

The Future of Medicinal Plants in Combating Emerging Infectious Diseases

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ABSTRACT

The rise of treatment-resistant pathogens and emerging infectious diseases (EIDs) has renewed interest in medicinal plants as alternative therapeutic agents. While modern medicine has made significant strides, the limitations of synthetic drugs—such as antibiotic resistance and slow drug development—necessitate complementary solutions. This paper explores the historical and contemporary roles of medicinal plants, their phytochemical properties, and mechanisms of action against pathogens. Case studies highlight successful applications, while discussions on regulatory, ethical, and sustainability challenges emphasize the need for responsible integration into global healthcare. Future research must focus on scientific validation, sustainable harvesting, and interdisciplinary collaboration to unlock the full potential of plant-based medicine in combating EIDs.

Keywords: Medicinal plants, emerging infectious diseases, antimicrobial resistance, phytochemistry, traditional medicine, ethnopharmacology, global health.

INTRODUCTION

The rise of infectious diseases has accelerated significantly, prompting renewed interest in medicinal plants, especially with the increasing incidence of treatment-resistant pathogens. New diseases, including AIDS, Ebola, hantavirus-related illnesses, and SARS, alongside persistent global threats like avian influenza, dengue, and bioterrorism pose serious public health challenges. These circumstances have intensified the urgency for exploring new remedies. Despite advancements in drug development through modern research and clinical trials, folk medicine using plants remains prevalent. Systematizing this use could enhance healthcare effectiveness, alleviate economic pressures on traditional communities, and promote sustainable natural resource utilization while providing farmers with alternative income. The growing issue of antibiotic resistance complicates the treatment of infectious diseases, with an alarming increase in bacterial resistance by the early 21st century. The limited availability of new antimicrobial drugs emphasizes the need for an alternative approach, potentially utilizing biological resources in the environment, such as medicinal plants, which have a history of interacting with pathogens. This paper discusses the recognition and validation of medicinal resources as anti-infective agents, addressing the challenges and applications necessary for achieving these goals [1, 2].

Historical Perspective on Medicinal Plants

The beginnings of the use of medicinal plants were instinctive; animals and primitive men used to consume certain plants instinctively to counteract disease. Over time, humans began to discover more and more specific medicinal plants for certain diseases intuitively, thus moving from an empiric use of medicinal flora to explicatory approaches. Medicinal plants had roles of almost paramount importance, given their potentialities, in numerous societies and cultures up to the recent past. Specifically, the herbal remedy was immediately comprehended as a root of knowledge permitting interactions with the sacred world. The role of the healer is also very ancient; it is not only an empirical-technician task but also a role of mediator, intercessor with the supernatural, and a custodian of a sacral knowledge. In such a context,

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the combination of the healer's guideline and the herbal preparation knowledge becomes the very essence of the "medicine". A great deal of biological-disease knowledge was acquired till the next-to-modern era when science modified the medical panorama and the medicinal flora knowledge, generally privileging rare exotic drugs. Nevertheless, despite the change and evolution, a soft form of the herbal remedy maintained continuity even in recent eras. This knowledge and the whole universe in which it was embedded came under the risk of oblivion at the beginning of the advent of the pharmaceutical industry. There is a post-industrial medical monoculture that was propagated starting from the next-to-modern era, which, coupled with the pharmacological industry revolutionization of the phytotherapeutic preparation, imposed a radical change in the concept of a drug in the general public. The herb, acknowledged for centuries as a therapeutic reservoir, is suddenly seen as an anachronistic, folkish remedy—whereas the drug is considered only the industrially produced, synthesised molecule. With time, this enormous botanical-therapeutic patrimony, which has been handed down for centuries, is increasingly less (even technically) comprehended. The intent is simply to offer homage to the memory of those peoples who, utilizing the sacred bond with their territory, ensured health and function to the communities of the past. Similarly, it is intended to offer, for the correctness of a broader medical context, a recovered perspective on the worth and the complexity of the knowledge of medicinal flora and on the universes in which such a knowledge was generated. Those histories are the roots of the present, and a recovery of a subjective awareness of this foundation is, in the eyes of the intent, essential for a correct evaluation of modern pharmacopeia and the further consideration of the future role of the knowledge and the utilization of the native flora. Let us linger on this often-ignored richness, on a richness which should not be viewed as the stone of an old house, but rather as the cornerstone of an edifice on whose healthiness the plausibility of the future to come is rooted [3, 4].

Emerging Infectious Diseases: An Overview

In this review, medicinal plants are proposed as a future solution for the combating of emerging infectious diseases (EIDs), which have worsened as human development progresses. The difficulty in addressing these challenges through contemporary medicine is discussed. The interconnectedness of health concerning humans, animals, and the environment is described, as well as the current limits of medical intervention. The need for a balanced integrated approach that includes traditional medicine is addressed, focusing on the potential of medicinal plants as herbal medicine against EIDs. Recommendations are made for a novel interdisciplinary approach, which necessitates the partnership of biologists, anthropologists, and environmentalists in addition to healthcare professionals. Case studies are used to illustrate the successful historical use of these medicines in fighting past pandemics. These ideas are proposed for development in further research and the foundation of national and international health policy. In February 2018, an outbreak of swine flu (H1N1) in northern Italy resulted in the confiscation of over 70,000 unsafe vaccines. 20 years ago, this event could have started a worldwide pandemic similar to that of 1918, but luckily was limited by improved healthcare and scientific understanding. As identified by the and the, emerging infectious diseases (EIDs) have become a disastrous threat. They describe diseases that have newly appeared in a population, or existed but are rapidly increasing, or might increase shortly. This definition is in reaction to the rise of new infectious diseases and the resurrection of existing infectious diseases that have not been seen in recent history. Diseases such as acquired immune deficiency syndrome (AIDS), severe acute respiratory syndrome (SARS), Ebola hemorrhagic fever, Middle East respiratory syndrome (MERS), Zika fever, and COVID-19 have raised increasing concern, not just because of the high mortality and morbidity rates, but also because of their profound social, economic, and environmental effects [5, 6].

Role Of Medicinal Plants in Traditional Medicine

One of the oldest legacies of all time in the life of humankind is medicinal plants. Various kinds of medicinal plants have been utilized in various forms by different traditional medicine systems from ancient times. Traditional medicine is the sum of the total knowledge, skill, and practices based on the experiences, beliefs of different cultures and times. It is part of the indigenous knowledge of the people and is known as traditional medicine or ethnomedicine in different localities. Traditional medicine relies on natural remedies; it is a cultural belief system and a way of life. Medicinal plants, by their therapeutic properties, are used to promote healing and forestall the onset of further diseases. The practice of using plants as remedies is as old as human civilization itself. Though there are many varieties of disease, the available remedies are scarce and sometimes inadequate. As a consequence, the findings of alternative remedies for diseases are a major challenge to the medical world. The most appropriate alternative

sources of treatment for communities in developing countries are medicinal plants based on their tradition. There are as many varieties of disease as there are stripes on a tiger's skin, and to treat each disease, one would need a special antidote. Where there are so many diseases as in the east, each must have its disease. The major handicap in the treatment of diseases has been the ignorance of the real nature of any illnesses. Any symptom associated with any sickness was and still is called a disease. Developed plant-based medicines have been formulated as therapeutic agents for the treatment and management of health disorders, thereby guaranteeing their members with a basic health care system. These medicinal plants have also been significantly effective in curing diseases for which pharmaceutical drugs offer only symptomatic relief. Since the 19th century, a large number of health care professionals, scientists, and educated persons in developing nations have not paid much attention to traditional medical knowledge [7, 8].

Phytochemistry of Medicinal Plants

Medicines derived from plants have been used for ages by diverse cultures all over the world. Medicinal plants and their high-value phytometabolites have emerged as promising alternative drug candidates for the treatment or prevention of various types of diseases. In most low- and middle-income countries, traditional medicine systems are as equally important as modern medicine in maintaining individuals' health. It is known that a diversity of chemical constituents is present in medicinal plants, which may consist of potentially beneficial bioactive compounds or play a variety of active roles in treatment. Among them, alkaloids, terpenoids, phenolics, steroids, polysaccharides, coumarins, and flavonoids are some extensively researched essential bioactive substances. These compounds are considered to inactivate, retard the growth, or kill the pathogen or inhibited from proliferating by interfering with its biosynthetic or metabolic pathways. In many cases, these bioactive molecules work by different mechanisms against various types of pathogens. For example, noscapine from opium poppy suppresses the synthesis of DNA, RNA, and protein and leads to cell death of host-symbiotic fungi. Epidemiological studies suggest that the diversity of plant-derived polyphenols protects against various diseases. Recent scientific exploration has also highlighted that all classes of phytochemicals display beneficial effects on health concerns. Bioactive compounds have been the vast interest of natural products chemistry and pharmacological research since the study of plants was initiated. Recently, high-throughput, bioinformatics, and systems biology approaches have provided valuable insight into drug discovery from natural sources. On one hand, several plant-based bioactive compounds or extracts are used efficiently in treating humans, and on the other hand, some are precluded due to their toxic nature or potential interactions, which compels the scientific community to set up a protocol to screen and analyze phytochemical compounds. Currently, several methodologies are available for the enrichment, isolation, extraction, characterization, and bioassay of plant-derived bioactive molecules, given the ever-increasing need for finding a bioactive principle. In light of these analyses, it is suggested that the rigorous examination of the chemical composition of medicinal plants and their primary or secondary metabolites is imperative for the effective translation of traditional knowledge into useful drugs. Furthermore, the scientific validation of phytoconstituents and its crucial efficacies will offer a mapped path to the possible formation of further substantial progression in the biomedical arena to reform the profitable resources for drug innovation in both developing and developed countries [9, 10].

Mechanisms of Action Against Pathogens

Medicinal plants have been historically used across cultures for various ailments, including infections. Yet, the reasons for their effects remained unclear, hindering acceptance by the medical community. Recent advancements in analytical methods and pharmacology have allowed for more thorough investigations. An intriguing question is how the antimicrobial effects were identified before modern techniques, with traditional pharmacopeias providing some theoretical frameworks that remain fragmented, especially concerning complex herbal mixtures. Strengthening these frameworks based on modern disease knowledge is essential for understanding potential effects. This progress will facilitate the adoption and research of these remedies through contemporary pharmacological methods, benefiting both areas. Plants produce numerous bioactive compounds with diverse biological effects, likely interfering with microbial growth and replication. Many infectious diseases arise from microbial infections, making herbal remedies potential antimicrobial agents. Documented mechanisms include antibacterial, antiviral, and antifungal properties, along with immune-enhancing effects that help the body fight infections. With rising antibiotic resistance, natural compounds' antimicrobial properties are being explored for therapeutic uses. However, the molecular modes of action for most compounds remain largely unknown.

Therefore, further pharmacological research could lead to new drug discoveries. Case studies of well-documented ethnopharmacological remedies reveal mechanisms of action while allowing a critical assessment of the scientific quality and plausibility of these reports [11,12].

Case Studies: Successful Applications

During the past two decades, infectious diseases have become one of the most serious threats to health worldwide. In both developing and developed countries, the emergence of new and reemergence of old infectious diseases has brought negative effects from social, health, and economic aspects. Inadequate public health infrastructures, the rise of antibiotic resistance, and the lack of new drugs have driven the search for alternatives in traditional medicinal knowledge for the treatment of infectious diseases. As an empirically based knowledge system, traditional medicine is a fusion of accumulated clinical experiences associated with the medicinal use of different resources. It includes herbal medicine, acupuncture, and massage and is an integral part of the culture and custom of specific populations. Since the empirical era, the phenotypic or morphological features of plants have led practitioners of traditional medicine to believe in the efficacy of specific plants. Traditional medicine is the foundation of millions of lives around the world. In the West, the use of phytomedicine is growing at a fast pace. These formulations are considered as an alternative to synthetic drugs. Not surprisingly, according to the WHO, over 75% of the world's population most heavily rely on traditional medicine to meet their primary health care needs. Although the therapeutic activity of many remedies has not been scientifically proven yet, literature instead supports the efficacy of several plant species in treating infectious diseases. Since this traditional knowledge is an oral tradition passed upon generations, it is currently being lost. In the scientific community, there is a consensus about the utility of traditional knowledge. One potential of ethnobotanical research is the development of new drugs. There are several therapies derived from traditional medicinal knowledge that have been formulated and investigated to generate scientific proof of their efficacy. Major projects are supporting clinical intervention studies on traditional medicinal plants, such as the antimalarial trials in Vietnam. In this way, traditional medicine has been shaped into evidence-based medicine [13, 14].

Challenges In Research and Development

Despite a growing body of scientific research in medicinal plants, many challenges limit potential uses to meet contemporary health. Global constraints of finances, regulation, and standardization in the process of validating traditional knowledge with scientific evidence are major obstacles to research and development. The difficulties in this verification process have been recognized by only a limited number of studies, remain complicated, or are about to begin. Furthermore, increasing demands on medicinal plants because of emerging diseases are directly correlated with the increasing loss of biodiversity and overharvesting. Urgent coordinated actions are needed to protect the natural resources that provide the latest hope for public health, and interdisciplinary collaboration amongst traditional medical practitioners, biomedical scientists, conservation biologists, as well as policy makers could enhance efforts to combat this health and environment crisis. Since it is believed that discussing sustainable use is a way to partly answer these challenges, a critical analysis in research and development efforts has been conducted so that further development can be another effort in answering urgent needs. A separate chapter then begins to offer some guidelines on the scope of research for which growth can be more structured and productive. As interest in traditional plant medicines has grown around the world, this potential has been recognized as useful for the development of new drugs, which could also contribute to significant profits for both industry and communities. However, despite some successful examples in plant-based drug discovery, several researchers have drawn attention to the potential constraints and problems in protecting intellectual property and bringing traditional health homes to market as evidence-based products that are safe, effective and of the right quality, the traditional term safety, efficacy, and quality claim [15, 16].

Regulatory and Ethical Considerations

Regulatory and ethical considerations are fundamental in arbitrating the future of medicinal plants for development as drugs to combat emerging infectious diseases. Ensuring consumer safety, therapeutic efficacy, and quality control of herbal products are top concerns for both consumers and the pharmaceutical industry. International and national guidelines are necessary, available but infrequently followed. Preclinical and clinical trials are requested, and investigational new drugs (IND) are needed. Developments of biopharmaceutical products of plant origin normally will not meet these guidelines and could violate patent rights and standardization processes. However, if requirements to new drug applications are waived or phased, plant products could be developed further along with developed

countries. Also, strategies to protect indigenous knowledge (IK) of medicinal plants are needed, following the Convention on Biological Diversity and the Trade Related Intellectual Property rights (TRIPs) of the World Trade Organization (WTO). Recent mega-bioprospecting agreements between pharmaceutical industries and developing countries could have more negative impacts on the IK of indigenous communities than the impact of bio-piracy and could be unethical. The vast majority of medicinal plants in the world are sourced from the wild, from where many are also modeled into pharmaceuticals. These practices pose major issues for conservation, biodiversity, sustainable development of local economies, and respect for the earth. Nonetheless, if obligations are met for conservation and sustainable development, these medicinal plants could be responsibly sourced from the wild. The requirements for technical background could be so imposed for bioprospecting agreements. Moreover, transparency is frequently suggested and highlighted yet often ill-practiced by the major role players of the pharmaceutical industry, and this also applies to herbal products, bioprospecting agreements, and the process of ethnopharmacological studies. Therefore, appraisal and research orientation are sought here on the processes of ethnobotany and ethnopharmacology. Such examination could provide guidelines as balanced and objective approaches to these disciplines, help to set standards, and thereby promote better understanding and cooperation between the industrialized and developing countries in these areas, ensuring that codes of good practice are implemented [17,18].

Sustainable Harvesting Practices

Medicinal plants have played a significant role in combating diseases throughout human history. Nevertheless, the over-exploitation and habitat degradation of many medicinal plants due to the destruction of natural ecosystems have threatened and even endangered these plant species. Various pharmaceutical companies are realizing the importance of protection measures and starting proactive conservation initiatives for sustainable use. Consequently, sustainable harvesting practices and the protection of wild resources are critical. Otherwise, the global medical industry, as well as millions of rural people in the developing world, could be in trouble. Several steps can support these efforts and ensure the perpetual and secure supply of medicinal plants. First, cultivation and horticulture can significantly reduce pressure on natural populations. Traditional morphological methods and molecular techniques can help decide whether certain plants can be cultivated. Second, sustainable systems of wild plants can be established with the direct involvement of local people to balance the growing demand with effective collection strategies. The significance of educating the target communities cannot be overstressed. The plans for sustainable use of the natural stock of medicinal plants can be economically beneficial for the rural population. Furthermore, such careful use of medicinal plants may even help preserve the whole eco-system better. It is important to understand that unless global biodiversity and social questions are considered, the protection of living resources could become impossible. Public health (economic, environmental, and social) should be treated jointly and not as separate issues. In this way, the health of living organisms and people, and future generations can be conserved. Most importantly, the views and opinions of rural societies should be rigorously included in planning. The whole world may learn about the significance of biodiversity through the example of a small and almost unknown country. Various initiatives should be encouraged if health conservation is to become a global matter [19, 20].

Integrating Traditional Knowledge with Modern Science

Medicinal plants have long been used for healing or disease prevention in indigenous communities. The World Health Organization has reported that 80% of the world's population who rely on traditional medicine choose plant-based therapies, and most of these rely on medicinal herbs. Researchers have invested in ethnopharmacology, an interdisciplinary field of inquiry that investigates traditional medical practices and the bioactive properties of plants. Conversely, many have advocated for the relevance of traditional knowledge to conduct ethnopharmacological research. Indigenous communities generally base their medical systems on traditional knowledge, where the healing process is linked to the cultural and spiritual world. Traditional medical practitioners frequently make use of practices such as spiritual healing, rituals, prayers, diet, and herbal medicines. In addition, the healing process might differ from those in Western medicine, and in many cases, indigenous medical systems treat patients' illnesses by rejuvenating their spirit and soul as well as by curing the physical symptoms. Because of the different points of departure and rationale of each knowledge system, an examination into traditional practices must be done respectively and carefully, with an understanding of the meanings these practices carry. However, as historical, geographical, and socio-financial barriers form, the discussion of medicinal plants has rarely been met through a cooperative dialogue. To face the threat of emerging infectious diseases, it

is important to acknowledge mosquito management comprehensively. Based on case studies from the Pacific and Latin America, it is noted that “traditional” practices can generate empirical results and hypotheses. Likewise, experimental results can provide explanatory support for “traditional” management. Accordingly, providing a secure and prosperous healthcare system publicizes the methodology and experimental results used, and conversing modestly with “traditional” mosquito management practitioners, aiming to propose a comprehensive adaptive mosquito management framework through a dialogue [21, 22].

Future Directions for Research

The lack of medicinal coverage in emerging economies is prompting the pharmaceutical industry to reorient research initiatives towards less lucrative therapeutic targets. In this sense, the treatment of infectious diseases, which has been neglected in the past, is now among the priorities addressed by pharmaceutical research. However, to prevent the emergence of multi-drug-resistant strains of common pathogens in the future, it becomes apparent that all feasible therapeutic approaches should be examined, including the use of traditional treatments based on medicinal plants. This paper examines world research trends regarding the use of plant materials as medicine. A first emphasis has been put on the reasons why the practice of traditional medicine is interesting. This is followed by a search on current research trends in Asia, Europe, Africa, and America. An innovative method has been developed to assess world research trends on the use of medicinal plants. Close contacts have been established with the research teams of various countries. Current research trends have been the focus of discussion in these encounters. A priority-based search in the geographical regions of these nations has furthermore been conducted to identify local research trends and to support the promotion of international collaboration. Traditional medicine fills the gap in underdeveloped countries where modern medical coverage is lacking. Established ethnopharmacy departments in studied countries are *Press-Pharm* and *Journals of Ethnopharmacology*, including the chemical structure and activity of certain traditional plant products cultured *in vitro*. Clinical tests aiming to scientifically validate a specific traditional prescription led to the synthesis of unanswered questions about the use of medicinal plants [23, 24].

Global Collaboration and Partnerships

Over the last two decades, new infectious diseases have emerged, prompting global cooperation to combat these pathogens and heal plant systems using chemotherapy. However, the increase in multiple-drug resistance, especially in immunocompromised individuals, poses significant challenges. Amidst these issues, higher plants provide promising opportunities for discovering new remedies. A significant percentage of modern pharmaceuticals derives from natural resources, and despite advancements in drug synthesis, botanicals remain a vital source of therapeutic agents. Transnational drug companies have previously focused on enhancing botanical efficacy, but recent shifts towards food safety and environmental concerns affect plant remedy research and applications. The article emphasizes critical priorities for the coming century, highlighting the potential of plant health in medication research and technological advancements. Despite extensive investments, fundamental knowledge remains underdeveloped, instilling a sense of urgency to create solutions. Collaborative efforts among scientists and policymakers are intensifying due to plant health maladies threatening food supplies and livelihoods, with the potential for severe losses looming. National interests often overshadow global concerns, necessitating cooperative efforts to allocate resources effectively. The importance of global surveys conducted by medical, social science, and epidemiology professionals has been underscored in strategies to contain emerging infectious diseases. Evidence suggests that drug resistance stems from the misuse of antibiotics, necessitating robust support from governments, NGOs, and academic institutions. Increased focus on desirable outcomes and sustainable practices is essential, and globally coordinated doctor surveys using consistent methodologies could be beneficial. Science faces both opportunities and challenges in an increasingly interconnected world, fostering collaboration across borders. Many nations have established networks to support global scientific relationships, fostering development and encouraging young scientists to participate in international collaboration. The UK's initiatives illustrate six key aspects of partnerships and alliances that contribute to successful relationship-building [25, 26, 27].

Public Awareness and Education

Health issues and the austerity measures triggered by the financial crisis have reminded many that medicinal plants are still a valuable part of humanity's pharmacopeia. There is clear urgency to promote the use of medicinal plants conscientiously and sustainably. Whenever discussing plants in this context, the tacit means of organized, structured, and targeted collections of plant material for specifically

therapeutic purposes is intended. Nurturing public awareness and knowledge about their potentials and specifics is essential to ensure present and future sound use. There is a need for a new approach, more concerted and more focused on what can be achieved within a short time frame. Although in a universal perspective, the knowledge here gathered from the past should suffice for the purpose, experience suggests that in practice, wider awareness and understanding will derive new attitudes, which in turn will lead to true and planned changes. Likewise, community education about the rational use of medicinal plants is seen as of the utmost importance, not least to avoid overexploitation of threatened species and also to make people aware of conservation needs and of the advantages to be gained from managed cultivation. Thanks to today's technology and communication networks, much can be done with modest resources through targeted projects presently considered innovative or experimental. Public awareness regarding medicinal plants, their therapeutic effects, and their potential for scientific exploitation in the treatment of physiological and infectious diseases has important repercussions from a social viewpoint. An increased awareness in the population about these issues would certainly influence health behavior, and a better acceptance of the utilization of traditional plant-based remedies might derive from a wider understanding of the problems at stake. On the other hand, a more conscious use of plants by the population would call for a new approach by health personnel, capable of considering the potential therapeutical value of the plant-based remedies used and less biased by prejudice. If successful, the normalization process might influence decision and policy makers, enhancing plant conservation and stimulating research as to the effectiveness of the remedies used [28, 29, 30].

Economic Implications of Medicinal Plants

There are significant economic implications to be considered in the increasing use of medicinal plants for Primary Health Care (PHC). Economic analysis shows that medicinal plants can play prominent roles in one of the most crucial aspects of the current global health situation. With the increasing use and commercialization of herbal products globally, a potential market of over \$100 billion per annum is forecast. It would be wise, therefore, not to overlook the benefits that medicinal plants could offer in tackling major global health problems in wider economic terms while addressing increasing public demands. However, actions are required to protect the interests of both the industry and rural communities. Both parties have responsibilities, at central and local levels, to create favourable conditions for sustainable and profitable development of the sector. Medicinal and aromatic plants must be seen as a way of diminishing the vulnerability of rural populations rather than enhancing it through the promotion of unsustainable practices. It is crucially important to develop rural areas to secure social stability and to maintain ecological environments. Efforts could, for example, be made through appropriate policy and legislation to regulate the collection, use, and trade of wild medicinal plants in both sustainable and equitable ways. Furthermore, the wealth of traditional knowledge of medicinal plants among indigenous people should be protected. In this context, the benefit sharing of genetic knowledge derived from the commercial R&D activities of natural products would be crucial. Moreover, access to modern biotechnologies for plant propagation, cultivation, and post-harvest management should be more facilitated at the rural community level. In drafting development plans for the on-farm cultivation of MAPs, it is crucial to take into general consideration the economic and commercial conditions of MAP producers and to deliberate on the appropriateness of setting up further specialized units where there are already large and economically sustainable producers [31, 32, 33].

CONCLUSION

Medicinal plants have historically played a vital role in human health and remain promising in addressing modern challenges like antimicrobial resistance and emerging infectious diseases. Despite their potential, obstacles such as regulatory barriers, sustainability concerns, and the need for scientific validation hinder their widespread acceptance. Future research must focus on integrating traditional knowledge with modern pharmacology, ensuring ethical bioprospecting, and fostering global collaboration. By promoting sustainable harvesting, public education, and international cooperation, medicinal plants can be developed into viable therapeutic solutions that complement modern medicine and enhance global health security.

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