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**Ethnomedicinal Plants in India: Traditional Knowledge, Therapeutic Applications, and Conservation Perspectives – A Systematic Review**

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**Abstract**

*India is one of the world's richest repositories of medicinal plant diversity, harbouring approximately 8,000 medicinal plant species (Botanical Survey of India, 2022). India possesses a rich diversity of medicinal plants that are widely used in traditional healthcare systems and are of considerable conservation importance (Gowthami et al., 2021). Medicinal plants are widely used in India's folk, tribal, and traditional healthcare practices, forming an important component of indigenous knowledge systems (Jain, 1994). This systematic review synthesizes the published literature on Indian ethnomedicinal plants with three specific objectives: (i) to map the diversity of traditional knowledge systems and their ethnobotanical documentation; (ii) to catalogue major therapeutic application categories supported by ethnobotanical and pharmacological evidence; and (iii) to critically examine the conservation status of, and threats to, ethnomedicinally important plant species, together with ongoing conservation strategies. A structured search of peer-reviewed databases (PubMed, Scopus, ScienceDirect, Web of Science and Google Scholar) and the Indian Journal of Traditional Knowledge repository was conducted using combinations of the terms 'ethnomedicine', 'ethnobotany', 'traditional knowledge', 'medicinal plants', 'India', 'conservation' and disease-specific keywords, supplemented by hand-searching of reference lists; more than twenty peer-reviewed primary ethnobotanical surveys, pharmacological studies and conservation assessments meeting the inclusion criteria were synthesized narratively. Ethnomedicinal knowledge in India is commonly documented through region- and tribe-specific ethnobotanical surveys, many of which employ quantitative indices such as the Informant Consensus Factor (ICF/FIC) and Fidelity Level (FL) to assess the reliability and significance of reported plant uses (Raj et al., 2018; Buragohain et al., 2024). Therapeutic applications reported in Indian ethnomedicinal literature encompass a wide range of health conditions, with antidiabetic, wound-healing, hepatoprotective, and antimicrobial uses being particularly well documented (Kumar et al., 2007; Tag et al., 2012; Shanmugasundaram & Venkataraman, 2006; Abat et al., 2017); and that despite this wealth of traditional knowledge and growing pharmacological validation, a substantial proportion of*

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*ethnomedicinal plant species in India face conservation threats from overharvesting, habitat degradation and unsustainable trade, with Conservation Assessment and Management Prioritisation (CAMP) exercises and IUCN-based assessments together identifying dozens of species in threatened categories (Gowthami et al., 2021). The review highlights the importance of protecting traditional medicinal knowledge through intellectual-property safeguards such as the Traditional Knowledge Digital Library (TKDL), which can help prevent biopiracy and support the preservation of India's indigenous medicinal heritage (Sen & Chakraborty, 2014).*

**Keywords:** *Ethnomedicine; Ethnobotany; Traditional knowledge; Medicinal plants; India; Conservation; Ayurveda; Biopiracy.*

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## **1. Introduction**

India is recognised as one of the world's mega-biodiverse countries and is home to two of the globe's thirty-six biodiversity hotspots — the Western Ghats and the Himalaya — together with the species-rich forests of Northeast India and the semi-arid and coastal ecosystems of peninsular India. Within this floristic wealth, nearly 8,000 plant species have been documented as possessing medicinal value (Botanical Survey of India, 2022), making the Indian subcontinent one of the richest genetic resource bases for medicinal plants in the world (Gowthami et al., 2021). India's rich botanical diversity is complemented by a diverse heritage of healing traditions. While codified systems such as Ayurveda, Siddha, Unani, and Sowa-Rigpa form important components of traditional healthcare, a substantial body of ethnomedicinal knowledge continues to be maintained through oral traditions among tribal and rural communities that rely on locally available medicinal plants for primary healthcare (Jain, 1994).

The World Health Organization has repeatedly drawn attention to the continuing reliance of large sections of the global population, particularly in developing countries, on herbal and traditional medicine for primary healthcare needs, underscoring the public-health relevance of ethnobotanical knowledge well beyond its cultural significance. In the Indian context, ethnomedicinal knowledge remains a dynamic and living tradition, transmitted primarily through oral exchange among traditional healers and forest-dependent communities. Nevertheless, its continuity is increasingly challenged by environmental degradation, changing land-use regimes, socioeconomic transformation, migration of younger generations away from traditional livelihoods, and weakening mechanisms of intergenerational knowledge transmission (Raj et al., 2018; Rao, 2017; Cruz García, 2006). Simultaneously, the plant resources on which this knowledge depends are themselves under threat from overharvesting, habitat degradation, and unsustainable commercial trade. Moreover, a substantial proportion of medicinal plants traded in India continue to be sourced from wild

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populations rather than cultivated stock, increasing pressure on natural habitats (Gowthami et al., 2021; Ved & Goraya, 2008; Schippmann et al., 2002).

Although a substantial body of literature exists on Indian ethnomedicinal plants, this literature is often fragmented across three relatively disconnected strands: (i) ethnobotanical surveys documenting traditional uses among specific tribal or regional communities; (ii) pharmacological and phytochemical studies validating (or otherwise) specific therapeutic claims; and (iii) conservation science assessing the threat status of medicinal plant species. There remains a need for syntheses that draw these strands together within a single analytical framework. The present systematic review attempts to do so, with the specific objectives of (i) mapping the diversity and documentation of traditional knowledge systems in India; (ii) cataloguing major therapeutic application categories supported by ethnobotanical and pharmacological evidence; and (iii) critically examining the conservation status of, and strategies for, ethnomedicinally important plant species.

## **2. Materials and Methods**

### **2.1 Search Strategy**

A structured literature search, following the general logic of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework, was conducted across PubMed, Scopus, ScienceDirect, Web of Science and Google Scholar, supplemented by searches of the Indian Journal of Traditional Knowledge repository (NISCPR). Search terms were combined using Boolean operators and included 'ethnomedicine', 'ethnobotany', 'traditional knowledge', 'medicinal plants', 'India', 'tribal', 'conservation', 'IUCN', 'CAMP' and disease-specific terms such as 'antidiabetic', 'wound healing' and 'hepatoprotective'. Reference lists of retrieved articles were hand-searched to identify additional relevant studies (snowball sampling).

### **2.2 Inclusion and Exclusion Criteria**

Studies were included if they (a) were published in peer-reviewed journals or recognised institutional/governmental sources; (b) reported primary ethnobotanical field data, pharmacological validation studies, or conservation assessments specifically concerning India; and (c) were available in English. Studies were excluded if they concerned ethnomedicinal plants outside the Indian subcontinent, were not peer-reviewed, or did not report verifiable source information. Given the substantial heterogeneity in study design, sample size, and outcome reporting that characterises the ethnobotanical literature, a quantitative meta-analysis was not feasible; the review therefore adopts a narrative-systematic synthesis approach, a method widely used in ethnobotanical and conservation literature reviews.

### **2.3 Data Synthesis**

More than twenty peer-reviewed primary studies and reviews meeting the inclusion criteria were retained and thematically organised into three broad domains corresponding to the review's

objectives: traditional knowledge systems and documentation; therapeutic application categories; and conservation status and strategies. Findings within each domain were synthesized narratively, with illustrative examples and representative studies discussed in depth rather than exhaustively enumerated.

### **3. Results and Discussion**

#### ***3.1 Traditional Knowledge Systems and Their Documentation***

India's traditional medicine landscape comprises both codified and non-codified systems. The codified systems — Ayurveda, Siddha, Unani and Sowa-Rigpa — are textually transmitted, institutionally taught, and administered under the Ministry of AYUSH, while non-codified ethnomedicinal knowledge is transmitted orally within specific tribal, rural and forest-dependent communities and is rarely documented outside dedicated ethnobotanical surveys. Jain (1994) was among the early researchers to systematically draw attention to the scale and significance of India's ethnobotanical knowledge base, highlighting the urgent need for its scientific documentation before it is lost to generational change.

Subsequent decades have seen a proliferation of region- and community-specific ethnobotanical surveys. Raj et al. (2018), for instance, documented the ethnomedicinal knowledge of forest-dependent communities of Indo-Mongoloid origin in the fringe areas of the Chilapatta Reserve Forest in Northern Bengal, interviewing 400 respondents including traditional healers and recording numerous plant species used for treating a wide range of ailments, including several uses reported for the first time from the study area. Similarly, Pala et al. (2019) documented the floristic composition and ethnomedicinal utilisation of plants maintained in home gardens of the Eastern Himalaya, highlighting the role of home gardens as a complementary, semi-domesticated source of ethnomedicinal plant material. Biswas et al. (2017) inventoried Ayurvedic and ethnomedicinal plants of the Kakrajhore forest area of West Bengal, while Buragohain et al. (2024) documented the ethnomedicinal plant knowledge of the Mishing community of Sivasagar district, Assam, reporting a high level of consensus among informants regarding plants used for symptomatic disease categories. Many of these recent surveys employ standardised quantitative ethnobotanical tools — including the informant consensus factor (ICF/FIC), fidelity level (FL) and use value (UV) — to assess the cultural significance and reliability of reported plant uses, lending greater methodological rigour to a field that has historically relied on purely descriptive reporting (Buragohain et al., 2024). This methodological shift represents an important advance, allowing comparison of the relative importance of species both within and across studies.

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### ***3.2 Geographic and Botanical Diversity of Ethnomedicinal Resources***

The Western Ghats, one of India's two global biodiversity hotspots, harbours a particularly rich ethnomedicinal flora. Kumar et al. (2018) compiled a comprehensive review of the ethnobotany, diversity and pharmacological importance of medicinal plants of the Western Ghats, while Malavika and Athira (2023) specifically highlighted the increasing number of endangered species within this regionally distinct flora, several of which are subject to substantial commercial harvesting pressure. The Himalayan region constitutes a second major reservoir of ethnomedicinal diversity: Mehra et al. (2023) reviewed the ethnomedicinal relevance and antibacterial potential of Himalayan medicinal plants of Uttarakhand, illustrating the high proportion of locally used species that also show measurable pharmacological activity. Northeast India — encompassing Assam, Arunachal Pradesh, Tripura and neighbouring states — represents a third major centre of ethnomedicinal diversity, reflecting both exceptional floristic richness and the cultural diversity of its numerous indigenous communities, as evidenced by the disease-specific surveys discussed in section 3.3.

### ***3.3 Therapeutic Application Categories***

Ethnomedicinal plants reported from India span almost the entire spectrum of human disease categories. Four categories are particularly well represented in the peer-reviewed literature and are discussed below; a summary is presented in Table 1.

***Antidiabetic applications.*** Given the rising burden of diabetes mellitus in India, antidiabetic ethnomedicinal plants have attracted considerable research attention. Tag et al. (2012) documented herbal medicines used in the treatment of diabetes mellitus in Arunachal Himalaya, northeast India, while Tarak et al. (2011) compiled an inventory of ethnobotanicals used as antidiabetic remedies by a rural community of Dhemaji district, Assam. Ghosh Tarafdar et al. (2015) similarly documented antidiabetic plants used among the ethnic communities of Unakoti district, Tripura. At a national scale, Ghosh et al. (2024) compiled a database of 1,305 plant species reported across India's ethnobotanical literature to possess antidiabetic properties, categorised by scientific name, family, local name, plant part used and state-wise availability — illustrating both the scale of this knowledge base and the continuing need for systematic pharmacological validation.

***Wound-healing applications.*** Kumar et al. (2007) authored a widely cited review analysing the ethnobotanical knowledge base for the treatment of cuts, wounds and burns in India, documenting the plants and preparation methods employed by tribal and folklore traditions and critically reviewing the (at the time, limited) pharmacological validation available for these traditional wound-healing claims. The authors noted that the great majority of plants reported in folklore and tribal practice for wound healing had not, at the time of their review, been subjected to rigorous pharmacological testing.

**Hepatoprotective applications.** Liver disorders constitute another major category of traditional treatment. Shanmugasundaram and Venkataraman (2006) demonstrated hepatoprotective and antioxidant effects of root extracts of *Hygrophila auriculata*, a plant widely used in Indian ethnomedicine, while Chattopadhyay (2003) examined the possible mechanism underlying the hepatoprotective activity of *Azadirachta indica* (neem) leaf extract — a species whose ethnomedicinal versatility extends across antimicrobial, antipyretic and dermatological uses as well.

**Antimicrobial and dermatological applications.** Abat et al. (2017) reviewed the ethnomedicinal, phytochemical, and pharmacological characteristics of four medicinally important Malvaceae species—*Abutilon indicum*, *Hibiscus sabdariffa*, *Sida acuta*, and *Sida rhombifolia*. The authors documented their traditional use in Ayurveda, Siddha, and folk medicine for the treatment of respiratory ailments, fever, liver and kidney disorders, and skin diseases, and noted that these species share several major classes of bioactive constituents, including alkaloids, phenolics, flavonoids, and steroids, which may contribute to their overlapping therapeutic properties.

Therapeutic Category	Representative Plant Taxa	Key Source(s)
Antidiabetic	<i>Gymnema sylvestre</i> , <i>Momordica charantia</i> , <i>Trigonella foenum-graecum</i> , <i>Syzygium cumini</i>	Tag et al. (2012); Tarak et al. (2011); Ghosh Tarafdar et al. (2015); Ghosh et al. (2024)
Wound healing	<i>Aloe vera</i> , <i>Centella asiatica</i> , <i>Azadirachta indica</i> , <i>Curcuma longa</i>	Kumar et al. (2007)
Hepatoprotective	<i>Hygrophila auriculata</i> , <i>Azadirachta indica</i>	Shanmugasundaram & Venkataraman (2006); Chattopadhyay (2003)
Antimicrobial / dermatological	<i>Abutilon indicum</i> , <i>Hibiscus sabdariffa</i> , <i>Sida acuta</i> , <i>Sida rhombifolia</i>	Abat et al. (2017)
General tribal/folk healthcare	Region-specific flora (e.g., <i>Chilapatta Reserve Forest</i> , <i>Eastern Himalaya home gardens</i> )	Raj et al. (2018); Pala et al. (2019); Biswas et al. (2017)

Table 1. Selected therapeutic categories of Indian ethnomedicinal plants, representative taxa, and key sources reviewed.

### 3.4 Intellectual Property, Biopiracy, and the Traditional Knowledge Digital Library

The scientific and commercial value of India's ethnomedicinal knowledge has, on several occasions, exposed it to the risk of 'biopiracy' — the patenting of traditional knowledge or biological resources by external parties without acknowledgement of, or benefit-sharing with, the original knowledge holders. The internationally publicised disputes over patents granted on the wound-healing properties of turmeric and the antifungal properties of neem, both of which were ultimately challenged and overturned on the basis of documented prior traditional use, catalysed the establishment of the Traditional Knowledge Digital Library (TKDL) by India's Council of Scientific and Industrial Research in collaboration with the Department of AYUSH. Sen and Chakraborty (2014) described

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the TKDL as a distinctive institutional mechanism that systematically translates traditional formulations recorded in Ayurveda, Siddha, Unani and Yoga texts into a format and set of languages accessible to international patent examiners, thereby providing documented prior art capable of preempting future biopiracy claims. The TKDL exemplifies how ethnobotanical documentation, beyond its scientific and conservation value, also carries significant legal and economic weight in protecting community knowledge rights.

### ***3.5 Conservation Status and Threats***

Despite — and partly because of — the scale of demand for medicinal plant raw material, a substantial proportion of India's ethnomedicinally important species face significant conservation threats. Gowthami et al. (2021) compiled a consolidated list of 84 threatened medicinal plant species of India by synthesising information from successive Conservation Assessment and Management Prioritisation (CAMP) exercises and IUCN Red List assessments conducted since the 1990s. The authors further highlighted that a substantial proportion of medicinal plants used in India continue to be sourced from wild populations, exposing many species to sustained harvesting pressure and increasing conservation concerns. The threatened status of many medicinal plant species in India has been attributed to overexploitation, unsustainable harvesting practices, habitat loss and degradation, and increasing commercial demand for plant-based raw materials. The historical foundation for systematic threat assessment in India was laid by Nayar and Sastry's (1987–1990) three-volume Red Data Book of Indian Plants, which subsequently informed CAMP exercises and later IUCN-based conservation assessments (Gowthami et al., 2021).

Regional assessments corroborate this national pattern. Malavika and Athira (2023) catalogued endangered medicinal plant species of the Western Ghats and highlighted the combined effects of restricted distribution, habitat degradation, and overexploitation on their conservation status. The International Union for Conservation of Nature has likewise emphasized the importance of medicinal plant collection to rural livelihoods in India, estimating that collection and processing activities contribute at least 35 million workdays annually, while warning that increasing demand and unsustainable harvesting threaten the long-term sustainability of this livelihood resource (IUCN, n.d.).

### ***3.6 Conservation Strategies***

In response to these threats, India has developed a multi-pronged conservation framework combining in-situ and ex-situ approaches with policy and institutional mechanisms, summarised in Table 2. In-situ strategies include the protection of medicinal plant populations within sacred groves, biosphere reserves and dedicated Medicinal Plant Conservation Areas (MPCAs), which conserve species within their natural ecological context and, in the case of sacred groves, benefit from long-standing

community-based protection rooted in cultural and religious practice. Ex-situ strategies include conservation through botanical gardens, seed and gene banks, and tissue-culture and cryopreservation repositories maintained by institutions such as the ICAR-National Bureau of Plant Genetic Resources, which are particularly important for species that are slow-growing, narrowly endemic, or difficult to propagate through conventional means (Gowthami et al., 2021).

At the policy level, the Biological Diversity Act, 2002 established the legal framework for regulating access to India's biological resources and associated traditional knowledge, and led to the creation of the National Biodiversity Authority (Government of India, 2002). The National Medicinal Plants Board (NMPB), functioning under the Ministry of AYUSH, has been tasked with coordinating the conservation, cultivation and sustainable trade of medicinal plant resources, including efforts to assess and bridge the gap between the demand for, and sustainable supply of, medicinal plant raw material (Ved & Goraya, 2008). Complementing these conservation mechanisms, the Traditional Knowledge Digital Library (Sen & Chakraborty, 2014), discussed above, indirectly supports conservation objectives by formally recognising and valuing traditional knowledge associated with specific plant species, thereby strengthening the case for their protection.

Mechanism	Description	Source(s)
<b>Assessment frameworks</b>	IUCN Red List criteria; Red Data Book of Indian Plants; CAMP exercises	Nayar & Sastry (1987-1990); Gowthami et al. (2021)
<b>In-situ conservation</b>	Medicinal Plant Conservation Areas (MPCAs), biosphere reserves and protected areas	Gowthami et al. (2021)
<b>Ex-situ conservation</b>	Botanical gardens, gene banks, tissue culture and cryopreservation repositories (e.g., ICAR-NBPGR)	Gowthami et al. (2021)
<b>Policy and institutional mechanisms</b>	Biological Diversity Act 2002; National Biodiversity Authority; National Medicinal Plants Board (NMPB)	Government of India (2002); NMPB documents; NBA documents
<b>Intellectual-property safeguards</b>	Traditional Knowledge Digital Library (TKDL), documenting traditional formulations to pre-empt biopiracy	Sen & Chakraborty (2014)

Table 2. Conservation assessment frameworks and strategies relevant to Indian ethnomedicinal plants.

#### 4. Research Gaps and Future Directions

- Integration gap: Ethnobotanical documentation, pharmacological validation and conservation assessment continue to be conducted largely as separate research streams; few studies systematically link a documented traditional use to both its pharmacological validation status and its conservation threat category for the same species.

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- Methodological heterogeneity: Considerable variation in survey design, sample size, and the use (or non-use) of quantitative indices such as informant consensus factor and fidelity level across ethnobotanical surveys limits the comparability of findings and precludes formal meta-analysis.
  - Validation gap: Kumar et al. (2007) observed that many medicinal plants traditionally used for the treatment of wounds, cuts, and burns in India had not yet been subjected to rigorous pharmacological evaluation, highlighting the need for further scientific validation of ethnomedicinal claims.
  - Cultivation gap: Continued dependence on wild harvesting for the majority of traded medicinal plant species (Gowthami et al., 2021) underscores the need for expanded cultivation, domestication and agro-technology development for high-demand, slow-growing or narrowly endemic species.
  - Benefit-sharing gap: Mechanisms for ensuring that tribal and local communities who are the custodians of ethnomedicinal knowledge receive equitable recognition and benefit-sharing, as envisaged under the Biological Diversity Act, 2002, require continued strengthening alongside intellectual-property safeguards such as the TKDL (Government of India, 2002; Sen & Chakraborty, 2014).

## 5. Conclusion

India's ethnomedicinal heritage represents a vast, biologically grounded and culturally embedded knowledge system that continues to support primary healthcare and provides an important source of leads for modern drug discovery. This review has synthesised evidence across three interconnected domains: the documentation of traditional knowledge through region- and community-specific ethnobotanical surveys, increasingly supported by quantitative ethnobotanical methods (Raj et al., 2018; Buragohain et al., 2024); the therapeutic applications of ethnomedicinal plants across major disease categories, including diabetes, wound healing, liver disorders, and microbial infections (Tag et al., 2012; Kumar et al., 2007; Shanmugasundaram & Venkataraman, 2006; Abat et al., 2017); and the conservation status and management of medicinal plant resources (Gowthami et al., 2021; Government of India, 2002). The evidence reviewed indicates that, despite India's exceptionally rich ethnomedicinal knowledge base and the development of institutional mechanisms such as the Traditional Knowledge Digital Library, the Biological Diversity Act, 2002, and the National Medicinal Plants Board, challenges remain in strengthening links between ethnobotanical documentation, scientific validation, sustainable resource management, and equitable benefit-sharing. Addressing these challenges through interdisciplinary research, expanded cultivation of medicinal plants, and effective implementation of biodiversity governance mechanisms will be

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important for ensuring that India's ethnomedicinal heritage continues to contribute to healthcare, conservation, and future drug discovery.

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