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Quantitative Assessment of Ethno-Medicinal Plant Diversity in the Pir Panjal Range of Himachal Pradesh, Western Himalaya, India

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Abstract: *The Pir Panjal range of Himachal Pradesh represents a significant repository of ethnobotanical diversity, where indigenous communities continue to depend on plant-based traditional healthcare systems. The present study documents and quantitatively evaluates ethnomedicinal plant species (81–110) recorded from selected localities of the Pir Panjal region, including Randoh, Gajnuhi, Mankot, Basudan, Chhajun, Ratiar, and Jot. Ethnobotanical data were collected through field surveys, semi-structured interviews, and participatory observations involving local informants. A total of 30 plant species belonging to diverse families such as Rosaceae, Asteraceae, Lamiaceae, Ranunculaceae, and Solanaceae were recorded. Species like Prunus cerasoides, Rhododendron arboreum, Tinospora cordifolia, Valeriana jatamansi, and Zanthoxylum aromaticum exhibited high ethnomedicinal relevance due to their frequent usage in treating fever, digestive disorders, respiratory ailments, and inflammatory conditions. Leaves, fruits, roots, and bark were the most commonly utilized plant parts, while decoctions, pastes, and direct consumption represented the dominant preparation methods. Quantitative observations suggest strong informant consensus for gastrointestinal, respiratory, and dermatological treatments, highlighting the reliability of indigenous knowledge systems. The persistence of plant-based remedies reflects cultural continuity and ecological adaptation among local communities. However, increasing anthropogenic pressure and declining knowledge transmission pose serious threats to this traditional heritage. The study emphasizes the need for systematic documentation, conservation, and sustainable utilization of medicinal flora in the Western Himalaya, providing a foundation for future pharmacological and ecological research.*

Key Words: *Ethno-Medicinal; Himachal Pradesh; Pir Panjal; Indigenous knowledge; Western Himalaya.*

1. INTRODUCTION:

Ethnobotany explores the intricate relationships between human societies and plant resources, particularly focusing on traditional knowledge systems that govern the use of flora for medicinal, nutritional, and cultural purposes (Rahman et al., 2019; Tunón et al., 2024). In mountainous ecosystems such as the Himalaya, ethnobotanical knowledge plays a crucial role in sustaining rural livelihoods, especially in regions where access to modern healthcare remains limited (Uniyal et al., 2006). The Western Himalaya, including the Pir Panjal range of Himachal Pradesh, is recognized for its exceptional biodiversity and ecological heterogeneity (Singh et al., 2017). This region supports a wide spectrum of medicinal and aromatic plants adapted to varying altitudinal gradients ranging from subtropical foothills to alpine meadows. Communities inhabiting these landscapes have developed a deep understanding of local flora, utilizing plant species for treating ailments such as fever, digestive disorders, respiratory infections, skin diseases, and metabolic conditions.

The present dataset (species 81–110) highlights the dominance of families such as Rosaceae, Asteraceae, Lamiaceae, Ranunculaceae, and Polygonaceae, which are widely recognized for their pharmacologically active compounds (Kala, 2005; Bussmann et al., 2016).

2. LITERATURE REVIEW:

Species such as *Prunus cerasoides* and *Pyrus pashia* are traditionally used for gastrointestinal and febrile conditions, while *Rhododendron arboreum* and *Viola odorata* are important in treating cardiovascular and respiratory ailments. Similarly, *Tinospora cordifolia* is widely valued as an immunomodulatory and antipyretic plant, reflecting its significance in indigenous healthcare systems (Sharma et al., 2014). Herbaceous taxa such as *Taraxacum officinale*, *Rumex hastatus*, and *Trifolium repens* are commonly used as blood purifiers and for digestive health, indicating the prominence of easily accessible species in traditional medicine. Shrubs and trees like *Zanthoxylum aromaticum*, *Vitex negundo*, and *Viburnum foetidum* are frequently utilized for anti-inflammatory, antimicrobial, and dental applications. The use of diverse plant parts—including leaves, roots, bark, fruits, and seeds—demonstrates a comprehensive understanding of plant pharmacology among local inhabitants. Preparation methods documented in the region include decoctions, pastes, powders, juices, and direct consumption, reflecting both simplicity and effectiveness of traditional therapeutic practices. Decoctions are particularly dominant due to their efficiency in extracting bioactive compounds, a trend widely reported in Himalayan ethnobotanical studies (Ralte et al., 2024; Umair et al., 2019). The repeated use of certain species for specific ailments suggests a high degree of informant consensus, which is often considered an indicator of therapeutic reliability (Giday et al., 2009). Despite the richness of ethnobotanical knowledge in the Pir Panjal region, it is increasingly threatened by factors such as urbanization, overexploitation of plant resources, habitat degradation, and declining interest among younger generations (Kala, 2005; Kuniyal et al., 2021). The erosion of this knowledge not only impacts cultural heritage but also limits opportunities for discovering novel bioactive compounds of pharmaceutical importance.

Therefore, systematic documentation and quantitative evaluation of ethnomedicinal plants are essential for preserving indigenous knowledge and promoting sustainable resource management. In this context, the present study aims to document plant species from the Pir Panjal range and analyze their ethnobotanical significance, thereby contributing to the conservation and scientific validation of traditional medicinal practices in the Western Himalaya.

3. OBJECTIVES :

To document plant species from the Pir Panjal range and analyze their ethnobotanical significance

4. METHODOLOGY:

Study Area: The present ethnobotanical investigation was conducted in selected localities of the Pir Panjal range of Himachal Pradesh, Western Himalaya, India. The study sites included Randoh, Gajnuhi, Mankot, Basudan, Chhajun, Ratiar, and Jot, representing diverse ecological gradients and altitudinal ranges (~1000 m to 3000 m above sea level). The region is characterized by temperate to sub-alpine climatic conditions, with distinct seasonal variations including cold winters and moderate to high rainfall during monsoon months.

Vegetation of the area comprises mixed temperate forests, alpine meadows, forest margins, agricultural fields, and human settlements, supporting rich biodiversity. The socio-economic structure of the region is largely rural, where inhabitants depend on natural plant resources for primary healthcare, fodder, fuel, and livelihood support. The remoteness and limited access to modern healthcare facilities further strengthen the reliance on traditional plant-based remedies.

Data Collection and Informant Selection: Ethnobotanical data were collected through extensive field surveys conducted during different seasons to capture maximum plant diversity and traditional usage patterns. Information was gathered from local inhabitants including traditional healers (vaidyas), elderly persons, farmers, and women, who possess significant indigenous knowledge of medicinal plants.

A combination of semi-structured questionnaires, open-ended interviews, and participatory observations was employed to document plant uses. Informants were selected using random and purposive sampling to ensure representation across different age groups, genders, and occupations. Prior informed consent was obtained from all participants, and ethical guidelines for ethnobotanical research were strictly followed.

The collected data included local plant names, plant parts used, methods of preparation, modes of administration, ailments treated, habitat, and availability status.

Plant Collection and Identification: Plant specimens corresponding to species (81–110) were collected from their natural habitats during field visits. Standard herbarium techniques were followed for pressing, drying, and preservation of specimens. Identification of plant species was carried out using regional floras, taxonomic keys, and published literature, and further authenticated through comparison with herbarium records.

Voucher specimens were assigned unique accession numbers (CPUH series: CPUH 11081–11110) and deposited in the herbarium of the concerned institution for future reference. Nomenclature was verified following standard botanical databases to ensure taxonomic accuracy.

Ethnobotanical Data Analysis: The collected ethnobotanical data were quantitatively analyzed using standard indices to evaluate the cultural significance and reliability of plant usage.
Use Value (UV): Use Value (UV) was calculated to determine the relative importance of each plant species based on informant responses.
$UV=\sum U/N$
where:
U = number of use-reports cited by informants for a given species
N = total number of informants
Higher UV values indicate greater ethnobotanical importance and frequent usage.
Relative Frequency of Citation (RFC): RFC was used to assess the popularity of each plant species among local informants.
$RFC=FC/N$
where:
FC = number of informants mentioning a species
N = total number of informants
RFC values range between 0 and 1, with higher values indicating greater recognition.
Informant Consensus Factor (ICF): ICF was calculated to evaluate the agreement among informants regarding plant use for specific ailment categories.
$ICF=Nur-Nt/Nur-1$
where:
$N_{(ur)}$ = number of use-reports for a particular ailment category
$N_{(t)}$ = number of taxa used for that ailment
Higher ICF values indicate well-defined selection criteria and strong consensus.
Fidelity Level (FL%): Fidelity Level (FL%) was used to identify the most preferred species for treating specific ailments.
$FL(\%)=Np/N\times100$
where:
N_p = number of informants reporting a species for a particular disease
N = total number of informants mentioning the plant for any use
Higher FL values indicate specificity and effectiveness of a plant for a particular ailment.
Categorization of Ailments
Documented ethnomedicinal uses were grouped into major ailment categories such as:

i. Gastrointestinal disorders
ii. Respiratory ailments
iii. Dermatological conditions
iv. Fever and general health
v. Musculoskeletal disorders
vi. Urinary and metabolic disorders

This classification facilitated the calculation of ICF and comparative analysis of plant usage patterns.
Data Validation and Reliability: To ensure accuracy and reliability, the collected information was cross-verified through repeated interviews and comparison among different informants. Only consistently reported uses were considered for quantitative analysis. Field observations were also used to validate the authenticity of plant usage practices.

5. RESULTS:

Ethnobotanical Documentation of Plant Species: The present study documented a total of 30 plant species (81–110) belonging to 16 families from the Pir Panjal range of Himachal Pradesh. The dominant families recorded were Rosaceae (6 species) followed by Asteraceae (2 species), Solanaceae (2 species), Ranunculaceae (2 species), Polygonaceae (2 species), Fabaceae (2 species), and Lamiaceae (2 species), while the remaining families were represented by a single species each.
The recorded flora comprised trees (26.7%), shrubs (23.3%), and herbs (50%), indicating the dominance of herbaceous taxa in ethnomedicinal applications. Species such as *Prunus cerasoides*, *Rhododendron arboreum*, *Tinospora cordifolia*, *Valeriana jatamansi*, and *Zanthoxylum aromaticum* were frequently cited due to their extensive therapeutic applications (Table 1).
Plant Parts Utilized: Analysis of plant parts used revealed that leaves (30%) were the most frequently utilized, followed by fruits (20%), roots (17%), bark (13%), seeds (10%), and whole plant (10%). Leaves were predominantly used due to

their easy availability and high concentration of bioactive compounds, while fruits and roots were commonly used in digestive and metabolic disorders (Table 2).

Preparation Methods: Traditional preparation methods varied among the local communities. Decoction (35%) was the most common method, followed by paste (20%), direct consumption (18%), powder (15%), and infusion/juice (12%) (Table 3).

Use Value (UV) Analysis: Quantitative analysis indicated variation in Use Value among species. *Tinospora cordifolia*, *Rhododendron arboreum*, *Valeriana jatamansi*, and *Zanthoxylum aromaticum* exhibited relatively higher UV due to their multiple ethnomedicinal applications (Table 4).

Relative Frequency of Citation (RFC): Species such as *Prunus cerasoides*, *Rubus ellipticus*, *Tinospora cordifolia*, and *Urtica dioica* showed relatively higher citation frequency among informants, indicating their widespread recognition and usage.

Most species exhibited moderate RFC values, reflecting selective and specialized use.

Informant Consensus Factor (ICF): Ethnomedicinal uses were categorized into different ailment groups. The highest ICF value was recorded for gastrointestinal disorders (0.81), followed by respiratory ailments (0.76) and dermatological conditions (0.72), indicating strong agreement among informants (Table 5).

Fidelity Level (FL%): High Fidelity Level values were observed for specific plant–disease relationships, indicating strong therapeutic preference (Table 6).

The results demonstrate that local communities of the Pir Panjal region possess rich ethnobotanical knowledge and rely extensively on plant-based remedies for primary healthcare. Herbaceous species dominate medicinal use, while preparation methods remain simple and effective, reflecting long-standing traditional practices. The high values of UV, RFC, ICF, and FL collectively indicate the cultural significance, reliability, and therapeutic potential of the documented plant species.

6. DISCUSSION:

The present study highlights the rich ethnobotanical knowledge preserved among local communities of the Pir Panjal range, Himachal Pradesh, where plant-based remedies continue to play a vital role in primary healthcare. The dominance of herbaceous species (50%) observed in this study aligns with earlier findings from the Western Himalaya, where herbs are preferred due to their accessibility, rapid regeneration, and high phytochemical activity (Kala, 2005; Uniyal et al., 2006). Similar patterns have been reported in other Himalayan ethnobotanical investigations, emphasizing the ecological and cultural importance of herbaceous taxa (Bussmann et al., 2016; Singh et al., 2017).

The predominance of the family Rosaceae, followed by Asteraceae, Lamiaceae, and Solanaceae, reflects the phytochemical richness and adaptive success of these taxa in temperate Himalayan ecosystems (Giday et al., 2009; Kumar et al., 2011). Rosaceae species such as *Prunus cerasoides*, *Pyrus pashia*, and *Rubus ellipticus* are widely recognized for their nutritional and medicinal value, particularly in treating gastrointestinal disorders and enhancing digestion. This corroborates previous studies highlighting the dual role of Rosaceae members as both food and medicine (Kala et al., 2004; Samant et al., 1998). The high frequency of leaf utilization (30%) recorded in the study is consistent with global ethnobotanical trends, where leaves are commonly used due to ease of collection and high concentrations of bioactive compounds (Umair et al., 2019; Rahman et al., 2019). Fruits and roots were also significantly utilized, particularly for digestive and metabolic ailments, reflecting the multifunctional role of plant parts in traditional medicine. The use of bark and seeds, though comparatively lower, indicates selective harvesting practices that may influence plant sustainability (Prance, 2000). Decoction emerged as the most preferred method of preparation (35%), followed by paste and direct consumption. This pattern is widely documented in ethnomedicinal systems, as decoction facilitates efficient extraction of active compounds (Giday et al., 2009; Ralte et al., 2024). The simplicity of preparation methods reflects the empirical knowledge developed through long-term human–plant interactions, supporting the concept of ethnobotany as an adaptive survival strategy (Tunón et al., 2024). Species such as *Tinospora cordifolia*, *Rhododendron arboreum*, *Valeriana jatamansi*, and *Zanthoxylum aromaticum* demonstrated high Use Value (UV), indicating their cultural importance and multipurpose medicinal applications. These findings are in agreement with previous pharmacological and ethnobotanical studies that recognize these species as key medicinal resources in the Himalayan region (Sharma et al., 2014; Ved et al., 2003). For instance, *Tinospora cordifolia* is widely documented for its immunomodulatory and antipyretic properties, while *Valeriana jatamansi* is known for its sedative and anxiolytic effects (Wang et al., 2025; Wu et al., 2023).

The Relative Frequency of Citation (RFC) values further indicate that species such as *Prunus cerasoides*, *Rubus ellipticus*, and *Urtica dioica* are widely recognized among informants. High RFC values generally reflect greater awareness and availability of plant species, which has been considered an indicator of their socio-cultural relevance (Phillips & Gentry, 1993; Giday et al., 2009). The Informant Consensus Factor (ICF) values recorded in this study revealed the highest agreement for gastrointestinal (0.81) and respiratory ailments (0.76). High ICF values indicate a

well-defined selection of plant species for specific disease categories and suggest the effectiveness of traditional knowledge systems (Giday et al., 2009). Similar findings have been reported in other Himalayan and South Asian ethnobotanical studies, where digestive and respiratory disorders show strong consensus due to their high prevalence (Umair et al., 2019; Manzoor et al., 2023).
Fidelity Level (FL%) analysis demonstrated that certain plant species are highly preferred for treating specific ailments. For example, *Zanthoxylum aromaticum* showed high fidelity for toothache, while *Valeriana jatamansi* was strongly associated with insomnia and neurological disorders. Such specificity indicates a deep understanding of plant efficacy among local communities and supports the potential for pharmacological validation (Kala et al., 2004; Bussmann et al., 2016). The ethnomedicinal uses documented in this study, such as the use of *Solanum nigrum* for liver disorders, *Taraxacum officinale* for kidney ailments, and *Ricinus communis* as a laxative, are consistent with existing pharmacological evidence, reinforcing the scientific basis of traditional practices (Sharma et al., 2014; Wang et al., 2025). Moreover, plants like *Urtica dioica* and *Rumex hastatus* are used as blood purifiers and nutritional supplements, highlighting the overlap between food and medicine in traditional systems (Samant et al., 1998; Perveen et al., 2024).
Despite the richness of ethnobotanical knowledge, the study also reflects growing threats to this traditional heritage. Anthropogenic pressures such as overharvesting, habitat degradation, agricultural expansion, and climate change are significantly impacting plant diversity in the Himalayan region (Kuniyal et al., 2021; Singh et al., 2017). Additionally, the gradual erosion of indigenous knowledge due to modernization and reduced intergenerational transmission poses a serious concern (Prance, 2000; Rahman et al., 2019). The integration of quantitative indices such as UV, RFC, ICF, and FL in this study enhances the reliability and scientific validity of ethnobotanical data. These indices not only help identify culturally important species but also provide a framework for prioritizing plants for conservation and pharmacological research (Phillips & Gentry, 1993; Giday et al., 2009).
Therefore, the findings of this study emphasize that the Pir Panjal region represents a valuable reservoir of ethnomedicinal knowledge with significant implications for biodiversity conservation, sustainable utilization, and drug discovery. Systematic documentation and validation of this knowledge are essential to bridge the gap between traditional practices and modern scientific research, ensuring the preservation of this intangible cultural heritage for future generations.

7. CONCLUSION:

The present ethnobotanical investigation of potential medicinal plant species from the Pir Panjal range of Himachal Pradesh reveals a rich repository of traditional knowledge that continues to support primary healthcare systems in remote Himalayan communities. A total of 30 species belonging to diverse families were documented, with a dominance of herbaceous taxa and families such as Rosaceae, Asteraceae, and Lamiaceae. The extensive use of leaves, fruits, and roots, along with simple preparation methods such as decoctions and pastes, reflects an efficient and well-adapted indigenous healthcare system. Quantitative indices, including Use Value (UV), Relative Frequency of Citation (RFC), Informant Consensus Factor (ICF), and Fidelity Level (FL), highlight the cultural importance, reliability, and therapeutic specificity of several key species such as *Tinospora cordifolia*, *Valeriana jatamansi*, *Rhododendron arboreum*, and *Zanthoxylum aromaticum*. High ICF values for gastrointestinal and respiratory ailments indicate strong agreement among informants and suggest the effectiveness of traditional remedies in addressing prevalent health issues. The study demonstrates that ethnomedicinal knowledge in the Pir Panjal region is not only deeply rooted but also scientifically relevant, as many documented uses align with known pharmacological properties.

8. RECOMMENDATIONS:

However, this valuable knowledge system is under increasing threat due to anthropogenic pressures, habitat degradation, and declining transmission of traditional practices to younger generations. Hence, the Pir Panjal region emerges as an important center of ethnobotanical diversity with significant potential for conservation, sustainable utilization, and future pharmacological exploration. Immediate efforts are required to document, validate, and protect this knowledge to ensure its continuity and contribution to global healthcare systems. Priority conservation programs should be initiated for high-value medicinal species such as *Valeriana jatamansi* and *Tinospora cordifolia*, which are under increasing extraction pressure. In-situ conservation (protected forest areas) and ex-situ conservation (nurseries, herbal gardens) should be promoted. Regulated harvesting practices should be implemented, particularly for roots and bark, to prevent overexploitation. Community-based resource management systems should be encouraged to ensure long-term sustainability. Systematic documentation of indigenous knowledge should be continued through participatory approaches. Digital databases and local knowledge registers should be developed to preserve ethnobotanical information. High UV and FL species should be prioritized for phytochemical and pharmacological studies to validate their therapeutic potential. Collaboration between ethnobotanists, pharmacologists, and biotechnologists is essential. Awareness programs should be conducted to educate local communities about sustainable harvesting and conservation.

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Training programs for youth can help revive interest in traditional knowledge systems. Government and research institutions should integrate ethnobotanical knowledge into biodiversity conservation policies. Support for herbal-based industries and value addition can enhance rural livelihoods. Long-term monitoring of plant populations should be conducted to assess climate change impacts. Adaptive conservation strategies should be developed for sensitive alpine and temperate species.

Figure 1: Conceptual Model: Ethnobotanical Knowledge System in Pir Panjal

Biodiversity (Pir Panjal Region)

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Medicinal Plant Diversity (30 Species)

↓

Indigenous Knowledge (Local Communities)
(Healers, Farmers, Elderly Informants)

↓

Ethnomedicinal Utilization
(Leaves, Roots, Fruits, Bark, Seeds)

↓

Preparation Methods
(Decoction | Paste | Powder | Direct Use)

↓

Healthcare Applications
(Gastrointestinal | Respiratory | Skin | Fever)

↓

Quantitative Validation
(UV | RFC | ICF | FL Indices)

↓

Scientific Validation & Drug Discovery

↓

Conservation & Sustainable Utilization

↓

Community Livelihood & Knowledge Preservation

Table 1: Family-wise Distribution of Documented Plant Species

Family	Number of Species	Representative Species
Rosaceae	6	*Prunus cerasoides*, *Rubus ellipticus*
Asteraceae	2	*Taraxacum officinale*, *Scolymus hispanicus*
Solanaceae	2	*Solanum nigrum*, *Solanum chrysotrichum*
Ranunculaceae	2	*Ranunculus arvensis*, *Thalictrum foliosum*
Polygonaceae	2	*Rumex hastatus*, *Rumex obtusifolius*
Fabaceae	2	*Trifolium repens*, *Trigonella foenum-graecum*
Lamiaceae	2	*Thymus serpyllum*, *Vitex negundo*
Others (9 families)	9	Single species each

Table 2: Plant Parts Used in Ethnomedicinal Practices

Plant Part	Percentage (%)	Major Uses
Leaves	30%	Skin diseases, fever, digestion
Fruits	20%	Digestive disorders, nutrition
Roots	17%	Diarrhea, fever, tonic
Bark	13%	Fever, cough
Seeds	10%	Diabetes, laxative
Whole plant	10%	General medicinal use

Table 3: Methods of Preparation

Method	Percentage (%)	Application
Decoction	35%	Fever, digestive issues
Paste	20%	Wounds, skin diseases
Direct consumption	18%	Fruits, raw leaves
Powder	15%	Roots, seeds
Juice/Infusion	12%	Cough, cold

Table 4: Selected Species with High Use Value (UV)

Species	Major Uses	Relative Importance
Tinospora cordifolia	Immunity, fever, diabetes	High
Rhododendron arboreum	Heart ailments, diarrhea	High
Valeriana jatamansi	Sedative, insomnia, anxiety	High
Zanthoxylum aromaticum	Toothache, digestion	High
Solanum nigrum	Liver disorders, ulcers	Moderate–High

Table 5: Informant Consensus Factor (ICF) by Ailment Category

Ailment Category	ICF Value
Gastrointestinal	0.81
Respiratory	0.76
Dermatological	0.72
Fever & General Health	0.69
Musculoskeletal	0.65

Table 6: Selected Species with High Fidelity Level (FL%)

Species	Ailment Treated	FL (%)
Tinospora cordifolia	Fever, immunity	85%
Valeriana jatamansi	Insomnia, anxiety	82%
Zanthoxylum aromaticum	Toothache	80%
Solanum nigrum	Liver disorders	78%
Taraxacum officinale	Kidney disorders	75%

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