

Exploring Indigenous Pharmacology Through Ethnobotany: A Review

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Abstract- Ethnobotany is the study of the relationship between plants and people, especially how indigenous communities use plants for food, medicine, and cultural practices. Medicinal plants form the backbone of traditional healthcare in many rural and tribal regions of the world. Studies show that a large portion of the world population still depends on herbal medicines, highlighting the global relevance of indigenous plant knowledge. The paper discusses the historical development of ethnomedicine, global and Indian diversity of medicinal plants, research methodologies, plant parts used, preparation methods, and major disease categories treated using herbal remedies. It further highlights the critical role of ethnobotanical knowledge in modern drug discovery, biodiversity conservation, and sustainable healthcare systems. Special emphasis is given to socio-cultural significance, conservation strategies, ethical concerns, intellectual property rights, and the urgent need to document and preserve traditional knowledge threatened by modernization, habitat loss, and climate change. The review also explores the integration of indigenous knowledge with modern pharmacology and sustainable development goals (SDGs). Ethnobotanical knowledge not only supports low-cost healthcare but also provides promising leads for novel drug discovery and ecosystem conservation. The study concludes that preserving and scientifically validating indigenous plant knowledge is essential for sustainable development, future healthcare innovation, and biodiversity protection.

Keywords- Ethnobotany, Indigenous knowledge, Medicinal plants, Traditional medicine, Sustainable healthcare

1. Introduction

The present use of medicinal plants in healthcare mainly comes from indigenous knowledge that has been passed down from one generation to the next. Likewise, traditional healers and herbal practitioners have long relied on their understanding of locally available plants to treat different illnesses [1]. Human civilizations have relied on plants for healing since ancient times. Indigenous communities possess valuable knowledge about medicinal plants, passed down through generations through oral traditions. These communities use local plants to treat diseases, maintain health, and manage ecosystems. Medicinal plants play a vital role in the healthcare of indigenous communities and are the primary source of treatment for many rural populations. Plants also provide food, medicine, fuel, animal feed, and materials for building [2]. According to the World Health Organization, nearly 88% of the world's population depends on herbal medicine for primary healthcare, especially in developing areas. Traditional medicine is still important because it is affordable, easy to access, culturally familiar, and often effective for basic health needs. Ethnobotanical research helps record this valuable knowledge before it is lost because of modernization and changing lifestyles [3]. Traditional folk practices are slowly disappearing because younger people are losing interest and over-the-counter medicines are easily available. It is very important to properly record the experiences of elders, whose practical knowledge about using medicinal plants is valuable. Documenting their traditional wisdom has provided new understanding and increased the treatment options for many diseases. Plants are very useful for people and have great potential for developing new medicines. Therefore, the results of this ethnobotanical study can serve as a starting point for further pharmacological research, especially on the plants that are most commonly used and highly valued for their healing properties. [4]. Recognizing the importance of indigenous knowledge helps protect the environment, encourage new healthcare ideas, and ensure that future generations can benefit from this valuable heritage. Traditional knowledge of plants also supports modern drug research and creates economic opportunities through herbal products, eco-tourism, and sustainable trade, showing its cultural, environmental, and economic value [5]. The traditional diet of the indigenous people of Ladakh is not only about meeting their nutritional needs. It reflects their strong faith in traditional knowledge and their sense of community, especially during religious and cultural events where local foods are shared. The harsh climate, low rainfall, and low oxygen levels in the region help these wild edible plants survive tough conditions and also make them rich in antioxidants [6].

Concept of Ethnobotany and Indigenous Knowledge-

Throughout history, knowledge about plants has been essential for human survival by providing food, medicine, shelter, and a sense of cultural identity. Indigenous communities have developed detailed ways of identifying, growing, and using plants through many years of observation and experience. This traditional knowledge has also supported modern scientific discoveries, as many medicines, farming methods, and ecological ideas have come from it. In recent years, ethnobotanical research has become more important for recording, protecting, and promoting this valuable plant knowledge [7]. Working together with indigenous communities is essential for carrying out ethnobotanical research in an ethical, respectful, and fair way. Such partnerships promote respect, mutual benefit, and sustainability, ensuring that both researchers and communities gain from the work. When researchers involve communities through consultation and active participation, they build trust and encourage a sense of ownership and empowerment. Including traditional knowledge in research methods provides valuable insights that improve the accuracy, relevance, and cultural understanding of the results. Collaborative research also helps protect cultural heritage, revive traditional knowledge, and support communities in shaping their own future. Respecting the intellectual property rights of indigenous people ensures ethical research practices and promotes social justice [8]. Ethnobotany is an interdisciplinary field that connects botany, anthropology, pharmacology, and ecology. It studies how people use plants in traditional practices, how they classify local plant species, the cultural beliefs linked with plants, and the sustainable ways they manage plant resources. Indigenous knowledge is based on experience, adapted to local environments, and passed down orally from one generation to the next. This valuable knowledge supports drug discovery, biodiversity conservation, and sustainable development. Indigenous knowledge and ethnobotany are very important for protecting the environment, biodiversity, and cultural heritage. However, they are still not widely included in higher education. As the need for sustainable education grows, it is necessary to bring traditional knowledge into academic programs to preserve cultural identity and help solve global challenges. Since 2010, interest in ethnobotany and indigenous knowledge has increased, especially in relation to the Sustainable Development Goals. Indonesia has contributed a large number of research papers and citations in this field. Studies also show that local knowledge plays a key role in creating teaching methods that suit local contexts and encourage new ideas in curriculum development [9].

Global Importance of Medicinal Plants-

Plants provide many essential resources such as food, wood, and fibers for textiles. Since ancient times, they have also been used to treat different diseases. In many parts of Africa, Asia, and Latin America, about 85% of people depend on plant-based medicines for healthcare. For instance, traditional healers in Nigeria use plants like mango, African yellow wood, and lemongrass to treat malaria. In rural India, turmeric and holy basil are commonly used to heal cuts and wounds. The Buyi community in China uses certain local plants to treat rheumatism, while herbal healers in the Peruvian Amazon use medicinal plants to treat herpes, snake bites, and cataracts. Because of their healing potential, plants are widely recognized in scientific fields such as pharmacy and natural products chemistry as important sources of medicines. The Philippines is known as one of the world's biodiversity hotspots. It has about 1.9% of the world's unique plant species and is home to around 10,078 vascular plant species belonging to 1,962 genera and 287 plant families. [10, 11,12,13]. Nepal is home to about 8.4 million indigenous people from different communities living in diverse landscapes. They have their own cultures, religious traditions, and rich systems of traditional medicine. Around 6,653 species of flowering plants have been recorded in the country, and about 1,792 to 2,331 of these are considered medicinal and aromatic plants. Even though Nepal has great potential to promote medicinal plants in national and international markets, it has not fully used these resources to generate income. Traditional herbal medicine in Nepal is strongly linked to cultural and religious beliefs and is practiced in rituals, spiritual healing, and self-care. For centuries, indigenous and local communities have used their traditional knowledge, guided by local customs and laws, to treat various diseases. This knowledge also helps in identifying and managing natural resources sustainably [14, 15]. Medicinal plants have been used for a long time and are an important part of healthcare in Ethiopia. However, these plants and the traditional knowledge linked to them are rapidly declining because of environmental changes and shifting social and economic conditions. So far, only a few studies have been carried out to identify these plants and to preserve the valuable knowledge held by local communities [16]. The medicinal value of plants has long been recognized in India. Many plant species are recorded in traditional healthcare systems such as Ayurveda

(1400–1800 species), Siddha (500–900 species), Unani (400–700 species), Homeopathy (around 372 species), and Sowa-Rigpa (about 250 species) [17].

Diversity of Medicinal plants used by Indigenous communities-

About ten percent of all vascular plants are used for medicinal purposes, and there are an estimated 350,000 plant species worldwide. Using plants to search for active compounds has produced a large amount of scientific research. Studies of publications in the Scopus database show that research on medicinal plants grew quickly over the past 20 years, reaching a peak around 2010 and then stabilizing at just over 5,000 papers each year. Overall, global research has focused more on finding new medicines and active compounds than on cultivating or domesticating plant species with medicinal potential. Ethnobotanical surveys reveal a huge diversity of plant species used in traditional medicine [18]. A recent study in Mizoram, India documented by [4] in which 124 ethnomedicinal plant species belong to 112 genera and 60 families from 206 informants. The most dominant growth form was herbs and the common plant part used were leaves. The decoction was prepared by the common decoction method. Maximum medicinal plants were documented from the Asteraceae family. These plant species were used for common ailments such as indigestion, burns, cuts, wounds, inflammations, fever, diabetes. The part of the plant including roots, seeds, bark, leaves, fruits were used. In an Ethiopian study where, a total 32 medicinal plants were studied for 32 different human ailments. In this study along with these plants some other ingredients including honey, butter, coffee, garlic, water, sugar were also added in the preparation of the herbal medicine [19]. In ethnobotanical study of medicinal plants of western Nepal around 132 plants were studied from 99 genera belonging to 67 families for various diseases like gastro-intestinal, parasitic, hepatobiliary disorders, blood and lymphatic system [20]. In a recent study at Ladakh, India around 52 wild edible plants from 40 genera belonging to 25 families were studied. These plants need more attention for conservation and cultivation as they are recorded in a red data book. Out of 52 plants one wild edible plant critically endangered, 2 endangered and 3 vulnerable were recorded [6]. In most of the cases common growth forms were herbs, shrubs, trees, climbers and epiphytes, out of which herbs were the common form used. Herbs dominate because they are easily available, fast growing and rich in bioactive compounds.

Preparation Methods and Therapeutic Applications of Medicinal Plants-

Herbal medicines have been used for thousands of years and are an important part of traditional healthcare and cultural practices worldwide. Today, growing interest in natural and alternative treatments has increased their popularity in modern healthcare markets. The World Health Organization has developed guidelines for the quality control and standardization of herbal medicines, which are followed by many countries. These guidelines explain possible harmful contaminants and residues in herbal drugs and provide basic principles for checking their quality and safety. Herbal preparations can include powdered or crushed plant materials, as well as extracts, tinctures, oils, juices, and processed plant resins. These products are made using methods such as extraction, distillation, pressing, purification, concentration, fermentation, and other biological processes [21]. Indigenous communities mostly use simple but effective methods of herbal medicine preparations including decoction that is prepared by boiling plant material in water for 15 minutes to 2 hours followed by cooling and filtration. This extraction method is not very selective, especially for compounds that do not dissolve in water. It often gives low yields and requires large amounts of water, which can raise safety and environmental concerns. Infusion is prepared by soaking plant parts in hot water, paste is prepared by crushing plant parts, powder is prepared by drying and grinding the plant parts, juice is produced by extracting fresh plant sap. In infusion extraction, plant materials are soaked in a fixed amount of hot or cold solvent for about 15 minutes. After that, the mixture is allowed to cool for around 45 minutes and then filtered [22]. Out of the above Decoction is the most common method, used in over 60% of cases. In maceration, dried plant material is soaked in a liquid solvent in a container and shaken regularly. It is then left at room temperature for about 2–7 days. This process softens and breaks the plant cell walls, allowing the bioactive compounds to dissolve into the solvent. Afterward, the liquid is filtered and the remaining plant material is pressed to recover any trapped solvent [23, 24]. In remote areas, traditional medicine often serves as the primary healthcare system.

Indigenous communities rely on many plant species to meet daily needs and treat a wide range of illnesses. Various plant parts are used to prepare medicines, decide the method of use, and determine suitable doses for consumption. Many of today’s most effective prescription drugs have their origins in bioactive compounds found in plants. Antioxidants are substances that neutralize reactive oxygen species and protect cells from damage. Medicinal plants rich in flavonoids, phenolic compounds, and vitamins C and E show strong antioxidant effects and help guard against diseases linked to oxidative stress, including heart disorders, neurodegenerative conditions, and cancer. These natural substances provide many health benefits, especially strong antioxidant effects. Several medicinal plants, including *Ocimum sanctum L.*, *Withania somnifera (L.) DunaL.*, *Curcuma longa L.*, and *Zingiber officinale Roscoe.*, are well known for their antioxidant properties [25]. Many plant-derived phytochemicals show anticancer potential by slowing the growth of tumor cells, triggering programmed cell death, and preventing the formation of new blood vessels that feed tumors. Compounds such as flavonoids, alkaloids, and terpenoids act on key cellular pathways, making them promising for cancer prevention and treatment. These plants including *Catharanthus roseus (L.) G. Don*, *Cannabis sativa L.*, *Moringa oleifera Lam.*, *Emblica officinalis (L)* etc. Several plants like *Boerhaavia diffusa*, *Phyllanthus niruri L.*, *Curcuma longa*, *Silybum marianum (L) Geartn.*, *Hemidesmus indicus R. Br.*, exhibits hepatoprotective property by decreasing inflammation, oxidative stress and liver injury caused by toxins. *Azadirachta indica A. Juss* considered as a sacred tree in Indian culture, exhibits antiviral activity, Antidiabetic, antimicrobial, Skin infection, Blood purifier, Anti-influenza virus, Anti-arthritic, Anti-inflammatory activity, *Tinospora cordifolia (Willd) Hook f.* used in cough, cold and in fever, also exhibits anti-inflammatory, immunomodulatory, antidiabetic activity. The seed of *Moringa oleifera* is used against neurodegenerative disorders [26]. In traditional Chinese medicine *Panax spp.*(Ginseng) is used in improving vitality, stamina and cognitive activity. Many native tribes of America from thousands of years ago used *Echinacea purpurea* for enhancing immunity and treating colds and infections (Figure1). In Egypt, Greek and Roman medicine *Aloe vera* is traditionally used in healing burns and soothing skin irritations. Extracts of *Ginkgo biloba* have been widely investigated for their ability to enhance memory and cognitive performance. Research also suggests their promising role in delaying the progression of neurodegenerative disorders such as Alzheimer’s and Parkinson’s disease [27, 28].

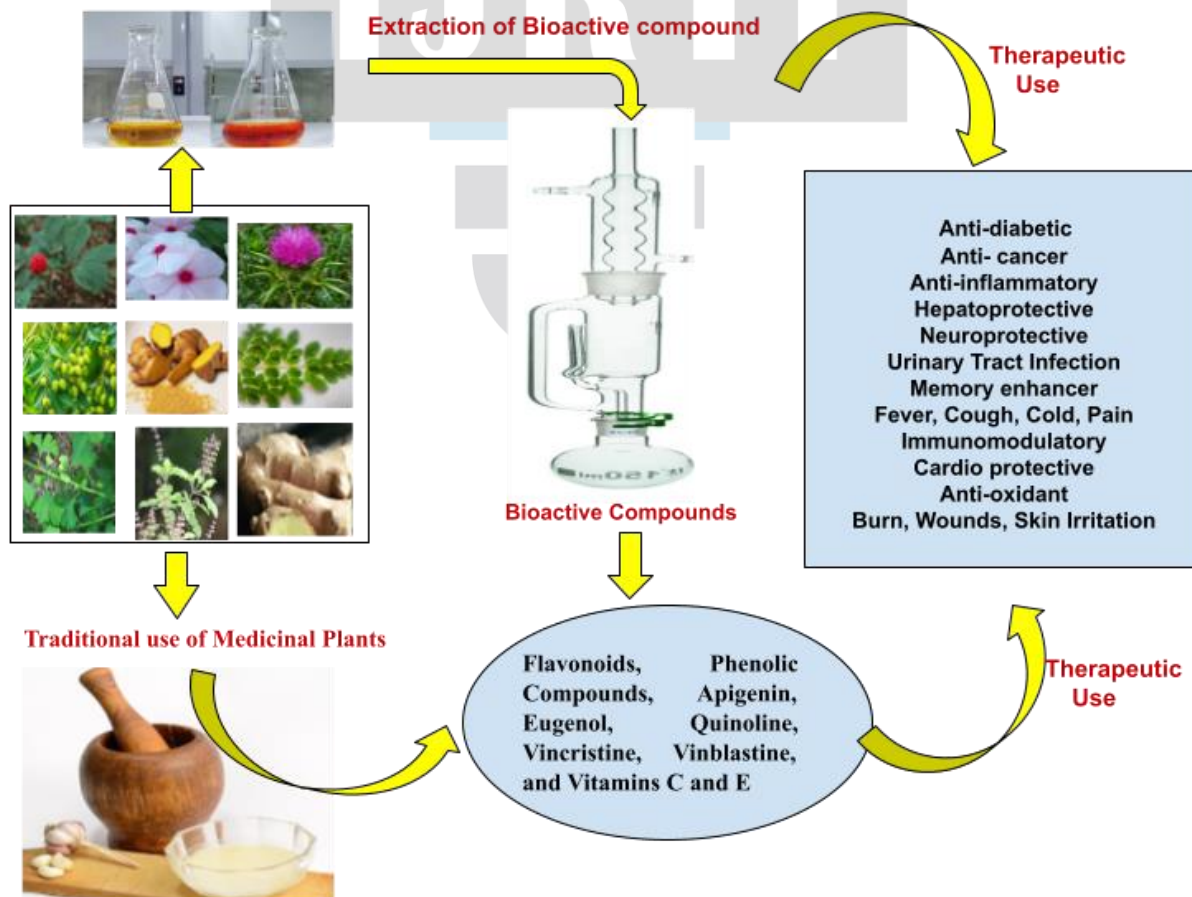


Figure1- Therapeutic use of various medicinal plants

Role in Drug Discovery and Pharmacology-

Medicinal plants form an essential base for modern drug discovery, as nearly 40% of today's medicines come from natural sources or are developed from plant-derived compounds. For centuries, plants have provided valuable chemical substances that scientists use as starting points to create effective treatments. Many important drugs used for managing serious illnesses such as cancer, diabetes, and infectious diseases have their origins in plant compounds. This strong link between traditional plant knowledge and modern pharmacology highlights the continuing importance of medicinal plants in developing safer and more effective therapies. Cromolyn, a synthetic derived from khellin, a chromone extracted from seeds of *Ammi visnaga* (L.) Lam. from Apiaceae, is used against bronchial asthma and other allergic conditions. Quinine, a quinoline alkaloid originally extracted from the bark of *Cinchona officinalis* L. belongs to the Rubiaceae family and is used against intermittent fever or malaria. Tubocurarine, obtained particularly from *Chondrodendron tomentosum* Ruiz & Pavon and *Curarea toxicifera* (Wedd.) are used in blocking neuromuscular transmission and thus achieves reversible muscle relaxation. Morphine is obtained from *Papaver somniferum* (L) which is used during surgery against severe pain. Vincristine and vinblastine are obtained from *Catheranthus roseus* and used against breast cancer and leukemia during chemotherapy. Lavender oil is obtained from *Lavandula angustifolia* and used in aromatherapy and headache for its soothing properties. Punarnava medicine, Punarnavasava. Punarnavarisht etc obtained from *Boerhaavia diffusa* and used against liver problems, kidney issue, Urinary tract infection etc. Brahmi tablets obtained from *Bacopa monnieri* are used against neurodegenerative disorders as mind tonic, enhance memory, and boost cognitive impairment. Aspirin is extracted from bark of Salix species which contain salicin used against pain and fever. Paclitaxel, commonly known as Taxol, is an important chemotherapy medicine originally obtained from the bark of *Taxus brevifolia*. It works as a strong anti-mitotic agent by stabilizing microtubules and stopping cancer cells from dividing [29]. Statins are cholesterol-lowering medicines that reduce Low-density lipoprotein levels and help prevent heart attacks and strokes. Interestingly, many statins were first discovered in fungi. The fungus *Monascus purpureus*, used to ferment red yeast rice, produces Monacolin K, a natural form of lovastatin. The edible oyster mushroom *Pleurotus ostreatus* also contains natural lovastatin. In biotechnology, *Aspergillus terreus* is widely used for the commercial production of lovastatin and simvastatin, while *Penicillium citrinum* was the original source of the first discovered statin, mevastatin. [30]. These examples clearly show how plant-based knowledge has contributed greatly to modern pharmacology and healthcare (Table2).

Medicinal Plants	Drugs Obtained	Therapeutic Use
Ammi visnaga (L)	Cromolyn sodium	Asthma, Allergy
Cinchona officinalis (L)	Quinine	Intermittent Fever, Malaria
Papaver somniferum (L)	Morphine	Seductive, use in surgery
Catharanthus roseus (L)G.Don	Vincristine, vinblastine	Breast cancer, Leukemia chemotherapy
Boerhaavia diffusa Linn.	Punarnavasav, Punarnavarishta	Hepatoprotective, Kidney issue
Bacopa monnieri (L.) Pennell	Brahmi tonic	Neurodegenerative disorders
Salix sp.	Aspirin	Fever and Pain
Taxus brevifolia Nutt.	Taxol	Cancer Chemotherapy
<i>Aspergillus terreus</i> <i>Monascus purpureu.</i>	Statin drugs- mevastatin lovastatin and simvastatin	Cholesterol reduction.

Table 2- Drugs obtained from medicinal plants and their therapeutic use

Threats to Ethnobotanical Knowledge-

Indigenous medicinal knowledge is rapidly declining due to Modernization, Urbanization, Loss of interest among youth along with various environmental threats such as Climate change, Overharvesting, Habitat loss. Human-driven activities have become the most significant threats to plant diversity, particularly medicinal species. The leading pressures include agricultural expansion, firewood collection, deforestation, the spread of cash crops, and charcoal production, all of which collectively endanger medicinal plant resources. A key challenge in the use of medicinal plants is maintaining consistency and quality in herbal formulations. Overharvesting, habitat degradation, and unsustainable collection practices continue to erode biodiversity and disrupt ecological balance. Moreover, the limited availability of rigorous scientific validation often restricts the acceptance of herbal remedies by healthcare professionals and regulatory bodies, slowing their integration into modern medical systems. To ensure safe and effective use, it is essential to investigate herbal drug interactions and conduct thorough safety assessments, particularly in cases involving multiple medications, to reduce the risk of adverse side effects. Traditional knowledge is often held by elderly people, making documentation urgent but in digital ethnobotanical research, protecting privacy and ensuring data security have become vital ethical responsibilities. As researchers document sensitive information related to traditional plant uses, cultural practices, and indigenous knowledge, strong data protection systems must be established to keep this information safe. Maintaining the confidentiality of participants' identities and personal details is essential for fostering trust and sustaining respectful collaboration with indigenous communities. Adherence to ethical standards and data protection regulations is crucial to prevent misuse of knowledge and to safeguard the cultural rights, dignity, and interests of the communities who share their traditional wisdom [31,27].

Conservation of Medicinal Plants -

Medicinal plants represent an abundant reservoir of bioactive compounds with diverse therapeutic potential, offering promising avenues for the prevention and management of disease. Despite existing challenges, the field continues to present vast possibilities for research and innovation. The integration of biotechnology, evidence-based medicine, and advanced analytical techniques can help overcome present limitations and unlock the full potential of plant-based remedies. Conservation strategies include

In-situ conservation and ex-situ conservation. In-situ conservation in cover the areas like sacred groves, community forests, and protected areas. In ex-situ conservation, conserve the medicinal plants by botanical gardens, Seed banks and Tissue culture. Sustainable harvesting and community participation are essential. Emphasising multidisciplinary collaboration, sustainable harvesting practices, and rigorous scientific validation will enable researchers to address the complex issues associated with medicinal plant use and support their inclusion within mainstream healthcare systems. Equally important is the preservation and respectful application of traditional knowledge, which enriches our understanding of plant-based therapies and supports the development of culturally sensitive healthcare solutions. With continued innovation, cooperation, and commitment to scientific evidence, medicinal plants can remain vital contributors to human health and well-being for generations to come [32, 33, 34].

Conclusion and future prospects-

Indigenous and traditional knowledge systems offer deep understanding of the healing potential and therapeutic applications of medicinal plants. Building collaborative partnerships among traditional healers, scientists, and healthcare professionals can support the proper documentation, scientific validation, and preservation of this knowledge, enabling its meaningful integration into contemporary healthcare. Interdisciplinary cooperation among fields such as botany, pharmacology, chemistry, biotechnology, and ethnobotany can foster innovative strategies for sustainable plant sourcing, standardising herbal formulations, and developing scientifically validated herbal medicines. Future research should prioritise uncovering the mechanisms of action of bioactive compounds, exploring synergistic interactions among phytochemicals, and studying their pharmacokinetic and pharmacodynamic behaviour. Medicinal plants used by indigenous communities are a valuable resource for healthcare, biodiversity conservation, and drug discovery. Ethnobotanical research plays a crucial role in documenting and preserving this knowledge. However, modernisation and environmental changes threaten both medicinal plants and traditional knowledge systems. Urgent documentation, conservation, and ethical collaboration with indigenous communities are essential to protect this heritage for future generations. Medicinal plants represent an abundant reservoir of bioactive compounds with diverse therapeutic potential, offering promising avenues for the prevention and management of disease. Despite existing challenges, the field continues to present vast possibilities for research and innovation. The integration of biotechnology, evidence-based medicine, and advanced analytical techniques can help overcome present limitations and unlock the full potential of plant-based remedies. Emphasizing multidisciplinary collaboration, sustainable harvesting practices, and rigorous scientific validation will enable researchers to address the complex issues associated with medicinal plant use and support their inclusion within mainstream healthcare systems. Equally important is the preservation and respectful application of traditional knowledge, which enriches our understanding of plant-based therapies and supports the development of culturally sensitive healthcare solutions. With continued innovation, cooperation, and commitment to scientific evidence, medicinal plants can remain vital contributors to human health and wellbeing for generations to come.

Acknowledgement-

The author would like to thank the Principal of the college and Dr. Ranadeep Mahal for their motivation, help and support.

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