

## ROLE OF PHARMACY PRACTICE IN THE SUSTAINABLE USE OF MEDICINAL PLANTS

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### ABSTRACT

Medicinal plants have historically served as important therapeutic agents and continue to be vital in healthcare and pharmacy practices. Recently, the rising popularity of herbal medicines has raised serious issues related to overexploitation, loss of biodiversity, contamination, and variability in the quality of plant-derived medications. Consequently, the sustainable use of medicinal plants has become critical to guarantee their ongoing availability, safety, and efficacy for future generations. This review concentrates on the idea of sustainability in the use of medicinal plants and its relevance in contemporary pharmacy practice. Key topics covered include the conservation of medicinal plant resources, the preference for cultivation over wild harvesting, sustainable harvesting techniques, quality

assurance, and regulatory considerations. Furthermore, the review emphasizes the essential function of pharmacists in encouraging the responsible use of herbal medicines, educating patients, ensuring ethical sourcing, and overseeing the safety of herbal drugs. It also tackles current challenges such as awareness deficits, environmental shifts, and inadequate standardization, while offering future insights for enhancing sustainable practices. By merging traditional knowledge with scientific validation and professional pharmacy services, the sustainable utilization of medicinal plants can enhance public health outcomes while safeguarding natural resources. This review underscores the obligation of pharmacy professionals in fostering sustainability as a core component of herbal drug development and healthcare delivery.

**KEYWORDS:** Medicinal plants, Sustainability, Pharmacy practice, Herbal medicines, Conservation.

## 1. INTRODUCTION

Medicinal plants are fundamental to traditional medicine practices and continue to play a significant role in contemporary healthcare and pharmacy. To this day, a significant portion of the world's population relies on plant-derived medicines for both disease prevention and treatment. The World Health Organization and other organizations have consistently highlighted the relevance of herbal medicines in primary healthcare, particularly in developing nations.

Recently, the popularity of medicinal plants has surged, driven by their natural origins, cultural acceptance, and perceived safety. Herbal medicines are commonly utilized in the creation of traditional remedies, nutraceuticals, and as sources of active pharmaceutical ingredients. Nevertheless, this increasing demand has led to serious issues such as overharvesting, depletion of natural resources, adulteration, and inconsistencies in drug quality.

Thus, the sustainable use of medicinal plants has become a crucial concern, not only from an environmental standpoint but also from the perspective of pharmacy practice. Unsustainable methods of collecting and processing medicinal plants directly impact the quality, safety, and therapeutic efficacy of herbal medications. This, in turn, affects patient outcomes and the public's trust in herbal treatments.

Contrary to many existing reviews that primarily address conservation or ethnobotanical issues, this review underscores sustainability as a professional obligation within pharmacy practice. Pharmacists are essential in promoting rational usage, ensuring quality, providing patient education, and sourcing herbal medicines ethically. Incorporating sustainable principles into pharmacy practice is vital to guarantee consistent drug quality, patient safety, and the long-term viability of healthcare.



## 2. MEDICINAL PLANTS IN HEALTHCARE AND PHARMACY PRACTICE

### 2.1 Role of Medicinal Plants in Healthcare

Medicinal plants have been utilized in healthcare systems for centuries and continue to be significant in the prevention and treatment of diseases. They are commonly employed in traditional medicine and remain pertinent in contemporary healthcare because of their natural origins, cost-effectiveness, and long-standing history of therapeutic use.

- Support primary and preventive health measures.
- Frequently utilized for chronic and lifestyle-related conditions.
- High levels of acceptance among patients.

Consequently, medicinal plants make a substantial contribution to accessible and sustainable healthcare.

### 2.2 Importance of Medicinal Plants in Modern Pharmacy

In contemporary pharmacy practice, medicinal plants are acknowledged as important pharmaceutical resources. Numerous medications are either directly or indirectly derived from plant sources, and medicinal plants act as raw materials for herbal medicines and nutraceuticals.

- Source of bioactive substances.
- Utilized in herbal formulations.
- Significant in the discovery of new drugs.

This underscores the necessity for scientific assessment and professional oversight in pharmacy practice.

### 2.3 Medicinal Plants in Pharmaceutical Care

Herbal medicines are frequently used in community pharmacy environments, often in conjunction with conventional medications. This increases pharmacists' responsibility to guarantee safe and rational usage.

- Widely available as over-the-counter herbal products.
- Potential for misuse and interaction risks.
- Require counseling from pharmacists.

Appropriate pharmaceutical care enhances patient safety and therapeutic results.

### 2.4 Medicinal Plants and Drug Quality

The quality of herbal medicines is heavily dependent on the quality of the raw materials from

medicinal plants. Aspects such as the source of the plant, harvesting methods, and handling techniques affect phytochemical content and therapeutic effectiveness.

- Poor quality results in variable efficacy.
- Adulteration leads to safety concerns.
- High-quality sourcing fosters patient trust.

Therefore, medicinal plants underpin the quality of herbal drugs.

### 2.5 Professional Role of Pharmacists

Pharmacists have a crucial role in the safe and effective integration of medicinal plants into healthcare. Their professional engagement ensures quality assurance and rational usage.

- Guarantee authentic sourcing.
- Educate patients about usage.
- Encourage responsible consumption.



## 3. CONCEPT OF SUSTAINABILITY IN MEDICINAL PLANT USE

### 3.1 Meaning of Sustainability in Medicinal Plant Utilization

Sustainability in the use of medicinal plants refers to the conscientious and strategic utilization of these resources to address current healthcare demands while safeguarding their availability for future generations. It highlights the importance of long-term utilization over immediate exploitation of natural resources.

- Emphasizes long-term resource availability
- Prevents the overuse of plant resources
- Strikes a balance between healthcare requirements and environmental preservation

Sustainability serves as the cornerstone for the responsible use of medicinal plants in pharmacy practice.

### 3.2 Need for Sustainability in Herbal Medicines

The rising demand for herbal medicines has exerted considerable pressure on medicinal plant resources. Unsustainable gathering and inadequate handling have led to the depletion of plant populations and a decline in the quality of raw materials.

- Excessive harvesting results in resource depletion
- Ineffective practices lead to variations in quality.
- Impacts therapeutic reliability

Thus, maintaining sustainability is crucial for upholding the efficiency and credibility of herbal medicines.

### 3.3 Sustainability from a Pharmacy Practice Perspective

From the perspective of pharmacy practice, sustainability is intrinsically linked to drug quality and patient well-being. Medicinal plants are the basis for the preparation of herbal medications, and any compromise at this initial stage affects the final product.

- Promotes the standardization of herbal medications
- Enhances safety and effectiveness
- Guarantees consistent therapeutic results

Consequently, sustainability should be regarded as a professional obligation within pharmacy practice.

### 3.4 Sustainability and Patient Safety

The sustainable use of medicinal plants ensures stable phytochemical content and reduces the risk of adulteration. This directly boosts patient safety and improves treatment results.

- Lowers the risk of adulteration
- Enhances medication consistency
- Increases patient confidence



#### 4. PRESERVATION OF MEDICINAL PLANTS

Preserving medicinal plants is crucial for balancing the growing healthcare needs and safeguarding natural resources. Many medicinal plants are still sourced from the wild, where uncontrolled harvesting, habitat loss, and environmental changes have greatly diminished their natural populations. The ongoing depletion of these plant resources endangers not only biodiversity but also the viability of the herbal medicine supply.

Conservation methods aim to safeguard medicinal plants while ensuring their accessibility for pharmaceutical and therapeutic purposes. In situ conservation focuses on protecting medicinal plants within their native ecosystems, allowing them to thrive and regenerate under natural conditions. This approach helps maintain ecological harmony and retains genetic diversity. On the other hand, ex situ conservation centers on safeguarding medicinal plants outside their natural settings through cultivation, botanical gardens, seed banks, and advanced techniques such as tissue culture. These methods are especially beneficial for conserving endangered and high-demand species.

From the viewpoint of pharmacy practice, conservation has significant implications for drug quality and patient safety. The scarcity of medicinal plants can often result in substitutions, adulteration, and the use of lower-quality raw materials, which undermine the safety and therapeutic efficacy of herbal medicines. Conservation guarantees a steady supply of authentic plant materials, which supports standardization and quality assurance in herbal drug manufacturing.

The significance of conservation in pharmacy practice includes

- Ensuring a consistent and dependable supply of raw materials
- Minimizing adulteration and substitution of herbal medicines
- Facilitating quality control and standardization
- Safeguarding biodiversity and healthcare sustainability.



## 5. SUSTAINABLE HARVESTING PRACTICES

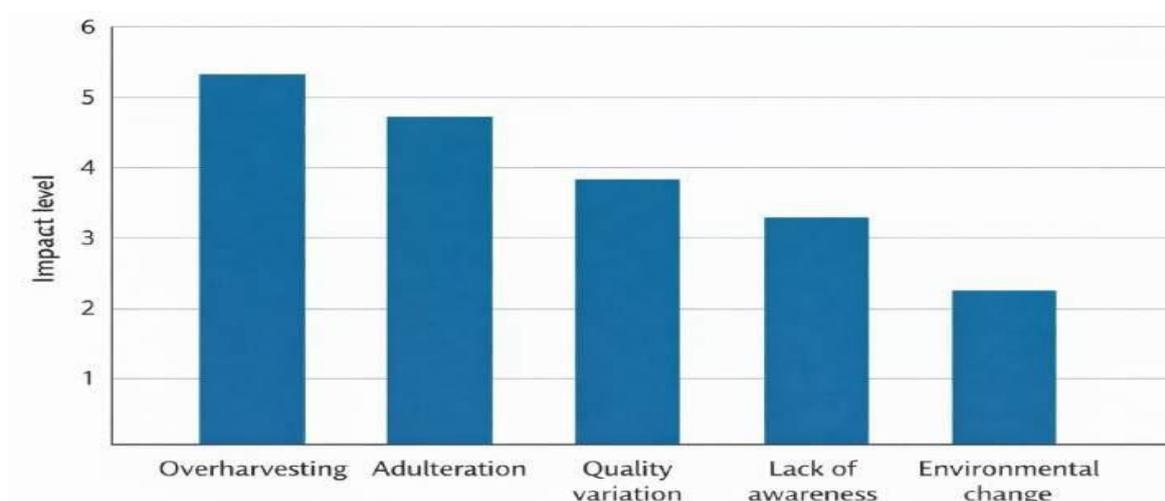
Practices for sustainable harvesting are vital to guarantee the enduring survival of medicinal plants while addressing the rising demand for herbal raw materials. Harvesting involves gathering specific parts of plants, such as leaves, roots, bark, flowers, or seeds, for medicinal purposes. When harvesting occurs without proper scientific guidance, it can significantly harm plant populations and disrupt their natural regeneration.

Sustainable harvesting focuses on selective and responsible collection techniques that reduce damage to both the plant and its surrounding ecosystem. Rather than uprooting entire plants, only the necessary parts are taken, allowing the plants to regenerate naturally. Additionally, harvesting is timed to coincide with seasons when the concentration of active constituents is at its peak, thus ensuring sustainability and quality in the drug.

In pharmacy practice, the principles of sustainable harvesting directly affect the therapeutic efficacy of herbal medicines. Improper harvesting techniques can result in diminished phytochemical content, contamination, and variability in the potency of the drug. Harvesting practices guided by scientific principles help ensure consistent quality in raw materials and facilitate the standardization of herbal formulations.

Key components of sustainable harvesting consist of

- Gathering only the required parts of the plant
- Preventing the complete destruction of the plant
- Implementing seasonal and rotational harvesting practices
- Utilizing traditional knowledge that is backed by scientific validation.



## 6. Quality Control and Standardization of Herbal Drugs

### 6.1 Quality Challenges in Herbal Medicines

The quality of herbal medicines often varies significantly due to factors such as plant species, cultivation conditions, harvesting techniques, and methods of processing. The unsustainable harvesting of medicinal plants further heightens the risk of adulteration, substitution, contamination, and a reduction in active ingredients. These challenges compromise the reliability of herbal medicines and may jeopardize patient safety.

### 6.2 Impact of Poor Quality on Therapy

The inconsistent quality of herbal drugs can lead to unpredictable therapeutic results. Differences in phytochemical profiles can cause diminished effectiveness or unforeseen side effects. Additionally, the absence of standardization hinders the acceptance of herbal medicines within evidence-based healthcare systems.

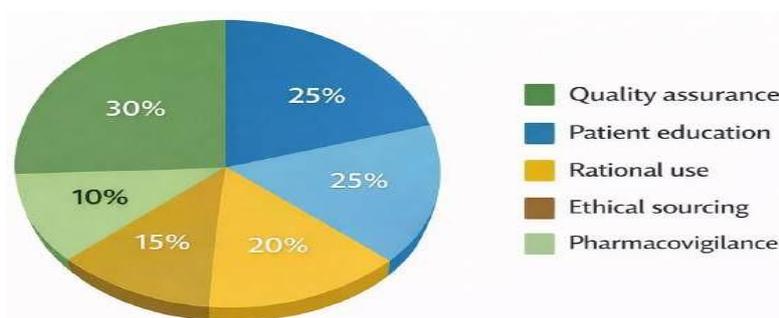
### 6.3 Role of Standardization in Pharmacy Practice

Standardization is intended to provide consistency in the identity, purity, strength, and composition of herbal medicines. This involves the correct identification of medicinal plants, regulated processing, and compliance with quality standards. Sustainable sourcing contributes to standardization by guaranteeing the availability of authentic and high-quality raw materials.

### 6.4 Pharmacy-Oriented Quality Assurance

In pharmacy practice, maintaining quality control is crucial for the safe dispensing and appropriate use of herbal medicines. Pharmacists are responsible for verifying the quality of products, educating patients, and preventing misuse or incorrect substitutions.

- Ensures a consistent therapeutic response
- Enhances patient safety
- Boosts professional credibility



## 7. ROLE OF PHARMACISTS IN SUSTAINABLE USE OF MEDICINAL PLANTS

### 7.1 Pharmacists as Key Healthcare Professionals

Pharmacists serve an essential role as connectors between medicinal plant resources and patient care. Their professional participation guarantees that herbal medicines are utilized safely, effectively, and responsibly within healthcare frameworks.

- Function as experts on herbal medications
- Connect traditional medicine with contemporary healthcare.
- Impact patient preferences and usage behaviors.

### 7.2 Role in Rational Use of Herbal Medicines

Numerous patients perceive herbal medicines as completely safe, which results in self-medication and excessive use. Pharmacists provide guidance to ensure the rational use of herbal medicines by patients.

- Offer accurate information regarding dosages and usage duration.
- Prevent misuse and excessive consumption.
- Recognize potential interactions between drugs and herbs.

Pharmacist role	Key activity	Impact on sustainability	Benefit to patient safety
Quality assurance	Raw material evaluation	Reduces adulteration	Ensures consistent efficacy
Rational use promoter	Evidence-based dispensing	Prevents overuse of plants	Minimizes misuse
Patient counsellor	Usage and safety guidance	Reduces unnecessary demand	Prevents adverse effects
Ethical sourcing advocate	Supplier verification	Supports sustainable supply	Improves product reliability
Regulatory supporter	Guideline compliance	Encourages standardization	Enhances drug quality
Pharmacovigilance contributor	ADR monitoring	Identifies unsafe products	Early risk detection
Educator	Public awareness programs	Promotes conservation	Improves informed use

### 7.3 Contribution to Quality Assurance and Ethical Sourcing

The sustainable utilization of medicinal plants relies on the authenticity and quality of herbal products. Pharmacists contribute to sustainability efforts by ensuring appropriate sourcing and adherence to quality standards.

- Promote the use of standardized herbal products.
- Minimize instances of adulteration and substitution.
- Advocate for ethical and sustainable supply chains.

#### 7.4 Role in Herbal Pharmacovigilance

Monitoring the safety of herbal medicines is an increasing responsibility within the pharmacy field. Pharmacists assist in identifying and reporting adverse effects associated with the use of herbal drugs.

- Enhance patient safety
- Identify quality-related problems
- Bolster public trust in herbal therapies.

#### 7.5 Educational and Advocacy Role

Pharmacists raise awareness about sustainability among both patients and healthcare professionals, fostering responsible utilization of medicinal plant resources.

- Inform patients about the safe use of herbal medicines.
- Encourage awareness about sustainability.
- Support the long-term viability of healthcare practices.



## 8. REGULATORY ASPECTS SUPPORTING SUSTAINABLE USE OF MEDICINAL PLANTS

### 8.1 Need for Regulation in Medicinal Plant Use

The rising demand for herbal remedies has made regulatory measures crucial to guarantee the sustainable utilization of medicinal plants. In the absence of adequate regulatory oversight, problems like overexploitation, adulteration, low-quality products, and unethical trade may emerge, jeopardizing both public health and biodiversity.

- Averts the overexploitation of plant resources
- Ensures the safety and quality of herbal remedies
- Safeguards the interests of consumers and patients

## 8.2 Regulatory Guidelines for Cultivation and Collection

Regulatory organizations offer guidelines for the cultivation, harvesting, and gathering of medicinal plants to foster sustainability. These guidelines promote scientific and ethical approaches that protect natural resources while ensuring a steady supply.

- Controlled agricultural practices
- Scientific methods for harvesting and collection
- Documentation and tracking of raw materials

Such initiatives contribute to maintaining both environmental equilibrium and pharmaceutical integrity.

## 8.3 Quality and Safety Regulations for Herbal Medicines

Regulations also concentrate on ensuring the quality and safety of herbal products available in the marketplace. Quality benchmarks help mitigate adulteration and guarantee therapeutic dependability.

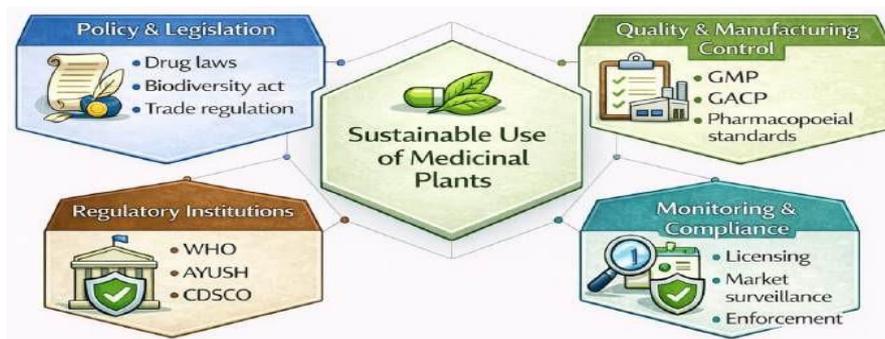
- Standardization of raw materials and final products
- Prevention of substandard and counterfeit items
- Safety assessment of herbal medicines

These regulations enhance confidence in herbal drug therapy.

## 8.4 Role of Regulations in Pharmacy Practice

In pharmacy practice, adhering to regulations guarantees that only safe, effective, and sustainably sourced herbal medicines are provided to patients. Pharmacists play a significant role in enforcing these regulations at the practice level.

- Ensure adherence to regulatory standards
- Support ethical sourcing and dispensing practices
- Encourage responsible use of herbal remedies



## **9. CHALLENGES IN SUSTAINABLE USE OF MEDICINAL PLANTS**

### **9.1 Demands–Supply Imbalance**

The swift rise in the demand for herbal medicines has resulted in a considerable disparity between the needed and accessible medicinal plant resources. Mass production and extensive consumption exert ongoing stress on limited natural resources, making it challenging to maintain a sustainable supply. This inconsistency often leads to overharvesting and the depletion of sought-after plant species.

### **9.2 Quality Variability and Adulteration**

A significant challenge in the sustainable use of medicinal plants is ensuring consistent quality. The scarcity of genuine raw materials prompts substitution and adulteration, which diminishes therapeutic efficacy and introduces safety risks. Fluctuations in cultivation, harvesting, and processing practices further contribute to the variability in the quality of herbal medicines.

### **9.3 Lack of Awareness and Training**

A critical obstacle is the limited knowledge among collectors, manufacturers, and consumers regarding sustainable practices. Insufficient training in proper harvesting, storage, and processing methods results in resource inefficiency and low-quality raw materials. This knowledge gap negatively impacts both sustainability and patient safety.

### **9.4 Environmental and Climatic Factors**

Changes in the environment, such as climate change, habitat loss, and diminished biodiversity, significantly influence the growth and viability of medicinal plants. These factors decrease plant availability and alter phytochemical makeup, making sustainable use more difficult.

### **9.5 Practice-Level Challenges in Pharmacy**

At the level of pharmacy practice, the absence of standardized information, limited enforcement of regulations, and the availability of unverified herbal products present further complications. These challenges make it harder to dispense and monitor herbal medicines rationally.

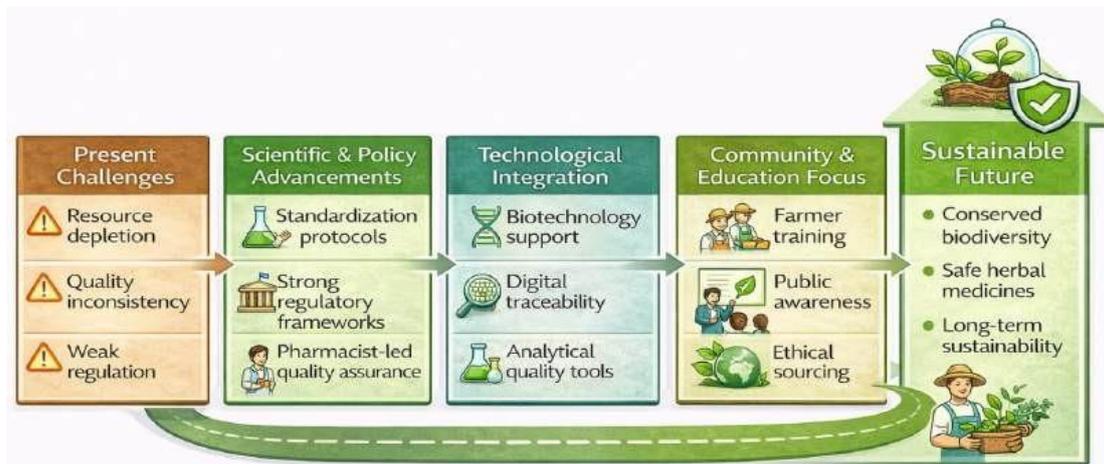


## 10. FUTURE PERSPECTIVES

In the years ahead, the sustainable application of medicinal plants is anticipated to become a crucial component of standard pharmacy practice. As herbal medicines gain popularity, pharmacists will take on an increased role in guiding patients towards the rational and responsible use of these products. Providing appropriate advice on dosages, treatment durations, and the limitations of herbal medicines can help mitigate misuse and reduce unnecessary pressure on medicinal plant resources.

Progress in scientific research will be essential in enhancing sustainability. Improved cultivation methods, more effective post-harvest processing, and better standardization of herbal medicines will contribute to maintaining consistent quality and therapeutic efficacy. The scientific validation of traditional medicinal plants will also foster their acceptance within modern healthcare and facilitate their safe integration with conventional treatments.

Education and awareness will be vital for promoting future sustainability. Incorporating sustainability principles into pharmacy education and ongoing professional development can prepare pharmacists with the necessary skills to manage herbal medicines responsibly. Furthermore, raising awareness among patients and healthcare professionals will promote informed choices and ethical use of products derived from medicinal plants.



## 11. RESULT AND DISCUSSION

The present review clearly demonstrates that the sustainable use of medicinal plants is a critical determinant of herbal drug quality, patient safety, and long-term healthcare sustainability.

Evidence from existing practices indicates that increasing global demand for herbal medicines has placed significant pressure on natural medicinal plant resources. This demand–supply imbalance has accelerated overharvesting and depletion of high-value plant species, often forcing manufacturers to depend on inferior or substituted raw materials. Such practices directly affect the phytochemical integrity of herbal medicines and result in inconsistent therapeutic outcomes.

Analysis further reveals that unsustainable harvesting and improper post-harvest handling are closely linked to quality variability in herbal drugs. Variations in plant species, harvesting time, environmental conditions, and processing methods contribute to fluctuations in active constituents. These inconsistencies not only reduce therapeutic effectiveness but also increase the risk of contamination and adulteration, thereby compromising patient safety. The lack of standardization remains a major barrier to the integration of herbal medicines into evidence-based pharmacy practice.

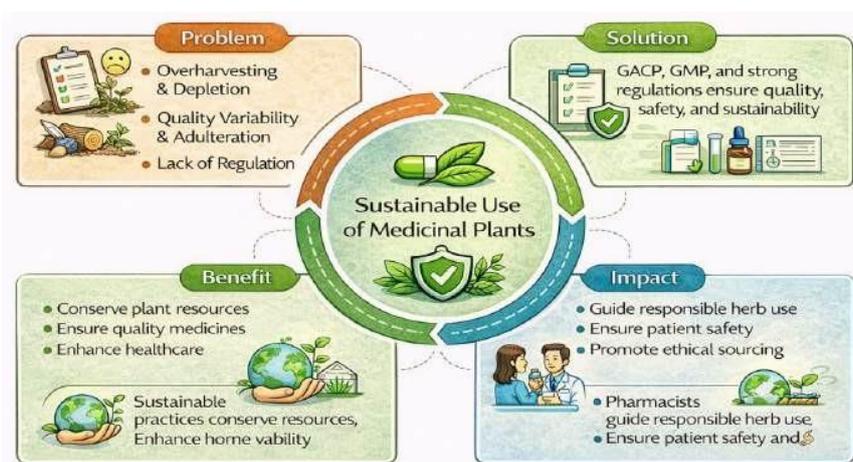
Regulatory oversight and standardization emerge as decisive factors in addressing these challenges. The application of Good Agricultural and Collection Practices, Good Manufacturing Practices, and pharmacopoeial standards has been shown to significantly reduce adulteration and improve consistency in herbal products. Where regulatory guidelines are effectively implemented, the quality and safety of herbal medicines are markedly

enhanced. This reinforces the importance of strong regulatory frameworks in ensuring sustainable sourcing and responsible utilization of medicinal plant resources.

The findings also highlight the central role of pharmacists in translating sustainability principles into practical healthcare outcomes. Pharmacist-led quality assurance, ethical sourcing, and patient counseling contribute substantially to the rational use of herbal medicines. By educating patients about appropriate dosage, duration of use, and possible interactions, pharmacists help prevent misuse and unnecessary consumption. This professional intervention indirectly reduces pressure on medicinal plant resources while improving therapeutic reliability and patient confidence.

From a future perspective, sustainability in medicinal plant use is expected to increasingly rely on scientific innovation and professional education. Advances in cultivation techniques, improved standardization methods, and the use of modern analytical and digital traceability tools can support consistent quality while conserving natural resources. Integrating sustainability concepts into pharmacy education and continuous professional development will further empower pharmacists to manage herbal medicines responsibly and ethically.

Overall, the discussion underscores that sustainability in medicinal plant use extends beyond environmental conservation and directly influences drug quality, patient safety, and healthcare effectiveness. Embedding sustainable practices within pharmacy practice, supported by regulatory compliance and professional accountability, is essential for ensuring the long-term viability of herbal medicines. Sustainable utilization of medicinal plants should therefore be regarded as a core professional responsibility within modern pharmacy practice, essential for safeguarding both public health and natural resources for future generations.



## 12. CONCLUSION

Medicinal plants continue to play an important role in healthcare and pharmacy practice by supporting both traditional and modern systems of medicine. They are widely used in the preparation of herbal medicines, nutraceuticals, and pharmaceutical products. However, the growing demand for medicinal plants, along with uncontrolled harvesting, habitat loss, and lack of proper quality control, has created serious challenges. These issues threaten the continuous availability, safety, and effectiveness of herbal medicines.

This review highlights the importance of sustainable use of medicinal plants as a necessary approach to overcome these challenges. Sustainable practices help protect medicinal plant resources while ensuring consistent quality of raw materials used in herbal drug preparation. Unsustainable use can lead to adulteration, variation in phytochemical content, and reduced therapeutic effectiveness, which directly affect patient safety and treatment outcomes.

The review also emphasizes the role of pharmacists in supporting sustainability within pharmacy practice. Through rational use of herbal medicines, quality assurance, patient education, and ethical sourcing, pharmacists can help reduce misuse and unnecessary pressure on medicinal plant resources. Active pharmacist involvement ensures that herbal medicines are used safely, effectively, and responsibly.

Overall, sustainable use of medicinal plants supports long-term healthcare needs by balancing patient safety, drug quality, and conservation of natural resources. Integrating sustainability into pharmacy practice is essential to ensure reliable healthcare delivery and protect medicinal plant resources for future generations.

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