Research Output Journal of Public Health and Medicine 5(1):42-49, 2025

ROJPHM

ISSN ONLINE: 1115-9715
ISSN PRINT: 1115-6147

https://rojournals.org/roj-public-health-and-medicine/

https://doi.org/10.59298/ROJPHM/2025/514249

Medicinal Plants in Global Health: A Comparative Study of Practices

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ABSTRACT

Medicinal plants have played a pivotal role in global healthcare systems from ancient times to the modern era. This paper examines the evolution, utilization, and cultural significance of medicinal plants, comparing traditional and modern practices across diverse regions, including Africa, Asia, and Latin America. Emphasis is placed on the historical transformation of plant-based treatments into standardized pharmaceuticals, the persistent use of herbal remedies in under-resourced communities, and the resurgence of interest in ethnobotanical knowledge in developed nations. Furthermore, the study discusses the methodological and scientific challenges in medicinal plant research, the integration of technology, and policy implications in achieving global health sustainability. A comprehensive analysis of global ethnobotanical studies reveals both the potential and pitfalls of traditional medicine, stressing the importance of ethical documentation, biodiversity conservation, and regulated medicinal plant usage. The research advocates for a synergistic approach, blending traditional wisdom with scientific innovation to ensure accessible, safe, and effective healthcare solutions worldwide.

Keywords: Medicinal plants, traditional medicine, ethnobotany, global health, herbal remedies, pharmaceutical industry.

INTRODUCTION

Until the 18th century, the therapeutic properties of many plants used as medicines were known. However, this knowledge was empirical; the active compound was unknown. The origin of modern science, especially in the Renaissance, made it possible to isolate the active principles of medical plants. This was achieved in the following two centuries, thanks to the efforts of many scientists, including Lavoisier, Bergius, Woesley, and Cavanilla. These active principles of plants, considered fundamental in the modern era, have been chemically compounded and obtained synthetically in the laboratory to produce medicines. At present, today's medicine needs the industry producing pharmaceutical medicines based on the active principles of plants. Along with the development of the industry that processes active principles of plants, in the last century, the extraction of drugs from animals and minerals was also considered modern medicine. Several explanations led to a research on limitations and trends of medicinal plants used in traditional medicine around the world today. The underdeveloped world does not have access to this modern medicine and continues to use traditional medicine based on medicinal plants. Also in developed countries, millions of people take on some form of herbal remedy. The most important countries currently engaged in medicinal plants and with a long tradition in this regard are: India, Mexico, China, Brazil, Chile, and the United States, among others. The possible trend to return to traditional medicine just as an information search may have drawbacks. Among these are the use of medicinal plants without health regulation and sanitary controls and whether or not the action of

chemical compounds is known and there are products that have become popular without properly researched products. Three types of studies on medicinal plants are found: those focused on a geographical area; those focused on a specific plant or family; and those focused on some type of medical interest activity [1, 2].

Historical Overview of Medicinal Plants

Until the 18th century, the therapeutic properties of many plants were known and used for medical purposes, but the active compounds in them were still unidentified. The Renaissance enabled the isolation of active principles from plants, leading to the establishment of modern medicine. Chemical drugs and extracts became prevalent, laying the foundation for the pharmaceutical industry, which is essential in today's healthcare system, particularly in developed countries. Drug companies produce large quantities of these medicines, which are crucial for treating various diseases. Conversely, underdeveloped regions lack access to synthetic medicines due to poverty and reliance on traditional medicine. This traditional approach is cost-effective and has enabled many people to maintain good health, shaped by varying cultural interpretations of health, disease, and treatment. Despite its benefits, traditional medicine has drawbacks, including the uncontrolled use of medicinal plants. The rise of modern medicine highlighted the importance of addressing infectious diseases and other health threats. As scientific investigation into potentially dangerous plants, including euphoric or toxic varieties, began, the risks associated with medicinal plants became evident. While some plants are safe, others may possess harmful active compounds. The abundance of herbal medicines and drugs led to misconceptions due to insufficient research, resulting in incorrect prescriptions and tragic outcomes. An example is the misfortune in Yugoslavia linked to the neglect of Mass epidemics in treatments. Misleading practices, including a committee's visit to the affected northern regions, showed the darker applications of medicinal plants. Regrettably, little has been done for those who suffered. Ethical concerns about the understanding of medicinal plants in these communities must be addressed by scientific research. Many traditional plants, such as goldenflower and whitehorn flower, remain unexplored and undocumented, signaling a gap in knowledge and attention that needs to be rectified [3, 4].

Global Perspectives on Medicinal Plant Use

Most of the 54 ethnobotanical studies on medicinal plants (MP) in Africa (n=121) were conducted in Ethiopia, followed by Nigeria (n=31), which are leaders in global MP research. Aside from Morocco, Northern African countries had at least 10 studies each. These studies included a documentary titled "The Last Forest," highlighting traditional healers and their MP uses. Colombia has the highest concentration of MP studies globally, with over 15 studies, benefiting from its unique flora and status as one of 17 megadiverse countries, alongside China. Despite China's rich biodiversity, MP research there is surprisingly limited. Comparative studies show significant differences in MP use worldwide; many countries have a long history of MP use, while others, like Finland, Israel, and the UK, have recent research from the last 30 years, resulting in fewer documented species. Conversely, Morocco, India, and Colombia boast long-established MP traditions. Ethiopia, with extensive MP documentation, and Kenya and Tanzania account for over 30% of Africa's flora, rich in species with unexplored potential. Increased government-funded ethnobotany research in Africa, where local communities utilize MP widely, likely contributes to the higher number of studies and species, while other nations may lack such scientific exploration. [5, 6].

Cultural Significance of Medicinal Plants

Medicinal plants are an important part of people's cultural heritage throughout the world. They play a significant role in many indigenous and local communities, often being the first line of treatment for ill health. Sufficient information is available for a broad category of medicinal plants deriving from the cultural beliefs of local communities. It is a sincere effort to gather traditional ethnobotanical information and document this swiftly disappearing knowledge. The importance of plants in the daily lives of local communities and the role of this knowledge in their social and economic well-being, and the ways it is being threatened due to globalization and modernization of societies. It has studied the presence of ṭamālā as an ethnic medicinal plant in the two diverse ecosystem contexts of Mount Kenya and Himalayas. This has also examined opportunities for possible productive coordination between local communities and scientific research. With recent advances in ethnobotanical surveys, an extensive list of medicinal plants has been compiled in the Himalayan region. However, these studies have centered around India, Pakistan, Bhutan, and Tibet. Very few studies have mentioned medicinal plants in Nepal, even within the home

study perspective of the Himalayas. It has contributed to a different pool of knowledge by scrutinizing local studies on Nepalese medicinal plants. It has identified 132 papers reporting medicinal plants in different ecosystems, various communities, and diseases. Information is available for gastro-intestinal disorders, skin ailments, and respiratory disorders. An account of the medicinal flora in different ecosystem contexts has also been given. Within the scope of the study was to take a case study of indigenous medicine practice in one of the remote parts of far-western Nepal. This is an important part of the ethnobotanical study to document lesser explored, remote regions and a population practice of indigenous knowledge. This study adequately documented medicinal plants used by indigenous people as well as the traditional cultural knowledge on indigenous medicine prescribed for different diseases and ailments. Additionally, chain of informants approach and anthropological tools have been used innovatively for tribal medicinal plant research. The fastest and oncoming vanishing knowledge of indigenous medicine and plants used by the tribal people is also known [7, 8].

Medicinal Plants in Western Medicine

Until the 18th century, the therapeutic properties of many plants were recognized, but their active compounds were unidentified. To address the unpleasant characteristics of these plants, distilled essences were utilized. In 1773, Wout first isolated an active principle from a medicinal plant, leading to significant advancements in modern science that enabled further isolation of active compounds. However, this was limited to a few plant species until the latter half of the 20th century, when efforts surged to isolate new active principles, expanding beyond monocentric processes. Today, the focus includes purified compounds through standardized processes and those derived from biotechnology, generating numerous new products based on these active principles. Specific medicines targeting the synthesis of anabolic steroids did not keep pace with positive drug test controls due to their quick elimination from the body. By 1997, only about 20 of 5200 registered active compounds in drugs were plant-based, despite their widespread use. The extensive diversity of the plant kingdom has not led to a corresponding increase in knowledge regarding medicinal plants. The gap between traditional medicine knowledge acquisition and modern scientific study has significantly narrowed. Initially, before the establishment of a medical school at UCC in 1820, medicinal plants followed traditional approaches. By the mid-20th century, widely used medicines stemmed from scientific advancements. Currently, a sustainable pharmaceutical industry largely relies on plant active principles. In developing regions, many still utilize traditional remedies, benefiting from their low cost. However, there is a concern about the diminishing role of the "doctorate" aspect of Western medicine, which could lead to drawbacks, such as using unregulated medicinal plants. While many plants are harmless, some contain potentially dangerous active principles [9, 10].

Comparative Analysis of Practices

The WHO estimates that over 80% of the population in developing countries use herbal plants, sustaining traditional knowledge through intergenerational exchange. One-fourth of the global drugs and three-fourths in developed countries originate from natural sources, including well-known drugs like aspirin and penicillin. Traditional plant-based medicine, utilized for millennia, is often cheaper than modern medicine and includes a variety of bioactive compounds with beneficial health effects, such as anti-inflammatory and anticancer properties. Despite the risks of toxicity and overdosing, there is significant reliance on medicinal plants for treating various ailments, including COVID-19. Common preparations include teas, ointments, and oil mixtures, with a notable use of leaves and roots. Plants exhibit unique properties in fertile gallery forest conditions, which enhance their efficacy. Future research should explore the pharmaceutical potential of medicinal plants, their role in agroforestry, and their use in religious practices while focusing on conserving herbal biodiversity. Promoting research into medicinal plant systems is vital to address sustainability challenges, implementing strategies that fall into biocompatibility, nanotechnology, and environmental engineering. Recommendations for enhancing biodiversity, improving formulations, facilitating the extraction of bioactive compounds, and integrating modern technologies into herbal medicine markets are also essential for global advancement [11, 12].

Ethnobotanical Research Methodologies

Before designing an ethnobotanical database, it is important to be aware of the previous experience of its creators in collecting, processing, and storing information on local uses. If possible, databases that are already functional at other institutions and can be adjusted to local needs should be used. Basic aspects of documenting local knowledge of biodiversity are discussed here. The focus of research can be made more precise on certain uses: tourism, crafts, food, medicine, etc. While all the activities with local knowledge of

biodiversity surround the same subject matter, the point of view of the researcher, institution, or company will determine the specifics of the information collected. In a day of recording data on the current use of useful plants in the region, the researcher will usually accept that all the information on a typical plant will fit into a small number of fixed categories of questions. Since there are many fixed categories of questions, it should be expected that single encompassing questions might not clarify all needed aspects of a typical plant. In general botany and floristics, it is usually accepted that each species has a unique scientific name (with very few noteworthy exceptions). According to this specialty, as much information on each species in the same language as is known and of interest internationally may be uploaded into this field. In this regard, as much analytical genome information about both classical morphology and molecular genetics as is currently available in the scientific community should be preserved. Medicinal Plants' uses are usually divided into anatomical therapeutic classes (ATC) [13, 14].

Challenges In Medicinal Plant Research

The challenges in medicinal plant research can be categorized into general, basic methodologies, methodological tools, and preservation/access. General challenges include the limited research in areas like agronomy, and there is a need for more studies on medicinal plants whose active principles remain uncharacterized. Increasing education in plant taxonomy, biochemistry, and pharmacognosy is essential for better resource availability. Basic challenges involve the development of analytical methodologies and chemical libraries for studying medicinal plants using sequence data. Research on chiral compounds is notably limited, although insights into chirality would enhance drug safety and efficacy assessments. Evaluating controlled drugs necessitates dose/response studies and compliance investigations. Methodological tool challenges arise from the quality-sensitive nature of plant extract research, which often neglects qualitative data on phytochemicals. Laboratories should adopt ISO 9001 to improve quality management. A lack of suitable models hampers in vivo efficacy testing. Preservation and access issues include the need for legal frameworks for biodiversity conservation, such as establishing faunal reserves and monitoring schemes. Raising awareness about the unregulated trade of rare species and sharing genomic resources or expertise could support the maintenance of domesticated medicinal plants [15, 16].

Role of Technology in Medicinal Plant Studies

In the context of the global effort of the United Nations in 2030 for the Sustainable Development Goals and the WHO Global Strategy on Traditional and Complementary Medicine, a bibliometric analysis of research output on medicinal plants was performed in the period 2010-2019. Publications and citations were obtained from the Scopus database and graphically analyzed using the software VOSviewer and Netdraw, while statistics were computed with Excel 2019. The paper counts 101 countries, the top 20 have produced 93.9% of the total publications, the USA being the most productive, followed by China, India, South Korea, and Brazil. The countries with the greatest collaboration link strength are the USA, China, and Brazil. All 101 countries, except Antigua and Barbuda and Monaco, have at least one label on the world map. At least 39 countries recorded no publications on medicinal plants, while Cuba, Togo, Bhutan, and Yemen have produced only one publication. The paper analyzes the publications by keyword occurrence and highlights diverse topical areas. The importance of conducting research to clarify discrepancies related to the safety and pharmaceutical efficacy of medicinal plants has been highlighted for scientific, agronomic, and traditional reasons. It provides insights into the overall production of knowledge in the field of medicinal plants at the country collaboration level as well as a clearer picture of future research priorities [17, 18].

Policy Implications for Global Health

In today's globalized world, many think local customs will fade, but the rapid integration of foreign cultures has reinforced traditional practices. Local health-related customs have gained recognition, presenting an opportunity to research and sustainably develop them for the benefit of people and the planet. The everyday practices that enable survival and identity formation are invaluable knowledge that should be documented and utilized. Notably, the use of medicinal plants exemplifies this. These plants are crucial for new drug development and healthcare solutions. Their application contributes to economic benefits, ethnic identity, biodiversity preservation, and sustainable agriculture, aligning with global health sustainability. Raising awareness about local medicinal knowledge is vital for disease prevention. Initiatives for poverty alleviation through income-generating health activities, managing medicinal plant resources, establishing nurseries, and training in high-demand medicinal plant cultivation will support sustainable development. A community-based approach will ensure the effective use of these plants in

health care, making local medicinal practices commonplace in global health. Ultimately, this approach will exemplify sustainable development, encouraging global appreciation for biodiversity as essential for sustainability [19, 20-30].

Future Directions in Medicinal Plant Research

Ethnobotanical research efforts have documented traditional knowledge about the uses and cultural importance of native plants in different countries. However, even though a large number of studies have already been conducted in this field, this topic remains an open research area, and there are still many territories that require ethnobotanical studies. Increasing attention on the uses of plants constitutes a first step towards the conservation of the plant genetic resources required for traditional medicine. Due to human interference and transformation of environments, changes in environments and use of the surrounding vegetation indirectly affect the past and present complex interaction between human and plant communities [30-40]. The influence of biogeographical zoning upon the use of plants was also mentioned. The study was based on the assumption that the relatively stable interaction of biogeoclimatic zoning and human communities leads to a certain equilibrium in the local plant communities. However, no baseline data representative of the initial state before human impact and other ancillary data providing information on the temporal and spatial variety of processes are available. There are some gaps and a lack of information that must be considered in future research. First, only data published in scientific journals with a WoS impact factor have been analyzed. Therefore, the results of this study can only be generalized to other scientific publication platforms. Second, the massive volume of data available makes it difficult to cover all aspects of research on the topic, such as threats and anthropogenic pressure on these species and sustainable use of the resources [41-45].

Case Studies of Successful Medicinal Plant Integration

Despite significant investments in health systems, the demand for traditional medicines remains strong. Plants continue to be a primary source of medicine in many cultures, with knowledge of their medicinal properties being passed down through generations. Approximately 80% of the world's population relies on medicinal plants for basic health care. These plants, alongside animal ingredients, are widely used in folk remedies for various ailments. They also play a crucial role in modern medicine. The World Health Organization supports the integration of traditional and modern health care, as emphasized in recommendations since the 1977 World Health Assembly, further bolstered by Agenda 21 and the Rio Declaration. The market for plant-based traditional health products is growing, with affordable herbal remedies merging into formal health care systems as an "over-the-counter" product category. The legislative framework for herbal medicine quality control has expanded significantly. In Asia, where dual health care systems and drug accessibility issues exist, there is an increasing demand for integration, despite concerns about oversight. A double integration process is observed, with WHO member states and multinational companies seeking access to previously protected markets. However, this trend raises warnings about potential loss of biodiversity, indigenous knowledge, and disruptions to local health care practices, prompting the need for careful investigation and solutions during these transitions [24-27].

CONCLUSION

Medicinal plants remain a cornerstone of global health practices, bridging centuries of traditional knowledge with modern scientific advancement. While modern pharmacology has revolutionized healthcare, a significant portion of the global population still relies on traditional plant-based remedies for their affordability, accessibility, and cultural relevance. The comparative analysis underscores that despite regional differences in usage and documentation, the shared human reliance on nature for healing unites diverse medical traditions. However, challenges such as unregulated use, limited scientific validation, and loss of indigenous knowledge persist. By integrating modern research methods, enhancing global collaboration, and implementing policies for conservation and education, medicinal plants can contribute more effectively to sustainable healthcare systems. Harnessing both traditional practices and cutting-edge science promises a holistic and inclusive future for global health—one that respects biodiversity, empowers communities, and delivers equitable medical solutions.

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CITE AS: Odile Patrick Thalia. (2025). Medicinal Plants in Global Health: A Comparative Study of Practices. Research Output Journal of Public Health and Medicine 5(1):42-49. https://doi.org/10.59298/ROJPHM/2025/514249