



ETHNOMEDICINAL RESOURCES, PEDO-CLIMATIC DYNAMICS, AND AGRO-INDUSTRIAL PROSPECTIVES OF ASSAM, NORTHEAST INDIA: A COMPREHENSIVE REVIEW

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Abstract:

Due to its diverse ecosystems and favorable climatic conditions, Assam possesses a rich repository of medicinal flora that has supported traditional healthcare systems across generations. Key botanical species such as Giloe, Neem, Tulsi, Amla, and Brahmi constitute the backbone of regional herbal medicine, offering natural remedies for various human ailments. Protecting and promoting these native species is essential for safeguarding community health, preserving ancestral ethnomedicinal heritage, and maintaining regional ecological stability. Ongoing scientific evaluation alongside sustainable collection methodologies remains critical to ensuring the long-term availability and utility of these botanical resources for future generations.

Keywords: Assam, Medicinal Plants, Traditional Knowledge, Indigenous Communities, Cultivation, Paedology.

1. Introduction

Assam, situated in the Eastern Himalayan biodiversity hotspot of Northeast India, is recognized for its extraordinary biological richness, ecological diversity, and cultural heritage. The state's unique geographical positioning, coupled with high annual rainfall and fertile alluvial river valleys, fosters a flourishing sanctuary for thousands of plant species, many of which possess significant therapeutic and economic value. For centuries, the indigenous tribal populations of Assam have harmoniously interacted with this lush environment, developing an intricate body of traditional ecological knowledge and natural healthcare practices. Ethnomedicinal flora serves not only as a primary line of healthcare for rural and remote communities but also as a vital repository of novel

phytochemical leads for drug discovery.

Despite this immense potential, regional ethnomedicinal heritage faces compounding pressures from ecological degradation, unsustainable harvesting, habitat loss, and climate variations. Furthermore, modern urban expansion threatens the intergenerational oral transmission of tribal medical practices. To fully capitalize on Assam's botanical wealth, a multidisciplinary approach bridging pedo-climatic characterization, systematic ethnobotanical documentation, phytopharmacological validation, and sustainable agronomic management is essential. This review provides a holistic synthesis of Assam's soil-climatic dynamics, rich indigenous medical traditions, therapeutic profiles of key native flora, and institutional frameworks necessary for advancing the region's bio-based agro-industrial prospective.

2. Pedo-climatic dynamics and agricultural landscape of Assam

Situated in northeastern India, Assam presents a varied landscape dominated by the Brahmaputra and Barak river valleys, extensive river systems, rolling foothill zones, and plateau regions (1). The climate transitions from humid subtropical conditions across the plains to temperate microclimates in elevated areas, fundamentally shaping the distribution of regional soil types and plant ecosystems (2, 3). The state features four primary soil classifications that dictate local plantation choices and agricultural output. Alluvial soils, predominant across the Brahmaputra Valley, are highly fertile and nutrient-rich, serving as the foundation for intensive tea, rice, and horticultural production. Laterite soils, situated in hilly terrains and eastern plateau regions, support tea, spices, and specific medicinal herbs when sustained by appropriate soil management and fertilization protocols (4). Red soils occur along foothills and gentle slopes, offering well-drained environments suitable for crops such as areca nut, rubber, and various fruits. Additionally, localized deposits of Terra Rossa soils are maintained for specialized tea gardens. The strategic agricultural utilization of these soil profiles drives Assam's plantation economy (5). Tea plantations thrive on well-drained alluvial and laterite soils that deliver the essential nutrients required for high-grade yields (6). Rubber plantations flourish in organic-rich, well-drained red soils along the Brahmaputra foothills, whereas valuable spices and medicinal plants are integrated into red and laterite soils based on specific physiological requirements. Horticultural produce, including citrus fruits, pineapples, and bananas, draws vigor from fertile alluvial lowlands. To sustain productivity and mitigate land degradation, plantation managers utilize comprehensive soil preservation techniques, including routine application of organic manures and chemical fertilizers, terrace engineering and vegetative cover to limit erosion on sloping landscapes, precise soil pH adjustments, and regulated irrigation schedules designed to prevent moisture stress.

3. Ethnomedicinal heritage and indigenous healing systems

Assam maintains an ancient relationship with natural healing systems, rooted deeply within its rich biodiversity and cultural traditions (7). For millennia, indigenous groups across the state—including the Bodo, Mishing, Karbi, Dima, Rabha, Tiwa, Deori, and Ahom communities—have developed, refined, and safeguarded an extensive pharmacopeia derived from wild flora, minerals, and organic substances (8). Historically, these tribal societies relied entirely on their empirical understanding of native plants to manage acute injuries, seasonal fevers, and chronic disorders. These therapeutic interventions were structurally intertwined with spiritual beliefs, community rituals, and daily dietary practices, forming a core pillar of tribal cultural identity.

The transmission of ethnomedicinal expertise relied heavily on oral traditions passed down through specialized lineage lines or familial apprenticeships (9). Traditional healers, recognized within their communities as Burias,

Ojhas, or Vaidyas, served as primary healthcare providers responsible for diagnosing illness and preparing customized botanical formulations from locally harvested roots, bark, leaves, and seeds. Their therapeutic repertoire encompassed herbal decoctions for common ailments, ritualistic applications aimed at spiritual protection, and the routine inclusion of functional herbs in daily meals for preventive health maintenance. In contemporary times, ethnobotanists and medical researchers continue to document these oral traditions, working to validate the clinical efficacy of celebrated native remedies such as Tulsi, Neem, Amla, and Guduchi. However, rapid urbanization, land conversion, and generational shifts pose significant threats to the survival of these unwritten practices, prompting urgent calls for systemic documentation, scientific verification, and formal integration into broader public healthcare frameworks.

4. Phytotherapeutic profile of key medicinal flora

Assam's warm, humid climate and abundant rainfall nurture a vast array of high-value medicinal plants utilized in traditional healing, Ayurvedic formulations, pharmaceutical extraction, and natural cosmetics (10). Among these, Tulsi (*Ocimum tenuiflorum*) stands out as an essential aromatic herb whose leaves yield decoctions rich in eugenol, ursolic acid, and rosmarinic acid, providing therapeutic relief for coughs, fevers, respiratory stress, and metabolic imbalance. Neem (*Azadirachta indica*) acts as a powerful multipurpose tree, with its leaves, bark, and seed oils delivering bioactive compounds like azadirachtin and nimbin that combat microbial infections, skin lesions, dental decay, and blood impurities. Aloe Vera (*Aloe vera*) provides a mucilaginous gel packed with polysaccharides and anthraquinones that accelerate epidermal repair, soothe thermal burns, and improve gastrointestinal function. Turmeric (*Curcuma longa*), widely cultivated for its curcuminoid content, acts as a potent systemic anti-inflammatory, antioxidant, and hepatoprotective agent, while Ginger (*Zingiber officinale*) relies on gingerols to alleviate nausea, digestive distress, and inflammatory pain.

The region's botanical inventory contains several other therapeutically vital species. Black Pepper (*Piper nigrum*) supplies piperine, which improves digestive health while enhancing the systemic bioavailability of other nutritional and medicinal compounds. Amla (*Phyllanthus emblica*) acts as an exceptional natural source of Vitamin C and ellagitannins, reinforcing immune response, digestive vigor, and metabolic regulation. Nootropic and adaptogenic support is provided by Brahmi (*Bacopa monnieri*), rich in bacosides that enhance cognitive processing and memory, and Ashwagandha (*Withania somnifera*), whose withanolides mitigate physical and mental exhaustion. Guduchi (*Tinospora cordifolia*) provides immune system support and fever reduction, Vasaka (*Justicia adhatoda*) supplies vasicine to dilate bronchial pathways during asthma or bronchitis, and Kalmegh (*Andrographis paniculata*) delivers bitter andrographolides that protect liver tissue and fight infections. Furthermore, Bael (*Aegle marmelos*) manages severe gastrointestinal disorders, Lemongrass (*Cymbopogon citratus*) provides antimicrobial citral essential oils, and Indian Pennywort (*Centella asiatica*) utilizes asiaticosides to accelerate microvascular healing and skin regeneration.

5. Agronomic standards, conservation, and institutional frameworks

Cultivating medicinal plants in Assam offers a sustainable path toward preserving wild populations while supporting rural economic development (11). Optimal cultivation requires selecting well-drained loamy or red lateritic soils with neutral to slightly acidic pH levels, situated in areas exposed to moderate temperatures and ample sunlight. Farmers employ species-specific propagation methods, utilizing seeds for Ashwagandha and Giloe, vegetative cuttings for Neem and Vinca, and rhizome division for Turmeric and Ginger. Field preparation involves

deep plowing, organic manure enrichment, precise field layout, and systematic crop spacing, such as thirty-centimeter grids for Tulsi. Crop maintenance emphasizes drip or furrow irrigation during dry spells, mechanical weeding, and organic pest control measures. Harvesting must be meticulously timed to coincide with peak secondary metabolite concentration in specific plant organs, followed by shade-drying and storage in airtight, light-protected containers to prevent active compound degradation.

Table 1: Ethnomedicinal use of plants from Assam

English Name	Assamese Name	Medicinal Benefits
Holy Basil	তুলসী (Tulsi)	Commonly used to relieve cough, cold, fever, and strengthen the body's natural immunity.
Neem	নিম (Nim)	Known for treating skin problems, supporting wound healing, and helping cleanse the blood.
Aloe Vera	ঘৃতকুমারী (Ghritkumari)	Applied to soothe burns, improve skin health, and support healthy digestion.
Turmeric	হালধি (Halodhi)	Valued for its anti-inflammatory properties and its role in healing wounds and fighting infections.
Ginger	আদা (Ada)	Helps ease indigestion, reduce nausea, and provide relief from coughs and colds.
Indian Gooseberry	আমলখি (Amlakhi)	A rich source of vitamin C that supports immunity and promotes digestive health.
Black Pepper	জালুক (Jaluk)	Traditionally used to ease sore throat, cough, and digestive discomfort.
Garlic	নহৰু (Nohoru)	Supports cardiovascular health and may help maintain healthy blood pressure levels.
Bael	বেল (Bel)	Widely used to improve digestive health and manage diarrhea.
Indian Pennywort	মানিমুনি (Manimuni)	Believed to enhance memory, assist wound healing, and improve digestion.
Mint	পদিনা (Podina)	Provides relief from digestive issues and may help reduce headaches.
Lemon Grass	নেমু ঘাঁহ (Nemu Ghas)	Commonly prepared as herbal tea to help with fever, colds, and relaxation.
Drumstick	চজিনা (Sojina)	Rich in nutrients and traditionally used to support bone health and reduce joint discomfort.
Malabar Nut	বাসক (Basak)	Frequently used in herbal remedies for cough, asthma, and other respiratory conditions.
Bitter Gourd	তিতা কেৰেলা (Tita Kerela)	Traditionally used to support healthy blood sugar levels.

Systemic support for the medicinal plant sector is reinforced by several regional research and administrative institutions. The Regional Ayurveda Research Institute in Guwahati conducts standardizing research, clinical

trials, and quality control evaluations on Ayurvedic formulations. The North East Institute of Science and Technology in Jorhat specializes in natural product chemistry, extraction technologies, and phytochemical isolation. Botanical documentation and biodiversity conservation are driven by Gauhati University's Department of Botany, the Assam State Council for Science & Technology, the ICAR Research Complex for NEH Region, and the State Forest Research Institute. Meanwhile, bodies like the Assam State Medicinal Plants Board coordinate state policy, offer financial subsidies, and promote commercial farming. These institutional initiatives help address key operational challenges, including market volatility, pest outbreaks, and shortages of quality planting stock, while positioning Assam's botanical resources—and its iconic export-driven tea industry—to meet growing global demand for natural healthcare solutions.

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