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The Innovative Potential of Key *Mentha* Species: An Assessment Based on Patent Analysis †

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Abstract: Morocco's rich biodiversity includes various aromatic and medicinal plants utilized for culinary and medicinal purposes. The genus *Mentha*, belonging to the Lamiaceae family, is notable for its widespread use in Moroccan culture. This genus encompasses several species with distinct phytochemical profiles, offering potential applications in cosmetics, medicine, and other sectors. However, understanding the innovation landscape related to *Mentha* in Morocco requires a comprehensive patent analysis, which can indicate trends, the technological focus, and potential commercial applications. This study identifies the *Mentha* species commonly used in Morocco and examines patent documents to reveal technological innovations linked to Moroccan *Mentha* species. Five major *Mentha* species were identified, namely *M. longifolia*, *M. pulegium*, *M. gattefossei*, *M. spicata*, and *M. suaveolens*, in addition to two hybrids (*Mentha* × *piperita* and *M. rotundifolia*). The patent analysis, focusing on the number of documents, jurisdictional distribution, and International Patent Classification (IPC) codes, highlights that China and the United States are leading jurisdictions, with 1113 and 915 patent documents, respectively. The primary IPC code, A61K36/53, corresponds to medicinal preparations containing mint. Among the eight identified species, *M. spicata* (spearmint) accounted for the highest patent activity, reflecting its widespread cultivation and use both in Morocco and globally. In contrast, *M. gattefossei* (persian mint), an endemic species, had minimal patent representation, suggesting limited international exploitation and potential opportunities for increased research and commercialization focused on this species.

Keywords: *Mentha*; *Lamiaceae*; plant diversity; patent analysis; Morocco

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1. Introduction

The genus *Mentha*, belonging to the family *Lamiaceae*, is currently represented by 24 species. This diversity has allowed it to be present in most of the world [1]. *Mentha* species, such as *Mentha longifolia* (longleaf mint) and *Mentha piperita* (peppermint), are widely valued not only for their aromatic properties but also for their notable pharmacological effects. *Mentha* species are notable for their rich phytochemical composition, which contributes to their health benefits [2,3]. These species contain a high concentration of phenolic compounds, including rosmarinic acid and quercetin, but the major compound is the monoterpenol menthol [4]. These bioactive molecules are known to have multiple health benefits, contributing to *Mentha*'s antioxidant, anti-inflammatory, and antimicrobial effects [5,6]. Studies show that infusions of *M. piperita* exhibit strong antioxidant activity, which correlates with their phenolic content. This antioxidant potential has made *Mentha* infusions popular as natural remedies and functional beverages [5].

Morocco, ranked, in 2023, as number one in peppermint and spearmint-producing countries [7], benefits from its remarkable plant diversity, allowing the development of

a rich tradition of using aromatic and medicinal plants both in cuisine and for health benefits [8,9]. Among these plants, the genus *Mentha* is essentially represented by seven species that hold a unique position in Moroccan cultural practices and traditional medicine, showcasing an extensive range of applications [5,10,11].

Species of *Mentha* are frequently used in Moroccan cuisine, both as herbal teas and as flavoring agents in dishes, enhancing aroma and taste. For example, *M. spicata* (spearmint) is commonly brewed as tea, while other species are used to season salads and meats, enriching their flavors [5]. Traditionally, *M. longifolia* is employed to treat gastrointestinal and respiratory disorders, as well as other ailments. Its use in treating various health conditions underscores the significance of *Mentha* species in Moroccan herbal medicine [11].

The increasing global demand for mint-based products, driven by their health benefits and culinary uses, highlights the economic significance of *Mentha* species [12]. The growing interest in natural and plant-based products has expanded the market for *Mentha*, making it economically important for Morocco. The demand spans food, cosmetic, and pharmaceutical industries, underscoring the commercial potential of the Moroccan *Mentha* species for Morocco. [6,12]. However, the country needs to increase its mint production to be able to meet the high domestic demand and claim to play a role among the top exporting countries, of which it is not one [13].

In this work, we conduct a patent analysis to investigate the technological innovations that focus on *Mentha* species grown in Morocco. Using data from specialized patent databases, we identify areas of innovation through patent activity. This analysis will map the technological landscape for *Mentha* species, highlighting their diverse applications and economic relevance.

2. Materials and Methods

2.1. Plant Species Identification

A bibliographic search was conducted to identify the *Mentha* species commonly used in Morocco [14]. Five major species, including *M. longifolia*, *M. pulegium*, *M. gattefossei*, *M. spicata*, and *M. suaveolens*, and two hybrids, *Mentha* × *piperita* L. and *M. rotundifolia* Huds, were identified (Figure 1). These species can be identified by their scientific names, their common names, and they have local vernacular names in Morocco (Table 1).

Table 1. Major Moroccan species of the genus *Mentha* [14].

Mentha Species	Common Name	Moroccan Vernacular Name *
M. longifolia L.	Longleaf mint	Tahindest–Nemdar Habaq el bahr
M. pulegium L.	Penny mint	Fliyyo
M. gattefossei Maire	Persian mint	Fliyyo dyal jbel
M. spicata L. (including *M. viridis* L.)	Spearmint	Na'na'
Mentha × *piperita* L.	Peppermint	Na'na' Al-abdi
M. suaveolens Ehr.	Round-leaved mint	Marseta Na'na' Lemsewwaf Timija
M. rotundifolia Huds. =*M. longifolia* × *M. suaveolens*		

* based on relevant Moroccan vernacular names of *Mentha* species [15].

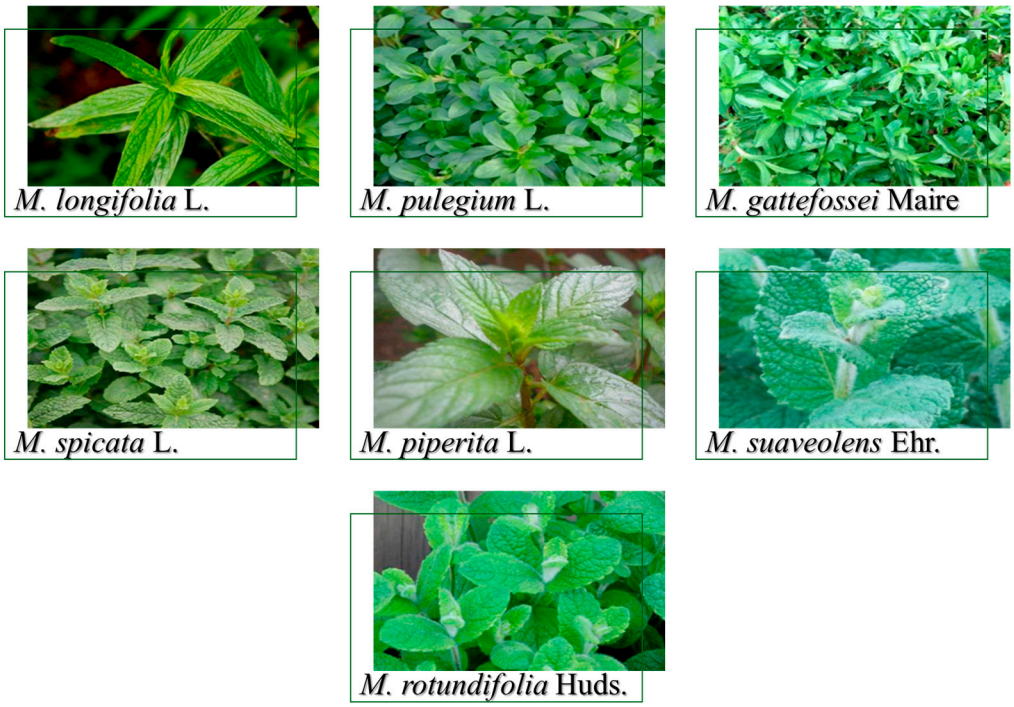


Figure 1. Photographs of the main Moroccan *Mentha* species: *M. longifolia* L., *M. pulegium* L., *M. gattefossei* Maire, *M. spicata* L., *M. piperita* L., *M. suaveolens* Ehr., and *M. rotundifolia* Huds. (Reproduced and adapted from El Hassani, 2020 [14], with permission from Elsevier; published under license, Copyright© 2020 Elsevier Ltd.).

2.2. Patent Document Collection

The patent data were collected using specialized databases, including The Lens and Google Patents [16,17]. The search focused on patent applications and granted patents related to each identified *Mentha* species. The keywords included species names, common names, and relevant Moroccan vernacular names.

2.3. Data Extraction and Classification

The patent documents were categorized based on the following criteria:

- Patent jurisdiction: identified the countries in which patents were filed.
- Patent types: differentiated between granted patents and patent applications.
- Patent families: assessed the number of simple and extended families to determine international interest.
- International Patent Classification (IPC) codes: classified patents based on IPC codes to identify the technological fields relevant to *Mentha* usage.

The genus *Mentha* is cited in the title, abstract, or claims of approximately 3400 patent applications and granted patents. The data were analyzed to determine the distribution of patents across jurisdictions, document types, and technological areas. Only the patent documents that specify the species selected for the study were included in this analysis.

3. Results and Discussion

3.1. Number of Patent Documents Published

Figure 2 presents the evolution of the number of patent documents published for the studied *Mentha* species over time. The graph illustrates a positive trend in patenting activity related to those *Mentha* species, signaling a robust growth in research and commercial interest over the last two decades. This trend underscores the potential of *Mentha* species as a valuable source of bioactive compounds and opens avenues for further technological innovation and intellectual property generation.

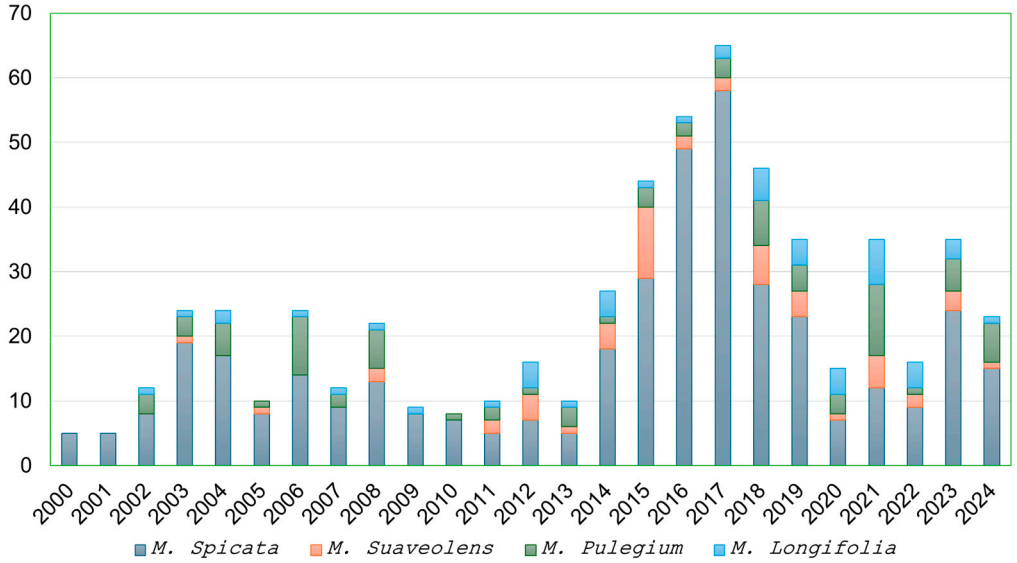


Figure 2. The evolution of the number of patent documents published since the year 2000 concerning the studied *Mentha* species.

Since the year 2000, there has been a steady rise in the number of patent documents published related to studied *Mentha* species (i.e., *M. longifolia*, *M. pulegium*, *M. gattefossei*, *M. spicata*, *M. suaveolens*, *Mentha* × *piperita*, and *M. rotundifolia*). This upward trend likely reflects a growing interest in plant-based innovations, particularly in the areas of health, cosmetics, and biotechnology. The graph shows significant growth around certain years, suggesting peak periods when patent filings were particularly high. This could be attributed to increased scientific research and industrial applications of *Mentha*, driven by discoveries of new uses or regulatory approvals for specific applications.

As a species-specific trend, *M. spicata* (spearmint) shows a consistently high level of patent activity compared to other species, which correlates with its global popularity and diverse applications. *M. pulegium* (penny mint) and *M. longifolia* (longleaf mint) also exhibit notable patenting activity, reflecting their use in traditional medicine and emerging industrial applications. Endemic species, such as *M. gattefossei* (Persian mint), have relatively fewer patent filings, indicating less commercial exploration, which might represent an opportunity for future research and patenting.

Approximately 94% of the patent documents were published after 2000, demonstrating a recent surge in interest in *Mentha* species. This aligns with broader trends in natural product research and the increased value placed on plant-based solutions for health and wellness industries.

Given the steady increase and sustained interest in *Mentha* species, it is likely that patenting activity will continue to grow, especially as the interest in bioactive compounds and sustainable products expands. The presence of major corporations, as indicated in the patent data (e.g., Unilever, Procter & Gamble, etc.), suggests that this field may attract further commercial investments.

3.2. Patent Distribution by Jurisdiction

The analysis revealed that China and the United States were the leading jurisdictions for patent filings related to *Mentha* species, with 1113 and 915 patent documents, respectively. This suggests a significant interest in *Mentha*-based innovations within these regions, likely driven by the regions' market size and investment in botanical and medicinal research.

3.3. International Interest in Mentha Species Through Patent Families

The distinction between simple and extended patent families allows us to gauge the level of international interest in the studied *Mentha* species present in Morocco. Simple patent families indicate filings within a single jurisdiction, while extended families reflect patent filings across multiple jurisdictions, signaling broader international interest.

Figure 3 presents a summary of the extracted data from patent documents concerning the studied *Mentha* species. This concerns specifically *M. spicata*, *M. suaveolens*, *M. pulegium*, and *M. longifolia* based on patent document count, patent families, as well as the IPC codes.

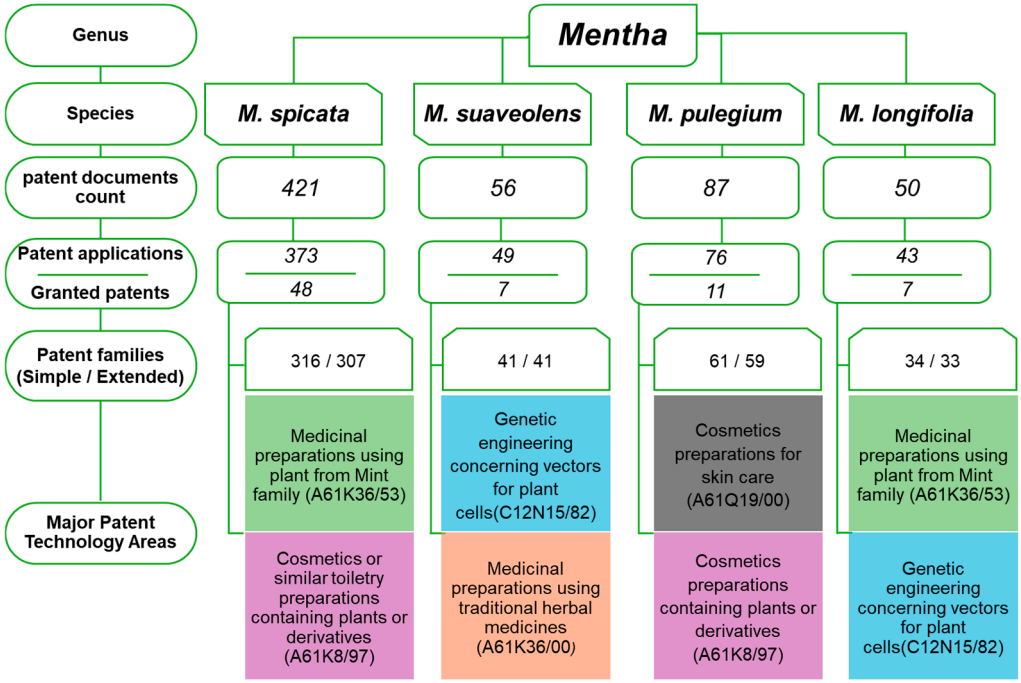


Figure 3. Summary of extracted data from patent documents concerning the major *Mentha* species: *M. spicata*, *M. suaveolens*, *M. pulegium*, and *M. longifolia*.

The data collected reveal a considerable number of patent families, especially simple ones, suggesting that the *Mentha* species studied and their natural derivative molecules are attracting significant global interest [18,19]. The trends show substantial numbers of simple and extended families for species like *M. spicata* (316 simple and 307 extended families), indicating that innovations related to this species are patented across several countries. This cross-jurisdictional filing demonstrates international interest, likely driven by this species' applications in the health, cosmetic, and food industries.

The presence of both simple and extended families reflects a blend of local and international patenting strategies. While simple families suggest that some applications may have been intended for local or regional markets, the existence of extended families highlights the commercial potential of *Mentha* species on a global scale.

3.4. Patent Classification and Technological Focus

Based on Figure 3, the IPC codes A61K36/53 and A61K36/00, designated for medicinal preparations containing mint, were the most frequently assigned codes among the patents studied. This aligns with the traditional medicinal uses of *Mentha* in Morocco, emphasizing its applications in therapeutic formulations [14]. Other significant codes included classifications for cosmetics (A61K8/97 and A61Q19/00) and genetic engineering (C12N15/82), indicating the potential of *Mentha* species in cosmetic formulations and biotechnological applications.

The patent landscape analysis highlights significant potential for future research and development involving Moroccan *Mentha* species. The concentration of patents in medicinal and cosmetic applications underscores existing demand, but there are opportunities for expanding into biotechnological innovations, especially for endemic species like *M. gattefossei*. Establishing more targeted studies on Moroccan *Mentha* could also foster economic opportunities by promoting local biodiversity within international markets.

3.5. Major Components: Pulegone and Carvone

The analysis of patents on the essential oil components of *Mentha* species present in Morocco identified pulegone and carvone as major active compounds with substantial patent activity [20]. Pulegone, derived mainly from *M. pulegium*, showed 753 patent documents, primarily in the context of medicinal and cosmetic applications. Carvone, found in *M. spicata* and *M. viridis*, had 2390 associated patents, with its applications extending into agriculture and food preservation. Companies such as Unilever and Bayer have filed patents involving these compounds, reflecting their commercial importance (Figure 4).

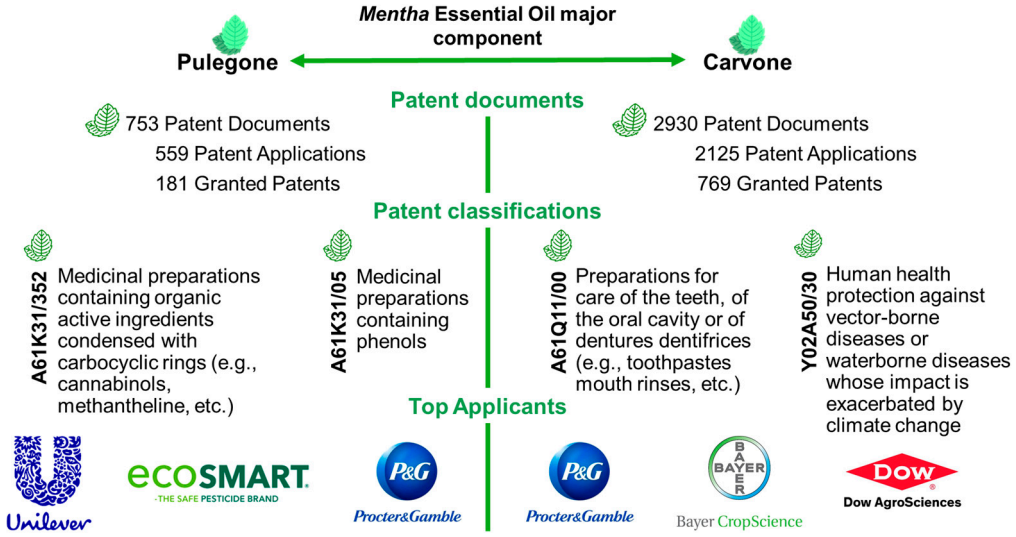


Figure 4. Summary of extracted data from patent documents concerning pulegone and carvone.

4. Conclusions

This patent analysis demonstrates that the genus *Mentha* holds considerable technological potential, particularly in medicinal and cosmetic applications. *M. spicata* is the most widely patented species, while species like *M. gattefossei*, which are endemic to Morocco, remain underrepresented. The high volume of patents filed in China and the United States reflects the global interest in *Mentha* species, particularly for active components such as pulegone and carvone. These insights can support policymakers, researchers, and companies in identifying areas of technological innovation and potential commercialization strategies for *Mentha* species. Future research should focus on underutilized species and explore their unique properties, which may reveal novel applications in fields such as biotechnology and sustainable agriculture. This work provides a foundation for mapping the innovation landscape of mint species, especially those grown in Morocco, and could facilitate further scientific and commercial exploration of the country's botanical resources.

Supplementary Materials: The following supporting information can be downloaded from https://sciforum.net/paper/view/19237 (accessed on 14 October 2024), Poster: El Boukhari, R.; Fatimi, A. The innovative potential of *Mentha* species in Morocco: An assessment based on patent analysis. The 3rd International Electronic Conference on Diversity (IECD 2024), Basel, Switzerland, 15–17 October 2024.

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