"Mountains, Myths, and Medicine: Ethnomedicinal Insights from Himalayan Tribal Communities"

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Abstract:

This systematic review examines the ethnomedicinal practices in various ecological zones of India, with a particular focus on the Indian Himalayas, tropical and subtropical areas, and islands, to understand the intricate relationships among biodiversity, cultural traditions, and socio-economic factors. In areas such as Uttarakhand and Ladakh, where sacred groves and community forests are crucial for biodiversity conservation, ethnomedicine is deeply connected to spiritual beliefs and traditional healing methods. However, the excessive harvesting of rare species like Picrorhiza kurroa and Nardostachys jatamansi presents serious sustainability concerns. Conversely, practices in Sathyamangalam and Mizoram showcase the use of more easily accessible plants from the Euphorbiaceae and Zingiberaceae families, which are often cultivated in home gardens, but also underline the vulnerability of traditional knowledge due to modernization and shifts among younger generations towards contemporary healthcare practices.

The research further demonstrates a detailed regional variation in preparation techniques, with high-altitude areas preferring wild-harvested decoctions and pastes, while tropical regions exhibit a growing trend towards bio-prospecting for scientific validation and commercialization. Despite the promise of merging traditional knowledge with modern healthcare practices, the decline of this knowledge—particularly among youth—remains a significant obstacle. Women, frequently the guardians of medicinal plant wisdom, are increasingly confronted by societal changes, underscoring the importance of gender-sensitive strategies in conservation initiatives.

Although community-based conservation strategies in Uttarakhand and Ladakh prioritize biodiversity protection, and regions like Sathyamangalam promote socio-economic empowerment through the commercialization of traditional remedies, the paper contends that a more holistic approach—integrating ecological, cultural, and socio-economic aspects—is vital for the sustainable future of these practices. This thorough analysis highlights the pressing need for strategies that not only safeguard the plants and methodologies but also enable local communities to navigate modern challenges while maintaining the significance of ethnomedicine in both local and global healthcare systems.

Introduction:

Ethnopharmacology is a rapidly growing discipline that connects sociocultural research with the natural sciences (Heinrich, M., 2015). Rooted in indigenous knowledge and cultural beliefs, the field of ethnomedicine collaborates with anthropology and botany to underscore the importance of traditional remedies in conserving biodiversity and cultural heritage (Sharma, P. K., et al., 2022).

Sacred summits have been integral to traditional medical practices due to their unique ecosystems and spiritual relevance. The flora and fauna in these areas are often viewed as potent healing resources, and specific rituals are believed to enhance their effectiveness. This blend of medicine and spirituality fosters sustainable systems of ethnomedicine, highlighting the need to protect both natural and cultural resources (Rosso, A. M., 2024).

The Himalayan region, rich in both biodiversity and cultural diversity, is home to various indigenous communities with unique ethnomedical practices. Over 1,700 species of medicinal plants are found in this region (Haq et al., 2021). Tribes in remote areas such as Lahaul-Spiti and Kalpa rely on these plants, with the oral traditions playing a vital role in the health and well-being of these communities (Bhoria, R., et al., 2022).

In the Himalayas, ethnomedicine is deeply intertwined with rituals and spiritual beliefs, especially around sacred peaks, which are believed to enhance the potency of healing herbs (Bargali, H., 2022). Traditional healers, who are the custodians of this ancient knowledge, adopt a holistic approach to health, encompassing mental, emotional, and spiritual well-being. The aim of this review is to provide a comprehensive overview of the ethnomedical practices in the Himalayas, stressing their significance, potential contributions to modern medicine, and the urgent need for preservation in light of environmental and socioeconomic challenges.

This review seeks to explore the ethnomedicinal practices of Himalayan tribal societies, emphasizing the role of sacred peaks and traditional healing methods. It also evaluates the potential advantages of these practices for contemporary healthcare, while highlighting the necessity to safeguard this knowledge amidst environmental and socioeconomic changes.

Materials and methods:

This review gathered medicinal plants that have been traditionally utilized in medicine through ethnobotanical surveys. The study adhered to the guidelines established by the Preferred Reporting Items for Systematic Review (PRISMA). Relevant articles for this research were identified while emphasizing the primary goals of this systematic review. Searches were conducted in the PubMed, Springer, and Scopus databases to find applicable literature. The search parameters did not consider time frames or publication dates and was last updated on January 31st, 2024. Specific combinations of keywords included "indigenous himalayan people; india" OR "ethnomedicine; india" OR "ethnomedicine; himalayan tribe" OR "india; indigenous people; himalaya; medicinal plants" AND "ethnomedicine; india; traditional knowledge," along with free-text terms utilized in the search. Only papers published from 2014 to 2024 were reviewed.

2. Inclusion and exclusion criteria

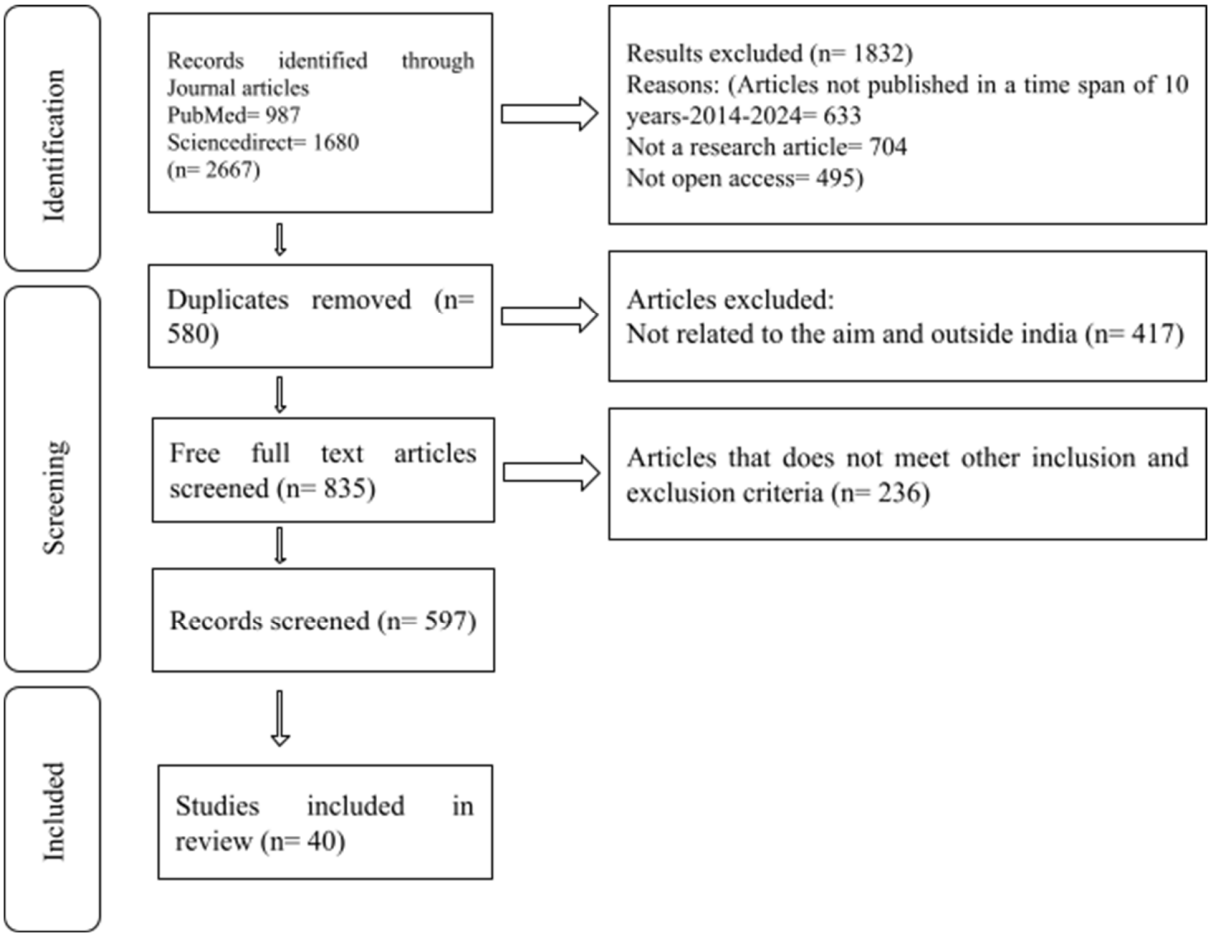
Studies and surveys on ethnomedicine that documented plants traditionally used to treat various ailments were incorporated into this review. The criteria for inclusion of articles encompassed full-length research articles published in English and ethnobotanical surveys carried out in India. The exclusion criteria encompassed articles published in languages other than English, review articles, articles focused on ethnoveterinary applications, and articles disseminated on platforms or forums outside of scientific journals.

3. Data selection

Initially, the author conducted a manual review of the titles and abstracts of journal articles to select those pertinent to the subject matter. All papers deemed potentially relevant were re-evaluated by the author. The procedure for data selection is illustrated in Fig. 1.

4. Data analysis and reporting

A comprehensive assessment of the literature search data was performed, summarizing information such as plant name, family, local or vernacular name, parts utilized, reported traditional applications, details about informants, and the area where the survey was conducted. Given the focus of this systematic review, no specific analytical tools were employed.



Results:

The systematic review offers important perspectives on the diverse ethnomedicinal practices of indigenous groups in these areas. This section compiles the results and provides a critical assessment of the information, highlighting the significance and challenges faced by traditional healing methods.

Ethnomedicinal Practices and Biodiversity Conservation - Indigenous populations in the Himalayas maintain a deep connection with their surroundings, often prioritizing both health and conservation within their ethnomedical practices. Sacred groves located in regions such as Uttarakhand, Sikkim, and Meghalaya serve as important biodiversity hotspots, containing medicinal plants like Nardostachys jatamansi and Picrorhiza kurroa (Negi et al., 2023). These sacred areas, grounded in cultural traditions and spiritual beliefs, illustrate the synergy between conservation efforts and traditional medical practices. Nevertheless, the pressures of modernization and overharvesting, along with the younger generation's

shift away from traditional cultural practices, threaten the sustainability of these customs (Ojha et al., 2020; Bhat et al., 2023).

Reduction and Application of Conventional Wisdom - Himalayan communities largely depend on traditional healers and medicinal plants for addressing common health issues such as gastrointestinal and skin problems. Elderly members of the community, who typically safeguard this knowledge, are crucial for its oral transmission. For example, research conducted in the Chakrata area identified over 120 plant species with significant antidiabetic effects, some of which have been scientifically corroborated (Kumar et al., 2019). However, younger generations migrating to urban environments and embracing modern healthcare practices are significantly undermining the intergenerational sharing of this essential knowledge, thus jeopardizing the survival of these traditions (Haq et al., 2021).

The Impact of Sociodemographic Factors on Ethnomedicine - Factors like education, occupation, and gender play a significant role in the maintenance and utilization of ethnomedicinal practices. Studies conducted in Ladakh and Kashmir demonstrate that older, rural individuals possess greater knowledge of medicinal plants, while those who are urbanized and well-educated appear less engaged due to easier access to modern healthcare (Bhat et al., 2021; Haq et al., 2021). Although women often take on the role of primary caregivers, they are less engaged in organized knowledge transmission, highlighting the necessity to consider gender dynamics when it comes to preserving these traditions (Laldingliani et al., 2022).

Principal Plant Families and Methods of Preparation - Plant families such as Lamiaceae, Fabaceae, and Asteraceae are commonly referenced in research across the Himalayas for their healing properties. Traditional methods of preparation, including decoctions, pastes, and topical applications, are prevalent, with leaves and roots being the most frequently utilized parts (Ojha et al., 2020; Kumar et al., 2019). However, the overharvesting of roots presents sustainability issues, pointing to the importance of conservation efforts and responsible harvesting methods (Negi et al., 2023).

Ethnomedicine as an Addition to Contemporary Medical Care - In isolated areas with limited access to modern healthcare facilities, ethnomedicinal practices remain crucial. A strong community consensus on the effectiveness of plants for treating conditions such as diabetes, skin ailments, and gastrointestinal disorders indicates a profound reliance on these natural remedies (Bhat et al., 2021; Ralte et al., 2024). While ethnomedicine complements contemporary healthcare, its official incorporation into modern medical systems necessitates thorough documentation, verification of medicinal properties, and application standardization (Haq et al., 2023).

Obstacles and the Need for Conservation - Modernization, climate change, and deforestation pose significant threats to the biodiversity that underpins ethnomedicinal traditions. These challenges are intensified by shifts in cultural and dietary practices and the decline of traditional agricultural methods (Kala & Nautiyal, 2023). Tackling these issues requires collaborative efforts, including community-led conservation initiatives, government policies that encourage sustainable approaches, and awareness campaigns (Negi et al., 2023; Ojha et al., 2020).

Introspection and the Future - The findings highlight the critical necessity to preserve the ethnomedical heritage of Himalayan tribal communities while maintaining its relevance in contemporary healthcare. This necessitates collaborative research that integrates perspectives from pharmacology, ecology, and anthropology (Bhat et al., 2021; Kumar et al., 2019). Promoting community involvement in conservation efforts and encouraging the sharing of knowledge between generations are essential steps in this endeavor. Merging traditional wisdom with contemporary scientific studies can help protect these practices, thereby amplifying their roles in public health and environmental sustainability (Haq et al., 2023).

Figure 1 depicts the geographical distribution of recorded medicinal plant species throughout different regions in India, particularly highlighting the Himalayan and Sub-Himalayan zones. The data indicates that the Barak Valley (Assam) represents the largest share of documented medicinal plant species, comprising 28.7% of the overall total (Barbhuiya et al., 2022). Following this is the Chakrata region in Uttarakhand (15.9%) (Kumar, A., et al., 2019), Ladakh (13.9%) (Haq et al., 2021), and Mizoram (13.6%) (Laldingliani et al., 2022). Areas like the Western Himalaya (Rudraprayag) (10.4%) (Singh et al., 2017), Tripura (6.8%) (Debbarma et al., 2017), and the Pangi Valley in the Cold Desert Himalaya (8.9%) (Rana et al., 2014) contribute smaller yet noteworthy proportions. This distribution emphasizes the rich ethnomedicinal diversity present in these areas and showcases their ecological and cultural importance in maintaining traditional medicinal practices in India.

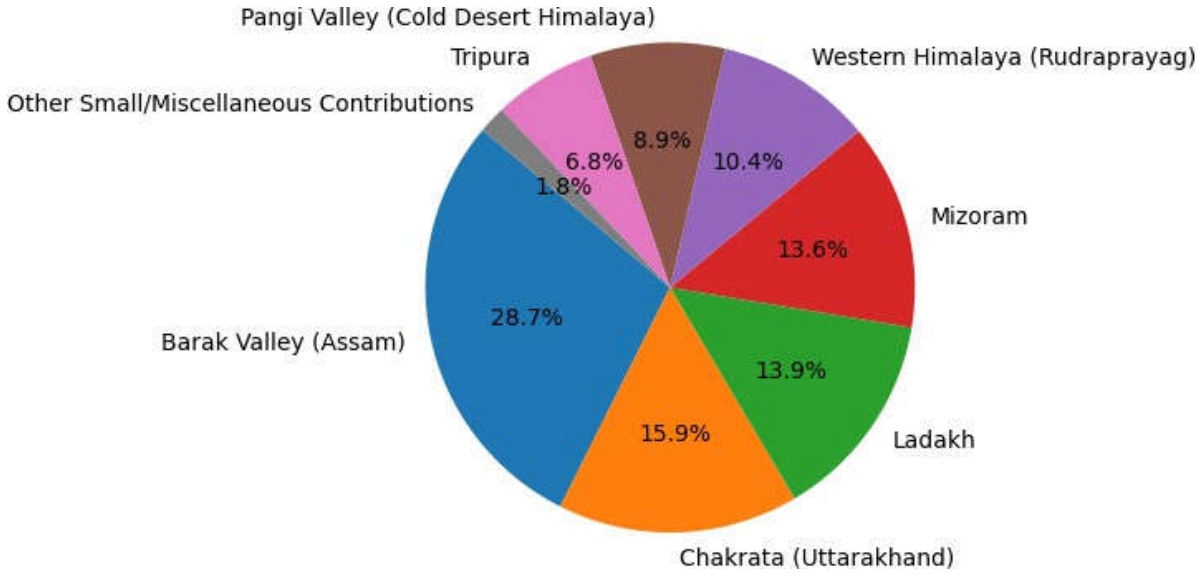


Figure 1- This figure represents the distribution of documented medicinal plant species across various regions in Indian himalayan and sub himalayan regions.

Figure 2 illustrates the distribution of plant parts utilized for medicinal purposes among tribal communities in the Indian Himalayan and sub-Himalayan regions. Leaves are the most frequently used plant component, representing 30.39%, followed by bark at 27.45% and roots at 24.51%. Fruits make up 14.0%, while rhizomes constitute 6.0%. Other parts, including stems and whole plants, account for 4.0% and 3.0%, respectively. Young shoots and oils have a minimal presence at 2.0% and 1.0%. This

distribution highlights a notable dependence on leaves, bark, and roots within traditional medicinal practices, reflecting their availability and bioactive properties. The prevalence of these plant parts is consistent with findings from ethnobotanical studies that underline their common use in traditional preparations such as decoctions and pastes (Ojha et al., 2020; Bhat et al., 2021). The lower prevalence of parts like young shoots and oils suggests their more specialized or supplementary roles in healing practices.

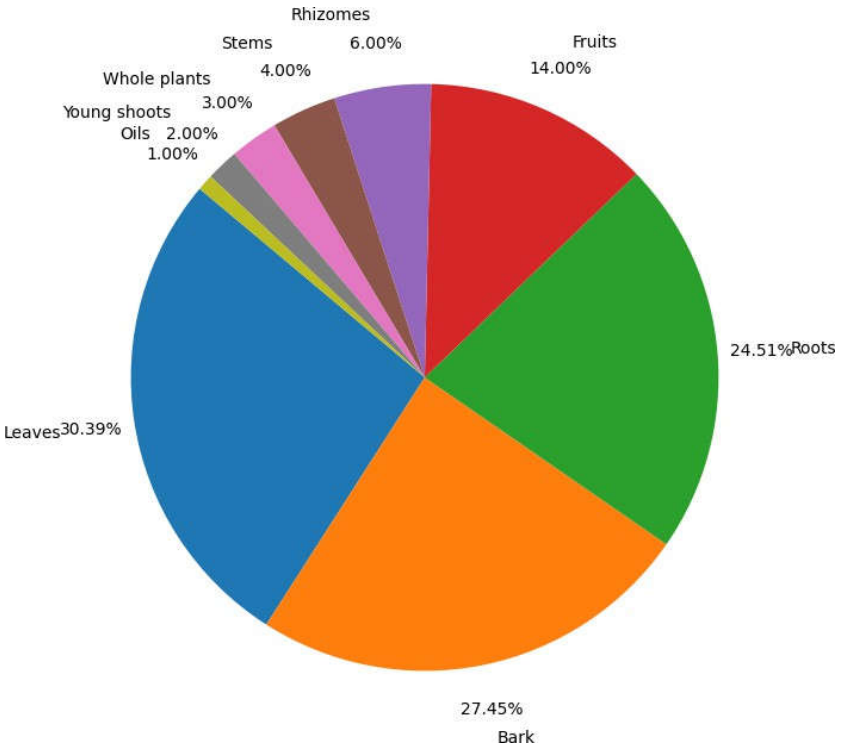


Figure 2- This figure shows the plant parts used for medicinal purposes

Medicinal Plants, Parts Used, and Their Uses

Botanical Name	Common Name	Part Used	Uses	Key Chemical Constituents	Tribe/Community	Region	References
Picrorhiza kurroa	**Kutki**	**Root**	**Liver ailments, fever, skin diseases**	**Picroside I & II, Kutkoside**	**Multiple tribes**	**Uttarakhand**	**(Negi, V. S., et al., 2023), (Singh, et al 2017)**

Nardostachys jatamansi	Jatamansi	Rhizome	Insomnia, anxiety, memory issues	Jatamansone, Nardostachysin	Bhutia	Uttarakhand	(Negi, V. S., et al., 2023)
Bergenia ciliata	Patharchatta	Leaf	Treats kidney stones	Bergenin, Gallic acid, Tannins	General Himalayan	Uttarakhand	(Ojha et al., 2020)
Angelica glauca	Choraka	Root	Fever, cough, respiratory disorders	Angelicin, Valerophenone	Beda, Brokpa	Ladakh, Pangi Valley	(Haq et al., 2023), (Rana et al., 2014)
Artemisia sp.	Wormwood	Leaf	Antidiabetic, skin diseases	Artemisinin, Santonin, Flavonoids	Jaunsari	Chakrata, Uttarakhand	(Kumar, A., et al., 2019)
Berberis aristata	Daruharidra	Root/Bark	Diabetes, jaundice, eye infections	Berberine, Palmatine	Jaunsari	Uttarakhand	(Kumar, A., et al., 2019)
Terminalia chebula	Harad	Fruit	Digestive aid, laxative, immunity booster	Chebulinic acid, Corilagin	Jaunsari, Gujjars	Uttarakhand, West Bengal	(Kumar, A., et al., 2019), (Raj, A. J., et al., 2018)
Phyllanthus emblica	Amla	Fruit	Antioxidant, improves immunity, diabetes	Vitamin C, Ellagic acid, Phyllemblin	Multiple tribes	Uttarakhand	(Kumar, A., et al., 2019), (Kumar, M., et al., 2021)
Justicia adhatoda	Vasaka	Leaf	Cough, asthma, bronchitis	Vasicine, Vasicinone (Alkaloids)	Jaunsari	Chakrata, Uttarakhand	(Kumar, A., et al., 2019)
Vitex negundo	Nirgundi	Leaf	Inflammation, arthritis, fever	Nishindine, Vitexin, Viridiflorol	Jaunsari	Uttarakhand	(Kumar, A., et al., 2019)

Smilax glabra	Chinese Smilax	Root	Antidiabetic, detoxification, skin health	Astilbin, Smilacin, Saponins	Jaunsari	Uttarakhand	(Kumar, A., et al., 2019)
Mallotus philippensis	Kamala Tree	Fruit/Flower	Worm infections, skin ailments	Rottlerin, Isorottlerin	Jaunsari	Uttarakhand	(Kumar, A., et al., 2019)
Rauvolfia serpentina	Indian Snakeroot	Root	Hypertension, psychiatric conditions	Reserpine, Ajmaline	Indigenous groups	Northern Bengal, Chilapata Reserve	(Raj, A. J., et al., 2018)
Acorus calamus	Sweet Flag	Rhizome	Cough, gastrointestinal issues	α-asarone and β-asarone	Irula, Khasi Tribe	Walayar Valley, manipur	(Venkatachalapathi, et al., 2018), (Prakash, N., et al., 2014)
Curcuma longa	Turmeric	Rhizome	Anti-inflammatory, women's health issues	Curcumin, Turmerone	Karbi, Khasi	Northeast India, Ladakh	(Kropi, K., et al., 2024), (Haq et al., 2021)
Zingiber officinale	Ginger	Rhizome	Gastrointestinal issues, respiratory conditions	Gingerol, Shogaol, Zingerone	Various communities	Across India	(Kropi, K., et al., 2024), (Chinnasamy, et al., 2018)
Centella asiatica	Asiatic Pennywort	Leaf	Wound healing, skin problems	Asiaticoside, Madecassoside	Indigenous	Northern Bengal	(Raj, A. J., et al., 2018)
Trigonella foenum-graecum	Fenugreek	Seed	Antioxidant, backache, kidney stones	Diosgenin, Trigonelline	Garhwali, Kumaoni	Uttarakhand	(Kumar, M., et al., 2021)
Cassia fistula	Amaltas	Bark	Antimalarial, digestive health	Anthraquinones (Rhein), Fistulic acid	General	India (antimalarial study)	(Qayum et al., 2016)

Ganoderma lucidum	**Reishi Mushroom**	**Fruit Body**	**Immune support, anti-cancer**	**Ganoderic acids, Polysaccharides**	**Indigenous groups**	**Kashmir, Chilapata Reserve (Northern Bengal)**	**(Dar et al., 2023), (Raj, A. J., et al., 2018)**
Saussurea costus	**Costus Root**	**Root**	**Asthma, bronchitis**	**Costunolide, Dehydrocostus lactone**	**Pangi tribes**	**Pangi Valley, Chamba (Himalayas)**	**(Rana et al., 2014)**

The 29 medicinal plants show that the therapeutic potency of these plants relates to how they are made, containing multiple components of phytochemicals that act upon specific body processes. Plants that grow at high altitudes, e.g., Kutki and Jatamansi, appear to contain the highest concentration of bitter glycosides and alkaloids, and these are used to protect the liver and maintain nervous system stability. Conversely, the airway specialists, Asuro and Costus Root appear to relax the bronchial muscles and facilitate proper breathing through the action of certain phytochemicals, such as Vasicine and Costunolide. It is found that metabolic health is primarily managed by Berberine and Diosgenin, which regulate blood sugar, and that Tannins have an astringent effect that helps to alleviate digestive issues as evidenced by Harro and Bael. Therefore, the selection of specific plant parts for the given plant—root, leaf, and seed is critical, due to the fact that those areas of the plant contain many of the necessary secondary metabolites that characterize the plant's incredible healing properties, for example, the anti-inflammatory properties of Curcumin from Turmeric and the hypertensive properties of Reserpine from Sarpagandha.

Discussion:

Ethnomedicinal research conducted in various regions of India, including the Himalayas and other ecological areas, showcases the richness of practices shaped by the local biodiversity, cultural customs, and socio-economic factors. In Uttarakhand and Ladakh, practices related to ethnomedicine focus on the unique biodiversity found in high-altitude areas and the preservation of rare and endangered species such as Picrorhiza kurroa and Nardostachys jatamansi. These methods are deeply connected to spiritual customs, like the stewardship of sacred groves and community forests, which are crucial for conserving biodiversity (Negi et al., 2023; Ojha et al., 2020). Meanwhile, in areas like Sathyamangalam and

Mizoram, the emphasis is on tropical and subtropical environments, where ethnomedicine revolves around readily accessible herbs and shrubs from families such as Euphorbiaceae and Zingiberaceae, often grown in community home gardens (Mandal et al., 2022; Chinnasamy, et al., 2018).

Methods of preparation showcase regional customs and the availability of resources. In Uttarakhand and Ladakh, the primary methods include decoctions and pastes, typically derived from wild-harvested materials, although the overharvesting of roots and rhizomes raises sustainability concerns (Ojha et al., 2020). In places like Sathyamangalam and the Nicobar Islands, there is a wider variety of preparation techniques, including fresh juice extraction and powdered forms, with a growing incorporation of modern bio-prospecting to substantiate traditional treatments (Chinnasamy, et al., 2018; Venkatachalapathi et al., 2018).

Cultural and spiritual elements significantly shape ethnomedicinal practices. In Uttarakhand and Ladakh, traditional medicine is linked to sacred sites and spiritual beliefs, with older members of the community depending on traditional healers (Vaidyas). However, modernization has led to decreased participation from younger individuals (Negi et al., 2023; Ojha et al., 2020). In Mizoram and Sathyamangalam, the continuity of ethnomedicinal knowledge is also at risk. Younger generations in these areas are moving towards contemporary healthcare systems, although women remain vital in the preservation and conservation of knowledge related to medicinal plants (Mishra et al., 2018; Saha et al., 2015).

The focus of research varies by locality. In Chakrata, the practices of the Jaunsari tribal community prioritize managing chronic conditions such as diabetes and respiratory issues through sustainable harvesting practices and traditional cures (Kumar et al., 2019; Haq et al., 2021). In Sathyamangalam and Mizoram, investigations delve into innovative applications of plants for antifertility, cancer treatments, and socio-economic advantages. These practices benefit from scientific endorsement and computational analysis, underscoring their potential for integration into contemporary healthcare systems (Sharma et al., 2015; Chinnasamy et al., 2018).

Despite the regional variances, challenges are shared across these areas. The loss of knowledge due to modernization and the waning interest from younger generations present major threats. For example, in Uttarakhand and Ladakh, the critical need for conserving rare species is highlighted to avert overharvesting (Negi et al., 2023; Ojha et al., 2020). In Mizoram and Sathyamangalam, advocating for community-based conservation and utilizing traditional knowledge for economic incentives are essential strategies to maintain these practices (Mandal et al., 2022; Chinnasamy, et al., 2018).

Merging traditional knowledge with modern healthcare systems is vital for these regions. The practices found in Uttarakhand and Ladakh resonate with global biodiversity and sustainability initiatives, particularly through the documentation and safeguarding of ethnomedicinal knowledge (Ojha et al., 2020). Conversely, in Sathyamangalam and Mizoram, the focus on socio-economic empowerment through the commercialization and validation of traditional remedies highlights a complementary strategy. An integrated approach that combines ethnomedicinal expertise with modern scientific progress can guarantee the conservation and sustainable advancement of these precious practices throughout India.

Conclusion:

The significant depth and relevance of ethnomedicinal practices in the Himalayan region and its surroundings are emphasized in this comprehensive review. The findings reveal a rich reservoir of Indigenous knowledge that is intricately linked to the environmental and cultural contexts of the communities examined. There is clear evidence of a harmonious relationship between Indigenous practices and the preservation of biodiversity, which ranges from the application of modern tools like the Normalized Difference Vegetation Index (NDVI) in Uttarakhand to pinpointing biodiversity hotspots, to thorough ethnobotanical recordings of plant species utilized for various medicinal purposes in Kharmang, Kangra, and elsewhere. All results highlight the urgent necessity to protect this valuable body of knowledge, for cultural preservation and as a vital resource for contemporary medical applications.

The ethnomedicinal traditions across a range of Indian locales exemplify a storied legacy of traditional insight that is deeply intertwined with local biodiversity, cultural practices, and socio-economic conditions. This review underscores the importance of ethnomedicine in areas such as Uttarakhand, Ladakh, Sathyamangalam, and Mizoram, illustrating their dependence on medicinal plants for health care, economic sustenance, and cultural preservation. While Himalayan regions focus on protecting rare and endemic species through sacred groves and community-managed forests, tropical and subtropical parts of India highlight the socio-economic potential of ethnomedicine through practices such as home gardening and community initiatives.

Nevertheless, despite geographic and ecological variations, shared challenges pose threats to these practices. Modernization, loss of generational knowledge, and the excessive harvesting of medicinal plants endanger the sustainability and transfer of traditional knowledge. Younger generations, who increasingly depend on modern healthcare solutions, tend to undervalue these age-old practices,

highlighting the necessity for focused interventions. This review pinpoints urgent conservation requirements in regions such as Uttarakhand and Ladakh, where rare species confront extinction risks, while also accentuating the socio-economic empowerment possibilities in Sathyamangalam and Mizoram through the commercialization and recognition of traditional remedies.

Merging traditional ethnomedicinal knowledge with contemporary healthcare systems arises as an essential route for sustainable development. This integration should focus on region-specific approaches, such as policy backing for conservation in the Himalayan areas and community-based economic incentives in subtropical zones. The documentation and validation of traditional knowledge through modern scientific approaches can close the gaps between Indigenous systems and current healthcare, ensuring the safeguarding of biodiversity and cultural richness while encouraging medical innovation.

In the end, an inclusive approach that honors and integrates the diverse ethnomedicinal practices of India into broader global health and sustainability initiatives will strengthen the durability of these systems. By tackling challenges and capitalizing on opportunities, ethnomedicine can continue to play a vital role in biodiversity conservation, community welfare, and socio-economic progress, maintaining its significance in an increasingly modernized era.

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