



# Cultural consensus in medicinal plant use among the Tangkhul Naga of Northeast India

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**Ethnobotany Research and Applications 33:36 (2026)** - <http://dx.doi.org/10.32859/era.33.36.1-11>

Manuscript received: 26/09/2025 - Revised manuscript received: 31/01/2026 - Published: 01/02/2026

## Research

### Abstract

**Background:** Traditional medicinal knowledge is vital for meeting primary healthcare needs in rural and indigenous populations and in supporting biodiversity conservation. The Tangkhul Naga community of Manipur, located in the Indo-Burma Biodiversity Hotspot, maintains rich ethnobotanical traditions, but quantitative analyses of their medicinal plant knowledge remain limited. This study aims to document medicinal plant usage in Tangkhul and to assess which species are culturally and therapeutically most important.

**Methods:** Data on medicinal plants were obtained through semi-structured interviews with the local informants. Quantitative botanical indices, including Informant Consensus Factor (ICF), Use Value (UV), and Fidelity Level (FL%), were applied to evaluate cultural consensus on ailments, species importance, and ailment-specific reliability of species.

**Results:** ICF values across nine ailment categories ranged from 0.9350 to 1.0, indicating strong agreement among informants and a robust ethnomedicinal knowledge base. Species with high UVs included *Allium hookeri* (UV = 0.787), *Aloe vera* (UV = 0.697), and *Ageratina adenophora* (UV = 0.642) as culturally salient multipurpose plants. Species exhibiting perfect FL% (100), namely *Acmella uliginosa*, *Ageratum conyzoides*, and *Allium sativum*, showed very high reliability for specific ailments. The most reported ailment categories were skin and dermatological disorders, respiratory illnesses, and digestive-metabolic ailments.

**Conclusions:** The findings show that Tangkhul traditional medicinal knowledge is both resilient and adaptive. Priority plant species identified here warrant pharmacological validation. Furthermore, these results highlight the need for initiatives in cultural preservation and sustainable species management to support both human health and biodiversity.

**Keywords:** Tangkhul Naga; Ethnobotany; Medicinal plants; Traditional knowledge; Cultural consensus; Indo-Burma Biodiversity Hotspot

## Background

Medicinal plants remain the foundation of primary health care for millions worldwide, particularly in regions where biomedical access is limited (Heinrich *et al.* 1998, Tamene *et al.* 2024). Beyond their pharmacological potential, ethnomedicinal practices represent complex cultural systems, linking ecological knowledge with identity, spirituality, and healthcare strategies (Phillips & Gentry 1993, Ralte *et al.* 2024). Ethnobotanical documentation therefore not only advances drug discovery but also safeguards intangible cultural heritage. Over the past decades, ethnobotany has developed robust methodological frameworks to move beyond descriptive inventories toward quantitative analysis. Indices such as Use Value (UV), Fidelity Level (FL%), and Informant Consensus Factor (ICF) are now widely applied to measure the cultural importance, therapeutic specificity, and collective agreement around plant use (Phillips & Gentry 1993, Heinrich *et al.* 1998). These tools provide a means to compare knowledge systems across cultures and to identify species with both high cultural salience and pharmacological potential. Recent studies in Nepal (Adhikari *et al.* 2024) and Ethiopia (Tamene *et al.* 2024) demonstrate how integrating quantitative ethnobotany with community-based research strengthens both cultural validation and bioprospecting outcomes.

The Indo-Burma Biodiversity Hotspot, encompassing Northeast India, is a global center of both biological and cultural diversity. The region harbors a rich assemblage of medicinal flora shaped by diverse indigenous practices (Mir *et al.* 2014, Bushi *et al.* 2021). Yet this knowledge system faces erosion due to modernization, land-use change, and generational shifts, creating urgency for systematic documentation and quantitative analysis. Recent ethnobotanical studies in neighboring Himalayan regions such as Sikkim and Arunachal Pradesh (Jishtu *et al.* 2025, Dhar *et al.* 2025) echo this concern, highlighting that rapid socio-ecological change threatens traditional plant knowledge even in remote mountain communities. Similar quantitative assessments in Nagaland (Vadeo 2023), Mizoram (Ralte *et al.* 2024), and Arunachal Pradesh (Bushi *et al.* 2021) have demonstrated how indices like UV, FL%, and ICF provide rigorous measures to identify culturally significant species and ailment categories.

Within this regional mosaic, the Tangkhul Naga of Manipur represent a distinct cultural group whose ethnomedicinal knowledge remains underexplored. Situated in a landscape where shifting cultivation and forest-based livelihoods dominate, the community continues to depend on wild and semi-domesticated plants for treating a wide spectrum of ailments. Despite this reliance, no prior study has systematically assessed the Tangkhul Naga's ethnomedicinal repertoire using quantitative indices. Such an approach can highlight not only culturally salient species but also the level of agreement among informants, offering insights into both therapeutic reliability and conservation priorities.

This study therefore undertakes a quantitative ethnobotanical assessment of medicinal plants used by the Tangkhul Naga community, it aims to (i) document species diversity and their associated ailment categories, (ii) evaluate informant consensus across health domains using ICF, and (iii) analyze species importance through UV and FL%. By integrating traditional knowledge with quantitative ethnobotany, this study will contribute to both biocultural conservation and the identification of species with pharmacological potential in the Indo-Burma Biodiversity Hotspot.

## Materials and Methods

### Study area

Ukhrul district, situated in the Northeastern corner of Manipur, India, extends from 24.8333° to 25.7000° N latitude and 94.0833° to 94.7500° E longitude (Figure 1). The landscape is predominantly hilly, with elevations ranging from 913 m to 3,114 m above mean sea level, interspersed with deep valleys and extensive forest cover. The district is largely inhabited by the Tangkhul Naga tribe, who maintain rich cultural traditions and community-based forest management practices (Government of Manipur 2023). As part of the Indo-Burma biodiversity hotspot, Ukhrul harbors a remarkable diversity of plant species, many of which are integral to local ethnomedicinal knowledge (Myers *et al.* 2000, Shimrah *et al.* 2018). The district headquarters is connected to Imphal, the state capital, via National Highway 150, covering approximately 84 km. The climate is temperate, with temperatures ranging from 3°C in winter to 33°C in summer and an average annual rainfall of 1,763.7 mm (Government of Manipur 2023).

### Data Collection

Ethnobotanical data were collected through field surveys conducted between January 2024 and December 2024 in Ukhrul District, Manipur. A purposive sampling was adopted to select knowledgeable informants based on community recommendations, including traditional healers, village elders, and experienced household heads recognized for their familiarity with medicinal plants. A total of 89 informants (40 males and 49 females), ranging in age from 21 to 80 years participated in the study. Data were gathered using a combination of semi-structured interviews, guided field walks, and

participant observation. Semi-structured interviews were used to document local plants names, ailments treated, plants parts used, preparation methods, modes of administration, and perceived therapeutic effectiveness. Field surveys were conducted in six representative Tangkhul Naga villages: Halang, Kachai, Chingai, Peh, Phungcham, and Paorei (Table 1). Voucher specimens of each recorded plant species were collected during guided walks with informants, processed following standard herbarium techniques, and identified using regional floras and taxonomic keys. Scientific names were verified with The Plant List and the Flora of Manipur (Mao & Mukherjee 2023) database. Voucher specimens were deposited at University School of Environment Management, Guru Gobind Singh Indraprastha University.

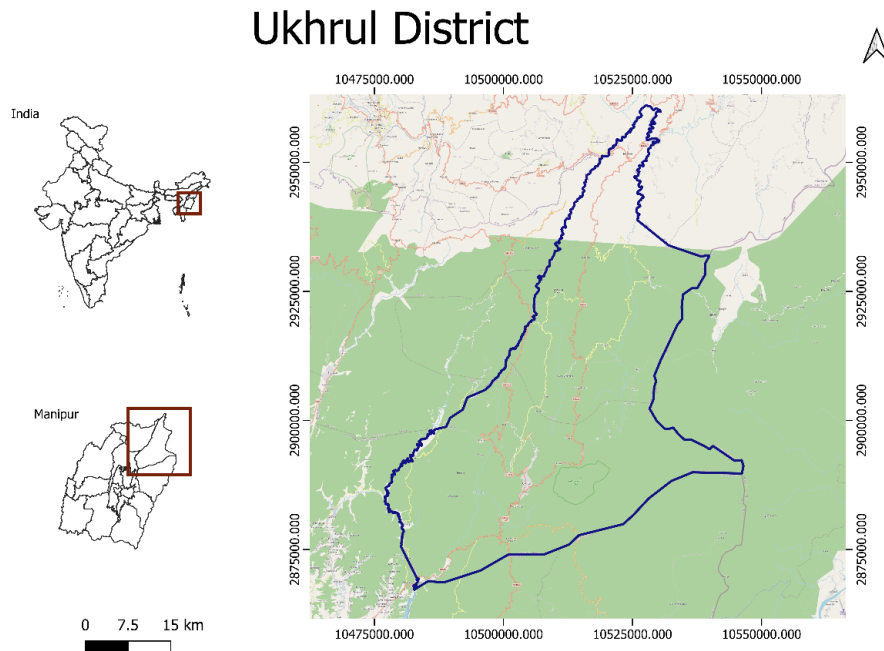


Figure 1. Map of Ukhrul District, Manipur, India, showing the study area

Table 1. Description of the selected study villages.

Name of Village	Longitude	Latitude	Elevation	Population (Census of India 2011)
Halang	94.368718° E	25.174323° N	1672 m	2878
Kachai	94.273624° E	25.235445° N	1407 m	2107
Chingai	94.498102° E	25.314362° N	1589 m	1118
Peh	94.395065° E	25.298508° N	1478 m	3800
Phungcham	94.389051° E	25.212329° N	1892 m	4041
Paorei	94.396993° E	25.237085° N	1873 m	2617

### Data Analysis

To evaluate the ethnomedicinal significance of plants reported by the community, both qualitative and quantitative analytical approaches were employed. Quantitative ethnobotanical indices were calculated to assess (i) Use Value (UV), (ii) Fidelity Level (FL %), and (iii) Informant Consensus Factor (ICF). These indices are widely applied in ethnobotanical research to standardize traditional knowledge and allow for cross-cultural comparisons (Phillips & Gentry 1993, Heinrich *et al.* 1998). All calculations and visualizations were carried out in RStudio software version 4.5.1 (R Core Team 2024, Posit Team 2025). The packages *ggplot2*, *dplyr*, and *ggrepel* were used for statistical summaries and figure generation (Wickham 2016, Slowikowski *et al.* 2024). ICF results were displayed in bubble charts, UV and FL% in scatter plots, and ailment prioritization in stacked bar charts.

**UV:** The Use Value reflects the cultural importance of a plant species by capturing the frequency of its citation across informants:

$$UV = \frac{\sum U_i}{N} \quad (i)$$

$U_i$  is the number of use-reports cited for species  $i$ , and  $N$  is the total number of informants interviewed. Higher UV values indicate that a species is widely known and used.

**FL%:** The Fidelity Level measures the proportion of informants who agree on the use of a species for a specific ailment, thereby highlighting its therapeutic reliability:

$$FL (\%) = \left( \frac{N_p}{N} \right) \times 100 \quad (\text{ii})$$

$N_p$  is the number of informants reporting the use of a species for the same ailment, and  $N$  is the total number of informants citing that species for any use.

**ICF:** The Informant Consensus Factor estimates the level of homogeneity among informants' knowledge within each ailment category:

$$ICF = \frac{N_{ur} - N_t}{N_{ur} - 1} \quad (\text{iii})$$

$N_{ur}$  is the number of use-reports for a category and  $N_t$  is the number of taxa used in that category. ICF values closer to 1 indicate higher consensus.

## Results

### Species Diversity and Ailment Categories

A total of 37 medicinal plant species belonging to 27 families were documented from six Tangkhul Naga villages in Ukhru District, Manipur (Table 2). The most represented families were Asteraceae (8 species), Zingiberaceae (5 species), and Lamiaceae (4 species). Herbs constituted nearly two-thirds of the recorded taxa, followed by shrubs and climbers, reflecting the community's reliance on easily accessible plants from nearby forests, jhum fields, and home gardens.

The documented species were used to treat nine major ailment categories (Figure 4). Digestive & Metabolic disorders accounted for the highest species richness (14 species, 203 use-reports), followed by Skin & Dermatological disorders (11 species, 227 use-reports) and Respiratory ailments (10 species, 187 use-reports). General ailments such as fever and body pain involved eight species (148 use-reports), Cardiovascular, Dental & Oral, and Musculoskeletal categories contained fewer species (2–4 each) but were supported by high use-report frequencies. Genitourinary & Reproductive disorders involved five species (74 use-reports), while Endocrine disorders were treated by a single species with eight use-reports.

### Informant Consensus Factor (ICF)

The ICF ranged from 0.9350 to 1.0 (Figure 2), indicating consistently high agreement among informants. The Endocrine category achieved the maximum value of 1.0, reflecting unanimous citation of a single species for this disorder. Dental & Oral (0.9800) and Cardiovascular (0.9683) categories also showed strong consensus despite being represented by only two or three species. Skin & Dermatological (0.9558), General ailments (0.9524), and Respiratory (0.9516) categories recorded slightly lower but still high ICF values. The Digestive & Metabolic category displayed the lowest ICF (0.9350) but had the highest species richness ( $n = 14$ ), suggesting a wider range of alternative remedies.

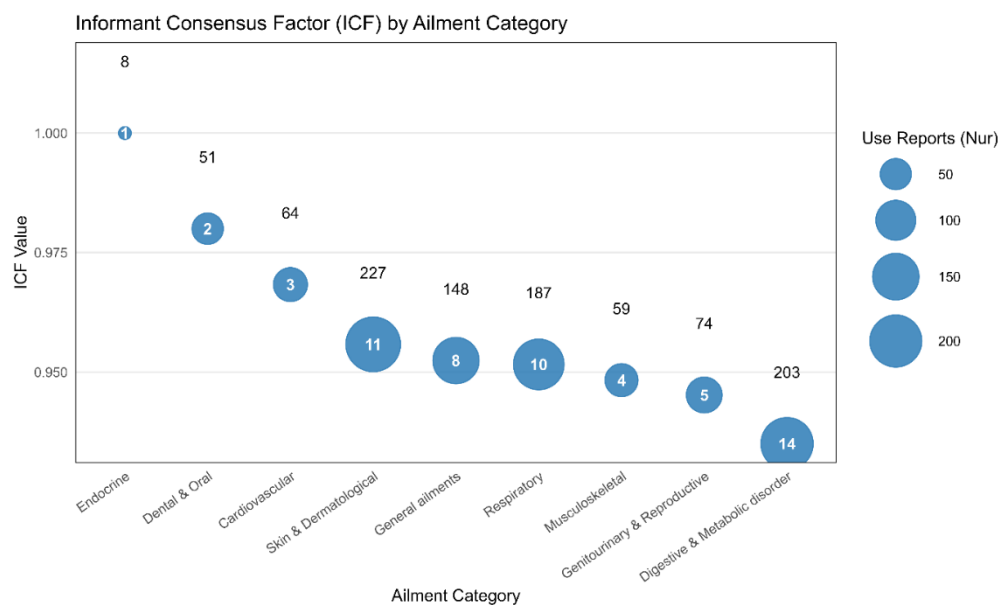


Figure 2. Informant Consensus Factor (ICF) by ailment category with bubble size and number above representing use reports (Nur) and numbers inside indicating species count (N<sub>t</sub>)

Table 2. Medicinal plant species recorded in the study area, with their taxonomic details, local names, plant parts used, modes of use, treated health conditions, corresponding ailment categories, use value (UV), and fidelity level (FL%)

Botanical Name	Family	Local Name	Part Used	Mode of Use	Health Conditions Treated	Ailment Category	UV	FL (%)
<i>Achyranthes bidentata</i> Blume; ARL-113/101	Amaranthaceae	Masupni	Leaves	Leaves boiled; bath or topical use after childbirth.	Post-delivery care, back pain, body ache	Musculoskeletal; Genitourinary & Reproductive	0.281	56.00
<i>Acmella uliginosa</i> (Sw.) Cass.; ARL-113/102	Asteraceae	Afokatoni	Leaves	Leaves warmed over embers then applied to the painful tooth.	Tooth pain	Dental & Oral	0.393	100.00
<i>Ageratina Adenophora</i> (Spreng.) R.M.King & H.Rob.; ARL-113/103	Asteraceae	Japan khawo	Leaves	Leaves heated/crushed; paste applied or juice consumed.	Piles, small cuts, bloating	Skin & Dermatological; Digestive & Metabolic	0.642	61.40
<i>Ageratum conyzoides</i> L.; ARL-113/004	Asteraceae	Khongjainapi	Leaves	Fresh leaves crushed into paste and applied to wounds.	Small cuts, wounds	Skin & Dermatological	0.438	100.00
<i>Allium hookeri</i> Thw.; ARL-113/105	Amaryllidaceae	Namrei	Whole plant	Plant boiled; decoction consumed.	Kidney problems, cough, stomach-ache	Genitourinary & Reproductive; Respiratory; Digestive & Metabolic	0.787	42.86
<i>Allium sativum</i> L.; ARL-113/206	Amaryllidaceae	Shomri	Bulb, leaves	Bulb eaten raw or boiled; juice consumed.	Cough, cold	Respiratory	0.393	100.00
<i>Aloe vera</i> (L.) Burm.f.; ARL-113/207	Asphodelaceae	Aloe vera	Leaves	Gel applied to burns/wounds; gel also ingested fresh.	Burns, wounds, stomach-ache	Skin & Dermatological; Digestive & Metabolic	0.697	56.45
<i>Alpinia galanga</i> (L.) Willd.; ARL-113/208	Zingiberaceae	Kanghu	Rhizome	Decoction prepared from rhizome.	Cough, fever	General ailments	0.326	100.00
<i>Amaranthus viridis</i> L.; ARL-113/209	Amaranthaceae	Chengkhruk	Leaves, stems	Boiled as soup/vegetable.	Snakebite tonic	General ailments	0.169	100.00
<i>Apium graveolens</i> L.; ARL-113/210	Apiaceae	Celery	Leaves, stalk	Leaves boiled and consumed.	High blood pressure prevention	Cardiovascular	0.247	100.00
<i>Artemisia vulgaris</i> L.; ARL-113/311	Asteraceae	Maharthing	Leaves (apical)	Leaves heated or crushed; paste applied externally.	Piles, wounds, traditional cleansing	Skin & Dermatological; Cultural/Other	0.348	38.71
<i>Bidens Pilosa</i> L.; ARL-113/312	Asteraceae	Phanang	Leaves	Decoction prepared from leaves and consumed.	Cough, urinary problems	Respiratory; Genitourinary & Reproductive	0.416	51.35

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<i>Boehmeria cylindrica</i> (L.) Sw.; ARL-113/313	Urticaceae	Hashai	Leaves	Leaves ground raw; juice taken orally.	Stomach-ache, menstrual pain	Digestive & Metabolic; Genitourinary & Reproductive	0.213	57.89
<i>Centella asiatica</i> (L.) Urb.; ARL-113/314	Apiaceae	Khongreihan	Whole plant	Paste applied externally; plant cooked as curry.	Wounds, high blood pressure, diabetes	Skin & Dermatological; Cardiovascular; Metabolic disorders	0.584	40.38
<i>Chenopodium ambrosioides</i> L.; ARL-113/315	Amaranthaceae	Nganamshi	Leaves	Heated and applied as paste on affected area.	Back pain, swelling in neck (goiter)	Musculoskeletal; Endocrine	0.303	70.37
<i>Clerodendrum colebrookianum</i> Walp.; ARL-113/416	Lamiaceae	Anphui	Leaves	Boiled leaves eaten as soup or chutney.	Controls high blood pressure	Cardiovascular	0.236	100.00
<i>Curcuma angustifolia</i> Roxb.; ARL-113/417	Zingiberaceae	Koktuiwon	Leaves, inflorescence	Leaves boiled and steam inhaled; flowers consumed.	Traditionally used to enhance immunity	General ailments; Cultural/Other	0.213	100.00
<i>Curcuma caesia</i> Roxb.; ARL-113/418	Zingiberaceae	Hui	Rhizome	Rhizome consumed raw as supplement.	Stomach-ache, asthma, piles	Digestive & Metabolic; Respiratory; Skin & Dermatological	0.326	37.93
<i>Curcuma longa</i> L.; ARL-113/419	Zingiberaceae	Yaingang	Rhizome	Powder mixed with hot water (optionally with honey and lemon).	Cough, skin infections	Respiratory; Skin & Dermatological	0.382	61.76
<i>Cymbopogon citratus</i> (DC.) Stapf; ARL-113/420	Poaceae	Lemon grass	Leaves, shoots	Consumed as tea; heated shoots applied to abdomen.	Fever, stomach-ache	General ailments; Digestive & Metabolic	0.292	57.69
<i>Dioscorea bulbifera</i> L.; ARL-113/521	Dioscoreaceae	Chingkha	Tuber	Tuber boiled and consumed.	Energy tonic	General ailments	0.056	100.00
<i>Drymaria cordata</i> (L.) Willd. ex Schult.; ARL-113/522	Caryophyllaceae	Khashang	Whole plant	Plant crushed; juice applied externally or taken orally.	Skin infections, cough	Skin & Dermatological; Respiratory	0.202	61.11
<i>Elisholtzia blanda</i> (Benth.) Benth.; ARL-113/523	Lamiaceae	Thaosom	Leaves	Decoction of leaves consumed as tea.	Fever, cold	General ailments	0.303	100.00
<i>Gynura cusimbua</i> (D.Don) S.Moore; ARL-113/524	Asteraceae	Khongpum	Leaves	Leaves crushed; paste applied to affected area.	Boils, skin infections	Skin & Dermatological	0.315	60.71
<i>Houttuynia cordata</i> Thunb.; ARL-113/525	Saururaceae	Toning khat	Leaves, rhizome	Fresh leaves eaten raw; rhizome boiled.	Diarrhea, dysentery, urinary problems	Digestive & Metabolic; Genitourinary & Reproductive	0.270	54.17
<i>Justicia adhatoda</i> L.; ARL-113/626	Acanthaceae	Ngayeng	Leaves	Leaf decoction consumed.	Asthma, cough, cold	Respiratory	0.169	100.00

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<i>Leucas aspera</i> (Willd.) Link; ARL-113/627	Lamiaceae	Khanghum	Leaves	Leaves crushed into paste and applied externally.	Skin infections, cuts	Skin & Dermatological	0.045	100.00
<i>Litsea cubeba</i> (Lour.) Pers.; ARL-113/628	Lauraceae	Thingne	Leaves, bark	Decoction of leaves or bark consumed.	Fever, headache	General ailments; Neurological	0.079	100.00
<i>Mimosa pudica</i> L.; ARL- 113/629	Fabaceae	Achonbung	Leaves, root	Plant parts crushed; juice taken or applied externally.	Dysentery, wounds	Digestive & Metabolic; Skin & Dermatological	0.135	58.33
<i>Ocimum sanctum</i> L.; ARL- 113/630	Lamiaceae	Tulsi	Leaves	Leaves chewed fresh or decoction prepared.	Cough, cold, fever	General ailments	0.348	100.00
<i>Oxalis corniculata</i> L.; ARL- 113/731	Oxalidaceae	Khatuiwon	Whole plant	Plant boiled and consumed as soup.	Stomach-ache, diarrhea	Digestive & Metabolic	0.135	100.00
<i>Paederia foetida</i> L.; ARL- 113/732	Rubiaceae	Luwui	Leaves, stem	Leaves boiled; decoction consumed.	Joint pain, stomachache	Musculoskeletal; Digestive & Metabolic	0.225	55.00
<i>Phlogacanthus thyrsoformis</i> (Roxb. ex Hardw.) Mabb.; ARL-113/733	Acanthaceae	Shakham	Leaves	Leaves boiled with meat; consumed as soup.	Cough, cold	Respiratory	0.056	100.00
<i>Plantago major</i> L.; ARL- 113/734	Plantaginaceae	Hanvathan	Leaves	Leaves crushed; paste applied on wound or swelling.	Wounds, inflammation	Skin & Dermatological; Musculoskeletal	0.360	53.13
<i>Polygonum chinense</i> L.; ARL- 113/735	Polygonaceae	Kangkhum	Leaves	Leaf paste applied externally or taken orally.	Mouth ulcers, diarrhea	Dental & Oral; Digestive & Metabolic	0.157	57.14
<i>Solanum americanum</i> Mill.; ARL-113/836	Solanaceae	Kongthang	Leaves, berries	Leaves boiled; berries eaten fresh.	Sore throat, cough	Respiratory	0.236	100.00
<i>Zingiber officinale</i> Roscoe; ARL-113/837	Zingiberaceae	Hui	Rhizome	Rhizome chewed raw or decoction prepared.	Cold, nausea, stomach-ache	Respiratory; Digestive & Metabolic	0.427	57.89

**Species Importance Based on Use Value (UV) and Fidelity Level (FL%)**

UV ranged from 0.045 (*Leucas aspera*) to 0.787 (*Allium hookeri*), reflecting variation in cultural importance and frequency of use (Figure 3). Other high-UV species included *Aloe vera* (0.697), *Ageratina adenophora* (0.642), and *Centella asiatica* (0.584). FL% values varied from 37.93% (*Curcuma caesia*) to 100% for several species (*Acmella uliginosa*, *Ageratum conyzoides*, *Allium sativum*, *Ocimum sanctum*, and others). High FL% indicates that a species is consistently used for a single ailment. Species such as *Acmella uliginosa* (Dental problems) and *Ageratum conyzoides* (wound healing) achieved perfect FL% despite only moderate UV, reflecting highly specialized applications with strong cultural consensus.

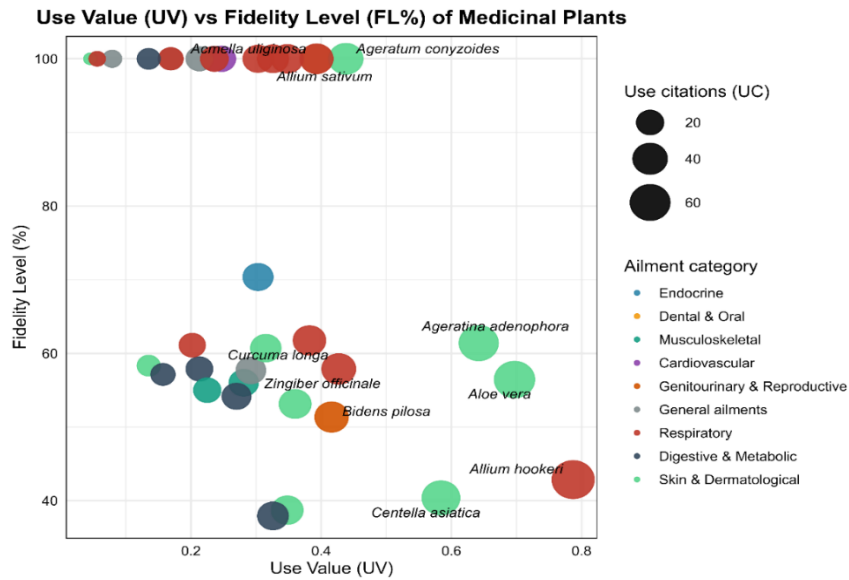


Figure 3. Scatter plot showing the relationship between UV and FL%, bubble size indicates the number of UC, and colors represent the primary ailment category

**Ailment Category Prioritization**

Combining ICF and species richness reveals the health priorities of the Tangkhul Naga community (Figure 4). Skin & Dermatological and Respiratory categories showed the highest combination of species richness and use-reports, indicating their prominence in local healthcare. Digestive & Metabolic disorders followed closely, reflecting the prevalence of gastrointestinal issues in subsistence farming communities. Although categories such as Cardiovascular, Dental & Oral, and Endocrine involved fewer species, their high ICF scores highlight the reliability and cultural significance of a small set of key remedies.

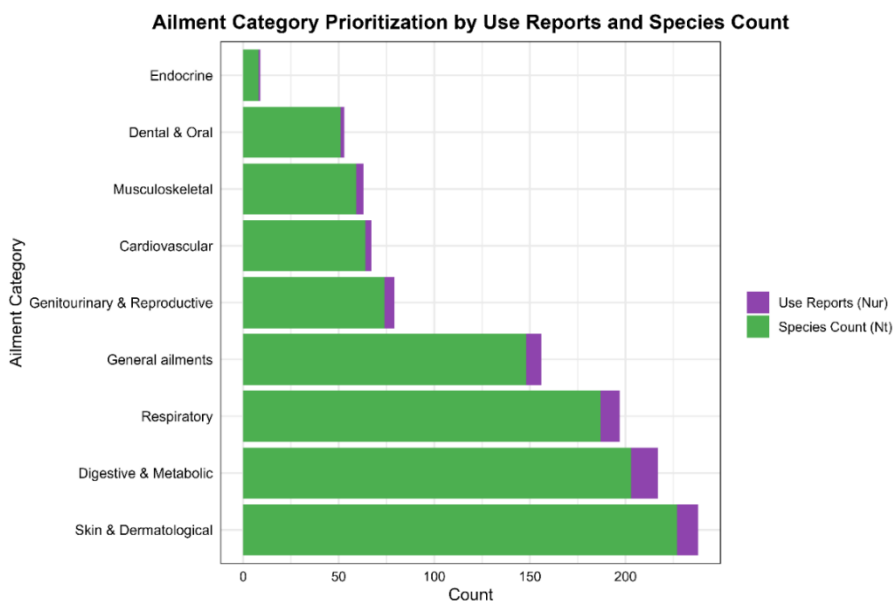


Figure 4. Distribution of use-reports and taxa across nine ailment categories among the Tangkhul Naga community

## Discussion

The Tangkhul Naga medicinal plant repertoire recorded in this study reflects a dynamic and highly structured knowledge system within the Indo-Burma biodiversity hotspot. The predominance of Asteraceae, Zingiberaceae, and Lamiaceae is consistent with patterns reported across Northeast India and the eastern Himalaya, where these families combine ecological abundance with a wealth of pharmacologically active secondary metabolites (Chettri & Kumari 2021, Dutta *et al.* 2023, Dhar *et al.* 2025). Herbs constituted nearly two-thirds of the taxa, a life-form preference also noted in Arunachal Pradesh and Sikkim, where easy collection and rapid regeneration favor herbaceous remedies (Tsering *et al.* 2022, Jishtu *et al.* 2025). Such convergence across neighboring regions underscores both ecological availability and the deep cultural embedding of herb-based therapeutics.

The distribution of species among ailment categories mirrors trends observed in other parts of Northeast India. Gastrointestinal, skin, and respiratory disorders accounted for the greatest diversity of remedies, a pattern also dominant in Mizoram and Nagaland where these conditions represent persistent health burdens in rural agrarian settings (Laldingliani *et al.* 2022, Vadeo 2023). Similar emphasis on digestive and dermatological treatments has been reported from Arunachal Pradesh (Bushi *et al.* 2021), Sikkim (Chettri & Kumari 2021), and high-altitude Himalayan communities (Jishtu *et al.* 2025), highlighting the shared biocultural drivers of ethnomedicinal practice across the Indo-Burma and Himalayan interface.

High ICF values across all nine ailment categories indicate strong agreement among informants in the selection of medicinal plants for specific health conditions. This consistency reflects remedies that are widely recognized, trusted, and repeatedly used within the community over time. The perfect consensus for endocrine disorders and the near-perfect values for dental and cardiovascular conditions indicate cultural confidence in a very narrow set of species for these treatments. Similar levels of agreement have been documented among the Meitei of Manipur (Thangjam *et al.* 2024), the Mizo of Mizoram (Laldingliani *et al.* 2022), and Himalayan groups in Sikkim and Arunachal Pradesh (Jishtu *et al.* 2025, Dhar *et al.* 2025). Slightly lower but still strong ICF values for skin, respiratory, and digestive disorders likely reflect their broader symptom spectra and the correspondingly larger set of available remedies. As shown elsewhere in Northeast India and Nepal, high ICF scores are reliable indicators of culturally entrenched and pharmacologically promising species (Semenya & Maroyi 2018, Tsioutsiou *et al.* 2022).

The combined analysis of UV and FL further clarifies species-level importance. High-UV plants such as *Allium hookeri*, *Aloe vera*, and *Ageratina adenophora* are used for multiple ailments, illustrating their multifunctional roles in household healthcare and their potential for broader pharmacological application. Similar prominence of multipurpose taxa has been reported for *Centella asiatica* and *Clerodendrum colebrookianum* in Mizoram and Arunachal Pradesh (Bushi *et al.* 2021, Ralte *et al.* 2024). In contrast, species such as *Acmella uliginosa* and *Ageratum conyzoides* achieved perfect FL despite only moderate UV, signaling highly specific applications supported by strong cultural consensus. This duality, versatile high-UV species alongside ailment-specific high-FL species, has also been described in Nepal (Adhikari *et al.* 2024) and among highland Ethiopian groups, where social factors such as age and education influence the retention of targeted remedies (Tamene *et al.* 2024).

The prioritization of ailment categories through combined ICF and species richness highlights both health burdens and therapeutic specialization. Skin and respiratory disorders emerged as top priorities, consistent with the global ethnobotanical record in which treatments for dermatological and respiratory conditions are among the most diverse (Tsioutsiou *et al.* 2022). Gastrointestinal disorders followed closely, reflecting the continuing relevance of plant-based digestive remedies documented across South Asia (Mir *et al.* 2014, Dutta *et al.* 2023). Although cardiovascular, dental, and endocrine categories involved fewer species, their high ICF values confirm the reliability of a small set of culturally entrenched treatments.

The Tangkhul Naga medicinal system shows striking parallels with neighboring Himalayan and Indo-Burma communities while maintaining distinctive species preferences shaped by local ecology and culture. The combination of high ICF values, multipurpose high-UV species, and ailment-specific high-FL species points to a knowledge system that is simultaneously resilient and adaptable. High ICF values reflect shared agreement among the informants and the stability of commonly trusted remedies, while high-UV species show reliance on familiar, multipurpose plants used in everyday healthcare. At the same time, high-FL species indicates carefully selected remedies for specific ailments, suggesting experiential refinement rather than random choice. Together, these patterns reveal a system that preserves a stable core of knowledge while remaining flexible in responding to different health needs. Such findings reinforce calls for biocultural conservation and pharmacological validation of key taxa (Tsioutsiou *et al.* 2022, Ralte *et al.* 2024) and align with recent assessments warning of rapid erosion of traditional knowledge under changing socio-economic conditions (Jishtu *et al.* 2025, Dhar *et al.* 2025).

## Conclusion

This study demonstrates the depth and resilience of Tangkhul Naga ethnomedicinal knowledge, as reflected in the consistently high Informant Consensus Factor (ICF) across nine ailment categories and the strong cultural reliance on species with high Use Value (UV) and Fidelity Level (FL%). The coexistence of versatile, multipurpose plants such as *Allium hookeri* and *Aloe vera* with highly ailment-specific species such as *Acmella uliginosa* and *Ageratum conyzoides* illustrates a balanced healthcare system that addresses both broad and targeted health concerns. Situated within the Indo-Burma biodiversity hotspot, this repertoire underscores the need for integrated conservation strategies that safeguard not only biological resources but also the intangible cultural heritage embedded in traditional healing practices. Pharmacological evaluation of high-UV and high-FL species could provide evidence to support their incorporation into wider healthcare frameworks, while community-driven efforts to transmit knowledge to younger generations are essential to counter rapid ecological and socio-cultural change. Collectively, these findings position the Tangkhul medicinal flora as a vital component of local health security and a valuable reservoir for future biocultural and pharmacological research.

## Declarations

**List of abbreviations:** ICF - Informant Consensus Factor; UV - Use Value; FL - Fidelity Level; UC – Use Citations; Nur – Use Reports; Nt – Species Count

**Ethics approval and consent to participate:** Prior to the survey, the objectives and purpose of the study were clearly explained to all participants in their local language. Verbal informed consent was obtained from each participant, ensuring that participation was voluntary and that they could withdraw at any time without any consequences. The study followed ethical guidelines for research involving human subjects, respecting participants' privacy and confidentiality of the information shared.

**Consent for publication:** Not applicable

**Availability of data and materials:** Not applicable

**Competing interests:** Not applicable

**Funding:** The first author (Shimrah) acknowledges the Indian Council of Social Science Research (ICSSR) for granting financial assistance in the form of Research grant (File No. 02/82/2022-23/ST/TS/RP) to carry out the study.

**Author contributions:** T.S. conceived and funded the research project, designed the study, and led field sampling and data collection. P.L. performed data analysis and prepared the first draft of the manuscript. J.L. contributed to data interpretation and critically reviewed and revised the manuscript. All authors read and approved the final version of the manuscript.

## Acknowledgements

The authors express their sincere gratitude to the Tangkhul Naga community members of Ukhrul District for generously sharing their knowledge and facilitating fieldwork.

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