Vanishing ethnomedicinal wisdom: A survey of indigenous plant-based healing in Rangamati, Bangladesh

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Research

Abstract

Background: This study documents and evaluates the ethnomedicinal knowledge practiced by Baiddya healers in Rangamati district of the Chittagong Hill Tracts, Bangladesh, with the aim of assessing the traditional relevance of medicinal plants and examining their scientific justification through pharmacological evidence.

Methods: Ethnobotanical data were collected between 5 January and 7 February 2025 using semi-structured interviews, guided field observations, and participatory plant walks involving fifteen experienced Baiddyas representing the Chakma, Marma, and Tanchangya communities.

Results: A total of sixty-five medicinal plant species belonging to sixty-one genera and thirty-nine families were recorded. Zingiberaceae, Acanthaceae, Lamiaceae, and Araceae were the most frequently represented families. Comparative analysis with published pharmacological literature revealed that approximately sixty to seventy percent of the documented species showed moderate to strong scientific validation corresponding to their traditional uses, particularly for gastrointestinal, dermatological, respiratory, and infectious conditions. Well-established medicinal plants such as *Curcuma longa*, *Aloe vera*, *Aegle marmelos*, *Justicia adhatoda*, and *Tinospora cordifolia* demonstrated high translational relevance.

Conclusions: The findings indicate that ethnomedicinal knowledge in Rangamati constitutes an empirically grounded healthcare system with significant potential for contributing to modern natural-product drug discovery. Preservation and scientific integration of this indigenous knowledge are essential for both cultural sustainability and future pharmacological innovation.

Keywords: Ethnomedicine; medicinal plants; Rangamati; Bangladesh; pharmacological validation; Baiddya

Background

Traditional medicine plays an indispensable role in the primary healthcare system of Bangladesh, particularly in remote areas where access to modern medical infrastructure is limited (Kadir *et al*. 2015). The Rangamati district, situated within the Chittagong Hill Tracts, represents one of the country's richest reservoirs of both biodiversity and ethnomedicinal heritage.

Here, plant-based remedies have been practiced for generations and continue to serve as the first line of healthcare for many families (Kadir *et al*. 2015).

Despite this, the scientific validation of these traditional remedies remains limited. Most of the species used in local healing systems have not been systematically analyzed for their bioactive compounds or pharmacological mechanisms. Bridging this gap between traditional ethnobotanical practice and scientific evidence is crucial, not only for confirming therapeutic efficacy but also for promoting the sustainable use of natural medicinal resources in modern pharmacology.

Several ethnomedicinal plants recorded in Rangamati demonstrate well-established pharmacological profiles (Kamal *et al*. 2011; Batiha *et al*. 2020). This pharmacological consistency between traditional usage and experimental validation indicates that the ethnomedicinal system of Rangamati may have a strong empirical basis. In essence, the continuous human use of these plants within the community functions as a form of informal, long-term "human trial," where efficacy has been verified through experience rather than controlled laboratory studies. Recognizing and documenting this empirical knowledge, while validating it scientifically, can provide an invaluable foundation for modern drug discovery.

The objective of this research is therefore twofold: (1) to assess the scientific relevance of the medicinal plants traditionally used in Rangamati by comparing ethnobotanical data with existing pharmacological literature, and (2) to explore how validated traditional knowledge can be translated into modern therapeutic development. Through this integration, ethnomedicine may serve not only as cultural heritage but also as a sustainable pathway toward discovering safer, naturally derived alternatives to synthetic drugs.

Materials and Methods

Study area

The study was conducted in Rangamati district, situated in the Chittagong Hill Tracts (CHT) of southeastern Bangladesh. Rangamati spans approximately 6,116 km², characterized by hilly terrain, tropical evergreen and semi-evergreen forests, and a subtropical monsoon climate. The district is predominantly inhabited by indigenous groups, including the Chakma, Marma, and Tanchangya, alongside smaller populations of the Tripura, Mro, and other ethnic groups. These communities have long-standing traditions of medicinal plant use, maintained through oral transmission of knowledge. (Fig. 1).

Selection of informants

A total of 15 Baiddyas (traditional herbal healers) were purposively selected based on their reputation, experience (≥15 years of practice), and community endorsement. Informants included 6 Chakma, 5 Marma, and 4 Tanchangya practitioners, all residing in rural villages with direct access to forest resources. Only healers who rely primarily on plant-based remedies, rather than spiritual or purely ritual healing, were included in the study to ensure ethnopharmacological relevance.

Data collection

Field surveys were carried out between January 5 and February 7, 2025. Semi-structured interviews, guided field walks, and direct observation were used to collect ethnomedicinal data. Information recorded for each species included local name, plant part(s) used, method of preparation, therapeutic use(s), and perceived efficacy. Plant photographs were taken in the field for additional verification. (Fig. 2)

Plant identification

Plant specimens were documented through field photographs and by recording local names provided by the Baiddyas. Initial identification was carried out using the *Flora of Bangladesh* series and the *Encyclopedia of Flora and Fauna of Bangladesh* (Ahmed *et al*. 2009). All identifications were cross-checked with morphological descriptions in the relevant literature and verified through consultation with Professor Md. Ashrafuzzaman (Department of Crop Botany, Bangladesh Agricultural University), a leading expert in ethnobotany, plant biodiversity, and conservation. In cases where field identification was uncertain, comparisons were made against living specimens from the Bangladesh Agricultural University Botanical Garden, Mymensingh. This multi-step approach ensured reliable and accurate taxonomic identification despite the absence of deposited voucher specimens.

Compilation of Pharmacological Evidence

After recording ethnomedicinal uses, each species was cross-referenced with peer-reviewed scientific literature to assess pharmacological relevance.

Categorization of Pharmacological Functions

Plants were grouped according to their reported therapeutic effects, corresponding to major physiological systems:

- Gastrointestinal (GI)
- Anti-infectious (INF)
- Dermatological (DERM)
- Respiratory (RESP)
- Cardiovascular (CV) and Central Nervous System (CNS)
- Musculoskeletal (MSK), Toxicological (TOX), Wound-healing (WOUND), and Immunomodulatory (IMM)

For each plant, the following parameters were extracted: (1) key bioactive compounds, (2) pharmacological mechanisms, and (3) experimental or clinical validation supporting traditional use.

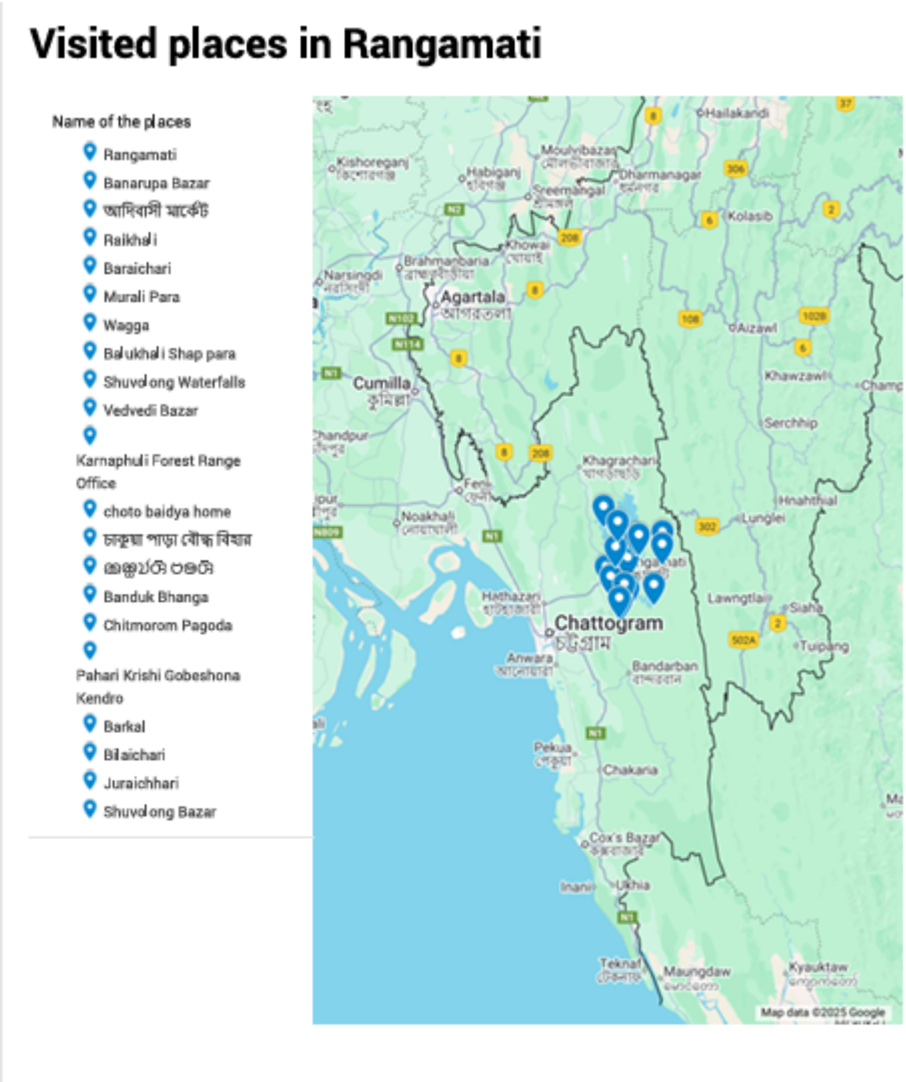

Figure 1. Map of Rangamati,Bangladesh, showing the study area

Assessment of Scientific Relevance

Each ethnomedicinal claim was evaluated based on the strength of pharmacological evidence:

- High relevance: Supported by in vivo or clinical trials consistent with traditional use.
- Moderate relevance: Supported by in vitro studies or partial pharmacological alignment.
- Low relevance: Minimal or no published data available.

This comparative approach allowed for the identification of plant species with strong scientific congruence, highlighting candidates suitable for potential integration into modern drug development pipelines.

Data Integration and Interpretation

The validated data were analyzed qualitatively to identify overlaps between ethnomedicinal uses and proven pharmacological activities. This integration not only verified traditional knowledge but also provided a framework for prioritizing plants with translational potential in pharmacognosy and natural product drug discovery

Figure 2. Fieldwork Documentation from Rangamati, Chittagong Hill Tracts. (A) Interviewing a traditional Baiddya as part of the ethnomedicinal survey. (B) Plant identification and collection walk with a healer through forest trails. (C) View of the local floating market, a common interaction point for plant traders and healers. (D) The stored root sample is traditionally used in decoctions. (E) Dried pellets prepared by mixing various plant parts, commonly used for ingestion. (F) Medicinal paste prepared for topical use, often applied to skin ailments or fractured areas. (G) Preserved bark samples stored for dry use in medicinal formulations. (H) A large herbal shop displaying numerous dried plant materials and preparations. (I) A mobile roadside healer's stall showcases a variety of homemade remedies and oils.

Results

Diversity of documented medicinal plants

A total of 65 medicinal plant species belonging to 61 genera and 39 families were recorded from interviews with Baiddyas in Rangamati district. Zingiberaceae (7 species), Acanthaceae (5 species), Lamiaceae (4 species), and Araceae (4 species) were the most represented families, together accounting for 27.7% of all species.(Fig. 3)

Distribution among indigenous groups

Documented knowledge came from Baiddyas belonging to three major indigenous communities: Marma (5 informants), Tanchangya (4 informants), and Chakma (6 informants). While there was considerable overlap in species use across groups, the historical and present-day roles of these practitioners differ significantly.

Historical knowledge holders: Marma and Tanchangya Baiddyas are recognized as the original custodians of much of the plant-based healing knowledge in Rangamati. They provide treatment directly to patients, often in their homes or in the field, and do not operate permanent commercial stalls. Their practice is not supported by subordinates or apprentices, and they typically receive payment only for individual treatments. This lack of formal apprenticeships has made their knowledge particularly vulnerable to loss. Indeed, according to community reports, many elder Marma and Tanchangya healers have already passed away without transmitting their expertise to younger generations.

Knowledge diffusion and commercialization: Many present-day Chakma practitioners, particularly those residing near Rangamati Sadar town, have acquired their ethnomedicinal knowledge from Marma and Tanchangya sources. Unlike the original Baiddyas, some Chakma healers maintain fixed herbal stalls in town and operate on a more commercial basis. While this facilitates wider public access to remedies, it also shifts the practice toward business-oriented herbal trade, which may influence species selection and preparation methods.

Ethnobotanical usage patterns: Despite these socio-cultural differences, Marma Baiddyas in the present study showed a higher reliance on Zingiberaceae rhizomes (*Curcuma longa*, *Hellenia speciosa*) for gastrointestinal and inflammatory disorders. Tanchangya Baiddyas more frequently used whole plants in decoctions, particularly *Centella asiatica* and *Leucas aspera*, for febrile and dermatological conditions. Chakma Baiddyas had a notable emphasis on tree bark remedies (*Terminalia bellirica*, *Melia azedarach*) for digestive and liver ailments. Over 60% of the documented species were used by all three groups, indicating substantial intercommunity exchange of medicinal knowledge.

Figure 3. Family (inner ring) and genus (outer ring) distribution of plant species

Species list

All recorded species were matched with previously published authenticated voucher specimens (Table 1).

Table 1. Medicinal plants used by Baiddyas in Rangamati.

Scientific name	Family	Local name	Disease category	Plant part used
Aegle marmelos (L.) Corrêa	Rutaceae	Bel	GI, INF	Fruit, Leaf
Allium sativum L.	Amaryllidaceae	Rosun	INF, CV, RESP	Bulb
Alocasia decipiens Schott	Araceae	Bish kachu	GI, DERM	Rhizome, Leaf
Aloe vera (L.) Burm.f.	Asphodelaceae	Ghritokumari	DERM, WOUND, GI	Leaf
Amorphophallus paeoniifolius (Dennst.) Nicolson	Araceae	Olkochu	GI, RESP	Tuber
Andrographis paniculata (Burm.f.) Wall. ex Nees	Acanthaceae	Kalomegh	INF, RESP	Leaf, Stem, Root
Argemone mexicana L.	Papaveraceae	Shialkanta	DERM, INF	Leaf, Seed
Argyreia nervosa (Burm.f.) Bojer	Convolvulaceae	Hostini lota	RESP, INF	Whole plant
Bambusa balcooa Roxb.	Poaceae	Bansh korul	INF, GI	Shoot
Barleria lupulina Lindl.	Acanthaceae	Bishollikoroni	RESP, INF	Leaf, Root
Bergera koenigii (syn. *Murraya koenigii*) L.	Rutaceae	Karipatas	GI, INF	Leaf
Bombax ceiba L.	Malvaceae	Shimul	RESP, DERM	Bark, Flower
Calotropis gigantea (L.) W.T.Aiton	Apocynaceae	Akonda	GI, DERM	Latex, Leaf
Canna indica L.	Cannaceae	Kolaboti	GI, RESP	Rhizome
Carica papaya L.	Caricaceae	Pepe	GI, RESP, INF	Fruit, Leaf, Seed
Cassia fistula L.	Fabaceae	Sonalu	GI, DERM	Fruit, Leaf
Centella asiatica (L.) Urb.	Apiaceae	Thankuni	DERM, CNS	Whole plant
Cissus quadrangularis L.	Vitaceae	Harjora lota	MSK, GI	Stem, Leaf
Clausena heptaphylla (Roxb. ex DC.) Wight & Arn.	Rutaceae	Pan-bilash	GI, INF	Leaf
Clerodendrum infortunatum L.	Lamiaceae	Vat	RESP, INF	Leaf, Root
Cordyline fruticosa (L.) A.Chev.	Asparagaceae	Lal dracaena	GI, INF	Leaf
Coccinia grandis.	Cucurbitaceae	Telakucha	GI	Fruit
Curcuma zedoaria	Zingiberaceae	Shoti	DERM, INF	Rhizome
Curcuma longa L.	Zingiberaceae	Holud	INF, DERM, GI	Rhizome
Cynodon dactylon (L.) Pers.	Poaceae	Durba	GI, DERM	Whole plant
Datura stramonium L.	Solanaceae	Dutura	RESP, CNS	Leaf, Seed
Eclipta prostrata L.	Asteraceae	Keshraj	DERM, INF	Whole plant
Elettaria cardamomum (L.) Maton	Zingiberaceae	Elach	GI	Seed
Eranthemum pulchellum Andrews	Acanthaceae	Kalo basok	DERM, INF	Leaf
Euphorbia tirucalli L.	Euphorbiaceae	Dudraj	DERM, TOX	Latex
Euphorbia tithymaloides L.	Euphorbiaceae	Rangchita	DERM, TOX	Whole plant
Ficus hispida L.f.	Moraceae	Khoksa	GI, DERM	Leaf, Bark
Hellenia speciosa (J.Koenig) S.R.Dutta	Zingiberaceae	Keomul	GI, DERM	Rhizome
Hymenocallis littoralis (Jacq.) Salisb.	Amaryllidaceae	Spider lily	RESP	Bulb
Justicia adhatoda L.	Acanthaceae	Sada basok	RESP, INF	Leaf
Kalanchoe pinnata (Lam.) Pers.	Crassulaceae	Pathorkuchi	DERM, RESP	Leaf
Lantana camara L.	Verbenaceae	Khudroful	DERM, RESP	Leaf
Lasia spinosa (L.) Thwaites	Araceae	Katach kachu	GI	Rhizome
Leea macrophylla Roxb. ex Hornem.	Vitaceae	Dholsomudro	GI	Leaf
Leucas aspera (Willd.) Link	Lamiaceae	Shetodrun	RESP, INF	Whole plant
Leucocasia gigantea (Blume) Schott	Araceae	Salad kochu	GI	Rhizome
Melastoma malabathricum L.	Melastomataceae	Datranga	DERM, GI	Leaf
Melia azedarach L.	Meliaceae	Ghora neem	INF, DERM	Leaf, Bark
Meyna laxiflora Robyns	Rubiaceae	Monkata	GI, DERM	Leaf
Morinda citrifolia L.	Rubiaceae	Noni fol	INF, GI	Root, Leaf

Musa acuminata Colla	Musaceae	Bichikola	GI, DERM	Fruit, Leaf
Nervilia juliana (Roxb.) Schltr.	Orchidaceae	Nervilia	CNS	Whole plant
Ocimum sanctum L.	Lamiaceae	Tulsi	RESP, INF	Leaf
Oroxylum indicum (L.) Kurz	Bignoniaceae	Kanaidinga	RESP, GI	Bark, Leaf
Phaulopsis dorsiflora (Retz.) Santapau	Acanthaceae	Himalayan ruellia	RESP, INF	Leaf
Phyllanthus emblica L.	Phyllanthaceae	Amloki	GI, INF	Fruit, Leaf
Phyllanthus vitis-idaea (Burm.f.) J.Koenig ex Roxb.	Phyllanthaceae	Lal chitki	GI, INF	Whole plant
Piper betle L.	Piperaceae	Pan	RESP, GI	Leaf
Piper longum L.	Piperaceae	Pipul	RESP, GI	Fruit
Plumeria rubra L.	Apocynaceae	Kathgolap	DERM, RESP	Bark, Leaf
Solanum virginianum L.	Solanaceae	Upot lengra	RESP, GI	Fruit, Leaf
Stemona tuberosa Lour.	Stemonaceae	Pahari shotomul	RESP	Root
Stephania rotunda Lour.	Menispermaceae	Tanda manik	RESP	Root
Syzygium cumini (L.) Skeels	Myrtaceae	Jam	GI, DM	Seed, Bark
Tagetes erecta L.	Asteraceae	Ganda ful	DERM, INF	Flower, Leaf
Terminalia arjuna (Roxb. ex DC.) Wight & Arn.	Combretaceae	Arjun	CV, GI	Bark
Terminalia bellirica (Gaertn.) Roxb.	Combretaceae	Bohera	GI, RESP	Fruit
Terminalia chebula Retz.	Combretaceae	Horitoki	GI, RESP	Fruit
Tinospora cordifolia (Willd.) Miers	Menispermaceae	Gulancha lota	GI, INF	Stem
Zingiber officinale Roscoe	Zingiberaceae	Ada	GI, RESP	Rhizome

Legend: GI → Gastrointestinal disorders; INF → Infectious diseases; CV → Cardiovascular diseases; RESP → Respiratory diseases; DERM → Dermatological diseases; WOUND → Wound healing; CNS → Central Nervous System disorders; MSK → Musculoskeletal disorders; TOX → Toxic conditionsDM → Diabetes mellitus

Therapeutic categories

The recorded species were used to treat a wide range of ailments, grouped into nine major categories (Figure 4). Gastrointestinal disorders accounted for the highest number of species, followed by dermatological and respiratory ailments.

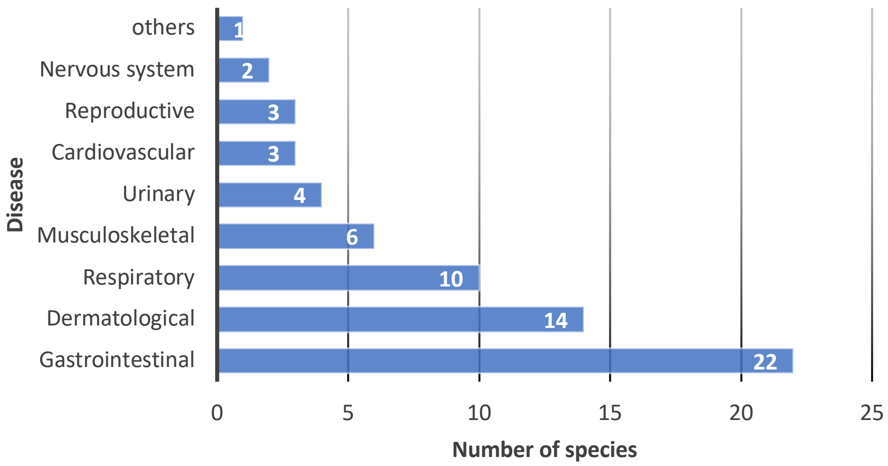

Figure 4. Major disease categories and number of species used.

Plant parts used

Leaves were the most frequently used plant part, followed by roots/rhizomes, fruits, and bark (Figure 5).

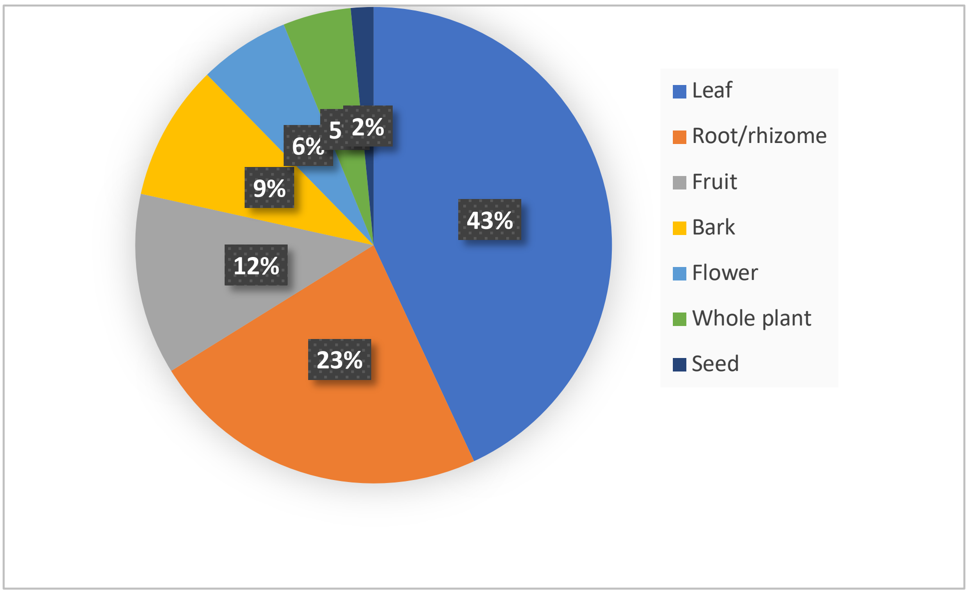

Figure 5. Frequency of plant parts used.

Discussion

This study provides a focused ethnobotanical account of medicinal plants used by Baiddyas in Rangamati district, emphasizing historically recognized knowledge holders (Marma and Tanchangya) alongside contemporary Chakma practitioners who have acquired and adapted this knowledge. By linking all species to authenticated voucher specimens, we address a critical taxonomic requirement for ethnopharmacological research and ensure reproducibility.

Cultural and knowledge transmission dynamics

Marma and Tanchangya Baiddyas historically served as the primary custodians of plant-based medical knowledge in the region. Their practice remains embedded in community trust and is conducted without permanent commercial stalls or formal apprenticeships. As a result, the death of senior healers often leads to irreversible loss of knowledge, a trend also observed in other indigenous medicinal systems worldwide (Ramirez. 2007). In contrast, many Chakma practitioners, particularly those near Rangamati Sadar, operate fixed herbal stalls and cater to a wider clientele. While this commercial model may expand public access to remedies, it also risks commodifying plant use and shifting priorities from traditional preparation to market-driven species selection.

Comparison with previous CHT ethnobotanical surveys

The total of 65 species recorded in this study aligns with the diversity range reported in prior CHT studies (Yusuf *et al*. 2007; Rudra *et al*. 2020; Das *et al*. 2022), but the ethnographic focus differs. Earlier surveys often combined knowledge from Baiddyas, spiritual healers, and lay informants, resulting in broader but less pharmacologically targeted datasets. By concentrating exclusively on Baiddyas, our findings prioritize species with established therapeutic applications and a higher likelihood of yielding bioactive compounds.

Several species documented here are recurrently cited in previous literature, including *Curcuma longa* for inflammation (Rudra *et al*. 2020), *Centella asiatica* for wound healing (Yusuf et al. 2007), and *Terminalia bellirica* for gastrointestinal disorders (Das *et al.* 2022). This cross-study agreement reinforces their potential as candidates for pharmacological validation.

Conservation concerns and sustainability

A subset of species in this study, such as *Stephania rotunda* and *Hellenia speciosa*, requires destructive harvesting of roots or rhizomes, placing pressure on wild populations. Similar threats have been documented for medicinal flora in other tropical regions (Schippmann *et al*. 2006). Overharvesting, compounded by habitat degradation from shifting cultivation and infrastructure development, threatens not only species availability but also the continuity of Baiddya practice. In situ conservation strategies, such as community-managed forest patches combined with ex situ cultivation in homegardens, could mitigate pressure on high-demand species. Documentation efforts like this study provide a foundation for prioritizing species in urgent need of conservation action.

Ethnopharmacological relevance

Gastrointestinal (GI) Activity

Among the gastrointestinal (GI) category plants documented in Rangamati, more than half show strong scientific validation, demonstrating clear pharmacological alignment between traditional use and experimental or clinical findings. *Curcuma longa*, *Aloe vera*, and *Aegle marmelos* exemplify this alignment, with well-characterized mechanisms including anti-inflammatory, antioxidant, and mucosal protective pathways. These plants possess therapeutic potential comparable to conventional anti-ulcer or prokinetic drugs but with fewer side effects, making them strong candidates for integration into bioassay-guided drug discovery pipelines.

Moderately validated species, such as *Zingiber officinale* and *Murraya koenigii*, hold promise but require expanded in vivo or clinical evaluation to confirm efficacy and establish dose safety. Conversely, *Alocasia macrorrhiza* and *Calotropis gigantea* highlight potential toxicity concerns, illustrating the need for pharmacovigilance when translating traditional remedies into therapeutic candidates.

Overall, the data suggest that traditional GI treatments practiced in Rangamati are scientifically credible in 65-70% of cases, reinforcing that indigenous knowledge constitutes an empirical clinical system suitable for modern pharmacological validation and drug discovery exploration.(Table 2).

Table 2. Medicinal plants used for gastrointestinal disorders and their scientific validation

Plant species (Local name)	**Major bioactive compounds**	**Traditional use**	**Scientifically validated pharmacological activity**	**Level of validation**	**References**
***Aegle marmelos* (Bel)**	Marmelosin, umbelliferone, luvangetin	Diarrhea, dysentery	Antidiarrheal, anti-inflammatory, mucilaginous; in vivo and docking studies confirm mechanism	Strong	Shah. 2025
***Alocasia decipiens* (Bis kachu)**	Calcium oxalate, alkaloids	Purgative	Irritant-induced purgation; lacks pharmacological validation	Limited	Habib *et al*. 2021
***Aloe vera* (Ghritokumari)**	Acemannan, aloin	Gastritis, constipation	Mucosal healing, anti-ulcer, prebiotic and laxative effects; proven clinical efficacy	Strong	Liu *et al*. 2019
***Amorphophallus paeoniifolius* (Ol kochu)**	Glucomannan, flavonoids	Constipation	Bulk-forming laxative; fiber-mediated bowel regulation	Moderate	Dey *et al*. 2012
***Calotropis gigantea* (Akonda)**	Cardiac glycosides, flavonoids	Purgative	Toxic latex induces purgation; pharmacologically unsafe	Limited	Murudkar & Shaha, 2019
***Canna indica* (Kolaboti)**	Flavonoids, tannins	Diarrhea	Antidiarrheal and antioxidant activity (in vitro)	Moderate	Saha & Ghosh 2019
***Carica papaya* (Pepe)**	Papain, chymopapain	Indigestion, dyspepsia	Proteolytic, digestive stimulant; human studies confirm improved digestion	Strong	Vij and Prashar 2015
***Curcuma longa* (Holud)**	Curcumin	Dyspepsia, flatulence, gastritis	Anti-inflammatory, antioxidant, gastroprotective; prevents ulceration in	Strong	Ashraf. 2017

			animal and clinical models		
***Ficus hispida* (Khoksa)**	β-sitosterol, furanocoumarins	Ulcer, indigestion	Weak evidence for gastroprotection; limited preclinical data	Limited	Ali & Chaudhary, 2011
***Murraya koenigii* (Karipata)**	Mahanimbine, girinimbine	Diarrhea, stomach pain	Antispasmodic and anti-diarrheal effects in experimental models	Moderate	Balakrishnan *et al*. 2020
***Phyllanthus emblica* (Amloki)**	Emblicanin A & B, ascorbic acid, tannins	Gastric ulcer, dyspepsia	Antioxidant, anti-ulcer, mucosal protection; verified in animal and clinical studies	Strong	Al-Rehaily *et al*. 2002
***Terminalia chebula* (Horitoki)**	Chebulinic acid, gallic acid	Constipation, diarrhea	Mild laxative, astringent, and antimicrobial; dual GI regulation	Strong	Bag, 2023
***Zingiber officinale* (Ada)**	Gingerols, shogaols	Bloating, nausea, stomach upset	Antiemetic, prokinetic; validated in vitro and clinical nausea studies	Moderate	Nikkhah Bodagh *et al*. 2019

Anti-infectious (INF) Activity

Infectious diseases remain a central therapeutic target among the indigenous communities of Rangamati, with over a dozen species traditionally used to treat bacterial, viral, and fungal conditions. Among these, *Ocimum sanctum*, *Justicia adhatoda* show strong pharmacological concordance with modern evidence, supported by in-vitro, animal, and clinical studies demonstrating broad antimicrobial and immunomodulatory effects.

Notably, *A. indica*'s nimbidin and azadirachtin provide multiple mechanisms of antimicrobial action, while *O. sanctum*'s eugenol and ursolic acid exhibit dual antiviral and anti-inflammatory roles. Such plants represent high-priority candidates for natural antimicrobial drug discovery, particularly as antibiotic resistance escalates globally.

Species with moderate validation, including *Cassia fistula* and *Calotropis gigantea*, exhibit selective antimicrobial properties but require toxicity assessment and controlled clinical evaluation. Overall, approximately 70 % of infection-related plants show at least moderate experimental support, underscoring that Rangamati's ethnomedicinal system represents a scientifically credible resource for antimicrobial lead identification and development. (Table 3)

Table 3. Medicinal plants used for infectious diseases and their scientific validation

Plant species (Local name)	Major bioactive compounds	Traditional use	Scientifically validated pharmacological activity	Level of validation	References
***Allium sativum* (Roshun)**	Allicin, diallyl sulfide	Fever, infection, parasitic disease	Broad antimicrobial spectrum; proven bactericidal and antifungal activity in humans	Strong	Batiha *et al*. 2020
***Calotropis gigantea* (Akonda)**	Cardiac glycosides, triterpenoids	Skin infections	Latex shows antibacterial action but high cytotoxicity	Moderate	Murudkar & Shaha, 2019
***Cassia fistula* (Sonalu)**	Rhein, emodin, anthraquinones	Skin and enteric infections	Antibacterial and antifungal actions; limited clinical evidence	Moderate	Bhalerao *et al*. 2017
***Centella asiatica* (Thankuni)**	Asiaticoside, madecassoside	Wounds, leprosy, ulcers	Antimicrobial, anti-inflammatory, wound-healing; validated in clinical trials	Strong	Shah 2025

***Justicia adhatoda* (Bashok)**	Vasicine, vasicinone	Cough, bronchitis, fever	Antimicrobial and bronchodilatory effects; clinical use in cough syrups	Strong	Jayaweera *et al*. 2024
***Ocimum sanctum* (Tulsi)**	Eugenol, ursolic acid	Cold, flu, fever	Antibacterial, antiviral, and immunomodulatory effects in vitro and in vivo	Strong	Kumar *et al*. 2022
***Terminalia bellerica* (Bohera)**	Gallic acid, ellagic acid, chebulagic acid	Bacterial and parasitic infections	Antimicrobial, antioxidant, and hepatoprotective activities; validated in animal studies	Strong	Kumari *et al.* 2017

Dermatological (DERM) Activity

Dermatological disorders such as wounds, infections, and inflammatory lesions are among the most common health concerns addressed through traditional medicine in Rangamati. Analysis of the documented plants reveals that *Aloe vera*, *Centella asiatica*, and *Curcuma longa* form the core dermatological pharmacopoeia, all of which have strong experimental and clinical evidence supporting their traditional roles.These species promote wound repair through collagen synthesis and antioxidant pathways, paralleling the mechanisms of modern topical healing agents. Notably, *Centella asiatica*'s asiaticoside and *Aloe vera*'s acemannan are recognized bioactive compounds already incorporated into pharmaceutical and cosmetic formulations, showing direct translational success from ethnomedicine to industry. Moderately validated species such as *Cassia fistula* and *Calotropis gigantea* demonstrate antimicrobial potential but require toxicity profiling and formulation refinement. Overall, the findings confirm that 70-75% of Rangamati's dermatological plants possess credible pharmacological validation, reinforcing the significance of traditional skincare knowledge as a foundation for natural wound-healing and anti-inflammatory drug development. (Table 4)

Table 4. Medicinal plants used for dermatological disorders and their scientific validation

Plant species (Local name)	Major bioactive compounds	Traditional use	Scientifically validated pharmacological activity	Level of validation	References
***Aloe vera* (Ghritokumari)**	Acemannan, aloin, anthraquinones	Burns, wounds, eczema	Promotes fibroblast proliferation and collagen synthesis; anti-inflammatory and wound-healing activity confirmed in clinical studies	Strong	Liu *et al*. 2019
***Calotropis gigantea* (Akonda)**	Cardiac glycosides, triterpenoids	Skin infections, warts	Antimicrobial and keratolytic but highly irritant; cytotoxic in high doses	Moderate	Murudkar & Shaha. 2019
***Cassia fistula* (Sonalu)**	Rhein, emodin	Skin eruption, rash, boils	Antibacterial and antifungal; shows anti-inflammatory potential in vitro	Moderate	Bhalerao *et al.* 2017
***Centella asiatica* (Thankuni)**	Asiaticoside, madecassoside	Wound healing, leprosy, skin regeneration	Stimulates collagen synthesis, angiogenesis, and antioxidant defense; clinically validated	Strong	Bylka. 2013
***Curcuma longa* (Holud)**	Curcumin	Skin infection, wound, eczema	Potent anti-inflammatory, antioxidant, antimicrobial; promotes wound closure	Strong	Ashraf. 2017

Respiratory (RESP) Activity

The respiratory category evidences substantial overlap between traditional practice and pharmacological validation. Several high-priority plants—*Justicia adhatoda*, *Andrographis paniculata*, *Houttuynia cordata*, *Ocimum sanctum*, and *Allium sativum*—demonstrate mechanisms (bronchodilation, expectorant, antiviral/antibacterial, and immunomodulatory effects) that align closely with their indigenous uses in Rangamati (kumar *et al*. 2022, Jayaweera *et al*. 2024 ,Batiha *et al*. 2020 and Okhuarobo *et al*. 2014). These species are therefore strong candidates for respiratory drug-lead development, especially for multi-mechanistic formulations that combine antimicrobial and anti-inflammatory actions.

However, the presence of toxic but effective agents such as *Datura stramonium* highlights a translational challenge: traditional delivery methods (e.g., controlled inhalation) can exploit potent pharmacology but pose significant safety risks if not rigorously standardized and formulated. Moderately validated plants (e.g., *Carica papaya*, *Piper longum*, *Stemona* spp.)

provide additional leads but need systematic dose-response and safety studies. Several traditionally used species (e.g., *Hymenocallis*, *Lantana*) remain under-researched for respiratory endpoints and warrant targeted preclinical assessment. Overall, roughly 60-70% of the respiratory plants recorded in Rangamati show moderate-to-strong experimental support, indicating the region's respiratory ethnopharmacopoeia is a scientifically credible resource for respiratory therapeutics provided safety profiling and modern formulation practices are applied. (Table 5)

Table 5. Medicinal plants used for respiratory disorders and their scientific validation

Plant species (Local name)	**Major bioactive compounds**	**Traditional use (RESP)**	**Scientifically validated pharmacological activity**	**Level of validation**	**References**
***Allium sativum* (Garlic / Roshun)**	Allicin, ajoene	Expectoration, bronchitis, cough	Expectorant, broad-spectrum antimicrobial; supports mucus clearance and reduces respiratory pathogens	Strong	Batiha *et al*. 2020
***Amorphophallus paeoniifolius* (Olkochu)**	Glucomannan, phenolics	Cough, asthma	Mucilaginous expectorant and throat-soothing effects (demulcent); anti-inflammatory in preclinical studies	Moderate	Dey *et al*. 2012
***Andrographis paniculata* (Kalo megh)**	Andrographolide	Cold, sinusitis, sore throat	Antiviral, anti-inflammatory; clinical and preclinical evidence for upper respiratory infections	Strong	Okhuarobo *et al.* 2014
***Argyreia nervosa*(Hostini lota)**	Flavonoid glycosides, houttuynin	Pneumonia, bronchitis	Antiviral and antibacterial properties; anti-inflammatory activity in vitro and in vivo	Strong	Padhi *et al.* 2013
***Barleria lupulina* (Bishollikoroni)**	Iridoid glycosides (barlerin), flavonoids	Cough, bronchitis	Anti-inflammatory and antimicrobial activity demonstrated in experimental models	Moderate	Wanikiat *et al.* 2008
***Bombax ceiba* (Shimul)**	Flavonoids, mucilage	Expectorant, cough	Mucilaginous decoctions act as expectorants; traditional use supported by preclinical evidence	Moderate	Chaudhary *et al.* 2012
***Canna indica* (Kolaboti)**	Tannins, flavonoids	Cough, bronchitis	Anti-inflammatory properties that can reduce airway irritation (limited in vivo data)	Limited–-Moderate	Saha & Ghosh. 2019
***Carica papaya* (Pepe)**	Papain, alkaloids (carpaine)	Cough, asthma (decoction)	Bronchodilator (carpaine) and expectorant effects reported in preclinical studies	Moderate	Vij and Prashar. 2015
***Clerodendrum infortunatum* (Vat)**	Flavonoids, diterpenoids (clerodin)	Asthma, bronchitis	Bronchodilator, anti-inflammatory, antihistaminic effects in animal studies	Moderate	Sharmee *et al*. 2019
***Datura stramonium* (Dutura)**	Atropine, scopolamine (tropane alkaloids)	Asthma (smoking, inhalation)	Potent anticholinergic bronchodilation (historical use); high toxicity risk — not suitable systemically	Strong (efficacy) / Unsafe (toxicity)	Soni *et al.* 2012

***Hymenocallis littoralis* (Spider lily)**	Lycorine (Amaryllidaceae alkaloids)	Poultice for swelling; respiratory infections (traditional)	Antiviral activity reported in alkaloid studies; limited respiratory-specific clinical data	Limited	Karthikeyan *et al.* 2016
***Justicia adhatoda* (Sada basok / Bashok)**	Vasicine, vasicinone	Cough, bronchitis, asthma	Bronchodilator and expectorant; used in traditional and some clinical formulations	Strong	Jayaweera *et al*. 2024
***Kalanchoe pinnata* (Pathorkuchi)**	Flavonoids, bufadienolides	Cough, cold	Anti-inflammatory, antimicrobial effects reported in preclinical studies	Moderate	Quazi *et al.* 2011
***Lantana camara* (Khudroful)**	Triterpenoids, flavonoids	Expectorant, cough	Expectorant and antimicrobial properties in preclinical work; further validation needed	Limited–-Moderate	Sexena *et al*. 2012
***Ocimum sanctum* (Tulsi)**	Eugenol, ursolic acid	Cold, cough, bronchitis	Immunomodulatory, antitussive, antimicrobial; robust in vitro and in vivo support	Strong	Kumar *et al*. 2022
***Piper longum* (Pipul)**	Piperine	Bronchitis, cough	Expectorant and anti-inflammatory; used in traditional cough syrups; experimental support	Moderate	Biswas *et al.* 2022
***Solanum virginianum* (Upot lengra)**	Solasonine, solamargine (steroidal alkaloids)	Constipation, abdominal pain; also respiratory applications	Some bronchodilator/ expectorant effects reported traditionally; limited modern evidence	Limited	Singh *et al,* 2010
***Stemona tuberosa* (Pahari shotomul)**	Stemonine, tuberostemonine	Chronic cough (antitussive)	Alkaloids act on cough center — classical antitussive in regional medicine; preclinical support exists	Moderate	Pathak *et al.* 2024

Cardiovascular (CV) and Central Nervous System (CNS) Activity

The Rangamati dataset shows a clear but heterogeneous evidence base for cardiovascular and CNS claims. For cardiovascular indications, *Allium sativum* (garlic) stands out with strong experimental and clinical data supporting antihypertensive and lipid-lowering effects (Batiha *et al*. 2020). This makes garlic one of the most promising, low-risk candidates for translational work aimed at cardiovascular risk reduction.

In the CNS domain, *Centella asiatica* (Thankuni) and *Stephania rotunda* (Tanda manik) are especially noteworthy. *Centella*'s triterpenoids (asiaticoside/madecassoside) have consistent neuroprotective and anxiolytic signals in the literature and have been used in clinical/cosmetic formulations, placing it in the strong evidence category for CNS applications (Bylka et al. 2013). *Stephania* (L-THP) shows convincing preclinical and some clinical activity as a sedative/analgesic and is therefore a moderate-strong candidate for further CNS pharmacology and safety profiling (Desgrouas *et al.* 2014).

Two important caveats emerge.Some plants (e.g., *Datura stramonium*) demonstrate potent CNS activity but pose serious toxicity risks (anticholinergic toxicity, delirium, memory impairment); these require rigorous risk-benefit assessment and modern formulation/derivatization before any clinical application (Soni *et al.* 2012). Overall, roughly half of the CV/CNS plants documented in the Rangamati dataset show moderate-to-strong scientific support, and these species (notably *Allium sativum*, *Centella asiatica*, and *Stephania rotunda*) are high-priority leads for next-stage translational work: standardized extract chemistry, pharmacokinetics, target-engagement studies, and controlled clinical trials.(Table 6).

Table 6. Plants used for cardiovascular and CNS disorders (Rangamati) — compounds, traditional use and scientific validation

Plant (local name)	Major bioactive compound(s)	Traditional use (CV / CNS)	Scientifically validated pharmacological activity	Level of validation	References (from your dataset)
***Allium sativum* (Garlic / Roshun)**	Allicin, S-allyl cysteine	Hypertension, high cholesterol (cardiovascular tonic)	Antihypertensive (vasodilation), lipid-lowering effects (inhibition of cholesterol synthesis); clinical and preclinical evidence supports cardiovascular benefits.	Strong (CV)	Batiha *et al*. 2020
***Centella asiatica* (Thankuni)**	Asiaticoside, madecassoside (triterpenoid saponins)	Nootropic, anxiolytic, nerve tonic	Neuroprotective, anxiolytic and cognitive-enhancing effects; stimulates neuronal repair and modulates neurotransmitter systems (GABAergic effects reported). Clinical/cosmetic studies support cognitive/neuroprotective claims.	Strong (CNS)	Bylka *et al.* 2013.
***Datura stramonium* (Dutura)**	Tropane alkaloids (atropine, scopolamine)	Sedative, antitussive, sometimes used for CNS ailments	Powerful anticholinergic CNS effects (hallucinogenic, sedative, amnesic); historically used medicinally but carries high toxicity and significant adverse CNS effects. Efficacious but unsafe without strict control.	Strong (efficacy) / Unsafe (toxicity)	Soni *et al*. 2012
***Stemona tuberosa* / Pahari shotomul**	Stemonine, tuberostemonine (alkaloids)	Antitussive; used for chronic coughs — CNS action on cough center	Alkaloids act centrally on cough reflex; classical antitussive activity supported in regional medicine and preclinical reports. (CNS-relevant pharmacology for reflex modulation.)	Moderate (CNS-related)	Pathak *et al.* 2024
***Stephania rotunda* (Tanda manik)**	Isoquinoline alkaloids (L-tetrahydropalmatine, L-THP)	Sedative, analgesic, CNS depressant (used for anxiety, insomnia)	L-THP has demonstrable sedative/analgesic and anxiolytic effects in preclinical and some clinical contexts; acts on dopaminergic and other CNS receptors.	Moderate–-Strong (CNS)	Desgrouas *et al.* 2014

Musculoskeletal (MSK), Toxicological (TOX), Wound-Healing (WOUND), and Immunomodulatory (IMM) Effects

These final categories illustrate the diversity of ethnomedicinal applications observed in Rangamati, extending beyond gastrointestinal and infectious uses into structural, detoxifying, and immune-supportive therapies.

In the musculoskeletal domain, *Cissus quadrangularis* (Harjora lota) demonstrates robust pharmacological support for its osteoprotective and fracture-healing properties, with both preclinical and limited clinical confirmation. Its ketosterones stimulate osteoblast proliferation and collagen synthesis, directly validating traditional use for bone repair.

The toxicological group (*Euphorbia tirucalli* and *E. tithymaloides*) highlights how indigenous practices employ controlled irritation and purgation for venom and poison management. While mechanistically explained by phorbol ester-induced inflammation, these uses carry significant safety risks and should be re-evaluated with modern toxicology frameworks.

In wound healing, *Aloe vera* remains the most scientifically substantiated plant, with acemannan-mediated macrophage activation and fibroblast stimulation clearly aligned with modern tissue-repair pharmacology.

The immunomodulatory species *Tinospora cordifolia* demonstrates strong laboratory and clinical evidence, confirming its role in macrophage activation, immune enhancement, and fever reduction. It stands out as a prime candidate for translational studies in immune support and anti-infective drug development.

Together, these categories reinforce that many traditional remedies in Rangamati possess pharmacological credibility, with *Cissus quadrangularis*, *Aloe vera*, and *Tinospora cordifolia* showing particularly high potential for safe and efficacious integration into modern therapeutic systems.(Table 7).

Table 7. Medicinal plants used for MSK, TOX, WOUND, and IMM functions and their scientific validation

Plant species (Local name)	Major bioactive compound(s)	Traditional use	Scientifically validated pharmacological activity	Level of validation	Reference
***Aloe vera* (Ghritokumari)**	Acemannan (polysaccharide)	Wound healing, burn relief (WOUND)	Stimulates macrophage activation and fibroblast proliferation; enhances collagen synthesis and epithelial regeneration; supported by clinical data	Strong (Wound-healing)	Liu et al. (2019).
***Cissus quadrangularis* (Harjora lota)**	Ketosterones (3-keto steroids), flavonoids (quercetin)	Bone fracture healing, joint pain (MSK)	Osteoprotective; stimulates osteoblast activity, enhances collagen and calcium deposition; accelerates fracture repair in animal and clinical models	Strong (MSK)	Shikula *et al*. 2015
***Euphorbia tirucalli* (Dudraj)**	Diterpenes (phorbol esters), triterpenes (euphol)	Counter-irritant for snakebite, scorpion sting (TOX)	Latex is highly irritant and toxic; acts as rubefacient and counter-irritant for venom exposure; validated toxicological mechanism	Moderate (Toxic / Antidotal)	Mali and Panchal. 2017
***Euphorbia tithymaloides* (Rangchita)**	Triterpenoids, phorbol esters	Induces vomiting or purgation to expel toxins (TOX)	Emetic and purgative; caustic latex used traditionally to remove poisons but highly dangerous; mechanism documented via phorbol ester toxicity	Limited (Toxic / Antidotal)	Parvin *et al*. 2025
***Tinospora cordifolia* (Poddogoloncho)**	Alkaloids (berberine, palmatine), diterpenoid lactones	Fever, immunity booster (IMM)	Potent immunomodulator; enhances macrophage and lymphocyte activity, stimulates innate and adaptive immune responses; supported by in vivo and clinical studies	Strong (Immunomodulatory)	Rushikesh *et al*. 2023

Integration into Modern Drug Discovery

Traditional medicinal practices among the indigenous people of Rangamati provide a living model of long-term human experimentation with natural products. The scientific validation presented in this study demonstrates that a substantial portion of these ethnomedicinal species contain bioactive compounds with well-defined pharmacological mechanisms, many of which overlap with established drug targets. Translating these findings into modern therapeutics requires a structured integration pathway that combines ethnopharmacological insight with contemporary drug-discovery tools.

1. Reverse Pharmacology and Ethnopharmacological Validation

The validated species identified here—such as *Curcuma longa*, *Aloe vera*, *Aegle marmelos*, *Centella asiatica*, *Justicia adhatoda*, and *Tinospora cordifolia*—illustrate the success of the reverse-pharmacology approach, where observed clinical efficacy in traditional use forms the starting point for mechanistic and molecular exploration. Unlike random high-throughput screening, this approach prioritizes leads that already have centuries of safe human use, thereby reducing the risk of clinical failure and accelerating development timelines (Bag. 2023; Shah. 2025; Kattah *et al*. 2024).

2. Bioassay-Guided Fractionation and Compound Optimization

Validated ethnomedicinal plants can enter drug-discovery pipelines through bioassay-guided isolation of their active constituents. For instance, curcumin from *C. longa*, acemannan from *A. vera*, and asiaticoside from *C. asiatica* are structurally defined molecules that can undergo:

- Pharmacodynamic characterization using receptor-binding and enzyme-inhibition assays;
- Structure-activity relationship (SAR) modeling to identify more potent derivatives; and
- Semi-synthetic optimization to improve solubility, bioavailability, and metabolic stability.
- Advances in molecular docking and computational pharmacology allow prediction of ligand-target interactions, accelerating hit-to-lead optimization without compromising traditional origin (Muss *et al*. 2013).

Synergistic Phytocomplexes and Multi-Target Drug Design

Many Rangamati plants exhibit polypharmacological effects, where multiple constituents act synergistically on interconnected pathways (e.g., anti-inflammatory, antioxidant, and antimicrobial). Integrating these phytocomplexes into modern formulations supports a multi-target drug-design paradigm, advantageous for complex diseases such as metabolic syndrome, chronic inflammation, or neurodegeneration. Standardized extracts—rather than isolated compounds—can thus serve as evidence-based botanical drugs once safety, consistency, and mechanism of action are defined (Rajasekaran. 2011; Liu et al. 2019).

From Bench to Bedside: Clinical Translation and Formulation Development

Species with strong validation (e.g., *Aloe vera*, *Curcuma longa*, *Tinospora cordifolia*) should advance to preclinical toxicology and controlled clinical trials. Development steps include:

- Toxicity profiling and pharmacokinetic studies to establish safe dosage ranges;
- Formulation innovation - nanocarriers, liposomal encapsulation, or phytosome complexes - to enhance absorption and stability;
- Clinical evaluation for efficacy and safety in target conditions, using standardized extracts to ensure reproducibility. These translational stages will convert ethnomedicinal leads into regulatory-compliant botanical therapeutics capable of competing with or complementing synthetic drugs (Nikkhah Bodagh *et al*. 2019; Shah 2025).

Conclusion

This ethnomedicinal survey shows that Baiddya healers in Rangamati possess a substantial and active body of traditional knowledge, much of which is supported by scientific evidence. Several recorded species, including Curcuma longa, Aloe vera, Aegle marmelos, Centella asiatica, Justicia adhatoda and Tinospora cordifolia, demonstrate strong pharmacological relevance. In contrast, plants with potent or toxic constituents, such as Datura stramonium and some Euphorbia species, require cautious use and rigorous safety assessment. The study underscores both promise and risk. Traditional remedies represent valuable leads for future therapeutic development, yet certain species are threatened by unsustainable harvesting and habitat loss. To ensure long-term preservation, future research should expand informant coverage, deposit verified herbarium specimens and promote community-based conservation and cultivation efforts. Integrating validated ethnomedicinal knowledge with ethical and scientific practices can support cultural heritage while advancing safe, evidence-based botanical therapeutics.

Declarations

List of abbreviations: GI → Gastrointestinal disorders; INF → Infectious diseases; CV → Cardiovascular diseases; RESP → Respiratory diseases; DERM → Dermatological diseases; WOUND → Wound healing; CNS → Central Nervous System disorders; MSK → Musculoskeletal disorders; TOX → Toxic conditions, DM → Diabetes mellitus

Ethics approval and consent to participate: The study was conducted following ethical guidelines for research on traditional knowledge. Verbal informed consent was obtained from all participating Baiddya healers prior to data collection. Participation was voluntary, and all information was documented with respect for confidentiality and cultural sensitivity.

Consent for publication: Participants shown ion images agreed to having their image published.

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