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BIODIVERSITY CONSERVATION, HEALTHCARE SUSTAINABILITY, AND FUTURE PHARMACOLOGICAL RESEARCH AT CHAMBA HIMACHAL PRADESH, INDIA

***Gulshan Kumar, Himanshu Thakur, Kanika**

Department of Bio-Sciences, Career Point University Hamirpur, Himachal Pradesh, India-176041.

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***Corresponding Author: Gulshan Kumar**
Department of Bio-Sciences, Career Point University Hamirpur, Himachal Pradesh, India-176041.

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ABSTRACT

The present study provides a comprehensive ethnobotanical assessment of ethnomedicinal grasses and associated herbaceous plant species used by indigenous and rural communities of Chamba District, Himachal Pradesh, India. Located in the north-western Himalaya, the district is characterized by a wide altitudinal range and diverse ecological zones, which support rich floral diversity and a long-established tradition of plant-based healthcare practices. Despite increasing dependence on modern medical systems, local communities continue to rely significantly on traditional ethnomedicine for primary healthcare, particularly in remote areas with limited medical accessibility. The study aimed to systematically document ethnomedicinal plant knowledge, analyze indigenous healthcare practices, and evaluate the cultural and ecological significance of medicinal grasses. Field data were collected from selected villages using ethnobotanical surveys combined with Participatory Rural Appraisal (PRA) techniques, including social mapping, resource mapping, transect walks, seasonal calendars, and focus group discussions. Information was gathered from key informants such as traditional healers (Vaidyas), shepherds, elderly villagers, and women with specialized knowledge of household remedies through structured, semi-structured, and unstructured interviews. Plant specimens were collected during different seasons to capture their phenological variation and were subsequently identified and authenticated using standard floras and herbarium comparisons. Ethnomedicinal data were systematically recorded, including local plant names, parts used, preparation methods, dosage, and therapeutic applications.

The results indicate that ethnomedicinal grasses, along with other herbaceous species, are widely used for the treatment of gastrointestinal disorders, respiratory ailments, skin infections, fever, inflammation, and musculoskeletal conditions. The study also reveals that traditional knowledge is primarily orally transmitted and is increasingly threatened by socio-economic transformation, modernization, and declining intergenerational transfer. Additionally, ecological pressures such as habitat degradation, overgrazing, and climate variability are contributing to the decline of several medicinal plant species. Therefore, the study highlights the urgent need for documentation, conservation, and sustainable management of ethnomedicinal plant resources in the Himalayan region. It also emphasizes the importance of integrating indigenous knowledge systems with scientific validation to support biodiversity conservation, healthcare sustainability, and future pharmacological research.

KEYWORDS: Ethnobotany; Ethnomedicinal grasses; Chamba; Traditional knowledge; Participatory Rural Appraisal (PRA); Biodiversity conservation

INTRODUCTION

The relationship between human societies and plants represents one of the oldest and most fundamental interactions in human history. Plants have served as a primary source of food, shelter, clothing, and medicine since prehistoric times, forming the foundation of traditional healthcare systems across diverse cultures. Among these uses, medicinal applications of plants have played a particularly significant role in sustaining human health, especially in regions where access to modern healthcare facilities remains limited. Ethnobotany, the scientific study of the relationships between people and plants, has emerged as a vital interdisciplinary field that documents, analyzes, and interprets traditional plant knowledge systems (Martin, 1995; Cotton, 1996). Ethnomedicinal studies are especially important in biodiversity-rich regions such as the Himalayan ecosystem, where indigenous communities possess extensive knowledge of local flora and its therapeutic applications. The Indian Himalayan Region (IHR), recognized as one of the world's biodiversity hotspots, harbors a vast array of medicinal plant species, many of which are used in traditional healing systems such as Ayurveda, Amchi, and local folk medicine (Cunningham, 2001). Within this region, Himachal Pradesh stands out due to its wide altitudinal variation, diverse climatic zones, and rich floristic composition, which collectively support a high diversity of ethnomedicinal plants, including grasses and herbaceous species. Chamba District, located in the north-

western part of Himachal Pradesh, is particularly significant in this context. The district is characterized by complex topography ranging from subtropical valleys to alpine meadows, creating a variety of ecological niches that support diverse plant communities. These ecological conditions have facilitated the development of a strong tradition of ethnobotanical knowledge among local communities, who rely heavily on surrounding plant resources for primary healthcare needs. Despite increasing modernization, many rural populations in Chamba continue to depend on traditional herbal remedies for treating common ailments due to accessibility, affordability, and cultural acceptance (Singh & Pandey, 1998). Ethnomedicinal knowledge in Chamba District is deeply embedded in the socio-cultural fabric of indigenous and rural communities. Traditional healers, locally known as Vaidyas, along with shepherds, elderly villagers, and women, play a central role in the preservation and transmission of plant-based medicinal knowledge. This knowledge is primarily oral in nature and is passed from one generation to another through practice and observation. However, with rapid socio-economic transformation, migration, and modernization of healthcare systems, this valuable knowledge is increasingly at risk of erosion (Posey, 1999). Among the various plant groups used in traditional medicine, grasses (family Poaceae) and herbaceous plants occupy a unique position. Grasses are among the most widely distributed plant families globally and are ecologically dominant in many ecosystems, including Himalayan meadows and grasslands. While grasses are commonly associated with fodder and agricultural use, several species also possess important medicinal properties. Ethnomedicinal grasses are traditionally used to treat digestive disorders, urinary infections, inflammation, fever, skin diseases, and respiratory ailments. Their widespread availability, ease of collection, and perceived therapeutic effectiveness make them an important component of rural healthcare systems (Heinrich et al., 2009). The Himalayan grassland ecosystems, particularly alpine and subalpine meadows, provide a rich habitat for ethnomedicinal grasses. These ecosystems are ecologically fragile but biologically diverse, supporting numerous endemic and medicinal plant species. The sustainable use of these resources is essential for maintaining ecological balance and ensuring the continued availability of medicinal plants for local communities. However, increasing anthropogenic pressure, overgrazing, deforestation, unregulated harvesting, and climate change are posing significant threats to these ecosystems (Cunningham, 2001). Ethnobotanical research plays a crucial role in documenting and preserving traditional plant knowledge before it is lost. Systematic documentation of ethnomedicinal plants not only contributes to biodiversity conservation but also provides a scientific basis for pharmacological research and drug discovery. Many modern medicines

have originated from traditional plant-based knowledge systems, highlighting the importance of ethnobotanical studies in identifying potential therapeutic agents (Fabricant & Farnsworth, 2001). In India, ethnobotanical research has gained significant momentum over the past few decades, particularly in Himalayan states where traditional knowledge systems remain relatively intact. Several studies have documented the medicinal uses of plants in Himachal Pradesh, Uttarakhand, and Jammu & Kashmir. However, despite these efforts, specific regions such as Chamba District remain underexplored in terms of detailed ethnomedicinal documentation, especially with respect to grasses and herbaceous plant species. This gap highlights the need for region-specific ethnobotanical studies that focus on both ecological and cultural dimensions of plant use. The present study is therefore situated within this broader scientific and cultural context, aiming to document, analyze, and validate the ethnomedicinal uses of grasses and associated plant species in Chamba District. It also seeks to understand the socio-cultural dynamics that influence traditional plant use, including knowledge transmission, gender roles, and community dependency on plant-based medicine. Additionally, the study integrates Participatory Rural Appraisal (PRA) techniques to ensure active involvement of local communities in knowledge documentation, thereby strengthening the participatory nature of ethnobotanical research (Chambers, 1994). Another important dimension of this study is the conservation perspective. The Himalayan region is experiencing rapid environmental changes due to climate variability and human intervention. These changes are affecting plant distribution patterns, phenology, and regeneration capacity. Medicinal plant species, particularly those with narrow ecological ranges, are highly vulnerable to these changes. Therefore, documenting ethnomedicinal knowledge is not only important for cultural preservation but also for biodiversity conservation and sustainable resource management (WHO, 2002). Furthermore, ethnomedicinal grasses represent an important yet under-researched component of Himalayan ethnobotany. While much attention has been given to woody plants and high-value medicinal herbs, grasses have often been overlooked despite their ecological abundance and medicinal relevance. This study attempts to bridge this gap by focusing specifically on ethnomedicinal grasses alongside associated herbaceous species, thereby contributing to a more comprehensive understanding of plant-based traditional medicine systems in the region. The integration of quantitative ethnobotanical methods, such as Use Value (UV), Informant Consensus Factor (ICF), and Fidelity Level (FL), provides a scientific framework for evaluating the relative importance and reliability of recorded plant uses. These indices help identify culturally significant species and prioritize them for further pharmacological and conservation studies (Phillips &

Gentry, 1993; Friedman et al., 1986). Such an approach enhances the scientific credibility of ethnobotanical research and facilitates its application in biodiversity management and drug discovery. In addition, herbarium specimen collection and taxonomic authentication are essential components of ethnobotanical research. Accurate identification of plant species ensures the reliability of data and provides a permanent scientific record for future reference. Herbarium collections also serve as important repositories for biodiversity conservation and taxonomic studies, enabling long-term monitoring of plant diversity and ecological changes (Jain, 1987). The socio-economic dimension of ethnomedicinal plant use is equally important. In rural Himalayan communities, medicinal plants provide an affordable and accessible alternative to modern healthcare systems. This is particularly relevant in remote areas of Chamba District, where healthcare infrastructure is limited and transportation is difficult. Ethnomedicinal knowledge therefore plays a critical role in primary healthcare delivery and contributes to community resilience and self-reliance. Despite its importance, traditional ethnobotanical knowledge is facing multiple threats. These include cultural erosion, declining interest among younger generations, habitat degradation, commercialization of plant resources, and lack of formal recognition of traditional knowledge systems. Without proper documentation and conservation efforts, much of this valuable knowledge may be permanently lost. In light of these considerations, the present study aims to provide a comprehensive ethnobotanical account of medicinal grasses and associated plant species in Chamba District. It seeks to contribute to scientific understanding, cultural preservation, and sustainable management of plant resources in the Himalayan region. By integrating traditional knowledge with modern scientific methodologies, the study highlights the importance of interdisciplinary approaches in addressing contemporary challenges related to biodiversity conservation and healthcare sustainability.

LITERATURE REVIEW

1. Global Perspective on Ethnobotany and Traditional Medicine

Ethnobotany, as a scientific discipline, focuses on the study of interactions between human societies and plant resources, particularly the traditional knowledge systems associated with plant use. The field has evolved significantly over the last few decades, moving from simple documentation of plant uses to an interdisciplinary science integrating ecology, anthropology, pharmacology, and conservation biology (Martin, 1995; Cotton, 1996). Traditional medicine, which relies heavily on plant-based remedies, remains a primary healthcare system for nearly 80% of the global population, particularly in developing countries (WHO, 2002).

Globally, ethnobotanical studies have revealed that indigenous communities possess vast knowledge about medicinal plants and their applications. This knowledge has played a critical role in modern drug discovery, with numerous pharmaceutical compounds derived from traditionally used medicinal plants. For instance, drugs such as morphine, quinine, and artemisinin have origins in ethnomedicinal knowledge systems (Fabricant & Farnsworth, 2001). This demonstrates the importance of ethnobotanical research in bridging traditional knowledge with modern biomedical science. Furthermore, ethnobotanical documentation is increasingly recognized as a tool for biodiversity conservation. As human activities continue to degrade natural ecosystems, traditional knowledge systems are also being lost. Scholars argue that ethnobotanical studies serve not only as scientific records but also as cultural preservation mechanisms (Posey, 1999). The integration of traditional ecological knowledge with conservation science has become a global priority for sustainable development.

2. Ethnobotanical Research in South Asia

South Asia, particularly India, Nepal, and Bhutan, is one of the richest regions in terms of ethnobotanical diversity due to its varied geography, climatic zones, and cultural diversity. India alone harbors thousands of medicinal plant species, many of which are used in Ayurveda, Siddha, Unani, and folk medicine systems. Ethnobotanical research in India has gained momentum since the late 20th century, with increasing attention to documenting indigenous plant knowledge across different ecological zones (Jain, 1987). In Nepal, studies by Kunwar et al. (2006) have documented extensive use of medicinal plants in Himalayan communities, highlighting the importance of traditional healers in primary healthcare systems. Similarly, studies in Bhutan and northeastern India have shown that ethnomedicinal practices are deeply embedded in cultural and spiritual traditions. These studies emphasize that plant use is not merely utilitarian but also symbolic and culturally significant. In India, ethnobotanical research has been extensively carried out in states such as Uttarakhand, Arunachal Pradesh, Sikkim, and Himachal Pradesh. These studies consistently reveal that rural and tribal communities rely heavily on wild plant species for treating common diseases such as fever, cough, skin infections, gastrointestinal disorders, and inflammation (Singh & Pandey, 1998). However, despite significant progress, many Himalayan regions remain underexplored, particularly in terms of systematic documentation and quantitative analysis.

3. Himalayan Region as an Ethnobotanical Hotspot

The Indian Himalayan Region (IHR) is recognized as one of the world's biodiversity hotspots due to its high species richness and endemism. It supports approximately 10,000 plant species, of which a significant proportion are medicinal (Cunningham, 2001). The region's steep altitudinal gradients and varied climatic conditions create diverse ecological niches that support a wide range of medicinal plant communities. Himalayan communities have developed intricate knowledge systems adapted to their environment. Ethnomedicinal practices in this region are closely linked to subsistence lifestyles, where plants are used not only for healthcare but also for food, fodder, and cultural rituals. Alpine meadows, temperate forests, and subalpine zones are particularly rich in medicinal plant diversity. However, the Himalayan ecosystem is ecologically fragile and highly susceptible to environmental changes. Overgrazing, deforestation, tourism, infrastructure development, and climate change have significantly impacted plant biodiversity. Several medicinal plant species are now facing threats of overexploitation and habitat loss (WHO, 2002). This makes ethnobotanical documentation and conservation research in the region critically important.

4. Ethnomedicinal Plants in Himachal Pradesh

Himachal Pradesh, located in the western Himalaya, is known for its rich floral diversity and strong tradition of herbal medicine. The state supports a wide range of medicinal plant species due to its varied climatic conditions, ranging from subtropical to alpine zones. Ethnobotanical studies in Himachal Pradesh have documented the use of plants for treating respiratory disorders, skin diseases, digestive issues, and musculoskeletal problems. Singh and Pandey (1998) reported that local communities in Himachal Pradesh rely extensively on wild plant species for primary healthcare. Traditional healers (Vaidyas) play an important role in maintaining and transmitting this knowledge. However, modernization and changing lifestyles are leading to a gradual decline in traditional plant knowledge. Several studies highlight that medicinal plants in Himachal Pradesh are often harvested from forest ecosystems without sustainable management practices. This has led to declining populations of high-value medicinal species. Cunningham (2001) emphasizes that unsustainable harvesting practices can significantly threaten the long-term availability of medicinal plant resources in Himalayan regions.

5. Ethnomedicinal Importance of Grasses (Poaceae Family)

Although much ethnobotanical research has focused on woody plants and high-value herbs, grasses (family Poaceae) represent an underexplored but ecologically important group of medicinal plants. Grasses are among the most widely distributed plant families globally and dominate many ecosystems, including Himalayan grasslands and alpine meadows. Ethnomedicinal grasses are traditionally used for treating a variety of ailments, including digestive disorders, urinary tract infections, fever, inflammation, and wound healing. Their widespread availability and ease of collection make them an important component of rural healthcare systems. Heinrich et al. (2009) note that even commonly overlooked plant groups such as grasses may possess significant pharmacological potential. In Himalayan regions, grasses also play a dual role as fodder and medicine. Shepherd communities, in particular, possess detailed knowledge of grass species and their ecological properties. However, scientific documentation of ethnomedicinal grasses remains limited compared to other plant groups. This gap highlights the need for focused studies on Poaceae species in ethnobotanical research.

6. Ethnobotanical Methods and Quantitative Approaches

Modern ethnobotanical research increasingly combines qualitative field methods with quantitative analytical tools. Traditional knowledge is documented through interviews, participatory rural appraisal (PRA), and field observations, while quantitative indices such as Use Value (UV), Informant Consensus Factor (ICF), and Fidelity Level (FL) are used to analyze data scientifically (Phillips & Gentry, 1993; Friedman et al., 1986). Martin (1995) emphasizes the importance of structured methodologies in ethnobotanical research to ensure data reliability and reproducibility. PRA techniques, including social mapping, resource mapping, and transect walks, allow researchers to actively engage with local communities and validate ecological knowledge. Heinrich et al. (1998) argue that informant consensus is a strong indicator of medicinal plant reliability. High consensus values often suggest that a particular plant species is widely accepted for treating specific ailments, making it a candidate for further pharmacological investigation.

7. Conservation Challenges and Threats

Despite its richness, Himalayan ethnobotanical diversity is under severe threat due to multiple factors. Habitat degradation, overharvesting, climate change, and socio-economic transformation are leading to rapid loss of medicinal plant species. Cunningham (2001)

highlights that unsustainable harvesting practices, especially of roots and whole plants, can lead to irreversible population declines. Climate change is also altering vegetation patterns in the Himalayas. Rising temperatures and shifting precipitation patterns are affecting plant phenology, distribution, and regeneration cycles. WHO (2002) stresses the importance of integrating traditional medicine conservation into broader environmental policies.In addition, the erosion of traditional knowledge due to modernization is a major concern. Younger generations are increasingly disconnected from indigenous plant knowledge systems, leading to cultural discontinuity (Posey, 1999).

8. Research Gap

Although several ethnobotanical studies have been conducted in Himachal Pradesh and surrounding Himalayan regions, there remains a significant research gap in the systematic documentation of ethnomedicinal grasses and herbaceous plants in Chamba District. Most previous studies have focused on woody plants or high-altitude medicinal herbs, while grasses have been largely overlooked. Additionally, there is limited integration of quantitative ethnobotanical methods with Participatory Rural Appraisal techniques in the region. This limits the scientific validation and comparative analysis of traditional knowledge systems. Therefore, a comprehensive study focusing on ethnomedicinal grasses and associated plant species in Chamba District is both timely and necessary.

9. Significance of the Present Study

The present study contributes to filling this gap by systematically documenting ethnomedicinal grasses and associated plant species in Chamba District. It integrates participatory field methods with quantitative ethnobotanical analysis to ensure scientific rigor and community involvement. The study also contributes to biodiversity conservation by identifying culturally significant and potentially pharmacologically important plant species. Furthermore, the study supports the preservation of indigenous knowledge systems and highlights their relevance in modern healthcare and sustainable development. By bridging traditional knowledge with scientific research, the study contributes to the global discourse on ethnobotany, conservation biology, and natural product research.

Research Gap:

Despite significant progress in ethnobotanical research across the Indian Himalayan Region, a critical gap still exists in the systematic documentation, quantitative analysis, and ecological validation of ethnomedicinal grasses and associated herbaceous plant species, particularly in

the Chamba District of Himachal Pradesh. Although Himachal Pradesh has been recognized as a rich repository of medicinal plant diversity, most previous studies have primarily focused on woody trees and high-altitude medicinal herbs, while grasses (family Poaceae) and other herbaceous species have received comparatively limited scientific attention. This imbalance in research focus has resulted in an incomplete understanding of the full spectrum of plant-based traditional healthcare systems practiced by rural and indigenous communities in the region. Existing ethnobotanical literature from Himachal Pradesh and adjoining Himalayan states largely emphasizes either broad floristic surveys or documentation of economically important medicinal plants. While such studies have contributed valuable baseline information, they often lack detailed ecological stratification and fail to adequately represent species that are ecologically dominant but medicinally underreported, such as grasses and common herbs found in village landscapes, grazing lands, and forest edges. As a result, many locally significant ethnomedicinal grasses used in day-to-day healthcare practices remain undocumented or poorly described in scientific literature.

Another major research gap lies in the limited application of Participatory Rural Appraisal (PRA) tools in a systematic and integrated manner within ethnobotanical studies of Chamba District. Although some studies have used interviews or surveys, very few have fully incorporated participatory tools such as social mapping, seasonal calendars, transect walks, and resource mapping to capture spatial, temporal, and cultural dimensions of plant use. This lack of participatory depth restricts the understanding of how ethnomedicinal knowledge is distributed within communities, how it varies across seasons and altitudinal gradients, and how it is transmitted across generations. Furthermore, there is a notable absence of quantitative ethnobotanical validation in many earlier studies conducted in the region. Most research remains descriptive, focusing on listing plant species and their uses without applying standardized indices such as Use Value (UV), Informant Consensus Factor (ICF), and Fidelity Level (FL). Without these analytical tools, it becomes difficult to assess the relative importance of species, identify culturally consensus-based medicinal plants, and prioritize taxa for pharmacological or conservation studies. This limits the scientific robustness and comparative value of earlier ethnobotanical findings. The taxonomic uncertainty and lack of properly curated herbarium documentation also represent a significant gap. In many cases, plant identification is based solely on local names or field-level recognition without proper voucher specimen preparation and authentication using standard floras. This leads to ambiguity in species identity, misclassification, and difficulty in validating previous records.

Additionally, herbarium-based reference collections from the Chamba region remain limited, restricting long-term scientific reference and biodiversity monitoring. Another important gap is the insufficient focus on community knowledge dynamics, particularly regarding how ethnomedicinal knowledge is transmitted, transformed, or lost over time. While some studies acknowledge knowledge erosion, very few investigate the socio-cultural drivers behind this decline, such as modernization, education systems, migration, and reduced dependence on traditional medicine. The role of women, shepherds, and traditional healers in maintaining this knowledge system is also underexplored in a structured analytical framework. Climate change and environmental degradation further intensify the research gap. Although Himalayan ecosystems are highly sensitive to climatic variations, there is limited localized research examining how changes in temperature, precipitation, and land use patterns are affecting the distribution, abundance, and phenology of ethnomedicinal grasses and herbs in Chamba District. This lack of ecological correlation studies restricts the ability to predict future availability and sustainability of medicinal plant resources. Moreover, there is a clear gap in the integration of ethnobotanical knowledge with conservation planning and policy frameworks. Most ethnobotanical studies remain academic in nature and do not effectively translate findings into practical conservation strategies or community-based resource management models. This disconnect reduces the real-world impact of research on biodiversity conservation and sustainable livelihood development.

Importantly, despite the global recognition of ethnobotanical knowledge as a valuable source for drug discovery, there is minimal pharmacological prioritization of ethnomedicinal grasses documented from the Chamba region. Many species identified in folk medicine have not been subjected to phytochemical screening or bioactivity studies, leaving their therapeutic potential scientifically unexplored. In summary, the existing body of literature reveals multiple interconnected research gaps, including the underrepresentation of ethnomedicinal grasses, lack of integrated PRA-based participatory research, limited quantitative validation, inadequate herbarium documentation, insufficient socio-cultural analysis, weak climate impact assessment, and poor translation of ethnobotanical knowledge into conservation and pharmacological applications. These gaps collectively justify the need for the present study, which aims to provide a comprehensive, scientifically validated, and participatory documentation of ethnomedicinal grasses and associated plant species in Chamba District, Himachal Pradesh. The present research on ethnomedicinal grasses and associated plant species of Chamba District, Himachal Pradesh is designed with a comprehensive set of

objectives that integrate ethnobotanical documentation, participatory field investigation, and scientific validation. The study aims not only to record traditional plant knowledge but also to analyze its ecological, cultural, and conservation significance in a systematic and meaningful manner.

Objectives

1. To systematically document ethnomedicinal grasses and associated plant species used by local communities in Chamba District
2. To analyze indigenous knowledge systems and validate ethnomedicinal practices using Participatory Rural Appraisal (PRA) techniques and quantitative ethnobotanical indices
3. To assess conservation status, knowledge transmission patterns, and sustainability of ethnomedicinal plant resources in the study area.

METHODOLOGY

1. Study Area Delineation

The study was conducted in selected rural and semi-urban regions of Chamba District, Himachal Pradesh, India. The district forms part of the north-western Himalaya and exhibits a wide altitudinal range from subtropical valleys to alpine meadows, resulting in high floristic diversity and rich ethnomedicinal knowledge systems (Champion & Seth, 1968). Study villages were selected based on ecological variation, accessibility, and dependence of local communities on plant-based traditional healthcare systems.

2. Research Design

The study followed a descriptive, exploratory, and participatory ethnobotanical research design, integrating qualitative Participatory Rural Appraisal (PRA) tools with quantitative ethnobotanical indices. This mixed-method approach is widely recommended for documenting indigenous knowledge systems while ensuring community participation and data triangulation (Martin, 1995; Cunningham, 2001).

3. Participatory Rural Appraisal (PRA) Techniques

Participatory Rural Appraisal (PRA) was a core methodological component used to ensure active involvement of local communities in knowledge documentation and validation (Chambers, 1994).

3.1 Social Mapping

Social mapping was used to identify households with ethnobotanical knowledge, distribution of traditional healers (Vaidyas), and plant resource users within villages. This helped in locating key informants efficiently and understanding knowledge distribution patterns.

3.2 Resource Mapping

Villagers collectively prepared resource maps indicating forest patches, grazing lands, and medicinal plant-rich zones. This participatory exercise helped identify natural habitats of ethnomedicinal grasses and herbs and their accessibility patterns (Chambers, 1994).

3.3 Seasonal Calendars

Seasonal calendars were developed with informants to document phenology, availability, and harvesting periods of medicinal grasses and plants. This helped correlate plant usage with seasonal ecological cycles.

3.4 Transect Walks

Transect walks were conducted along ecological gradients (valley to alpine zones) with local guides to directly observe plant distribution, harvesting practices, and habitat conditions. This method ensured real-time ecological validation of ethnobotanical data (Martin, 1995).

3.5 Focus Group Discussions (FGDs)

Group discussions were organized with shepherds, women, and traditional healers to validate plant uses, preparation methods, and local nomenclature. FGDs helped reduce individual bias and strengthen data reliability (Cunningham, 2001).

3.6 Ranking and Preference Analysis

Preference ranking exercises were conducted to identify the most commonly used and culturally significant ethnomedicinal grasses and plants for specific ailments.

4. Ethnobotanical Interviews

Structured, semi-structured, and unstructured interviews were conducted using a pre-tested questionnaire. Information recorded included local names, plant parts used, therapeutic applications, preparation methods, dosage, and route of administration (Cotton, 1996). Cross-verification among multiple informants ensured data reliability.

5. Herbarium Collection and Preparation Procedures

Plant specimen collection and herbarium preparation were conducted following internationally accepted ethnobotanical and taxonomic standards (Jain, 1987).

5.1 Field Collection of Plant Specimens

Plant specimens were collected during multiple field visits across different seasons to capture phenological stages (flowering, fruiting, and vegetative phases). Each specimen was assigned a unique field number and accompanied by detailed field notes including:

- Locality and GPS coordinates
- Altitude and habitat type
- Associated vegetation
- Local (vernacular) name
- Ethnomedicinal use information

Care was taken to collect representative samples without disturbing local populations, especially for rare or overexploited species (Jain, 1987).

5.2 Pressing and Drying

Collected specimens were immediately pressed in field plant presses using blotting sheets and newspaper layers. Blotters were changed regularly to prevent fungal growth and ensure proper drying. The specimens were dried under controlled conditions to preserve morphological features such as leaves, stems, flowers, and reproductive structures.

5.3 Poisoning and Preservation

Dried specimens were treated with a mild fungicide solution (e.g., mercuric chloride or alternative safe preservatives where applicable) to prevent insect infestation and microbial degradation, following standard herbarium practices (Bridson & Forman, 1998).

5.4 Mounting on Herbarium Sheets

Dried specimens were mounted on standard herbarium sheets (42 × 28 cm) using adhesive and linen strips. Each sheet included a label containing:

- Scientific name (confirmed later)
- Family
- Local name
- Collection number
- Collector details
- Habitat description
- Ethnomedicinal notes

5.5 Identification and Taxonomic Authentication

Species identification was carried out using regional floras and taxonomic keys such as *Flora of British India* and *Flora of Himachal Pradesh*. Final authentication was confirmed through consultation with botanists and comparison with authenticated herbarium specimens (Hooker, 1872–1897; Singh & Pandey, 1998).

5.6 Herbarium Deposition

Authenticated specimens were systematically arranged and deposited in a recognized institutional herbarium for future reference and verification, ensuring long-term scientific accessibility and conservation of plant records.

5.7 Photographic Documentation

High-resolution digital photographs were taken in natural habitats, capturing diagnostic features, growth forms, and ecological conditions. This supplemented herbarium records and assisted in future taxonomic verification.

6. Data Recording and Management

Ethnobotanical data were recorded in structured field notebooks and later digitized. Data categories included plant identity, life form, medicinal use, preparation method, and route of administration. Standardization ensured consistency and facilitated quantitative analysis (Heinrich et al., 2009).

7. Data Validation and Triangulation

To enhance reliability, triangulation was performed through:

- Repeated interviews with different informants
- Cross-validation with PRA outputs
- Herbarium-based taxonomic verification
- Comparison with published ethnobotanical literature (Martin, 1995)

8. Ethical Considerations

Prior informed consent was obtained from all participants. The study followed ethical guidelines of the International Society of Ethnobiology, ensuring respect for indigenous knowledge systems and confidentiality of informants (ISE, 2006).

9. Data Analysis

Ethnobotanical data were analyzed using descriptive statistics and standard indices such as Use Value (UV), Informant Consensus Factor (ICF), and Fidelity Level (FL). Comparative

analysis was conducted with Himalayan ethnobotanical studies to determine regional similarities and uniqueness (Kunwar et al., 2006). The integration of PRA techniques with rigorous herbarium methodology ensures a participatory, scientifically valid, and reproducible ethnobotanical study. This approach strengthens both community engagement and taxonomic accuracy, providing a robust framework for documenting ethnomedicinal grasses and plant diversity in the Chamba Himalaya.

List of Ethnomedicinal Plant Species of Chamba District.

S. No.	Botanical Name	Local Name	Life Form	Part Used	Form of Usage	Route of Administration	Medicinal Uses
1	*Achyranthes bidentata* Blume	Puthknda	Herb	Roots, leaves	Paste, decoction	Oral, topical	Used in joint pain, wounds, and inflammation
2	*Angelica glauca* Edgew.	Chura	Herb	Roots	Powder, decoction	Oral	Digestive disorders, cough, cold
3	*Artemisia absinthium* L.	Charmra	Shrub	Leaves	Infusion, paste	Oral	Fever, stomach ailments, intestinal worms
4	*Asparagus racemosus* Willd.	Saapaya	Climber	Roots	Powder, tonic	Oral	General weakness, reproductive health
5	*Bacopa monnieri* (L.) Wettst.	Brahmi	Herb	Whole plant	Juice, paste	Oral	Memory enhancement, nervous disorders
6	*Bauhinia variegata* L.	Kachnar	Tree	Bark, flowers	Decoction, vegetable	Oral	Thyroid disorders, ulcers, digestive problems
7	*Berberis aristata* DC.	Banhaldi	Shrub	Roots, bark	Paste, decoction	Oral, topical	Eye diseases, fever, skin infections
8	*Berberis lycium* Royle	Kasmal	Shrub	Roots, fruits	Juice, paste	Oral	Diabetes, jaundice, eye problems
9	*Bergenia ligulata* (Wall.) Engl.	Shaprotri	Herb	Rhizome	Powder, decoction	Oral	Kidney stones, urinary disorders

10	*Betula utilis* D. Don	Bhuj ptra	Tree	Bark	Paste, smoke	Topical, inhalation	Wound healing, respiratory ailments
11	*Cannabis sativa* L.	Bhang	Herb	Leaves, seeds	Paste, extract	Oral	Pain relief, digestive stimulant
12	*Cedrus deodara* G. Don	Deor	Tree	Wood, bark	Oil, paste	Topical	Skin diseases, rheumatism
13	*Corylus jacquemonti i* Decne.	Thangi/Thang oli	Tree	Fruits, bark	Raw, decoctio n	Oral	Nutritive tonic, digestive aid
14	*Crataegus oxyacantha* L.	Pinyath	Shrub	Fruits	Juice, decoctio n	Oral	Heart ailments, blood pressure control
15	*Cotoneaster microphyllu s* Lindl.	Kadhor	Shrub	Fruits	Raw, juice	Oral	Digestive and nutritional uses
16	*Desmodium elegans* DC.	Kathi	Shrub	Leaves, roots	Paste, decoctio n	Oral, topical	Fever, body pain
17	*Datura stramonium* Wall.	Datura	Herb	Leaves, seeds	Smoke, paste	Inhalation, topical	Asthma, pain relief
18	*Diplazium esculentum* (Retz.) Sw.	Kasror	Fern	Young fronds	Cooked vegetable	Oral	Digestive health, nutrition
19	*Ficus palmata* Roxb.	Phakura	Tree	Fruits, latex	Raw, paste	Oral, topical	Constipatio n, wound healing
20	*Grewia robusta* Burch.	Dhaman	Tree	Bark, leaves	Decoctio n	Oral	Fever, skin ailments
21	*Hypericum oblongifoliu m* Hook.	Phiunli	Shrub	Leaves, flowers	Paste, oil	Topical	Cuts, wounds, inflammatio n
22	*Jasminum officinale* L.	Swain	Climber	Flower s, leaves	Paste, infusion	Oral, topical	Skin disorders, headache
23	*Jurinea macrocepha la* DC.	Guggal	Herb	Roots	Powder, paste	Oral	Digestive disorders, tonic
24	*Malva neglecta* Wallr.	Sonchal	Herb	Leaves	Cooked vegetable , paste	Oral, topical	Constipatio n, inflammatio n
25	*Mirabilis jalapa* L.	Raat ki Rani	Herb	Roots, flowers	Paste, juice	Oral, topical	Skin diseases,

							swelling
26	*Morus serrata* Wall.	Krum	Tree	Fruits, leaves	Raw, decoction	Oral	Sore throat, nutritional supplement
27	*Murraya koenigii* Spreng.	Kadhi Pata	Shrub	Leaves	Spice, juice	Oral	Digestive disorders, diabetes
28	*Ocimum sanctum* L.	Tulsi	Herb	Leaves	Infusion, juice	Oral	Cough, cold, immunity booster
29	*Picrorhiza kurroa* Royle ex Benth.	Kour	Herb	Rhizome	Powder, decoction	Oral	Liver disorders, fever
30	*Phyllanthus emblica* L.	Amla	Tree	Fruits	Juice, powder	Oral	Vitamin supplement, immunity
31	*Phytolacca acinosa* Roxb.	Ranshag, Ashlu	Herb	Roots, leaves	Paste, decoction	Oral, topical	Rheumatism, inflammation
32	*Prunus cornuta* Wall.	Jammu	Tree	Bark, fruits	Decoction	Oral	Fever, digestive disorders
33	*Pteridium aquilinum* (L.) Kuhn	Kinus	Fern	Young fronds	Cooked vegetable	Oral	Nutritive food, digestive aid
34	*Rosa macrophylla* Lindl.	Gulabri	Shrub	Flowers, fruits	Syrup, paste	Oral	Cooling agent, digestive tonic
35	*Rubus ellipticus* Sm.	Akhan	Shrub	Fruits, roots	Raw, decoction	Oral	Diarrhea, nutritional value
36	*Rumex dentatus* Wall.	Jangli palak	Herb	Leaves	Cooked vegetable	Oral	Constipation, anemia
37	*Rumex hastatus* Link ex Meisn.	Katimithi	Herb	Leaves	Juice, paste	Oral	Digestive and liver disorders
38	*Salix alba* L.	Chirand	Tree	Bark	Decoction	Oral	Fever, pain relief
39	*Smilax aspera* L.	Dadrund	Climber	Roots	Decoction	Oral	Blood purification, skin diseases
40	*Stellaria monosperma* Buch.-Ham. ex D. Don	Kokuwa	Herb	Whole plant	Paste, decoction	Oral	Fever, inflammation

41	*Swertia chirata* C.B. Clarke	Charayta	Herb	Whole plant	Decoction	Oral	Malaria, fever, liver disorders
42	*Taxus baccata* Thunb.	Barhami	Tree	Leaves, bark	Extract	Oral	Anticancer and respiratory uses
43	*Tinospora cordifolia* Miers	Gloe	Climber	Stem	Juice, decoction	Oral	Fever, immunity booster
44	*Trillium govanianum* Wall.	Nagchatri	Herb	Rhizome	Powder	Oral	Sexual weakness, tonic
45	*Urtica dioica* L.	Ain	Herb	Leaves	Soup, paste	Oral, topical	Joint pain, anemia
46	*Valeriana jatamansi* D. Don	Shamak, Mushakwaa	Herb	Roots	Powder, oil	Oral	Insomnia, nervous disorders
47	*Viburnum mullaha* Buch.-Ham. ex D. Don	Tilhanj	Shrub	Fruits, bark	Decoction	Oral	Digestive disorders
48	*Viola canescens* Wall.	Vanksha	Herb	Flowers, leaves	Syrup, paste	Oral	Cough, cold, sore throat
49	*Vitex negundo* L.	Bana	Shrub	Leaves	Paste, decoction	Oral, topical	Joint pain, swelling
50	*Zanthoxylum aromaticum* Miq.	Trimiria	Shrub/Tree	Fruits, bark	Powder, spice	Oral	Toothache, digestive stimulant

Livestock Management, Ethnomedicinal Importance and Fodder Development: The medicinal plant species documented from the Chamba district of Himachal Pradesh play an important role not only in traditional healthcare systems but also in livestock management and rural livelihood support. Several herbaceous species, shrubs, climbers, and trees are directly or indirectly utilized as fodder resources for cattle, sheep, and goats in mountainous regions. Species such as *Rumex dentatus*, *Diplazium esculentum*, *Urtica dioica*, *Morus serrata*, and *Pteridium aquilinum* are commonly used as supplementary green fodder, especially during lean seasons when cultivated fodder availability declines. The leaves and young shoots of these species provide nutrients, improve digestibility, and help maintain livestock productivity in traditional agro-pastoral systems. Ethnomedicinally, many of these plants are used in indigenous veterinary practices for the treatment of livestock ailments. For example, *Vitex negundo* leaves are applied externally to reduce swelling and joint pain in animals, while *Tinospora cordifolia* and *Ocimum sanctum* are administered orally to improve

immunity and resistance against infections. Decoctions prepared from *Berberis aristata*, *Swertia chirata*, and *Picrorhiza kurroa* are traditionally used to manage digestive disorders, fever, and parasitic infections in both humans and domestic animals. Such traditional ethnoveterinary knowledge has been preserved by local communities and contributes significantly to low-cost healthcare practices in remote Himalayan villages. The integration of medicinal grasses, herbs, shrubs, and fodder trees into livestock management systems supports sustainable agriculture and biodiversity conservation. Tree species such as *Bauhinia variegata*, *Ficus palmata*, and *Salix alba* provide lopped foliage used as emergency fodder during winter months. Similarly, climbers like *Smilax aspera* and *Asparagus racemosus* contribute to forage diversity in forest grazing areas. The use of multipurpose plant species reduces dependency on commercial feed resources and enhances ecological resilience in hill farming systems. Fodder development strategies in Himalayan regions emphasize the conservation and propagation of nutritionally rich and medicinally important species. Community-based agroforestry practices, rotational grazing, pasture management, and cultivation of high-value fodder plants are increasingly encouraged to improve livestock productivity. The cultivation of species such as *Murraya koenigii*, *Phyllanthus emblica*, *Morus serrata*, and *Bacopa monnieri* can simultaneously support fodder availability, household nutrition, and medicinal plant conservation. Sustainable harvesting practices, nursery development, and awareness among local communities are essential for preserving these valuable plant resources. The ethnomedicinal plants of Chamba district therefore represent an important linkage between traditional healthcare, livestock sustainability, fodder security, and rural socio-economic development. Scientific validation and conservation of indigenous knowledge associated with these species can contribute to integrated livestock management, sustainable fodder development, and biodiversity preservation in Himalayan ecosystems.

DISCUSSION

The Chamba District of Himachal Pradesh, located in the North-Western Himalaya, represents one of the most botanically diverse regions of India due to its wide altitudinal gradient (600–6,800 m), varied climatic zones, and heterogeneous habitats ranging from subtropical valleys to alpine meadows. This ecological complexity supports a rich assemblage of medicinal plant species traditionally utilized by indigenous communities such as Gaddis, Gujjars, and Bharmouris (Samant et al., 1998; Kala, 2005). Ethnomedicinal knowledge in this region is deeply embedded in cultural traditions and has been transmitted

orally across generations. Local healthcare practices rely heavily on wild flora for treating common ailments such as gastrointestinal disorders, respiratory infections, skin diseases, inflammation, and musculoskeletal problems (Uniyal et al., 2006). The ethnomedicinal flora of Chamba district includes herbs, shrubs, climbers, and trees, with herbs dominating the spectrum due to their high abundance and accessibility. Species such as *Achyranthes bidentata*, *Berberis aristata*, *Valeriana jatamansi*, *Aconitum heterophyllum*, and *Saussurea costus* are widely reported for their medicinal significance (Chauhan et al., 2012). Herbaceous plants contribute the highest proportion (approximately 55–65%), followed by shrubs (15–20%), trees (10–15%), and climbers (5–10%). The dominance of herbaceous species is attributed to their rapid regeneration capacity and adaptation to alpine and subalpine environments (Kala, 2000). Different plant parts are used depending on therapeutic requirements:

- Roots and rhizomes: Frequently used for tonic and anti-inflammatory preparations (*Nardostachys jatamansi*, *Aconitum heterophyllum*)
- Leaves: Commonly used for wound healing and skin infections (*Urtica dioica*, *Ocimum sanctum*)
- Bark: Used for gastrointestinal and fever treatments (*Berberis aristata*)
- Whole plant: Often used in decoctions (*Swertia chirayita*)
- Seeds and fruits: Used as digestive and carminative agents (*Trigonella foenum-graecum*)

Overharvesting of roots and rhizomes is a significant conservation concern due to their destructive harvesting methods (Samant et al., 2001). Traditional preparations include decoctions, infusions, pastes, powders, and fresh juice extracts. Oral administration is most common, followed by topical application for skin-related ailments. The choice of preparation depends on the ailment type, plant availability, and cultural beliefs (Sharma et al., 2010). Several plant species of Chamba district have high medicinal value *Berberis aristata*: Used for diabetes, liver disorders, and infections due to berberine content (Sharma et al., 2010). *Valeriana jatamansi*: Sedative and anti-anxiety properties (Chopra et al., 1956). *Aconitum heterophyllum* which is used for fever and digestive disorders, but requires caution due to toxicity. *Saussurea costus* which is used for respiratory ailments and inflammation. *Achyranthes bidentata* which is Traditionally used for musculoskeletal pain and kidney disorders. These species also hold pharmacological importance, with several bioactive compounds identified through phytochemical investigations (Kala, 2005; Joshi et al., 2013). Medicinal plants contribute significantly to the rural economy of Chamba district. Local

communities collect and sell high-value medicinal plants such as *Picrorhiza kurroa* and *Saussurea costus*, which are traded in regional markets. However, lack of sustainable harvesting practices often leads to population decline in wild habitats (Uniyal et al., 2006). Ethnobotanical knowledge also supports primary healthcare in remote areas where modern medical facilities are limited, making traditional medicine a vital healthcare system. The major threats to ethnomedicinal flora include overharvesting of underground plant parts, habitat destruction due to deforestation and grazing, climate change affecting alpine ecosystems, lack of systematic cultivation practices several species are now listed as endangered or vulnerable under IUCN criteria, including *Aconitum heterophyllum*, *Nardostachys jatamansi*, and *Saussurea costus* (Samant et al., 1998). To ensure long-term survival of ethnomedicinal plants, the following strategies are recommended:

- Promotion of **in-situ conservation** through protected areas
- Development of **ex-situ conservation** programs such as botanical gardens
- Encouragement of **cultivation practices** among local farmers
- Implementation of **sustainable harvesting protocols**
- Documentation of traditional knowledge before it is lost (Kala, 2005)

Community participation is essential for effective conservation planning. The ethnomedicinal flora of Chamba district represents a valuable biological and cultural heritage. It plays a critical role in healthcare, livelihoods, and biodiversity conservation. However, increasing anthropogenic pressure and unsustainable harvesting threaten its survival. Integrated conservation strategies combining scientific research and traditional knowledge are necessary to ensure sustainable utilization of these plant resources.

Livestock Management, Ethnomedicinal Importance and Fodder Development: The medicinal plant species documented from the Chamba district of Himachal Pradesh play an important role not only in traditional healthcare systems but also in livestock management and rural livelihood support. Several herbaceous species, shrubs, climbers, and trees are directly or indirectly utilized as fodder resources for cattle, sheep, and goats in mountainous regions. Species such as *Rumex dentatus*, *Diplazium esculentum*, *Urtica dioica*, *Morus serrata*, and *Pteridium aquilinum* are commonly used as supplementary green fodder, especially during lean seasons when cultivated fodder availability declines. The leaves and young shoots of these species provide nutrients, improve digestibility, and help maintain livestock productivity in traditional agro-pastoral systems. Ethnomedicinally, many of these

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The integration of medicinal grasses, herbs, shrubs, and fodder trees into livestock management systems supports sustainable agriculture and biodiversity conservation. Tree species such as *Bauhinia variegata*, *Ficus palmata*, and *Salix alba* provide lopped foliage used as emergency fodder during winter months. Similarly, climbers like *Smilax aspera* and *Asparagus racemosus* contribute to forage diversity in forest grazing areas. The use of multipurpose plant species reduces dependency on commercial feed resources and enhances ecological resilience in hill farming systems. Fodder development strategies in Himalayan regions emphasize the conservation and propagation of nutritionally rich and medicinally important species. Community-based agroforestry practices, rotational grazing, pasture management, and cultivation of high-value fodder plants are increasingly encouraged to improve livestock productivity. The cultivation of species such as *Murraya koenigii*, *Phyllanthus emblica*, *Morus serrata*, and *Bacopa monnieri* can simultaneously support fodder availability, household nutrition, and medicinal plant conservation. Sustainable harvesting practices, nursery development, and awareness among local communities are essential for preserving these valuable plant resources. The ethnomedicinal plants of Chamba district therefore represent an important linkage between traditional healthcare, livestock sustainability, fodder security, and rural socio-economic development. Scientific validation and conservation of indigenous knowledge associated with these species can contribute to integrated livestock management, sustainable fodder development, and biodiversity preservation in Himalayan ecosystems.

The Chamba district of Himachal Pradesh, located in the Western Himalaya (approx. 32–33°N latitude), represents one of the most biodiversity-rich and ethnobotanically significant regions of India. The varied altitudinal gradient ranging from subtropical valleys to alpine meadows provides a unique ecological setting that supports a rich assemblage of medicinal

and fodder plants. The dependence of local tribal communities such as Gaddis and Gujjars on plant resources for healthcare, livestock feeding, and livelihood sustenance has been well documented in several ethnobotanical investigations (Rani et al., 2013; Thakur et al., 2016; Rana et al., 2019).Plants in this region are not only used for human healthcare but also play an equally important role in ethnoveterinary practices and livestock management systems. More than 70–80% of rural populations in remote Himalayan villages depend on traditional knowledge systems for primary healthcare and animal husbandry needs (Kala, 2005; Sharma et al., 2010). The present dataset of 50 species highlights the interrelationship between medicinal use, fodder utility, and ecological sustainability.The recorded plant species include herbs, shrubs, climbers, ferns, and trees, reflecting high functional diversity. Herbs dominate the dataset, followed by shrubs and trees, which is consistent with other Himalayan ethnobotanical reports (Thakur et al., 2016; Arora et al., 2018). Herbaceous plants such as *Bacopa monnieri*, *Urtica dioica*, *Rumex dentatus*, and *Malva neglecta* are abundant in moist habitats and agricultural margins. These species are easily accessible and are therefore widely used in both medicinal and fodder systems. Shrubs like *Berberis aristata*, *Vitex negundo*, and *Swertia chirata* occupy mid-elevation slopes and forest edges, while trees such as *Ficus palmata*, *Morus serrata*, and *Bauhinia variegata* provide long-term biomass resources.

Climbers such as *Tinospora cordifolia*, *Asparagus racemosus*, and *Smilax aspera* contribute significantly to forest understorey biodiversity and are important sources of medicinal extracts. Ferns like *Diplazium esculentum* and *Pteridium aquilinum* represent edible wild greens, commonly used as seasonal vegetables and supplementary fodder in rural diets. The diversity of life forms indicates a highly adaptive plant community capable of supporting both human healthcare and livestock feeding systems under harsh Himalayan climatic conditions.Ethnomedicinal use of plants in Chamba reflects a deeply rooted traditional healthcare system based on empirical knowledge accumulated over generations. Plants are primarily used in crude forms such as decoction, infusion, juice, paste, powder, and raw consumption. A large proportion of species such as *Swertia chirata*, *Berberis aristata*, *Murraya koenigii*, *Rumex hastatus*, and *Bauhinia variegata* are used to treat digestive disorders. This aligns with findings by Sharma et al. (2010), who reported that digestive ailments are among the most frequently treated conditions in Himalayan ethnomedicine. Bitterness, antimicrobial compounds, and alkaloids present in these plants contribute to their therapeutic potential. *Swertia chirata* is particularly valued as a liver tonic and febrifuge, widely used in both human and veterinary systems. Species such as *Ocimum sanctum*, *Viola*

canescens, *Artemisia absinthium*, and *Tinospora cordifolia* are extensively used for cough, cold, asthma, and fever. These plants possess essential oils, flavonoids, and anti-inflammatory compounds which support respiratory health. *Ocimum sanctum* (Tulsi) is considered one of the most important medicinal plants in Indian traditional medicine, often referred to as a "life herb" due to its immunomodulatory properties (Chopra et al., 1956).

Plants such as *Cedrus deodara*, *Berberis aristata*, *Hypericum oblongifolium*, and *Ficus palmata* are widely used for skin infections, wounds, and inflammation. Resinous compounds and antimicrobial phytochemicals make these plants effective in external applications. *Hypericum* species are particularly known for their wound healing properties, consistent with global ethnopharmacological reports. *Bacopa monnieri*, *Valeriana jatamansi*, and *Asparagus racemosus* are important nervine tonics used for memory enhancement, insomnia, and reproductive health issues. These plants contain bioactive compounds such as bacosides, valepotriates, and steroidal saponins that influence neurological and hormonal balance (Kala, 2005). One of the most important aspects of Himalayan ethnobotany is the integration of medicinal plants into livestock feeding systems. In Chamba district, fodder scarcity during winter months makes wild edible plants essential for livestock survival. Species such as *Urtica dioica*, *Rumex dentatus*, *Malva neglecta*, and *Diplazium esculentum* are rich in nutrients and widely used as green fodder. *Urtica dioica* is especially important due to its high protein and mineral content, improving milk production and livestock strength. Trees such as *Morus serrata*, *Ficus palmata*, *Bauhinia variegata*, and *Salix alba* provide seasonal fodder through lopping. These species form a crucial part of agroforestry systems in Himalayan villages (Rana et al., 2019). Climbers like *Tinospora cordifolia* and shrubs like *Vitex negundo* contribute to browsing systems for goats and sheep. Their leaves are often mixed with cultivated fodder to enhance nutritional quality. The integration of wild fodder plants into livestock feeding reflects a sustainable ecological practice that reduces dependence on commercial feed and supports biodiversity conservation. Ethnoveterinary medicine plays a critical role in rural livestock management in Chamba district. Farmers use plant-based remedies for treating common animal diseases such as fever, indigestion, wounds, and joint pain. *Vitex negundo* leaves are applied externally to reduce swelling in cattle, while *Tinospora cordifolia* decoction is used to improve immunity in livestock. *Berberis aristata* and *Swertia chirata* are also used in controlled doses for digestive and parasitic infections in animals. These practices are cost-effective, accessible, and environmentally sustainable, especially in remote regions where veterinary services are

limited (Thakur et al., 2016). Traditional preparation methods include: decoction (boiling plant material in water), infusion (soaking leaves or flowers), Paste (crushing fresh plant parts), powder (drying and grinding roots or bark), juice extraction (fresh plant pressing).

Routes of administration are mainly oral and topical, with inhalation used in a few cases such as *Betula utilis* bark smoke therapy. The simplicity of these methods ensures accessibility for rural populations. Many species in the study area are categorized as Not Evaluated (NE) under the IUCN Red List, although some like *Angelica glauca*, *Taxus baccata*, and *Betula utilis* are regionally threatened. Overharvesting, habitat degradation, and climate change pose serious threats to Himalayan medicinal plant diversity (Kala, 2005). Unsustainable collection of roots and bark is particularly concerning as it leads to plant mortality. Conservation strategies such as community-based resource management, cultivation of medicinal plants, and awareness programs are essential for long-term sustainability. Ethnomedicinal plants contribute significantly to rural livelihoods. They provide primary healthcare resources, fodder for livestock, seasonal food supplements and income from wild plant trade. Plants like *Berberis lycium*, *Swertia chirata*, and *Valeriana jatamansi* have commercial importance in herbal medicine markets. This creates economic opportunities for rural communities but also increases harvesting pressure. The ethnomedicinal plant diversity of Chamba district represents a complex interaction between ecology, traditional knowledge, livestock management, and rural livelihood systems. The integration of medicinal and fodder uses highlights the multifunctional role of Himalayan flora. Sustainable utilization, conservation, and scientific validation of these plants are essential for preserving both biodiversity and indigenous knowledge systems. The region serves as a living laboratory of ethnobotanical wisdom, contributing significantly to natural resource-based healthcare and agro-pastoral sustainability.

CONCLUSION

The present ethnobotanical investigation of medicinal grasses and associated plant species in selected rural and semi-urban regions of Chamba District, Himachal Pradesh, provides a comprehensive understanding of the rich indigenous knowledge systems that continue to exist within Himalayan communities. The study demonstrates that the local population maintains a deep and dynamic relationship with surrounding plant biodiversity, particularly through the use of ethnomedicinal grasses and herbaceous flora for primary healthcare needs. Despite the increasing influence of modern healthcare systems, traditional plant-based

knowledge remains a vital component of rural health practices, especially in remote and geographically challenging areas where access to modern medical facilities is limited.

The floristic richness of Chamba District, shaped by its wide altitudinal variation ranging from subtropical valleys to temperate and alpine ecosystems, supports a diverse range of medicinal grasses and herbaceous plants. These ecological conditions have contributed significantly to the evolution of a culturally embedded ethnobotanical knowledge system. The study highlights that grasses belonging to the Poaceae family, along with associated herbaceous medicinal plants, are widely utilized for treating a range of human ailments including digestive disorders, respiratory infections, skin diseases, fever, inflammation, and musculoskeletal problems. The frequent use of these species reflects their accessibility, abundance, and perceived efficacy within local healing traditions. The findings also reveal that traditional healers, locally known as Vaidyas, along with elderly villagers, shepherds, and women, play a crucial role in the preservation and transmission of ethnobotanical knowledge. This knowledge is primarily transmitted orally from one generation to another, making it vulnerable to erosion due to socio-cultural transformation, modernization, and changing livelihood patterns. Younger generations are increasingly less involved in traditional plant-based practices, leading to a gradual decline in ethnomedicinal knowledge continuity. The application of Participatory Rural Appraisal (PRA) techniques in the study facilitated active community participation and provided deeper insights into spatial distribution, seasonal availability, and cultural significance of medicinal grasses. Tools such as social mapping, resource mapping, transect walks, seasonal calendars, and focus group discussions proved highly effective in documenting indigenous ecological knowledge.

These participatory methods not only enriched the dataset but also strengthened trust and collaboration between researchers and local communities, ensuring authenticity and cultural sensitivity in data collection. High consensus among informants regarding specific grasses and herbs indicates strong cultural agreement on their medicinal efficacy. Such plants may serve as potential candidates for pharmacological screening and drug development studies. The convergence of qualitative and quantitative data underscores the reliability of traditional knowledge systems as a scientific resource. The herbarium collection and taxonomic authentication process ensured scientific accuracy in species identification and long-term preservation of plant specimens. Proper documentation of morphological features, ecological habitats, and ethnomedicinal uses has resulted in the development of a valuable reference

collection for future research. The herbarium serves not only as a scientific archive but also as a conservation tool for monitoring biodiversity loss and changes in vegetation patterns over time. The study also highlights the increasing pressure on natural habitats due to anthropogenic activities such as overgrazing, deforestation, unregulated harvesting of medicinal plants, agricultural expansion, and infrastructure development. These factors are contributing to the degradation of natural ecosystems and threatening the survival of several medicinal plant species, particularly those with narrow ecological ranges or high economic value. If current trends continue, there is a significant risk of loss of both biodiversity and associated traditional knowledge systems. Furthermore, climate change is emerging as a critical factor influencing the distribution and phenology of medicinal plants in the Himalayan region. Changes in temperature and precipitation patterns are likely to affect the availability and regeneration cycles of several ethnomedicinal grasses and herbs.

This ecological shift may further disrupt traditional harvesting practices and reduce the accessibility of important medicinal resources for local communities. In summary, the present study confirms that the ethnomedicinal grasses and associated plant species of Chamba District form an integral part of local healthcare systems, cultural identity, and ecological knowledge frameworks. However, this valuable heritage is under threat due to socio-economic changes, environmental degradation, and loss of traditional knowledge transmission pathways. The documentation of this knowledge represents an important step toward its preservation, scientific validation, and sustainable utilization. The study also emphasizes the need to integrate traditional knowledge systems with modern scientific approaches to promote holistic healthcare and biodiversity conservation.

RECOMMENDATIONS

Based on the findings of the present study, several important recommendations are proposed to ensure the conservation of ethnomedicinal plant diversity, preservation of indigenous knowledge systems, and sustainable utilization of natural resources in the Chamba Himalayan region. Firstly, there is an urgent need to undertake comprehensive conservation programs targeting ethnomedicinal grasses and herbaceous plant species. In-situ conservation strategies should be prioritized by protecting natural habitats such as community forests, alpine meadows, and grazing lands. These ecosystems serve as primary reservoirs of medicinal plant diversity and must be safeguarded from unsustainable exploitation. Community-based Forest management systems should be strengthened to involve local people in conservation

activities, ensuring both ecological sustainability and livelihood security. Secondly, ex-situ conservation measures such as the establishment of medicinal plant nurseries, botanical gardens, and seed banks should be promoted. These initiatives will help preserve genetic diversity and ensure the availability of important medicinal species for future generations. Special attention should be given to rare, endangered, and overexploited species, particularly those with high medicinal value and limited distribution. Thirdly, there is a strong need for documentation and digitalization of traditional knowledge systems.

Indigenous ethnomedicinal knowledge is rapidly declining due to modernization and changing socio-cultural dynamics. Therefore, systematic documentation through ethnobotanical databases, digital herbarium records, and audio-visual archives should be undertaken. Such efforts will ensure long-term preservation and accessibility of knowledge for researchers, policymakers, and future generations. Fourthly, capacity-building programs and awareness campaigns should be conducted among local communities, especially youth, to revive interest in traditional plant knowledge. Educational initiatives in schools and colleges should include ethnobotanical studies and biodiversity conservation topics to foster respect for indigenous knowledge systems. Training programs for local healers and collectors can also improve sustainable harvesting practices and reduce ecological pressure on wild populations. Fifthly, there is a need to promote scientific validation and pharmacological research on widely used ethnomedicinal grasses and plants. Species with high Use Value (UV) and strong Informant Consensus Factor (ICF) should be prioritized for phytochemical screening, bioactivity analysis, and drug development studies. Collaboration between ethnobotanists, pharmacologists, and biochemists can lead to the discovery of novel therapeutic compounds derived from Himalayan flora. Sixthly, sustainable harvesting guidelines should be developed and implemented at the community level. Overharvesting of roots, rhizomes, and whole plants can severely impact regeneration capacity. Therefore, selective harvesting techniques, seasonal restrictions, and rotational collection practices should be encouraged. Local forest departments and community institutions should jointly monitor harvesting activities to ensure ecological balance. Seventhly, integration of traditional medicine systems with primary healthcare services should be encouraged. Local ethnomedicinal knowledge can complement modern healthcare systems, particularly in remote areas where access to medical facilities is limited. Collaborative frameworks between traditional healers and formal healthcare providers can enhance healthcare delivery and cultural acceptance. Eighthly, policy-level interventions are essential to protect

ethnobotanical resources. Government agencies should formulate region-specific conservation policies focusing on Himalayan medicinal plant diversity. Legal frameworks should recognize the rights of indigenous communities over traditional knowledge and ensure benefit-sharing mechanisms in case of commercial utilization. Ninthly, climate change adaptation strategies should be incorporated into conservation planning. Monitoring of phenological changes, habitat shifts, and species distribution patterns is necessary to understand the long-term impact of climate variability on medicinal plant populations. Adaptive management strategies should be developed to mitigate climate-related risks. Finally, future research should focus on long-term ecological monitoring and interdisciplinary studies combining ethnobotany, ecology, pharmacology, and socio-economics. Such integrated approaches will provide a holistic understanding of plant-human interactions and contribute to sustainable development in the Himalayan region. The ethnomedicinal plant wealth of Chamba District represents not only a biological resource but also a cultural and intellectual heritage of immense value. Its conservation requires a balanced approach that integrates scientific research, community participation, and policy support. The present study underscores the urgency of preserving this fragile knowledge system and ensuring that it continues to benefit both local communities and global scientific advancement in a sustainable and ethical manner.

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