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Review

Investigation Utilization of Medicinal Plants: From Historical Practices to Contemporary Medicine

Shaymaa Al-Majmaie [1,*], Rana H. Naser [2], Sarah H. Hadi [2], Abbas Murtadeh Ismail [3] and Sushmita Nath [4]

[1] Department of Biotechnology, College of Science, University of Diyala, Baqubah 32001, Iraq
[2] Department of Science, College of Basic Education, University of Diyala, Baqubah 32001, Iraq
[3] Department of Biology, College of Science for Women, Baghdad University, Baghdad 10071, Iraq
[4] Centre for Reproductive Medicine and Andrology, University Hospital Münster, 48149 Münster, Germany
* Correspondence: shaymaa@uodiyala.edu.iq

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Abstract: This study explores the use of medicinal plants from historical traditions within contemporary medical practice, highlighting their continued relevance across diverse cultures and healthcare systems. Indigenous populations and ancient civilizations employed botanical remedies to treat a wide spectrum of diseases, laying the foundation for traditional healing systems and contributing to empirical medical knowledge. To evaluate these practices in a modern context, a structured narrative review and data-driven synthesis were conducted. Data were retrieved from PubMed, Scopus, ScienceDirect, and Google Scholar, prioritizing publications from 2000–2024 while including earlier works for historical context. Sources were classified according to cultural significance and pharmacological validation. The synthesis identifies medicinal plants that are both culturally significant and pharmacologically substantiated. The findings demonstrate the renewed relevance of herbal therapies in integrative healthcare and underscore the importance of preserving traditional knowledge while ensuring rigorous, evidence-based validation. Overall, this study advocates for a comprehensive framework that bridges cultural heritage and modern biomedical practice to address contemporary health challenges.

Keywords: medicinal plants; plant biodiversity; ethnobotany; iraqi plants; iraq

1. Introduction

Nature present critical insights into the interactions among diverse phenomena. Throughout history, humans have sought natural remedies for illnesses by turning to medicinal plants. In early societies, their use was largely intuitive, resembling instinctive behaviors observed in animals [1,2]. This reliance stemmed from limited understanding of disease etiology and plant-based therapeutic properties. Over time, however, the reasoning for using particular medicinal plants became more explicit. The application of these interventions progressed from initial trial-and-error methods to a rigorously evidence-based framework, informed by systematic observation, pharmacological evaluation, and scientific experimentation. Medicinal plants play a critical role in supporting both human health and ecological sustainability. They provide vital ecosystem services and function as indicators of environmental health, warranting careful scientific and conservation attention. Since prehistoric times, plants have been valued for their multifaceted benefits, including nutrition, shelter, clothing, and medicinal purposes. The therapeutic use of botanicals can be traced to ancient civilizations such as Mesopotamia, China, Greece, Egypt, India, and Persia [3,4]. These cultures established the foundations of traditional medical systems, which evolved from centuries of empirical knowledge into structured healing traditions. At present, more than 50,000 plant

species are utilized in pharmaceutical and cosmetic industries, representing over 10% of all known plants. Their distribution, however, is uneven, with global demand rising annually by 8–15% in regions such as Europe, North America, and Asia. The pharmacological value of medicinal plants lies in their diverse bioactive compounds, located in seeds, roots, leaves, fruits, flowers, and whole plants. These compounds demonstrate direct and indirect therapeutic properties and frequently act synergistically, enhancing their role in modern healthcare and drug discovery [5–7]. The transition from empirical use to evidence-based validation continues to shape current research. Ethnobotanical knowledge provides the cultural and historical context, while pharmacological studies confirm efficacy, safety, and mechanisms of action. Complementary medical and cultural strategies safeguard cultural heritage, advance integrative healthcare, and support the development of sustainable therapeutic alternatives [8–10].

Accordingly, this review synthesizes both historical and contemporary perspectives. It examines the cultural significance of medicinal plants in relation to their pharmacological properties and highlights prevailing challenges, emerging trends, and future prospects.

2. Methodology

This study was conducted as a narrative review with elements of data-driven synthesis, aiming to explore the historical usage, pharmacological significance, and cultural importance of medicinal plants. A comprehensive literature search was performed across multiple scientific databases, including PubMed, Scopus, ScienceDirect, and Google Scholar. Search terms combined keywords such as "*medicinal plants*", "*traditional medicine*", "*pharmacological properties*", "*cultural significance*" and "*Iraq/ Middle East*" to ensure broad coverage of both historical and contemporary sources.

Inclusion criteria were:

- Peer-reviewed articles, ethnobotanical surveys, and pharmacological studies published between 2000 and 2024.
- Seminal works published prior to 2000 to provide historical and cultural context.
- Studies explicitly addressing either pharmacological activities of medicinal plants or their cultural/traditional applications.

Exclusion criteria were:

- Non-scientific sources, duplicate records, and studies without primary or secondary data relevant to medicinal plant use.

To address the stated objective of bridging empirical frameworks with evidence-based approaches, the selected studies were categorized into two main domains:

(1) Cultural and historical significance—sources documenting traditional knowledge, indigenous practices, and ethnobotanical records.
(2) Pharmacological validation studies reporting phytochemical analyses, experimental pharmacology, or clinical applications.

A thematic synthesis approach was then applied to integrate findings across both domains, enabling comparison between cultural uses and scientific validation. This method ensured that the review not only summarized existing knowledge but also critically highlighted overlaps, gaps, and future research needs.

3. Results

3.1. Global Importance of Medicinal Plants

Medicinal plants play a vital role in global healthcare systems, particularly in developing countries where traditional medicine remains a primary source of treatment.

According to the World Health Organization (WHO), approximately 80% of the world's population relies on plant-based medicines for their primary health needs [11].

Moreover, beyond traditional use, medicinal plants have made significant contributions to modern pharmacology. Many clinically important drugs, including morphine, quinine, and paclitaxel, are derived directly or indirectly from botanical sources [12].

Interest in complementary and alternative medicine is growing globally. This trend is driven by concerns over the side effects of synthetic drugs and the rise of antimicrobial resistance. As a result, there has been a surge in herbal product markets worldwide.

The recent resurgence emphasizes the vital ecological, economic, and therapeutic significance of medicinal plants. These plants play an essential role in both preventive and curative healthcare, highlighting their importance in promoting overall well-being.

3.2. Geographic Distribution of Medicinal Plants

The distribution of medicinal plants across the continents exemplifies a rich array of traditional knowledge and biodiversity. Asia holds particular significance due to its extensive variety of medicinal species, with countries such as China and India leading in the utilization and advancement of herbal remedies. Traditional Chinese Medicine and Ayurveda are reliant on these plants, both of which have been practiced for millennia, reflecting their profound importance in health and wellness [13]. In Africa, indigenous communities utilize a wide variety of medicinal plants. Examples include rooibos (*Aspalathus linearis*), known for its antioxidant properties, and devil's claw, commonly used to alleviate pain and inflammation. These plants are central to traditional healing practices among various ethnic groups. They address a range of health concerns, from digestive issues to chronic pain [14].

North America hosts an estimated 3000–5000 medicinal plant species. Notable examples include Echinacea, often used to enhance immune function, and goldenseal, recognized for its antibacterial properties. Indigenous peoples have historically utilized these plants, reflecting the continent's rich herbal traditions [15].

South America is similarly abundant in medicinal flora. Species such as cinchona, which provides quinine for malaria treatment, and cat's claw, valued for its immune-boosting and anti-inflammatory effects, are widely used. These plants remain staples in traditional medicine systems, illustrating the close relationship between local culture and healthcare practices [16]. Europe is estimated to have 4000–6000 medicinal species. Chamomile and valerian are among the most widely used. This diversity highlights the importance of preserving both the plants and their traditional applications [17]. Oceania hosts between 1500 and 3000 medicinal plant species. The tea tree is notable for its essential oil, which has strong antiseptic properties. Indigenous Australian communities have long used this plant for skin ailments and general health, showcasing the region's unique contributions to global medicinal plant diversity [18] (Figure 1).

Overall, the extensive and diverse distribution of medicinal plants underscores the critical need to conserve these species. Their preservation supports global healthcare, promotes health security, and safeguards cultural heritage.

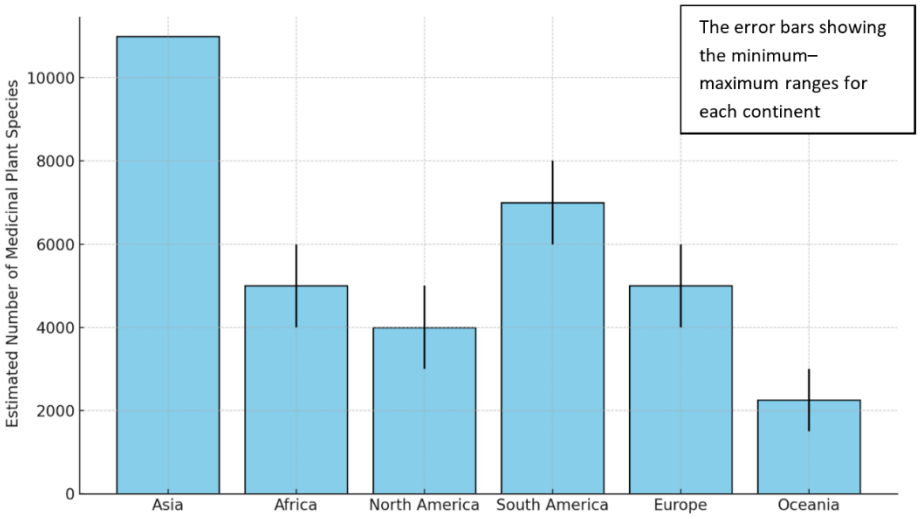

Figure 1. The average estimated number of medicinal plant species by continent.

3.3. The Historical Usage of Medicinal Plants

Medicinal plants have been used for drug preparation for over five thousand years, according to the oldest written evidence discovered. Their use dates back thousands of years and has evolved significantly across various cultures and scientific eras. This evidence was found on a Sumerian clay slab and is believed to be approximately 5000 years old. The tablet has 12 drug preparation recipes with over 250 plants, including poppy, henbane, and mandrake alkaloids [19]. Around 2500 BC, Emperor Shen Nung wrote a book called "Pen T'Sao" which discussed roots and grasses used for medicinal purposes. The book contained information about 365 drugs, including many that are still in use even today. Some of these include ginseng, cinnamon, ephedra and camphor [20,21]. The esteemed literary works like The Ebers Papyrus, The Iliad, The Odyssey, the Bible, De Causis Plantarium, Historia

naturalis, concurrently a pharmacist, De re medica, and De Materia Medica book, authored by Dioscorides are the hallmark references of utilization of herbal remedies in the treatment of diverse ailments. In the 7th century AD, the Slavic people utilized a variety of plants for different purposes. *Rosmarinus officinalis*, *Ocimum basilicum*, *Iris germanica*, and *Mentha viridis* were used in cosmetics, while *Allium sativum* was utilized as a remedy. *Veratrum album*, *Cucumis sativus*, *Urtica dioica, Achillea millefolium*, *Artemisia maritime*, *Lavandula officinalis*, and *Sambuci flos* were utilized for repelling insects such as lice, fleas, moths, mosquitoes, and spiders. Furthermore, *Aconitum napellus* was employed as a poison for hunting [22]. During the Middle Age, the practice of healing, cultivating medicinal plants, and preparing drugs were predominantly carried out by the esteemed physicians residing in monasteries. These physician monks were known to rely on 16 medicinal plants, which they commonly grew within the monasteries by themselves. The plants included but were not limited to sage, anise, Greek seed, savory, and tansy. The Arab contributions to pharmacotherapy are significant, having introduced numerous medicinal plants that have endured over time and are still widely in use. The plants utilized by the Arab pharmacists, such as aloe, deadly nightshade, henbane, coffee, ginger, strychnos, saffron, curcuma, pepper, cinnamon, rheum, and senna, not only provided genuine medicinal value but also enabled the replacement of certain potent drugs with more gentle alternatives for enhanced patient outcomes [23–25].

In the 18th century, Linnaeus revolutionized taxonomy with a comprehensive nomenclature system. He created a clear and concise method for identifying and classifying species by combining capitalized genus names with non-capitalized species names. Today, Linnaeus' system remains a vital tool for scientists and researchers worldwide. The early 19th century saw a significant breakthrough in understanding medicinal plants with the discovery of alkaloids from various plants and the isolation of glycosides. This marked the beginning of scientific pharmacy. Over time, the development of chemical methods led to the discovery of other active substances in medicinal plants, including tannins, saponosides, vitamins, hormones, and essential oils. This knowledge has played a critical role in advancing our understanding of the medicinal properties of various plant species. It has opened up new avenues for research and development, paving the way for new drugs and therapeutic interventions [7].

In the late 19th and early 20th centuries, medicinal plants were at risk of becoming obsolete due to inadequacies caused by enzymes during the drying process. The efficacy of such plants in therapy is dependent on the drying method used. In the 19th century, there was a shift towards using pure therapeutics, alkaloids, and glycosides, which gained popularity over their sources. However, it was later discovered that although pure alkaloids worked quickly, alkaloid drugs provided more comprehensive and long-lasting effects. As the early 20th century approached, there were advances in techniques to stabilize fresh medicinal plants, particularly those with unstable therapeutic compounds. Furthermore, extensive research was conducted on the manufacturing and cultivating of medicinal plants under various conditions [26,27].

3.4. Development of Herbal Therapeutics

The number of plant species used for medicinal purposes by humans is 28,187. The World Health Organization has meticulously documented over 20,000 species of medicinal plants, recognizing their potential as a source of new drugs [28]. Historically, medicinal plants were utilized in their complete form within traditional medicine. Practitioners have been observed to demonstrate a high degree of confidence in the efficacy of herbal medicines, based on positive patient outcomes. The use of herbs moved to the second step by subjecting the herbs to certain processes like stir-frying or soaking in vinegar or wine before they are utilized. In clinical practice, after a traditional diagnosis, a complex and personalized course of treatment is prescribed instead of the whole plant using parts such as leaves, flowers, stems, roots or seeds [7]. Acquiring knowledge about the properties and uses enables practitioners to follow different procedures to treat diverse afflictions. The scientific explanation is extracting on type of natural products used to heal the target diseases such as flavonoids, alkaloids, glycosides, essential oil or any other group of secondary metabolites [29]. Herbal medicine is an age-old practice, also referred to as complementary, alternative, or traditional medicine. Its efficacy is not limited to curing ailments alone, but also extends to preventive healthcare and acting as a supplement to existing treatments [30].

Currently, a substantial body of clinical evidence supports the use of plant-derived pharmaceuticals, which are capable of producing a significant and positive impact on health. These biopharmaceuticals, generated by plants, have the potential to produce affordable, highly scalable therapeutic proteins that can effectively address a range of health issues. It is hoped that the utilization of plants in this manner will provide a pathway to develope new vaccines that are safe, effective, and accessible to individuals residing in developing countries [31]. Many medicines and pharmaceuticals derived from plants such as Artemisinin from *Artemisia annua*, Atropine from *Atropa belladonna*, Codeine from *Papaver somniferum*, Dronabinol and Cannabidiol obtained from *Cannabis sativa*, Digoxin from *Digitalis purpurea*, Morphine (*Papaver somniferum*) and Salicin from *Salix alba* [32].

3.5. Linking Traditional Use to Modern Pharmacology

Medicinal plants contain a wide range of bioactive compounds that contribute to their therapeutic effects. These phytochemicals such as alkaloids, flavonoids, glycosides, terpenoids, and polyphenols are responsible for the antimicrobial, anti-inflammatory, anticancer, and antioxidant activities observed in many traditional remedies. Numerous plants have been scientifically validated for their pharmacological potential, and several active compounds have been isolated for use in modern medicine [33]. The following Table 1 highlights a selection of medicinally important plants, their major bioactive constituents, and their primary therapeutic applications, illustrating the critical link between traditional knowledge and evidence-based drug development.

Table 1. Botanicals with Pharmacologically Relevant Compounds and Traditional Uses.

Medicinal Plant	Active Compounds	Medicinal Uses	Reference
Aloe vera	Aloin, Polysaccharides, Emodin	Skin healing, burns, anti-inflammatory, digestion aid	[34]
Turmeric (*Curcuma longa*)	Curcumin	Anti-inflammatory, antioxidant, joint pain relief	[35]
Garlic (*Allium sativum*)	Allicin, S-allyl cysteine	Cardiovascular support, antimicrobial, immune booster	[36]
Ginger (*Zingiber officinale*)	Gingerol, Shogaol	Anti-nausea, digestive aid, anti-inflammatory	[37]
Peppermint (*Mentha piperita*)	Menthol, Menthone	Irritable bowel relief, antispasmodic, headache relief	[38]
Ginseng (*Panax ginseng*)	Ginsenosides	Energy booster, immune modulation, stress reduction	[39]
Chamomile (*Matricaria chamomilla*)	Apigenin, Bisabolol	Anxiety relief, sleep aid, digestive support	[40]
Licorice (*Glycyrrhiza glabra*)	Glycyrrhizin, Glabridin	Cough relief, ulcers, liver support	[41]
Echinacea spp.	Alkamides, Caffeic acid derivatives	Immune support, cold and flu treatment	[42]
Neem (*Azadirachta indica*)	Azadirachtin, Nimbin	Antibacterial, skin conditions, antiparasitic	[43]

3.6. Role of Medicinal Plants in Modern Drug Discovery

Medicinal plants have long been a cornerstone of drug discovery, offering structurally diverse and biologically active compounds. Despite advances in synthetic chemistry, a significant proportion of modern drugs continue to be sourced from natural origins. Studies estimate that approximately 25% of currently approved pharmaceuticals are derived directly from higher plants, while additional drugs are semi-synthetic derivatives of plant compounds or inspired by plant-based templates [12]. This underscores the ongoing relevance of botanical sources in pharmacology and biomedicine (Figure 2).

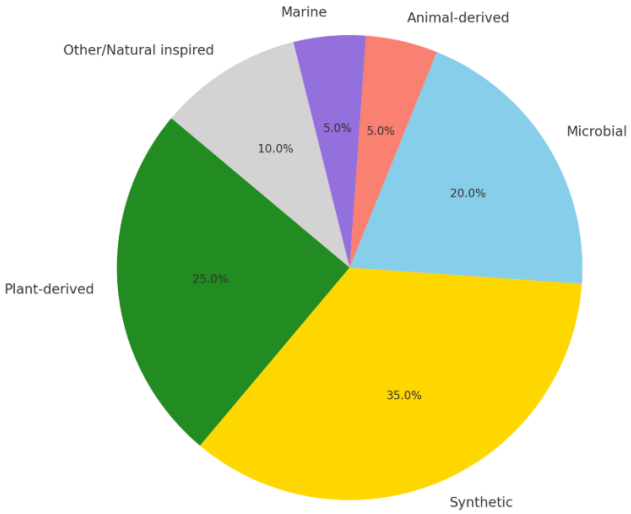

Figure 2. Estimated contribution of different source to modern drugs.

4. Current Challenges and Ongoing Efforts

Medicinal plant extracts have emerged as a safer and natural alternative to synthetic medicines. They are often readily available in local communities and offer cost-effective treatment options. Additionally, their ease of administration and profound therapeutic benefits make them a valuable treatment option. Furthermore, medicinal

plant extracts may be a useful alternative in cases of drug resistance or side effects. There are inherent challenges associated with the use of plant natural extracts as antimicrobial pharmaceuticals that require careful consideration:

4.1. Requirement for Thorough Research Designs

Contemporary research has brought to light the importance of exercising prudence in the administration of medicinal plant compounds in the absence of accurate evidence of their efficacy. To ensure their safety and efficacy, well-controlled, double-blind toxicological and clinical studies are indispensable. It is imperative to acknowledge the rarity of such studies, as they represent the most effective means of proving the efficacy and safety of medicinal plant compounds [44,45].

Ongoing Research: International collaborations, such as WHO-supported trials on *Artemisia annua* (antimalarial) and *Curcuma longa* (anti-inflammatory), are gradually expanding the evidence base. Randomized controlled trials (RCTs) funded by organizations like the NIH are also testing phytomedicines for chronic diseases [46,47].

4.2. Standardization and Quality Control

The use of medicinal plants presents several challenges, such as adulteration of active compounds, insufficient cultivation and collection methods, lack of standardization in preparation, and inadequate storage. These issues significantly impact the development of novel antimicrobial agents. Addressing these factors is necessary to facilitate progress in antimicrobial research [48].

Ongoing Research: Pharmacopoeias (European, Indian, and Chinese) now include herbal drug monographs with reference standards, while analytical tools such as DNA barcoding and metabolomics are increasingly used to ensure authenticity and quality [49–51].

4.3. Variability in Composition

The levels and mechanisms of active compounds in plant extracts can be influenced by numerous factors, including seasonal variations, geographical conditions, and processing methods. Research is underway to develop analytical techniques that can more accurately assess these variables, ensuring consistency and quality in herbal products. Projects utilizing advanced technologies like high-performance liquid chromatography (HPLC) are critical in establishing quality control measures [49,52,53].

Ongoing Research: Techniques such as HPLC, LC–MS, and NMR profiling are now routinely applied in both research and industrial production to establish reproducible phytochemical fingerprints [54].

4.4. Impact of Climate Change

Variation in rainfall and humidity across geographical regions significantly influences the composition and yield of bioactive compounds in medicinal plants, even within the same species. Ongoing global climate change further complicates this issue by altering local weather patterns, thereby threatening the stability of compound production and composition in established growing areas [50].

Ongoing Research: Plant tissue culture, hydroponics, and controlled-environment cultivation are increasingly used to stabilize production. Biotechnology approaches, such as metabolic engineering, help ensure a stable supply despite environmental fluctuations [54].

4.5. Complex Interactions among Compounds

The interactions among the diverse compounds present in medicinal plants complicate scientific analysis. Current research employs systems biology and metabolomics to elucidate these complex relationships. These approaches facilitate the identification of synergistic effects among multiple compounds. Metabolomics specifically enables the characterization of downstream products resulting from gene and protein expression [55].

Ongoing Research: Network pharmacology and computational modeling are now being applied to map compound interactions at the molecular level, clarifying synergistic mechanisms in multi-component herbal formulations [56].

4.6. Regulatory and Quality Assurance Frameworks

The synergism of compounds in a complex mixture creates a unique set of challenges for scientific research. Specifically, the current technological landscape does not provide sufficient means to investigate the effects of multiple compounds that act on potentially multiple biological targets [28].

Ongoing Research: International bodies such as the EMA, FDA, and WHO have introduced guidelines for herbal medicinal products, focusing on safety, efficacy, and quality standards. Harmonization initiatives like the International Council for Harmonisation (ICH) are working to align regulations globally [57].

4.7. Application of Pharmaceutical Science

The adaptation of pharmaceutical science methodologies to herbal medicine is still evolving. Research initiatives are exploring how to apply modern drug development techniques to herbal products, which could enhance their acceptance in the medical community.

Ongoing Research: Advances in nanotechnology, novel drug delivery systems (liposomes, nanoparticles), and pharmacokinetic modeling are increasingly applied to herbal medicine to improve bioavailability and clinical effectiveness [58].

4.8. Biotechnology in Medicinal Plant Research

The absence of quality control, identification, and standardization of chemical compounds and drug formulations poses a significant challenge in applying the same procedure across diverse medicinal products. The incorporation of herbal medicine into the evidence-based medicine paradigm is a relatively novel development.

Ongoing Research: Plant biotechnology including metabolic engineering, CRISPR-based genome editing, and synthetic biology is being harnessed to produce stable, high-yield phytochemicals in vitro, reducing dependency on wild harvesting [59].

By addressing these challenges through ongoing research and collaboration within the scientific community, we can enhance the understanding and application of medicinal plants in modern healthcare. Strengthening these efforts will not only validate traditional uses but also safeguard the ecological and cultural heritage associated with these invaluable resources.

4.9. Market Trends and Growth

In recent years, the global herbal medicine market has experienced substantial growth, driven by increased consumer interest in natural and plant-based therapies (Figure 3). This trend is supported by the rising demand for complementary and alternative medicine (CAM), coupled with growing awareness of the adverse effects of synthetic drugs. According to a market analysis by Grand View Research (2022) [60], the global herbal medicine market was valued at approximately USD 151.9 billion in 2021, and it is projected to reach USD 430.0 billion by 2030, expanding at a compound annual growth rate (CAGR) of 11.16% during the forecast period. This growth is attributed to factors such as increasing geriatric populations, rising prevalence of chronic diseases, and expanding use of herbal products in personal care, dietary supplements, and pharmaceuticals [60]. The surge in investment in research and development, along with regulatory support for herbal products in many countries, also contributes to market expansion.

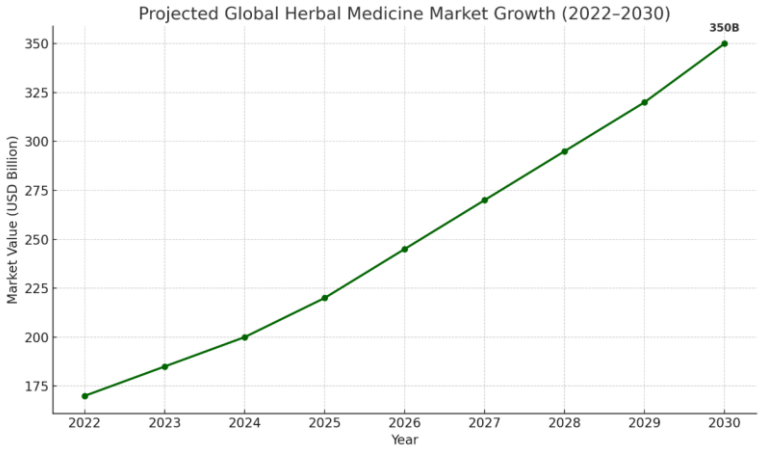

Figure 3. The global herbal medicine market growth from 2022 to 2030.

5. Future Perspectives

The employment of medicinal plants and their derivatives is experiencing rapid growth within the pharmaceutical industry, rendering them a highly auspicious resource for a diverse range of applications:

(1) Medicinal herbs are an untapped source of bioactive compounds. Unfortunately, only a small percentage of their properties have been thoroughly investigated so far. There are still a significant number of medicinal plants that remain unexplored, which could hold great potential for the discovery of novel resistance-modifying compounds. These compounds could be valuable therapeutic tools [61].
(2) There is an urgent need to develop novel approaches and tools to overcome these challenges and enable a comprehensive analysis of the underlying mechanisms of action [62].
(3) The current percentage of approved antimicrobial compounds derived from medicinal plants may not be an accurate representation of the potential of these compounds for future applications as antimicrobial therapies [12].
(4) It is imperative to undertake in vivo testing on animal models of infection to ascertain the clinical significance of compounds and establish a valid correlation with in vitro efficacy results [63].
(5) It is recommended that the structural composition of the compounds be subjected to modifications aimed at enhancing their pharmacokinetic and pharmacodynamic profiles. Additionally, it would be beneficial to conduct comprehensive structure-activity relationship analyses to better understand the correlation between the chemical structure and the biological activity of the compounds under investigation [28].
(6) Further research is needed to understand the synergistic interactions within medicinal plant extracts and between compounds and antibiotics to identify multiple pathways for targeting antimicrobial activity. Although interactions can be beneficial or harmful, in-depth studies, including toxicity assessments, are necessary to establish the potential of these products as biomedical agents [28].

6. Conclusions

Medicinal plants have played a significant role in healthcare throughout history, forming the basis of various traditional healing systems worldwide. Recent scientific research increasingly supports their efficacy. These plants contain numerous bioactive compounds that have contributed to the development of modern pharmaceuticals, highlighting their significance in drug discovery and therapeutic innovation. The growing global interest in natural remedies is driven by increased health awareness, demand for alternatives to synthetic drugs, and concerns regarding antimicrobial resistance. Consequently, medicinal plants are becoming more prominent in both preventive and therapeutic healthcare. Although medicinal plants have been widely used in traditional medicine, only a limited number of species have undergone rigorous scientific evaluation for pharmacological efficacy, safety, and mechanisms of action. This gap in knowledge highlights the necessity for multidisciplinary research that combines ethnobotany, phytochemistry, pharmacology, and biotechnology. Furthermore, ensuring the sustainable use of medicinal plant resources is essential, particularly given the ongoing loss of biodiversity and the threat of overharvesting. Future efforts should prioritize collaboration among researchers, policymakers, and healthcare professionals to scientifically validate and standardize herbal therapies. Preserving indigenous knowledge systems and ensuring equitable benefit-sharing from natural products are also critical. Stakeholders must strengthen international partnerships, improve regulatory frameworks, and advance public education to facilitate the integration of medicinal plants into evidence-based medicine. These measures will support a sustainable healthcare model that incorporates both traditional practices and scientific innovation.

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Conflicts of Interest

The authors declare no conflict of interest. Given the role as Editorial Board Members, Shaymaa Al-Majmaie had no involvement in the peer review of this paper and had no access to information regarding its peer-review process. Full responsibility for the editorial process of this paper was delegated to another editor of the journal.

Use of AI and AI-assisted Technologies

No AI tools were utilized for this paper.

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