the population seeking basic healthcare services (Aremu and Pendota, 2012). Medicinal plants have long been utilized as healing resources in local communities worldwide for millennia. However, the development of basic analytical techniques over the past seven decades has greatly enhanced our understanding of these plants (Fitzgerald et al., 2020). Biocultural diversity refers to the intricate interplay between the Earth's biological, cultural, and linguistic diversities. Traditional knowledge encompasses the accumulated wisdom and practices passed down through generations, guiding human societies in their interactions with the environment (Bakar et al., 2022).

The study of human-plant interactions falls within the field of ethnobotany, a discipline focused on examining indigenous knowledge regarding the perception, utilization, and management of plants. Indigenous knowledge encompasses the wisdom, rules, standards, skills, and mental frameworks developed and preserved by local communities within specific regions (Chekole et al., 2015). Preserving the traditional knowledge held by indigenous peoples is crucial as it continues to diminish over time, with only a few communities possessing extensive traditional and botanical knowledge. Ethnobotanical surveys have been carried out in various African communities, including provinces in East Africa such as Somalia, Ethiopia, and Kenya (Tantengco et al., 2018). Numerous challenges hinder the propagation, cultivation, and utilization of herbal plants on the continent. These challenges include insufficient domestication of valuable plant species, inadequate

propagation methods, over-harvesting, limited technology, inadequate investments and marketing information, lack of pest and disease control measures, and insufficient laboratory analysis capabilities (Nwafor et al., 2021).

Indigenous healthcare systems in Africa predominantly rely on plant-based remedies. Africa offers numerous opportunities for cultivating medicinal and aromatic plants, with climatic factors such as daylight duration, rainfall patterns, and temperatures significantly impacting the physical, chemical, and biological characteristics of these species (Rajamani et al., 2019). The documentation of medicinal plants worldwide holds immense significance as traditional medicinal knowledge is often transmitted orally and risks being lost if not properly documented. Traditional medicine plays an invaluable role in local communities worldwide, particularly in Africa. Despite some medicinal and aromatic plants being identified by both local and scientific names, there are thousands of such plants in Africa that remain undocumented with regards to their local and scientific names (Mukaila et al., 2022).

#### **2.5. Conservation and Sustainable Handling of MAPs Resources in Africa**

African traditional medicine has a rich history spanning centuries, contributing significantly to the region's socio-cultural heritage (Elujoba et al., 2005). Ethnobotanical studies conducted across Africa affirm that indigenous plants form the primary component of traditional medicine (Cunningham, 1997). Moreover, the evidence indicates that the increasing reliance of industrialized societies on medicinal plants has led to the extraction and development of numerous medications, including chemotherapeutics, derived from these plants, as well as from traditional herbal plants (UNESCO, 1994). Among African nations, Tanzania stands out with the highest value, boasting 496 threatened plant species, while Mauritania has the lowest value at 0 (IndexMundi, 2016). Four key areas comprise an effective medicinal plant conservation strategy: in-situ, and ex-situ conservation, education, and research. These areas are summarized below.

##### **2.5.1. In-situ conservation technique**

As part of the in-situ conservation process, plants and other biological resources are safeguarded and preserved in their natural habitats. To maintain representative populations of delicate medicinal plant



species, it is essential to designate protected sites or other ecosystems where ecological processes can persist unhindered (Cunningham, 1997).

### 2.5.2. Ex-situ conservation technique

This entails the cultivation of trees and the care of biological collections in orchards and home gardens located other than their natural habitats. (Roche, 1992). It is important to preserve species as a safety measure and contingency against extinction. The slow-growing species that pose a threat to wild populations and are unlikely to be cultivated commercially are the most likely to be harvested as medicinal plants (Cunningham, 1993).

### 2.5.3. Education and research

Due to the nature of the subject, the discussion of medicinal plants must be a long-term endeavor that involves the training of personnel and the backing of organizations and the aware public. Enhancing national education and research standards plays a pivotal role in addressing the conservation of medicinal plants, a factor that is contingent upon the economic development of African nations (Cunningham, 1993).

## 2.6. Importance in Traditional Medicine

According to WHO estimates, traditional medicine (TM) provides medical care to around 80% of the world's population (Jansen et al., 2010). One of the most significant uses of plants in many ethnic groups is in traditional medicine, where plants and plant products are employed (Guigma et al., 2012). Environmental conservation has difficulties due to anticipated population growth and the effects of climate change on plants and flora. Preservation the beneficial plants is particularly dependent on the interaction of changing environmental conditions and growing exploitation pressure. Effective conservation is based on a thorough understanding of use patterns, true usefulness, and particularly medicinal effectiveness (Zizka et al., 2015).

## 3. CONCLUSION

In conclusion, this study has shed light on the significant role these plants play in traditional medicine, cultural practices, and economic activities across the continent. The richness of Africa's flora highlights the immense potential for medicinal and

aromatic resources. Traditional knowledge, passed down through generations, underscores the importance of ethnobotanical studies to document and preserve indigenous practices. The conservation implications of this study are crucial. As medicinal plant supplies are depleted due to environmental degradation and over-harvesting, effective conservation strategies are imperative. Balancing the needs of local communities, traditional medicinal practitioners, and commercial interests is essential for the sustainable use of these plant species. Recognizing the significance of traditional medicine, which serves as a primary source of healthcare for a relevant proportion of the population, underscores the need to integrate conservation efforts with the preservation of indigenous knowledge. As Africa continues to face challenges such as deforestation and climate change, the conservation of MAPs plants becomes integral in order to ensure the well-being of the ecosystems, communities, and the rich cultural heritage embedded in traditional healing practices. This study strongly advocates the following set of key recommendations aimed at promoting the sustainable management of herbal and aromatic plants:

- I. Developing and enforcing sustainable harvesting guidelines for MAPs and implementing community-based cultivation programs to empower local communities and reduce pressure on wild populations.
- II. Recognizing and integrating traditional knowledge into conservation strategies, fostering collaboration between practitioners and scientists.
- III. Establishing educational programs for awareness about the cultural, ecological, and economic significance of these plants.
- IV. Fostering international collaboration and knowledge exchange, seeking support from global organizations for large-scale conservation initiatives.

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