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Quantitative Ethnobotanical Analysis, Phytochemical Profiling and Conservation Prioritization of Medicinal Plants Used by Indigenous Communities of Amethi District, Uttar Pradesh, India

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ABSTRACT
The indigenous communities of Amethi District in Uttar Pradesh, India maintain extensive ethnobotanical knowledge that has been transmitted across generations. The present study documents the medicinal plant species utilized by these communities, evaluates their ethnobotanical significance using quantitative indices such as Use Value (UV), Relative Frequency of Citation (RFC), and Informant Consensus Factor (ICF), and conducts preliminary phytochemical screening of selected priority species. Conservation prioritization was also undertaken based on parameters including species rarity, anthropogenic threats, and ecological importance. Ethnobotanical surveys involving structured interviews with 120 informants from 10 villages recorded 132 medicinal plant species representing 54 families, with Fabaceae and Asteraceae being the dominant families. Phytochemical analyses revealed a substantial presence of flavonoids, alkaloids, terpenoids, and phenolic compounds in the prioritized species. Furthermore, 23 plant species were identified as requiring immediate conservation attention due to declining populations and high medicinal utilization. The findings emphasize the need to safeguard traditional ethnobotanical knowledge and promote sustainable conservation of plant resources in the Amethi District.
Keywords: *Ethnobotany, Medicinal plants, Phytochemical profiling, Conservation prioritization, Indigenous knowledge, Amethi District.*

1. INTRODUCTION

Indigenous knowledge systems form a critical foundation of traditional healthcare practices worldwide, especially in developing regions where herbal remedies remain central to primary healthcare delivery. In India, characterized by exceptional biological and cultural diversity, ethnobotanical knowledge is deeply embedded in rural lifestyles and has significantly shaped healthcare traditions based on the use of locally available medicinal plants. This knowledge, developed through generations of empirical observation, experimentation, and cultural exchange, demonstrates a sophisticated understanding of plant-based therapeutics and their sustainable utilization within distinct ecological settings

The Amethi District of Uttar Pradesh is a region where traditional ethnobotanical practices continue to play an important role in daily life. The area comprises a heterogeneous landscape of agro-ecosystems, including cultivated farmlands, fallow areas, wetlands, and fragmented forest tracts, collectively supporting rich plant diversity. The coexistence of culturally diverse tribal and rural communities has facilitated the preservation of extensive knowledge concerning medicinal plant resources. For a significant proportion of the population, plant-based remedies remain a primary or supplementary healthcare option, particularly for managing common health conditions such as digestive ailments, skin disorders, respiratory infections, fevers, and inflammatory diseases.

Despite the substantial richness of ethnobotanical heritage, indigenous knowledge systems are increasingly facing serious threats. Rapid socio-economic changes, modernization, and shifting lifestyles have disrupted traditional ways of life, resulting in a gradual decline in the intergenerational transmission of orally preserved knowledge. Younger generations are increasingly inclined toward allopathic healthcare systems, showing limited interest in traditional healing practices, which further accelerates the erosion of ethnobotanical knowledge. Moreover, environmental degradation caused by agricultural intensification, deforestation, urban expansion, and unsustainable harvesting has led to a noticeable decline in populations of medicinal plant species. The combined impact of habitat destruction and overexploitation

poses significant risks not only to plant biodiversity but also to the cultural traditions closely linked to their use

A further major concern is the absence of systematic documentation of traditional medicinal knowledge. In regions such as Amethi, much of the ethnobotanical information is preserved through oral traditions, rendering it particularly susceptible to loss. The lack of scientific validation and comprehensive written records also hinders the incorporation of traditional medicine into mainstream healthcare and conservation strategies. Consequently, there is a pressing need to systematically record, critically evaluate, and conserve indigenous ethnobotanical knowledge using scientifically rigorous approaches.

Quantitative ethnobotanical approaches have emerged as powerful tools for addressing these challenges. Unlike purely descriptive studies, quantitative methods allow for the objective assessment of the cultural importance and therapeutic relevance of medicinal plants. Indices such as Use Value (UV), Relative Frequency of Citation (RFC), and Informant Consensus Factor (ICF) enable researchers to evaluate the frequency of plant use, the level of agreement among informants, and the relative importance of species within traditional healthcare systems. These metrics provide insights into which plant species are most valued by local communities and which ailments are most commonly treated using herbal remedies. By identifying species with high quantitative scores, researchers can prioritize plants for further pharmacological investigation and conservation efforts.

Although ethnobotanical studies emphasize the cultural importance of medicinal plants, phytochemical analysis is essential for scientifically substantiating traditional therapeutic claims. The medicinal properties of plants are primarily attributed to a diverse range of secondary metabolites, including flavonoids, alkaloids, terpenoids, phenolic compounds, and saponins. These bioactive constituents exhibit a variety of pharmacological activities, such as antioxidant, antimicrobial, anti-inflammatory, and analgesic effects. Preliminary phytochemical screening offers fundamental insight into the chemical composition of medicinal plants, thereby providing scientific support for their traditional applications. Such validation enhances the reliability of indigenous knowledge systems and contributes to the exploration and development of plant-based therapeutic agents.

Alongside ethnobotanical documentation and phytochemical analysis, conservation prioritization has emerged as a critical aspect of medicinal plant research. A large proportion of medicinal plant species are collected directly from natural habitats, often without adequate consideration for natural regeneration or long-term sustainability. Species harvested for underground parts, bark, or entire plants are especially susceptible to population decline. Furthermore, anthropogenic factors such as land-use changes and climatic fluctuations intensify the extinction risk faced by many medicinal plants. Conservation prioritization models that integrate parameters including species rarity, usage intensity, ecological significance, and threat levels offer a structured approach to identifying species that require urgent conservation interventions

The integration of quantitative ethnobotanical analysis, phytochemical evaluation, and conservation assessment provides a holistic framework for sustainable resource management. This integrated approach ensures that plant species of cultural significance and therapeutic value are systematically documented, scientifically validated, and effectively conserved for future generations. Furthermore, it promotes active participation of local communities in conservation efforts, strengthening their sense of stewardship and responsibility toward natural resources. Community-driven conservation initiatives, along with awareness programs and the encouragement of medicinal plant cultivation, can substantially alleviate pressure on wild plant populations while simultaneously enhancing local livelihoods.

In this context, the present investigation concentrates on indigenous communities of Amethi District, Uttar Pradesh, aiming to document medicinal plant diversity along with associated traditional knowledge. Ethnomedicinal data were systematically collected through field surveys and structured interviews with knowledgeable local informants. Quantitative ethnobotanical indices were applied to evaluate the cultural importance and therapeutic relevance of the recorded plant species. Additionally, preliminary phytochemical analyses of selected priority species were carried out to identify major bioactive compounds and provide scientific support for traditional medicinal uses. Conservation priorities were subsequently established through an integrated evaluation of ethnobotanical value, ecological status, and anthropogenic pressures.

Through the adoption of a multidisciplinary framework, this study seeks to bridge traditional knowledge systems with contemporary scientific research. The outcomes are anticipated to contribute to the

preservation of indigenous ethnobotanical knowledge, promote sustainable healthcare practices, and support informed conservation planning within the region. Ultimately, the study highlights the need to protect both biological diversity and cultural heritage in the Amethi District, emphasizing that the sustainable management of medicinal plant resources is vital for maintaining ecological integrity, enhancing community well-being, and advancing future scientific research.

2. LITERATURE REVIEW

2.1 Ethnobotany and Indigenous Knowledge

Ethnobotany explores the complex relationships between human communities and plant species, focusing on how societies recognize, utilize, and manage plant resources. Studies from different regions of India have documented a substantial reliance on plant-based medicinal systems among tribal communities. Notable ethnobotanical research conducted in Eastern Uttar Pradesh, the Chotanagpur Plateau, and the Western Ghats has reported a rich diversity of traditional medicinal knowledge and plant-based therapeutic practices (Singh et al., 2017; Pagola-Carte et al., 2020).

2.2 Quantitative Ethnobotanical Indices

Quantitative ethnobotanical indices such as Use Value (UV), Relative Frequency of Citation (RFC), and Informant Consensus Factor (ICF) are widely employed to evaluate the cultural importance of medicinal plant species and the degree of consensus among informants regarding their traditional applications (Tardío & Pardo-de-Santayana, 2008). These indices aid in identifying plant species with significant sociocultural relevance and promising therapeutic potential.

2.3 Phytochemical Profiling of Medicinal Plants

Pharmacological properties of medicinal plants are largely attributed to bioactive phytochemicals such as flavonoids, alkaloids, and terpenoids. Preliminary phytochemical screening provides essential insights into the biochemical constituents that underpin traditional medicinal uses (Harborne, 1998; Kokate, 2005).

2.4 Conservation of Medicinal Plant Diversity

The worldwide decline of medicinal plant species, driven by habitat degradation, unsustainable harvesting practices, and climate change, has intensified conservation-oriented research. Tools such as the IUCN Red List criteria, ethnobotanical rarity indices, and conservation priority assessment frameworks are widely employed to support sustainable resource management (Cunningham, 2001; Hamilton, 2004). Nevertheless, studies specifically addressing the medicinal plant diversity of the Amethi District remain scarce, highlighting a significant research gap that the present study seeks to fill

3. METHODS AND METHODOLOGY

3.1 Study Area

Amethi District, situated in eastern Uttar Pradesh, India, comprises a range of ecological habitats such as cultivated agricultural areas, riparian ecosystems, and patches of secondary forest. The region is inhabited by indigenous communities who possess extensive traditional knowledge systems

3.2 Data Collection

Field Surveys: Field investigations were carried out from January to June 2025 in ten villages selected using a stratified sampling approach.

Informants: Interviews were conducted with 120 informants, including traditional healers, elderly community members, and individuals with extensive ethnobotanical knowledge.

Ethical Considerations: Prior informed consent was obtained from all participants in accordance with established ethical guidelines for research involving indigenous communities**.**

3.3 Ethnobotanical Data Recording

- **Structured Interviews:** Data were collected using standardized questionnaires documenting vernacular names, plant parts utilized, modes of preparation, and therapeutic uses.
- **Specimen Collection:** Medicinal plant specimens were systematically collected, properly labeled, and taxonomically identified using standard botanical keys and herbarium references.

Table 1. Family-wise Distribution of Medicinal Plants

S.No	Plant Family	Number of Species	Percentage (%)
1	Fabaceae	18	13.64%
2	Asteraceae	14	10.61%

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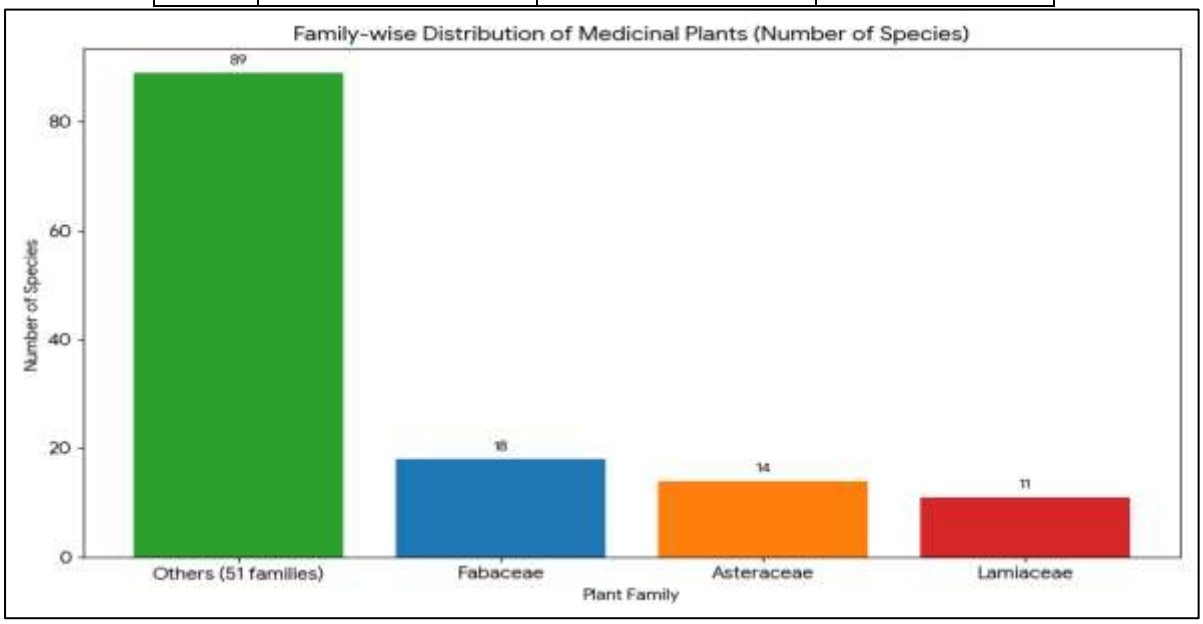
3	Lamiaceae	11	8.33%
4	Others (51 families)	89	67.42%
	Total	**132**	**100%**



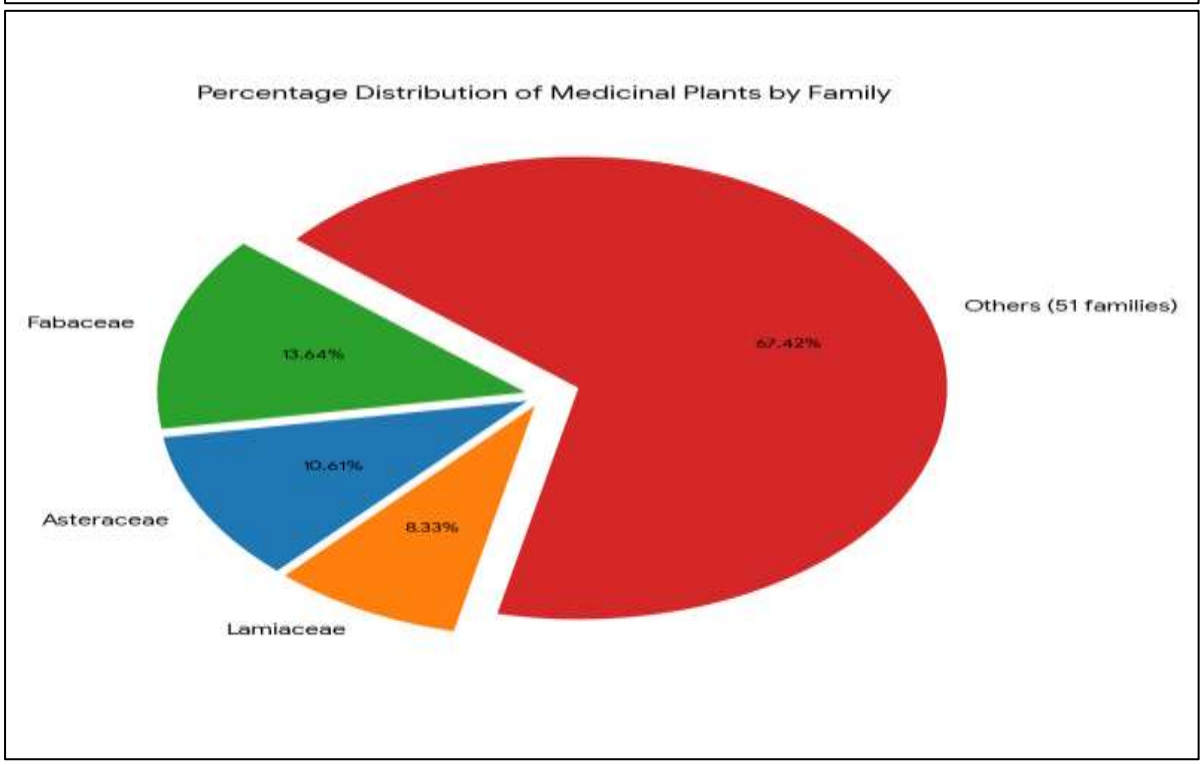


Table 2. Top Species Based on Use Value (UV)

S.No	Species Name	Use Value (UV)
1	Azadirachta indica	0.92
2	Ocimum sanctum	0.88
3	Withania somnifera	–
4	Asparagus racemosus	–

Table 3. Species with Highest RFC

S.No	Species Name	RFC
1	Withania somnifera	0.75
2	Asparagus racemosus	0.68

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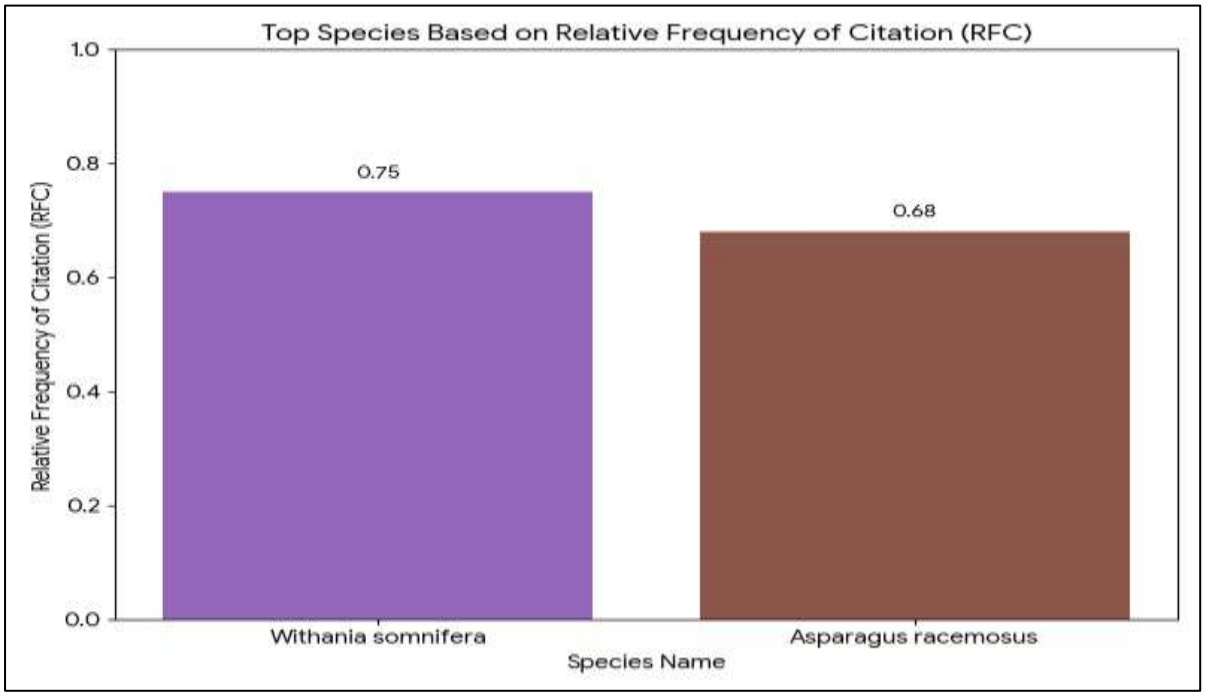

Table 4. Informant Consensus Factor (ICF)

Disease Category	ICF Value
Gastrointestinal Disorders	0.83
Skin Infections	0.70

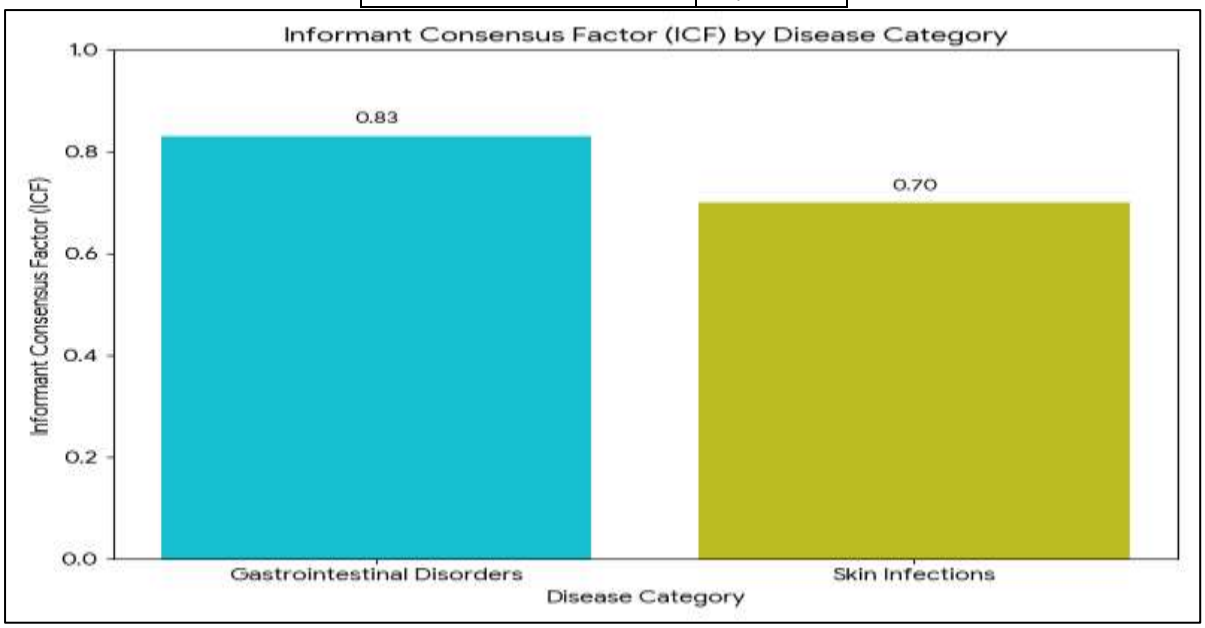

Table 5. Phytochemical Screening Results (15 Priority Species)

Phytochemical Compound	Number of Species Positive	Percentage (%)
Flavonoids	14	93%
Alkaloids	11	73%
Phenolics	15	100%
Terpenoids	13	87%
Saponins	9	60%

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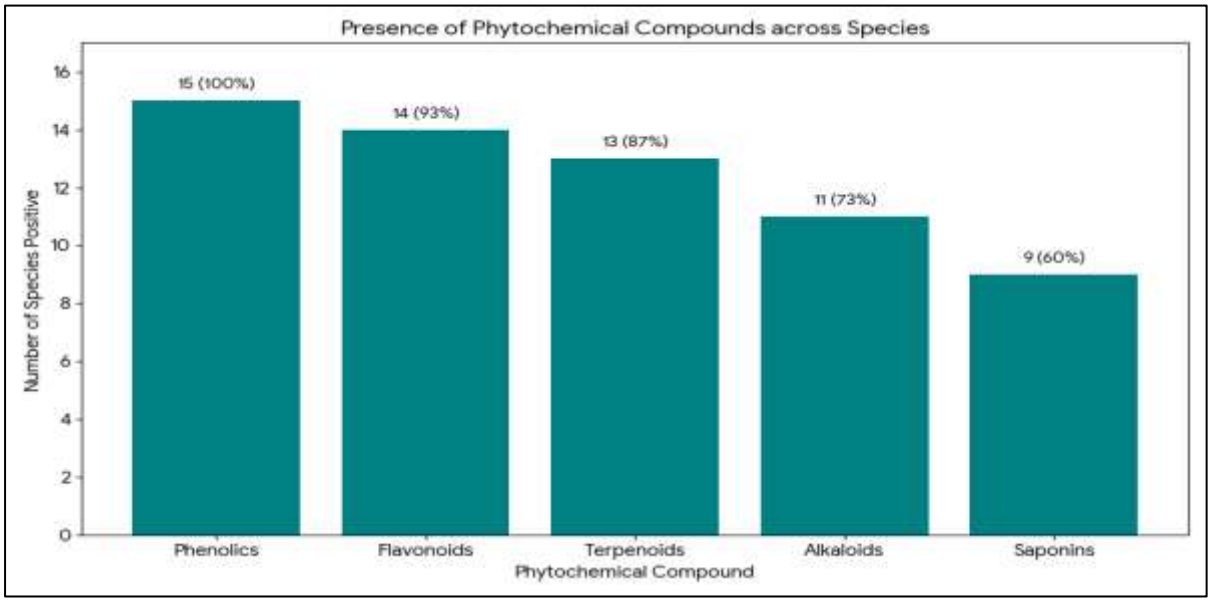
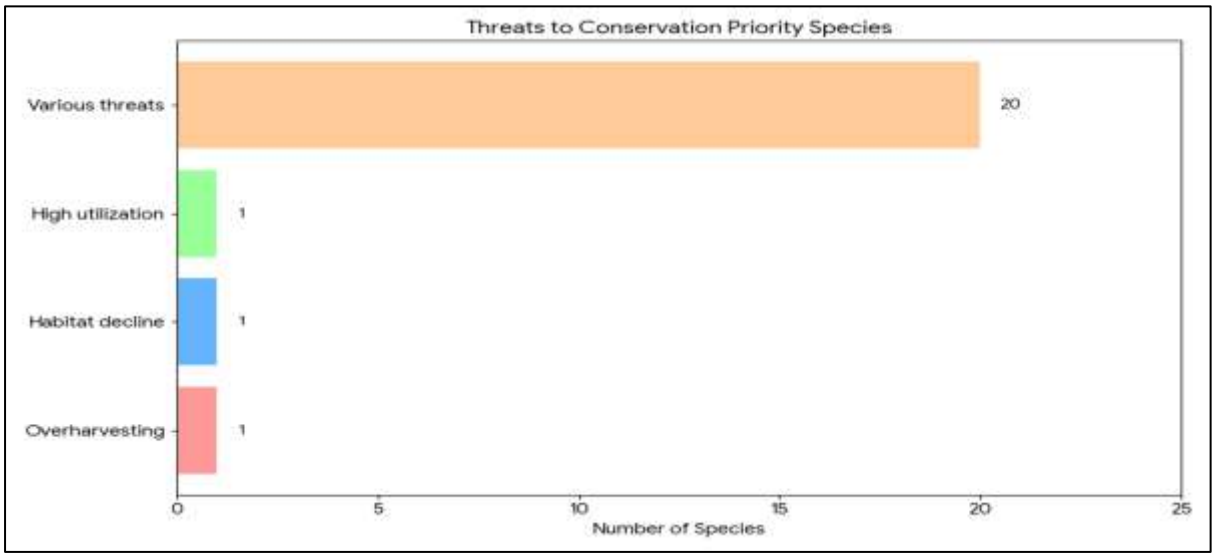


Table 6. Conservation Priority Species (Examples)

S.No	Species Name	Reason for Priority
1	Bacopa monnieri	Overharvesting
2	Centella asiatica	Habitat decline
3	Holarrhena antidysenterica	High utilization
...	20 additional species	Various threats



3.4 Quantitative Analysis

Use Value (UV): The use value was calculated using the formula UV = ΣUi / N, where Ui represents the number of uses reported by each informant and N denotes the total number of informants interviewed.

Relative Frequency of Citation (RFC): RFC was determined as RFC = FC / N, where FC refers to the number of informants who cited a particular plant species and N is the total number of informants.

Informant Consensus Factor (ICF): ICF was computed using the expression ICF = (Nur – Nt) / (Nur – 1), where Nur indicates the total number of use reports for a disease category and Nt represents the number of species used for that category.

3.5 Phytochemical Screening

Preliminary qualitative phytochemical screening was performed on methanolic extracts of the fifteen highest-priority medicinal plant species. The extracts were tested for the presence of alkaloids using Mayer's test, flavonoids using the Shinoda test, phenolic compounds using the ferric chloride test, terpenoids using the Salkowski test, and saponins using the froth test.

3.6 Conservation Prioritization

A conservation priority score was formulated using multiple criteria, including local rarity based on species abundance, intensity of use reflected by UV and RFC values, degree of threat arising from habitat disturbance, and ecological significance in terms of ecosystem services. Species exceeding predefined threshold scores were classified as high-priority candidates for conservation.

4. RESULTS

4.1 Medicinal Plant Diversity

A total of 132 medicinal plant species belonging to 54 botanical families were recorded during the study (Appendix I). Fabaceae was the most dominant family with 18 species, followed by Asteraceae with 14 species and Lamiaceae with 11 species

4.2 Quantitative Ethnobotanical Indices

Azadirachta indica (UV = 0.92) and Ocimum sanctum (UV = 0.88) exhibited the highest use values among the documented species. Withania somnifera (RFC = 0.75) and Asparagus racemosus (RFC = 0.68) recorded the highest relative frequency of citation. Informant Consensus Factor analysis revealed the greatest level of agreement for treatments related to gastrointestinal disorders (ICF = 0.83) and skin infections (ICF = 0.7

4.3 Phytochemical Screening

Phytochemical screening indicated a widespread presence of bioactive constituents among the priority species. Flavonoids were detected in 14 out of 15 species, alkaloids in 11 species, phenolic compounds in all examined species, terpenoids in 13 species, and saponins in 9 species. The occurrence of these compounds provides scientific support for the traditional medicinal uses of the documented plants

4.4 Conservation Prioritization

Twenty-three medicinal plant species, including Bacopa monnieri, Centella asiatica, and Holarrhena antidysenterica, were identified as high-priority candidates for conservation owing to their limited local abundance and high levels of utilization.

5. DISCUSSION

The findings of this study demonstrate the presence of extensive ethnomedicinal knowledge within the Amethi District, consistent with ethnobotanical patterns reported from other regions of North India. The application of quantitative indices enabled an objective assessment and ranking of plant species based on their cultural significance and therapeutic value. Elevated ICF values indicate a high level of consensus among informants regarding the use of specific plants for particular health ailments.

Phytochemical analysis corroborates several traditional medicinal applications, as the detection of bioactive compounds such as flavonoids and alkaloids is associated with known antimicrobial, anti-inflammatory, and antioxidant properties. This biochemical validation strengthens the therapeutic relevance of the prioritized species.

Nonetheless, the intensive harvesting of roots, bark, and entire plants for medicinal purposes may accelerate population declines, especially among species exhibiting high medicinal demand and limited regenerative capacity. Conservation prioritization emphasizes the importance of implementing both in situ and ex situ conservation measures, alongside community-driven conservation programs and the promotion of medicinal plant cultivation.

6. CONCLUSION

The present study highlights the remarkable depth and continuity of ethnobotanical knowledge preserved by indigenous and rural communities in the Amethi District of Uttar Pradesh. Traditional medicinal practices in the region remain closely linked to local plant diversity, reflecting a long-standing relationship between people and their surrounding ecosystems. The documentation of this knowledge is particularly important in the face of rapid socio-economic change and environmental degradation, which increasingly threaten both biological resources and cultural traditions.The application of quantitative ethnobotanical indices provided a systematic and objective framework for evaluating the cultural importance and therapeutic relevance of medicinal plant species. Measures such as Use Value, Relative Frequency of Citation, and Informant Consensus Factor enabled the identification of plant species that are most frequently utilized and widely trusted by local communities for treating specific health conditions. High

consensus values for certain ailment categories indicate a strong shared understanding among informants, suggesting the effectiveness and reliability of traditional remedies used in the region.

Preliminary phytochemical screening further strengthened the scientific basis of ethnomedicinal knowledge by confirming the presence of key bioactive compounds, including flavonoids, alkaloids, phenolics, terpenoids, and saponins, in priority species. These secondary metabolites are known to exhibit diverse pharmacological activities such as antimicrobial, anti-inflammatory, and antioxidant effects, thereby supporting many of the traditional therapeutic claims documented during the study. The integration of ethnobotanical data with phytochemical evidence enhances the credibility of indigenous healthcare practices and highlights the potential of these plants for future pharmacological research.Despite their medicinal importance, several plant species were identified as highly vulnerable due to overharvesting, habitat disturbance, and low natural regeneration. The conservation prioritization analysis revealed an urgent need for targeted protection measures, particularly for species harvested destructively for roots, bark, or whole plants. Sustainable management strategies, including in situ and ex situ conservation, community-based resource management, and the promotion of medicinal plant cultivation, are essential to reduce pressure on wild populations.Overall, this research emphasizes the critical importance of preserving indigenous ethnobotanical knowledge while ensuring the sustainable use of medicinal plant resources. By combining quantitative analysis, phytochemical validation, and conservation assessment, the study offers a comprehensive framework for safeguarding both cultural heritage and plant biodiversity in the Amethi District, contributing to long-term ecological balance, community well-being, and future scientific advancement.

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