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Indigenous knowledge of Mangar Community on medicinal uses of ethnomedicinal plants in South Sikkim, Eastern Himalaya

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Ethnobotanical knowledge connects biodiversity, cultural heritage, and drug discovery. A household survey (n = 50) among the Mangar community of Sikkim, Eastern Himalaya, and documented 46 wild medicinal species across 33 families. Quantitative indices, such as relative frequency of citation (RFC), use value (UV), informant consensus factor (ICF), fidelity level (FL), and Cultural Importance Index (CI) were used to prioritize culturally important species. The major portion of the harvested species was leaves (26%), while "crushed" was the major preparation method (23%). The highest RFC and UV values, 0.70 and 0.94, for *Drymaria cordata* and *Ocimum tenuiflorum*, respectively, reflect the "hub" potential of these species for use in household therapy. Conversely, 31 use-reports (~48%) revealed perfect fidelity, indicating the existence of a set of single-ailment 'specialist' plant species. The overlap of FL with ICF revealed the existence of four ailment clusters, namely bone fracture, internal and external wounds, respiratory, and fever, wherein perfect specialists correlated with high consensus (ICF ≥ 0.90). The hierarchical cluster analysis using Jaccard similarity index revealed the organized and non-random nature of traditional knowledge, wherein multipurpose species formed the core, while ailment-specific species formed the periphery. Although some of the culturally important species, such as *Aloe vera* and *Swertia chirayita*, are pharmacologically supported, species like *Viscum articulatum*, *Bergenia ciliata*, and *Astilbe rivularis* need region-specific ethnopharmacological evaluation and conservation assessment under the Mangar ethnomedicinal system. These findings emphasize the community's rich biocultural heritage and the need for its documentation, conservation, and quantitative analysis.

Keywords: Ethnomedicinal knowledge, Eastern Himalaya, Medicinal plant diversity, Mangar community, Sikkim, Traditional healthcare system

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The Eastern Himalayas are widely recognized as a repository of both floral and ethnic diversity. The north-eastern parts of India, located in the Eastern Himalayas, are known to have significant biological and cultural diversity, with around 145 tribal communities residing in the area[1]. Approximately 1,350 plant species are used by the tribal communities to prepare traditional medicines for various ailments[2].

Tribal communities and local communities of the northeastern Himalayas have been closely associated with nature and have built long and extensive knowledge systems, primarily on the use of plants and plant products to treat and manage various health problems[3]. These communities live in proximity to nature and have built extensive traditional knowledge related to biotic resources[4]. The healing practice has played an important role in the discovery of some of the important modern, life saving drugs[5].

Despite its richness, ethnomedicinal practices are largely undocumented and are being transmitted orally through the generations[6]. This chain is further weakening with urbanization, industrialization, emigration, habitat loss, and changes in lifestyle[7,8]. To raise awareness, field-based research and systematic documentation are critical in identifying and prioritizing species in need of conservation and those with potential for medicinal drug discovery[9].

Sikkim, located in the Eastern Himalaya, comprises diverse ecological zones from tropical to alpine, supporting an exceptional range of floral and faunal diversity[9]. Plants have played a central role in traditional healing systems in developing countries and

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remain embedded in local communities' cultural and spiritual practices[10]. In the context of Sikkim and Darjeeling, over 490 medicinal plant species have been recorded[11], while some reports estimate more than 707 species with recognized medicinal value[12]. More recently, Sikkim has been designated a biocultural hotspot of ethnobiological plants, with over 1128 species, along with six ethnic communities (Bhutia, Lepcha, Limboo, Nepali, Sherpa, and Tibetan) that are involved in biocultural relationships[13].

These communities have developed region-specific ethnomedicinal knowledge over generations, including precise methods of preparation, dosage, and plant part usage[14]. While substantial ethnobotanical documentation exists for communities such as the Limboos, Lepchas and Bhutias[12-14], limited research has focused specifically on the Mangar community, one of the aboriginal communities of Sikkim.

Therefore, the objectives of this study are:(a) to compile an inventory of ethnomedicinal plants used by the Mangar community in Mamley and Kamrang;(b) to document information related to plant parts used, modes of preparation, and ailments treated; (c) to evaluate the ethnobotanical data using quantitative indices such as Fidelity Level (FL%), Informant Consensus Factor (ICF), Use Value (UV), Relative Frequency of Citation (RFC), and Cultural Importance Index (CI); and (d) to explore the structural organization and internal coherence of the Mangar ethnomedicinal knowledge system using hierarchical cluster analysis.

Materials and Methods

Study area

The study was conducted in Mamley and Kamrang villages, South Sikkim, India (27°10′8″–27°14′16″N; 88°19′53″-88°24′43″E), covering 490.85 km² at 1,675 m altitude. Located ~2 km apart near Namchi, the villages support 2,519 people in 517 households, representing major ethnic groups—Bhutia, Lepcha, and Nepalese (Rai, Limboo, Chettri, Pradhan, Tamang, Mangar, Gurung, and Kami). The study focused on documenting ethnomedicinal uses of wild plants by the Mangar community.

Ethnomedicinal data collection

The ethnobotanical data were collected via semi-structured interviews, focus groups, and household questionnaires (January – March 2023; 50 respondents: 35 Mamley, 15 Kamrang). The questionnaire involved demographic details, usage of plants, parts used, preparation processes, and their local names. Priority was given to elderly interviewees, while local support facilitated the process of identifying plants.

Plant collection and identification

Plant specimens cited by informants were collected and identified using regional floras. Identifications were confirmed by Dr. Arun Chettri and Dr. Santosh Kumar Rai. Voucher specimens were prepared and deposited in the Herbarium, Department of Botany, Sikkim University, under accession numbers SUH838–SUH883.

Data processing and statistical analysis

All statistical analysis were conducted using IBM SPSS Statistics v26 software. The ethnomedicinal knowledge score was calculated by the number of plant species cited. Since normality checks (Kolmogorov–Smirnov and Shapiro-Wilk) showed non-normal distribution (Table S1; Supplementary file), non-parametric tests were used: Kruskal-Wallis test for age groups, Mann-Whitney U test for gender, and Spearman rank correlation between age and knowledge score, with $p<0.05$.

Quantitative ethnobotanical analysis

Quantitative analysis of the collected data was done using five quantitative indices. These were Relative Frequency of Citation (RFC), Use Value (UV), Informant Consensus Factor (ICF), Fidelity Level (FL%), and Cultural Importance Index (CI). RFC is used to evaluate the importance of each plant species using the formula $RFC = FC/N$, where FC is the number of people citing each plant species, and N is the number of people interviewed[15,16]. Use Value (UV) is used to evaluate the number of uses reported for each plant species using the formula $UV = \Sigma Ui/N$, where Ui is the number of uses reported for each informant[17]. ICF ($ICF = (Nur - Nt)/(Nur - 1)$) assesses agreement among informants within ailment categories, where Nur is the total use reports, and Nt is the number of species cited[18,19]. FL% is used to evaluate the preferred plant species used to treat specific ailments using the formula $FL = (Np/N) \times 100$, where Np is the number of use reports for a particular ailment, and N is the total use reports for that species[20]. CI ($CI = \sum(UR_{ui}/N)$) evaluates overall cultural significance across ailment categories, where UR_{ui} represents use reports per ailment and N is the total number of informants[21].

Multivariate analysis of species co-citation

To examine associations among medicinal plant species based on informant citations, a transposed binary presence–absence matrix was prepared (1 = cited, 0 = not cited). As the data were asymmetric binary, PCA was unsuitable. Therefore, hierarchical cluster analysis using Jaccard similarity and average linkage was performed, and a dendrogram was generated to visualize species clusters in the ethnomedicinal knowledge system.

Results

Demographic data

During the ethnobotanical survey, a total of 50 households were recorded in the study area. Of the total informants, 62% were males and 38% were females. The age distribution showed 26% were aged 15-29, and 38% were 30-44. Of the remaining, 16% were between 45-59, while 20% were over 60 years. Based on occupation, most informants were self-employed, making up 36% of the distribution. This was followed by farming (24%), unemployed (14%), government staff (12%), students (7%), and retired people (7%).

Socio-demographic influence on ethnomedicinal knowledge

Influence of age on ethnomedicinal knowledge

Ethnomedicinal knowledge was compared for different ages using Kruskal-Wallis analysis but revealed no significant differences (Table S2), although there was a slight trend towards higher ranks with increasing ages (H (2) = 0.685, p=0.710). This indicates that knowledge is shared across generations, reflecting active transmission and a robust cultural knowledge system within the Mangar community.

Influence of gender on ethnomedicinal knowledge

No significant difference was found using the Mann-Whitney U test in terms of ethnomedicinal knowledge in relation to gender, with the mean rank for male respondents being 24.89 while the mean rank of female respondents was 26.50 (U = 275.500, p=0.697). This implies that knowledge is equally distributed among genders in Mangar society.

Ethnomedicinal data collection

A total of 46 wild ethnomedicinal plant species belonging to 33 families were documented (Table 1). The most commonly used life forms were herbs (45%), followed by trees (32%) and other life forms (Fig. 1). The family Zingiberaceae had the highest number of species (Fig. 2), including *Curcuma caesia*, *Curcuma longa*, *Kaempferia rotunda*, *Zingiber officinale*, and *Zingiber zerumbet*. Lamiaceae included *Mentha spicata*, *Ocimum basilicum*, and *Ocimum tenuiflorum*, while Asteraceae comprised *Artemisia vulgaris*, *Ageratina adenophora*, and *Tagetes erecta* (Fig. 3).

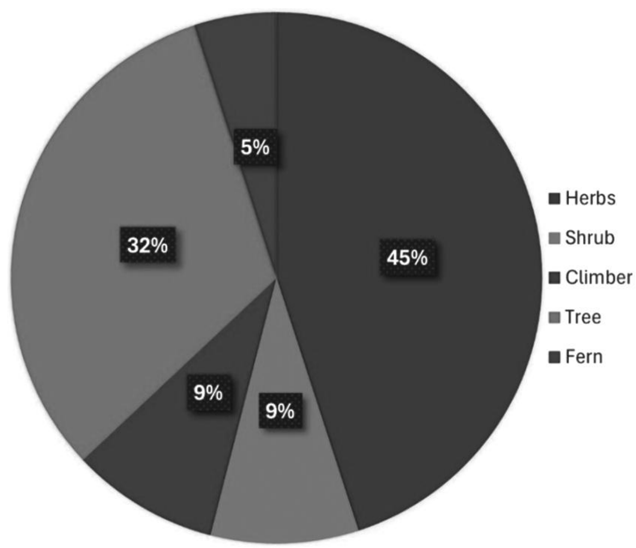

Fig. 1 — Various life forms of documented plants

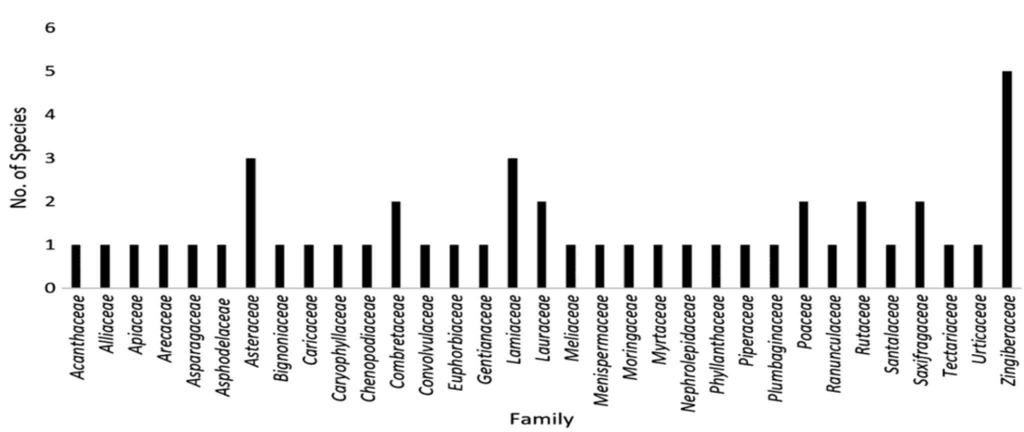

Fig. 2 — Families of the documented plant species

Table 1 — Ethnomedicinal plants used by Mangar tribe of Mamley and Kamrang Villages in Sikkim

Sl. No.	Scientific Name	Local Name	Family	Disease /Ailment	Parts Used	Mode of Application	Mode of Treatment	UV	FL (%)	CI
1	*Allium hookeri* Thwaites (SUH838)	Dungdunge saag	Alliaceae	Gastritis, diarrhoea	Young Leaves	Cooked	Leaves are cooked as a vegetable to treat gastritis, diarrhoea, and aid digestion	0.02	50	0.04
2	*Aloe vera* (L.) Burm.f. (SUH839)	Ghuikumari	Asphodelaceae	Cuts and burn	Leaves	Gel	Aloe gel is applied topically to cuts and burns.	0.4	100	0.32
3	*Artemisia vulgaris* L. (SUH840)	Tetaypati	Asteraceae	Cuts and wounds, nose bleeding	Leaves	Crushed	Crushed leaf applied to cuts and wounds; inserted in nostril to stop bleeding.	0.66	100	0.40
4	*Asparagus racemosus* Willd. (SUH841)	Kurilo	Asparagaceae	Breast feeding, respiratory, diabetes	Root	Juice	Juice taken for diabetes and to enhance lactation	0.08	33	0.08
5	*Azadirachta indica* A. Juss (SUH842)	Neempati	Meliaceae	Fever, respiratory, dental problem	Leaves, stem	Crushed, juice	Leaf juice taken for fever; stem rubbed on gums for periodontal disease	0.24	25	0.18
6	*Bergenia ciliata* (Haw.) Sternb. (SUH843)	Pakhenbeth	Saxifragaceae	Cuts and wounds	Rhizomes, flower	Crushed	Rhizome paste applied to cuts and wounds.	0.14	100	0.20
7	*Calamus erectus* Roxb. (SUH844)	Phakrey	Arecaceae	Diabetes	Fruits	Chewed (raw)	Fruits eaten for diabetes	0.06	100	0.08
8	*Carica papaya* L. (SUH845)	Mewa	Caricaceae	Jaundice	Fruit	Eat (raw)	Unripe fruit eaten raw for jaundice	0.04	100	0.06
9	*Chenopodium album* L. (SUH846)	Bethu saag	Chenopodiaceae	Body ache	Leaves and young shoot	Cooked	Cooked as vegetable for body ache	0.04	100	0.04
10	*Cinnamomum tamala* (Buch.-Ham.) T. Nees & Eberm. (SUH847)	Tejpata	Lauraceae	Blood dysentery	Mature leaves	Boiled	Boiled mature leaves drunk for dysentery	0.02	100	0.04
11	*Clematis buchananiana* DC. (SUH848)	Pinasay lahara	Ranunculaceae	Sinusitis, headache	Roots	Mashed	Mashed fresh roots inhaled for sinusitis and nasal blockage; juice used for headache	0.04	50	0.04
12	*Coriandrum sativum* L. (SUH849)	Dhania	Apiaceae	Gastritis, stomach pain	Shoot	Chewed (raw)	Shoot chewed raw for gas and stomach pain	0.04	50	0.06
13	*Curcuma caesia* Roxb. (SUH850)	Kalo hardi	Zingiberaceae	Body ache	Rhizome	Crushed and boiled	Boiled crushed rhizome consumed for piles and body ache	0.08	100	0.10
14	*Curcuma longa* L.(SUH851)	Hardi	Zingiberaceae	Body ache	Rhizome	Crushed and boiled	Boiled crushed rhizome consumed for body ache and fever	0.08	67	0.04
15	*Cuscuta reflexa* Roxb. (SUH852)	Paheli lahara	Convolvulaceae	Jaundice	Whole plants	Decoction and Juice	Juice or decoction taken orally to treat jaundice	0.06	100	0.06
16	*Cynodon dactylo n*(L.) Pers. (SUH853)	Dubo	Poaceae	Cuts and wounds	Whole plants	Juice	Juice applied on cuts and wounds	0.02	100	0.08
17	*Tectaria coadunata* (J. Sm.) C. Chr. (SUH854)	Kalo ningro	Tectariaceae	Dysentery	Roots	Eat(raw)	Roots eaten for dysentery	0.02	100	0.02
18	*Drymaria cordata* (L.) Willd. ex Schult. (SUH855)	Abijalo	Caryophyllaceae	Sinusitis, cold, sore throat	Whole plants	Crushed	Heated whole plant vapour inhaled for sinusitis and nasal blockage	0.86	63	1.20
19	*Ageratina adenophora* (Spreng.) R.M.King & H.Rob. (SUH856)	Banmara	Asteraceae	Cuts, bruises	Leaves, tender stem	Crushed	Crushed tender stem and leaf extract applied on cuts and bruises	0.3	100	0.40

… Contd.

Table 1 — Ethnomedicinal plants used by Mangar tribe of Mamley and Kamrang Villages in Sikkim (Contd.)

Sl. No.	Scientific Name	Local Name	Family	Disease /Ailment	Parts Used	Mode of Application	Mode of Treatment	UV	FL (%)	CI
20	*Jatropha curcas* L. (SUH857)	Kadam	Euphorbiaceae	Dental diseases	Stem	Chewed	Stem chewed or rubbed on teeth to prevent dental problems.	0.08	100	0.08
21	*Kaempferia rotunda* L. (SUH858)	Bhuichampa	Zingiberaceae	Bone fractures	Bulbs	Mashed	Bulb paste bandaged on fractures to reduce swelling.	0.16	100	0.16
22	*Litsea cubeba* (Lour.) Pers. (SUH859)	Siltimbur	Lauraceae	Gastritis	Fruit	Crushed, decoction, eat raw	Ground fruits consumed to treat gastritis	0.02	100	0.12
23	*Mentha spicata* L. (SUH860)	Pudina	Lamiaceae	Gastritis, cold	Leaves	Crushed	Crushed green leaves eaten for gastritis and cold	0.28	40	0.32
24	*Moringa oleifera* Lam. (SUH861)	Sajana	Moringaceae	High blood pressure	Flower, stick,	Cooked	Flowers and stick cooked as vegetable to lower blood pressure	0.1	100	0.06
25	*Murraya koenigii* (L.) Spreng.(SUH862)	Curry patta	Rutaceae	Fever, dysentery	Leaves, fruits	Crushed, boiled	Leaf juice with water taken for fever; boiled fruit consumed for dysentery	0.02	50	0.04
26	*Nephrolepis cordifolia* (L.) C. Presl (SUH863)	Pani amala	Nephrolepidaceae	Diabetes	Tubers	Eat (Raw/boiled)	Tubers are taken as anti-diabetic	0.08	100	0.06
27	*Ocimum basilicum* L. (SUH864)	Babari	Lamiaceae	Measles, allergic reaction, fever	Tender leaves, flower	Crushed, paste	Juice taken for fever; paste applied on allergy	0.04	50	0.12
28	*Ocimum tenuiflorum* L. (SUH865)	Tulsi	Lamiaceae	Fever, diarrhoea	Leaves	Crushed, Eat (raw), decoction	Crushed leaf juice taken for fever and diarrhoea	0.94	37	0.76
29	*Oroxylum indicum* (L.) Kurz (SUH866)	Totola	Bignoniaceae	Diabetes, high blood pressure	Seed, flower	Eat raw, cooked	Cooked flowers consumed for high blood pressure; seeds for diabetes	0.18	67	0.24
30	*Phlogacanthus thyrsiformis* (Roxb. ex Hardw.) Mabb. (SUH867)	Tetay	Acanthaceae	High blood pressure, diabetes	Flowers	Cooked	Cooked flowers eaten to lower blood pressure and diabetes	0.24	62	0.28
31	*Phyllanthus emblica* L. (SUH868)	Amala	Phyllanthaceae	Gastritis, high blood pressure, diabetes	Fruits	Chewed (raw), cooked	Raw fruit chewed and juice inhaled for gastritis, blood pressure, and diabetes	0.2	20	0.30
32	*Piper nigrum* L.(SUH869)	Mariz	Piperaceae	Throat pain, gastritis	Fruit	Powder	Powder in hot water taken for throat pain and gastritis	0.02	100	0.10
33	*Plumbago zeylanica* L.(SUH870)	Chetu	Plumbaginaceae	Bone fracture	Leaf	Crushed	Leaf paste applied on bone fracture	0.06	100	0.04
34	*Psidium guajava* L. (SUH871)	Ambak	Myrtaceae	Dysentery	Tender leaves, bark	Boiled, eat (Raw)	Leaves and bark boiled or chewed raw for dysentery	0.1	100	0.16
35	*Saccharum officinarum* L. (SUH872)	Ukhu	Poaceae	Jaundice, urinary diseases	Stem	Eat (Raw), crushed	Juice taken for jaundice and urinary disorders	0.14	75	0.14
36	*Tagetes erecta* L. (SUH873)	Saipatri	Asteraceae	Sore throat, throat pain	Dry flowers	Chewed (raw)	Dry flower chewed for sore throat and throat pain	0.02	100	0.08
37	*Terminalia bellirica* (Gaertn.) Roxb. (SUH874)	Barra	Combretaceae	Cough and cold	Fruit	Chewed raw	Fruit consumed for cough and cold	0.04	100	0.04

… *Contd.*

Table 1 — Ethnomedicinal plants used by Mangar tribe of Mamley and Kamrang Villages in Sikkim (Contd.)

Sl. No.	Scientific Name	Local Name	Family	Disease /Ailment	Parts Used	Mode of Application	Mode of Treatment	UV	FL (%)	CI
38	*Terminalia chebula* Retz. (SUH875)	Harra	Combretaceae	Sore throat, cough	Fruits	Chewed (raw)	Fruit consumed for sore throat and cough	0.66	54	0.76
39	*Tinospora cordifolia* (Willd.) Miers (SUH876)	Gurjo	Menispermaceae	Joint pain, body ache	Stem	Powder	Powder mixed with water taken for body and joint pain	0.08	100	0.14
40	*Urtica dioica* L.(SUH877)	Sisnu	Urticaceae	Bone fracture, high blood pressure	Roots and flower	Mashed, cooked	Mashed root paste applied on fractures; cooked flowers eaten to lower blood pressure	0.28	50	0.26
41	*Viscum articulatum* Burm.f.(SUH878)	Harchur	Santalaceae	Bone fracture	Leaf, stem	Crushed	Stem ground and leaves applied to the affected area	0.1	100	0.12
42	*Zanthoxylum armatum*DC. (SUH879)	Timbur	Rutaceae	Cough and cold	Fruit	Crushed	Crushed fruit consumed for cough and cold	0.06	100	0.06
43	*Zingiber officinale* Roscoe (SUH880)	Aduwa	Zingiberaceae	Cough, throat infection, gastritis	Rhizome	Eat raw, boiled	Rhizome taken orally for cough and throat infection; boiled rhizome consumed for gastritis	0.24	38	0.24
44	*Zingiber zerumbet* (L.) Smith (SUH881)	Phachyang	Zingiberaceae	Joint pain	Rhizome	Crushed	Crushed rhizome applied to affected area	0.02	100	0.02
45	*Swertia chirayita* (Roxb. ex Fleming) H. Karst. (SUH882)	Chirawto	Gentianaceae	Fever	Leaves, Stems	Boiled	The dried leaves and stems are boiled and consumed as tea	0.08	100	0.08
46	*Astilbe rivularis* Buch.-Ham. ex D. Don (SUH883)	Budo Okhati	Saxifragaceae	Body Pain	Rhizome	Boiled and cooked	Crushed rhizome is boiled and administered orally	0.06	100	0.10

Parts used and mode of application

The most harvested plant part was leaves (26%), followed by fruits (17%), and stems and rhizomes (8% each) (Fig. 4). Species such as *Artemisia vulgaris*, *Aloe vera*, *Allium hookeri*, *Chenopodium album*, *Ageratina adenophora*, and *Mentha spicata* were primarily used for their leaves.

Documented plants were applied in various ways for treating ailments, categorized into ten modes: crushed (23%), boiled (13%), cooked (10%), raw (13%), chewed (13%), mashed (8%), juice (10%), decoctions and powders (4%), and gel (2%) (Fig. 5). The crushed method was the most frequently used, as seen in species like *Artemisia vulgaris* and *Azadirachta indica*, whose leaves are crushed for treatment. Rhizomes of *Bergenia ciliata* and *Curcuma caesia* were also crushed and applied to respective ailments.

Relative Frequency of Citation (RFC) and Use Value (UV)

Drymaria cordata exhibited the highest RFC (0.70), followed by *Ocimum tenuiflorum* (0.60), *Terminalia chebula* (0.44), *Ageratina adenophora* (0.34), and *Aloe vera* and *Artemisia vulgaris* (0.30 each), while *Tectaria coadunata*, *Murraya koenigii*, and *Zingiber zerumbet* showed the lowest values (0.02) (Supplementary Fig. S1).

Based on use value (UV), *Ocimum tenuiflorum* (0.94), *Drymaria cordata* (0.86), and *Artemisia vulgaris* (0.66) were the most prominent species (Table 1), whereas *Allium hookeri*, *Cinnamomum tamala*, and *Cynodon dactylon* had the lowest UV (0.02). High UV reflects extensive use, while low values indicate limited application. Notably, *Ocimum tenuiflorum* and *Drymaria cordata* emerged as key ethnomedicinal species with broad therapeutic use.

Information Consensus Factor (ICF) analysis of ailments

The Informant Consensus Factor (ICF) showed high agreement among Mangar informants for all 14 categories of ailments, pointing to a cohesive traditional knowledge system (Table 2). Absolute agreement was seen for blood purifier and Urinary Tract Infection (UTI), where ICF was 1.00, signifying complete agreement among all informants for plant choice. Similarly, high levels of agreement were seen for Fever (0.93), Respiratory (0.92), Internal and External wounds (0.91), Migraine (0.90), and Stomach

Fig. 3 — (a) *Urtica dioica*,(b) *Tinospora cordifolia* (c) *Piper nigrum*, (d) *Allium hookeri* (e) *Terminalia chebula* (f) *Saccharum officinarum* (g) *Phlogacanthus thyrsiformis* (h) *Astilbe rivularis* (i) *Ocimum tenuiflorum* (j) *Oroxylum indicum* (k) *Murraya koenigii* (l) *Bergenia ciliata* (m) *Moringa oleifera* (n) *Mentha spicata* (o) *Jatropha curcas* (p) *Kaempferia rotunda* (q) *Cuscuta reflexa* (r) *Chenopodium album* (s) *Calamus erectus* (t) *Curcuma caesia*

related problems (0.90), pointing to well-established traditional knowledge systems for common ailments. Similarly, moderately high levels of agreement were seen for Diarrhoea/dysentery (0.88), Bone fracture (0.86), and High Blood Pressure (0.86). Lower levels of agreement were seen for Diabetes (0.82), Physical pain (0.83), and Gastritis (0.83), with Jaundice having the lowest agreement at 0.75. These findings point to more varied traditional knowledge and possibly less standardised plant choice for these ailments. Overall, the high ICF values underscore the perceived efficacy and strong homogeneity of medicinal plant use within the community.

Ailment-specific fidelity of documented medicinal plants

Fidelity Level (FL) values represent the level of informant agreement concerning the medicinal plant species under consideration. Higher Fidelity Level values, close to 100%, obtained for plant species such as *Aloe vera*, *Artemisia vulgaris*, *Calamus erectus*, and *Psidium guajava* indicate the specialized treatment preferences of the informants concerning the treatment of cuts, wounds, dysentery, and diabetes, respectively.

In contrast, species such as *Ocimum tenuiflorum*, *Mentha spicata*, and *Phyllanthus emblica* presented moderate to lower FL values. This does not indicate lower medicinal value, but rather a therapeutic versatility, whereby a single species has been adapted to target a variety of ailments. Species with high values for Use Value (UV) and FL, such as *Drymaria cordata* and *Artemisia vulgaris*, are flagged as culturally important and are considered first-line candidates for phytochemical and pharmacological screening in the future. Overall, the FL approach has revealed the adaptive and complex nature of indigenous medicine through its demonstration of a pattern of high ailment-specific fidelity among a subset of species, and a pattern of therapeutic versatility among others.

Informant consensus and fidelity patterns in medicinal plants

Combined analysis of Informant Consensus Factor (ICF) and Fidelity Level (FL) resulted in the identification of patterns in the structured Mangar ethnomedicinal system. For instance, ailments such as Internal and external wounds, Fever, Respiratory, Migraine, and Stomach related problems were associated with very high informant consensus values, such as 0.91, 0.93, 0.92, 0.90, and 0.90, respectively. However, Diabetes, Gastritis, and Physical pain were associated with relatively lower informant consensus values, such as 0.82, 0.83, and 0.83, respectively, implying a relatively more open-ended approach to plant selection. Species fidelity analysis helped to further elucidate these patterns. *Aloe vera* (cuts and burns), *Artemisia vulgaris* (cuts and wounds), *Bergenia ciliata* (wounds), *Kaempferia rotunda* and *Plumbago zeylanica* (bone fracture), *Psidium guajava* (diarrhoea/dysentery), *Swertia chirayita* (fever), and *Viscum articulatum* (bone fracture) were among the taxa that showed full ailment specificity (FL = 100%). Evidence for strong ailment-specific cultural agreement can also be seen from the convergence of high ICF values such as Internal and external wounds (0.91) and Fever (0.93) with species having FL = 100%. On the other hand, species such as *Drymaria cordata* (UV = 0.86; FL = 63%), *Ocimum tenuiflorum* (UV = 0.94; FL = 37%), and *Terminalia chebula* (FL = 54%) with high frequency of citation had moderate fidelity levels. Their lower value indicates multifunctional application in multiple categories of ailments. This suggests that instead of exclusivity, high levels of agreement in such cases can be attributed to general household knowledge and therapeutic flexibility. Overall, these results show two complimentary patterns within the Mangar ethnomedicinal system: 1) multifunctional "hub" species with high use value but moderate fidelity,

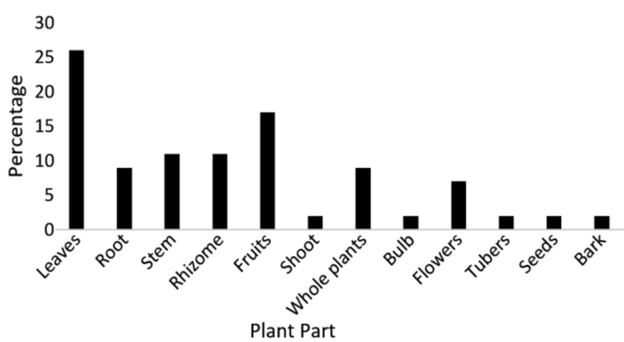

Fig. 4 — Relative use (%) of the documented medicinal plant species

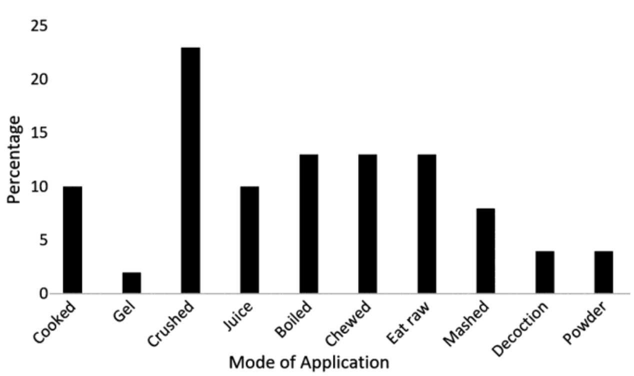

Fig. 5 — Various mode of application of ethnomedicinal plants of study area

Table 2 — Different ailment categories and their ICF value recorded in the study area

Ailment category	Diseases	ICF
Bone fracture	Bone fracture	0.86
Diabetes	Diabetes	0.82
Gastritis	Gastritis	0.83
High Blood Pressure	Hypertension	0.86
Internal and external wounds	Cuts, wounds, bruises, nose bleeding	0.91
Physical pain	Body ache, toothache, joint pain, sore throat	0.83
Fever	Fever	0.93
Respiratory	cold, cough, sinusitis	0.92
Jaundice	Jaundice	0.75
Migraine	Migraine	0.90
Diarrhoea/dysentery	Diarrhoea/dysentery	0.88
Blood purifier	Blood purifier	1
Stomach related problems	Stomach-related problems	0.90
UTI (Urinary Tract Infection)	Burning sensation during urination	1

and 2) ailment-specialist species with high FL and high ICF. This dual structure highlights the community's conventional healthcare knowledge's specialisation and adaptability.

Cultural importance index (CI)

The range for the Cultural Importance Index (CI) among the 50 informants varied from 0.02 to 1.20. The CI for *Drymaria cordata* was found to be the highest at 1.20, followed by *Ocimum tenuiflorum* and *Terminalia chebula* at 0.76, and then *Artemisia vulgaris* and *Ageratina adenophora* at 0.40. The lowest CI was found for *Tectaria coadunata* and *Zingiber zerumbet* at 0.02, while *Aloe vera*, *Mentha spicata*, and *Phyllanthus emblica* showed moderate values. Overall, higher CI values reflect broader recognition and greater cultural significance among informants.

Hierarchical cluster analysis of species co-citation patterns

Hierarchical cluster analysis using the Jaccard similarity coefficient indicated the existence of a structured organization in plant knowledge, with three major clusters at a rescaled distance of ~15. The first cluster consisted of closely associated, frequently co-cited and multipurpose species (e.g., *Drymaria cordata*, *Ocimum tenuiflorum*, *Aloe vera*, and *Terminalia chebula*), indicating the core part of the ethnomedicinal system and high use values. The second cluster consisted of moderately associated speciessuch as *Bergenia ciliata*, *Azadirachta indica*, *Swertia chirayita*, and *Tinospora cordifolia*, forming a transitional group between core and peripheral taxa. The third cluster consisted of a heterogeneous group of peripheral and specialized species (e.g., *Zanthoxylum armatum*, *Curcuma longa*, *Murraya koenigii*, and *Zingiber zerumbet*), some of which formed small sub-clusters while others remained relatively distinct. The clustering pattern also reveals internal sub-structuring within intermediate and peripheral groups, with species such as *Cinnamomum tamala*, *Carica papaya*, and *Jatropha curcas*, as well as *Zanthoxylum armatum* and *Terminalia bellirica*, forming distinct sub-clusters, while taxa like *Zingiber zerumbet* remain relatively isolated. These patterns indicate finer therapeutic associations among certain species. In general, the pattern reveals that ethnomedicinal knowledge in the Mangar Community is not randomly arranged but rather follows a hierarchical, core-periphery structure, in which the multipurpose species are the central therapeutic nucleus, while the disease specialists are located in the peripheral but culturally significant positions (Fig. 6).

Discussion

The study revealed clear patterns in the use, cultural importance, and consensus of medicinal plant species, highlighting the coexistence of widely cited multipurpose taxa and specialized species in traditional healthcare. Inferential analyses showed no significant differences in ethnomedicinal knowledge across demographic groups, indicating that such knowledge is collectively maintained and broadly distributed within the community through shared cultural practices and oral traditions[22].

A total of 46 medicinal species from 33 families were documented, with Zingiberaceae, Lamiaceae, and Asteraceae being the dominant families. Zingiberaceae is also reported as the most important family among the Limboo of KBR and Lepcha of Dzongu, North Sikkim[12,14]. Similarly, Asteraceae with 342 species reported in Sikkim[23] is another family widely prominent in the ethnomedical usage of Mangar community. Plant families with higher species diversity are more likely to possess a wide range of bioactive compounds and should be investigated for pharmacological properties[24]. Herbs were the most used medicinal plants by the Mangar community, similar to reports from the Limboo tribe in South-West Khangchendzonga Biosphere Reserve, Sikkim[12].

While this study found leaves to be the most harvested, studies in Kitam Bird Sanctuary, South Sikkim, reported fruits as the most used[9]. However, earlier research identifies leaves as the predominant part for treating various ailments[10-13].The underground parts of medicinal plants, such as the roots, rhizomes, and bulbs, have reportedly been the most widely utilised components in Sikkim's higher elevation areas[14]. Some of the plant species used for its leaf parts in the present study are *Artemisia vulgaris, Aloe vera, Allium hookeri*, *Chenopodium album*, *Ageratina adenophora*, *Mentha spicata*. The dominance of leaf harvesting (26%) indicates that the use is relatively sustainable, as the ecological impact is generally lower compared to root/rhizome harvesting. The sources of most species, according to the informants, are found in nearby forests, fallow land, and agricultural areas, and are mostly used for domestic consumption rather than commercial sale. Species that involve rhizome use, such as *Bergenia ciliata*, may

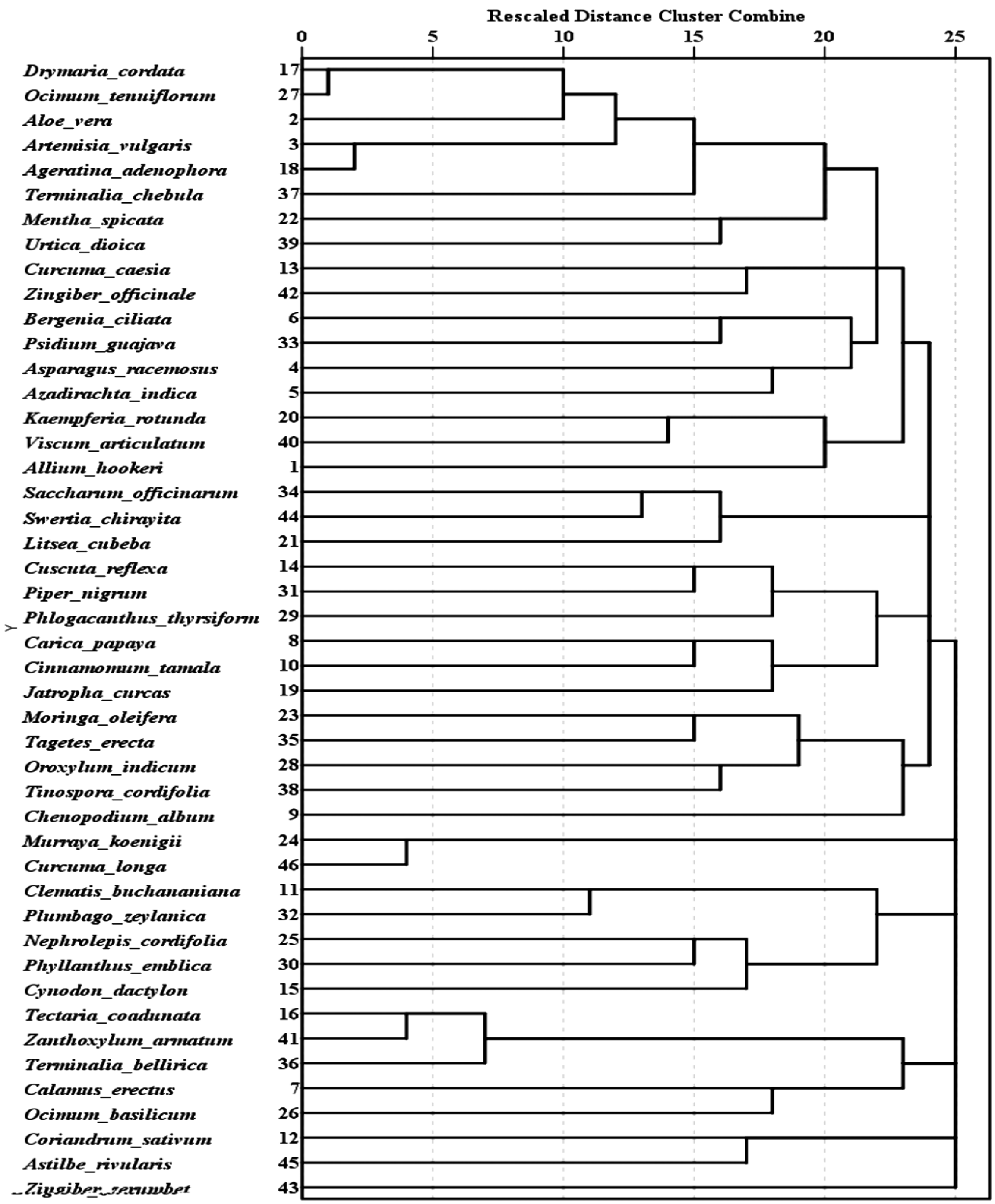

Fig. 6 — Hierarchical cluster dendrogram of 46 medicinal plant species based on informant citation patterns using Jaccard similarity and average linkage (between groups)

need to be monitored to prevent over-harvesting, especially in the fragile Himalayan environment, where regeneration is slow, and habitats are specific[3]. These findings suggest that plant use in the community of Mangar does not occur in a purely extractive manner, but is part of local ecological awareness and patterns of seasonal harvest, reflecting adaptive resource management practices.

The modes of preparation, dominated by crushed, boiled, chewed, and cooked formulations, indicate reliance on simple and accessible therapeutic processing methods characteristic of traditional healthcare systems[25]. However, it may also be noted that the ethnomedicinal use of plants varies across different states in Northeast India, reflecting the diverse cultural practices of indigenous communities. For instance, *Aloe vera* is used for cuts and burns by the Mangar, but for lice, fever, diarrhoea, and dysentery by the Angami of Nagaland[26]. Likewise, *Zingiber officinale* treats cough and asthma among the Meitei of Manipur[27], but gastritis among the Mangar of Sikkim.

Quantitative indices highlighted the cultural importance of key taxa. *Ocimum tenuiflorum* showed the highest use value (UV = 0.94), indicating its central role in household healthcare and ritual practices in the Mangar community. High use value and citation frequency reflect cultural importance and may indicate long-term empirical validation in traditional medical systems[28,29].

Species with low use value in this study, such as *Allium hookeri*, *Cinnamomum tamala*, and *Cynodon dactylon*, show high use value in Uttarakhand, and Madhya Pradesh[30,31]. *Drymaria cordata* recorded the highest RFC (0.70) and second highest UV (0.86), used here for sinusitis, throat pain, and fever, but for jaundice by Assam's tea tribes[32], skin diseases by Adi tribes, and fever by Monpa tribes[33].

The Cultural Importance Index (CI), together with UV and RFC, helped provide a holistic measurement of the cultural importance of plants by incorporating citations and medicinal uses in addition to use frequency. CI scores were between 0.02 and 1.20 for this study, signifying a varying degree of acceptance and effectiveness of the plants used. Species with high CI scores are those that are popularly known[21], commonly used, and utilized in a variety of diseases.

Drymaria cordata showed the highest Cultural Importance (CI = 1.20), underscoring its role as a key multipurpose species in Mangar traditional healthcare. *Terminalia chebula* and *Ocimum tenuiflorum* also exhibited relatively high CI (0.76), indicating strong therapeutic relevance. Moderately used species included *Mentha spicata*, *Aloe vera*, *Ageratina adenophora*, and *Artemisia vulgaris*, reflecting notable but less intensive use. Similar results have also been obtained for other studies, where frequently cited and multipurpose species often emerge as culturally important species for traditional healthcare systems of the native populations[34]. The convergence of high CI with elevated Use Value (UV) and Relative Frequency of Citation (RFC), particularly for *Drymaria cordata* and *Ocimum tenuiflorum*, highlights their central role in the community's ethnomedicinal system, driven by frequent use, cultural embeddedness, and intergenerational knowledge transmission.

The highest value of ICF was found to be associated with blood purification and Urinary Tract Infection (UTI) treatment (1), with *Phyllanthus emblica* and *Saccharum officinarum* being used due to antioxidant, detoxifying, and antimicrobial properties[35,36]. Remedies for the treatment of fever (ICF 0.93) included *Ocimum tenuiflorum* and *Zingiber officinale*, which are known to display anti-inflammatory, antioxidant, analgesic, and immunomodulatory properties[37,38]. Respiratory problems (ICF 0.92) were treated with *Mentha spicata* and *Kaempferia rotunda*. *Mentha spicata* is traditionally used to cure cough and cold[39], and *Kaempferia* species, of which *Kaempferia galangal* has been reported for their traditionally use to cure cough and asthma[40]. The lowest ICF (0.75) was for jaundice, for which *Drymaria cordata* has also been reported from Assam[41].

Species exhibiting complete fidelity (FL = 100%) indicate exclusive association with specific ailments and represent culturally specialized therapeutic taxa within the Mangar ethnomedicinal system. Species such as *Aloe vera, Artemisia vulgaris, Bergenia ciliata, Kaempferia rotunda, Plumbago zeylanica, Psidium guajava, Swertia chirayita*, and *Viscum articulatum* showed strong ailment-specific use. Such a high degree of fidelity, therefore, would be attributed not only to specificity in pharmacology but would also be a reflection of socially constructed therapeutic identity, implying that there was a general agreement among people that these plants were culturally approved remedies. High agreement among informants would be an indication of culturally validated knowledge of plants, which was socially constructed[42]. The convergence of maximum fidelity (FL = 100%) with high Informant Consensus Factor values, such as wounds (ICF = 0.91) and fever (ICF = 0.93), indicates a culturally consolidated therapeutic core. This pattern suggests that knowledge of these ailment-specific, high-fidelity taxa is widely shared and transmitted across generations, reflecting stable biocultural traditions. High consensus in this context signifies structured cultural agreement and collective memory within an organized indigenous medical system[43].

The overlap of high FL and ICF identifies species that are both pharmacologically promising and culturally central, reflecting specialization, symbolic value, and knowledge transmission shaped by shared practice as much as biological efficacy. While the use of plants such as *Aloe vera* and *Swertia chirayita* is well documented, the use of *Viscum articulatum*, *Bergenia ciliata*, and *Astilbe rivularis*, among others, also indicates high levels of local agreement, underscoring the need for region-specific ethnopharmacological validation and conservation, especially for the Himalayan region[3,44,45].

Hierarchical cluster analysis using the Jaccard similarity method indicated the presence of a non-random pattern in the medicinal plant knowledge of the Mangar community. A core–periphery pattern was observed, with highly co-cited multipurpose species such as *Drymaria cordata*, *Ocimum tenuiflorum*, *Aloe vera*, and *Terminalia chebula* forming the central cluster, reflecting shared knowledge networks. Such clustering patterns indicate cognitive classification and functional grouping of medicinal plants based on cultural experience and therapeutic reliability[44]. The intermediate cluster, consisting of *Bergenia ciliata*, *Swertia chirayita*, and *Tinospora cordifolia*, shows the overlapping therapeutic use, and the peripheral clusters consisting of specialist species show ailment-specific knowledge among fewer informants. The hierarchical structure shows that the Mangar ethnomedicinal knowledge is not random but culturally organized and influenced by the socio-ecological interface and collective memory.

Overall, the integration of quantitative indices, inferential statistics, and cluster analysis reveals that Mangar ethnomedicinal knowledge is highly consensual, structured, and shaped by long-term human–environment interactions. These findings highlight traditional healthcare as a socio-ecological system integrating medicinal, cultural, and ecological values[44].

Conclusion

This study documents 46 wild medicinal plant species from 33 families used by the Mangar community of South Sikkim, revealing a structured and culturally embedded ethnomedicinal system. The use of quantitative indices such as RFC, UV, FL, ICF, CI, and inferential statistics, along with cluster analysis has proved that traditional knowledge is collectively shared and systematically organized, with no significant demographic variation, indicating active intergenerational transmission.

High ICF values and a large number of species with complete fidelity (FL = 100%) indicate a high level of cultural consensus and ailment-specific specialization, while multipurpose species such as *Drymaria cordata* and *Ocimum tenuiflorum* are part of the therapeutic core. Cluster analysis further supports a core–periphery structure comprising widely cited “hub” species and culturally validated specialists.

While some species are pharmacologically well established, others with high local consensus require region-specific validation and conservation attention. Overall, the study reaffirms that the ethnomedicinal knowledge of the Mangar community is an integrated biocultural system with a history of long-term socio-ecological interactions and thus warrants documentation and conservation for sustainable healthcare and Himalayan biocultural heritage.

Supplementary Data

Supplementary data associated with this article is available in the electronic form at https://nopr.niscpr.res.in/jinfo/ijtk/IJTK_25(4)(2026) 370-383_SupplData.pdf

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Author Contributions

SG, SKR, AC designed the research, AMT helped in analysis, RG, SR conducted field survey, ARS, AS, RB curated the data.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethics Approval and Consent to Participate

This study involved documentation of traditional knowledge through semi-structured interviews and, as per Sikkim Alpine University Institutional Ethics Committee (IEC) guidelines, was exempt from full ethical review due to its minimal-risk nature. Free Prior Informed Consent (FPIC) was obtained from all participants and community representatives, and participation was voluntary with the study purpose clearly explained.

Data Availability

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

References

1 Irshad Ali A N M & Das I, Tribal situation in North East India, *Stud Tribes Tribals*, 1 (2) (2003) 141-148. https://doi.org/10.1080/0972639X.2003.11886492

2 Dutta B K & Dutta P K, Potential of ethnobotanical studies in North East India: An overview, *Indian J Tradit Know*, 4 (1) (2005) 7-14

3 Kala C P, Ethnomedicinal botany of Apatani tribe in the Eastern Himalayan region of India, *J Ethnobiol Ethnomed*, 1 (2005) 11. https://doi.org/10.1186/1746-4269-1-11

4 Hamil F A, Apio S, Mubiru N K, Mosango M, Bukeny-Ziraba R, *et al*., Traditional herbal drugs of Southern Uganda, I, *J Ethnopharmacol*, 70 (3) (2000) 281-300. https://doi.org/10.1016/s0378-8741(00)00180-x

5 Kirtikar K R & Basu B D, *Indian Medicinal Plants – with illustrations*, 2nd edn (Oriental Enterprises, Dehra Doon, India), 2001.

6 Kala C P, Current status of medicinal plants used by traditional Vaidyas in Uttaranchal, India, *Ethnobot Res Appl*, 3 (2005) 267-278.

7 Ragupathy S, Steven N G, Maruthakkutti M, Velusamy B & Ul-Huda M M, Consensus of the 'Malasars' traditional aboriginal knowledge of medicinal plants in the Vellangiri holy hills, India, *J Ethnobiol Ethnomed*, 4 (2008) 8. https://doi.org/10.1186/1746-4269-4-8

8 Teklehaymanot T & Giday M, Ethnobotanical study of medicinal plants used by people in Zegie Peninsula, Northwestern Ethiopia, *J Ethnobiol Ethnomed*, 3 (2007) 12. https://doi.org/10.1186/1746-4269-3-12

9 Pradhan P, Dasila K & Singh M, Uses of ethnomedicinal plants by the people living around Kitam Bird Wildlife Sanctuary, South Sikkim, India, *Acta Ecol Sin*, 42 (4) (2022) 259-268. https://doi.org/10.1016/j.chnaes.2021.09.020

10 Rajalakshmi S, Vijayakumar S & Arulmozhi P, Ethnobotanical survey of medicinal plants in Thanjavur and its surrounding (Tamil Nadu, India), *Acta Ecol Sin*, 39 (5) (2019) 380-397. https://doi.org/10.1016/j.chnaes.2018.09.010

11 Sharma T P & Sharma S, *Medicinal plants of Sikkim*, (Beracah Printing and Stationery, Gangtok, Sikkim), 2010.

12 Badola H K & Pradhan B K, Plants used in healthcare practices by Limboo tribe in South-West of Khangchendzonga Biosphere Reserve, Sikkim India, *Indian J Tradit Know*, 12 (3) (2013) 355-369.

13 O'Neill A R, Badola H K, Dhyani P P & Rana S K, Integrating ethnobiological knowledge into biodiversity conservation in the Eastern Himalayas, *J Ethnobiol Ethnomed*, 13 (1) (2017) 21. https://doi.org/10.1186/s13002-017-0148-9

14 Pradhan B K &Badola H K, Ethnomedicinal plant use by Lepcha tribe of Dzongu valley, bordering Khangchendzonga Biosphere Reserve, in North Sikkim, India, *J Ethnobiol Ethnomed*, 4 (1) (2008) 22. https://doi.org/DOI: 10.1186/1746-4269-4-22

15 Vitalini S, Iriti M, Puricelli C, Ciuchi D, Segale A, *et al*., Traditional knowledge on medicinal and food plants used in Val San Giacomo (Sondrio, Italy): an alpine ethnobotanical study, *J Ethnopharmacol*, 145 (2) (2013) 517-529. https://doi.org/10.1016/j.jep.2012.11.024

16 Bibi T, Ahmad M, Tareen B R, Tareen N M, Jabeen R, *et al*., Ethnobotany of medicinal plants in district Mastung of Balochistan province-Pakistan, *J Ethnopharmacol*, 157 (2014) 79-89. https://doi.org/10.1016/j.jep.2014.08.042

17 Phillips O, Gentry A H, Reynel C, Wilkin P & Galvez-Durand B C, Quantitative ethnobotany and Amazonian conservation, *Conserv Biol*, 8 (1994) 225-248. https://doi.org/10.1046/j.1523-1739.1994.08010225.x

18 Heinrich M, Ankli A, Frei B, Weimann C & Sticher O, Medicinal plants in Mexico: healers' consensus and cultural importance, *Soc Sci Med*, 47 (11) (1998) 1863-1871. https://dx.doi.org/10.1016/S0277-9536(98)00181-6

19 Logan M H, Informant consensus: a new approach for identifying potentially effective medicinal plants, In: Etkin N L (Ed.), *Plants in Indigenous Medicine and Diet: Biobehavioural Approaches* (Redgrave Publishers, Bedford Hills, NY) (1986) 91-112. https://doi.org/10.4324/9781315060385-6

20 Friedman J, Yaniv Z, Dafni A & Palewitch D, A preliminary classification of the healing potential of medicinal plants, based on a rational analysis of an ethnopharmacological field survey among Bedouins in the Negev desert, Israel, *J Ethnopharmacol*, 16 (2-3) (1986) 275-287. https://doi.org/10.1016/0378-8741(86)90094-2

21 Tardío J & Pardo-de-Santayana M, Cultural importance indices: a comparative analysis based on the useful wild plants of Southern Cantabria (Northern Spain), *Econ Bot*, 62 (1) (2008) 24-39. https://doi.org/10.1007/s12231-007-9004-5

22 Reyes-García V, Godoy R, Vadez V, Apaza L, Byron E, *et al*., Ethnobotanical knowledge shared widely among Tsimane' Amerindians, Bolivia, *Science*, 299 (5613) (2003) 1707. https://doi.org/10.1126/science.1080274

23 Singh H B, Prasad P & Rai L K, Folk medicinal plants in the Sikkim Himalayas of India, *Asian Folkl Stud*, 61 (2002) 295-310. https://doi.org/ 10.2307/1178975

24 Gras A, Hidalgo O, D'Ambrosio U, Parada M, Garnatje T & Vallès J, The role of botanical families in medicinal ethnobotany: A phylogenetic perspective, Plants (Basel), 10 (1) (2021) 163. https://doi.org/10.3390/plants10010163

25 Heinrich M, Barnes J, Gibbons S & Williamson E, *Fundamentals of Pharmacognosy and Phytotherapy*, (Elsevier), 2009.

26 Chase P & Singh O P, Ethnomedicinal plants used by Angami tribe of Nagaland, India, *Indian J Trop Biodivers*, 21 (1&2) (2013) 29-42.

27 Yumnam J Y & Tripathi O P, Traditional knowledge of eating raw plants by the *Meitei* of Manipur as medicine/nutrient supplement in their diet, *Indian J Tradit Know*, 11 (1) (2012) 45-50.

28 Phillips O & Gentry A H, The useful plants of Tambopata, Peru: Statistical hypotheses tests with a new quantitative technique, *Econ Bot*, 47 (1993) 15-32. https://doi.org/10.1007/BF02862203

29 Baydoun S, Chalak, L, Dalleh H & Arnold N, Ethnopharmacological survey of medicinal plants used in traditional medicine by the communities of Mount Hermon, Lebanon, *J Ethnopharmacol*, 173 (2015) 139-156. https://doi.org/10.1016/j.jep.2015.06.052

30 Sikarwar R L S, Pathak B & Jaiswal A, Some unique ethnomedicinal perceptions of tribal communities of Chitrakoot, Madhya Pradesh, *Indian J Tradit Know*, 7 (4) (2008) 613-617.

31 Sharma G & Nautiyal A R, *Cinnamomum tamala*: A valuable tree from Himalayas, *Int J Med Aromat Plants*, 1 (1) (2011) 1-4.

32 Bhattacharyya R, Medhi K K & Borkataki S, Phytochemical analysis of *Drymaria cordata* (L.) Willd. ex Schult. (whole plant) used by tea tribes of erstwhile Nagaon district of Assam, India, *Int J Pharm Sci Res*, 10 (9) (2019) 4264-4269. DOI: 10.13040/IJPSR.0975-8232.10(9).4264-69

33 Ramashankar & Rawat M S, Ethnobotanical observations of *Drymaria cordata* Willd. ex Roem & Schult. (Caryophyllaceae), *Bull Arunachal For Res*, 24 (2008) 22-24.

34 Abbasi A M, Khan M A, Shah M H, Shah M M, Pervez A, *et al*., Ethnobotanical appraisal and cultural values of medicinally important wild edible vegetables of Lesser Himalayas-Pakistan, *J Ethnobiol Ethnomed*, 9 (1) (2013) 66. https://doi.org/10.1186/1746-4269-9-66

35 Liu X, Zhao M, Wang J, Yang B & Jiang Y, Antioxidant activity of methanolic extract of emblica fruit (*Phyllanthus emblica* L.) from six regions in China, *J Food Compos Anal*, 21 (3) (2008) 219-228.

36 Williams I O, Onyenweaku E O & Atangwho I J, Nutritional and antimicrobial evaluation of *Saccharum officinarum* consumed in Calabar, Nigeria, *Afr J Biotechnol*, 15 (33) (2016) 1789-1795. https://doi.org/10.5897/AJB2015.14877

37 Ayustaningwarno F, Anjani G, Ayu A M & Fogliano V, A critical review of Ginger's (*Zingiber officinale*) antioxidant, anti-inflammatory, and immunomodulatory activities, *Front Nutr*, 11 (2024) 1364836. doi: 10.3389/fnut.2024.1364836

38 Bhat H P, Jakribettu R P, Boloor R, Fayad R & Baliga M S, Use of ayurvedic medicinal plants as immunomodulators in geriatrics: Preclinical studies, In: *Foods and dietary supplements in the prevention and treatment of disease in older adults*, (Academic Press), (2015) 143-149. https://doi.org/10.1016/B978-0-12-418680-4.00015-4

39 Mahendran G, Verma S K & Rahman L U, The traditional uses, phytochemistry and pharmacology of spearmint (*Mentha spicata* L.): A review, *J Ethnopharmacol*, 278 (2021) 114266. https://doi.org/10.1016/j.jep.2021.114266

40 Elshamy A I, Mohamed T A, Essa A F, Abd-El Gawad A M, Alqahtani A S, *et al*., Recent advances in *Kaempferia* phytochemistry and biological activity: A comprehensive review, *Nutrients*, 11 (10) (2019) 2396. https://doi.org/10.3390/nu11102396

41 Bhattacharyya R, Medhi K K, Borthakur S K & Borkataki S, An ethnobotanical study of medicinal plants used against jaundice by tea tribes of Morigaon District, Assam (India), *J Nat Remedies*, 20 (1) (2020) 16-28. https://doi.org/10.18311/jnr/2020/23879

42 Trotter R T & Logan M H, Informant consensus: a new approach for identifying potentially effective medicinal plants, In: *Plants in Indigenous Medicine and Diet: Biobehavioural Approaches*, Etkin N L (Ed.), (Redgrave Publishers, Bedford Hills, NY), (1986) 91-112. https://doi.org/10.4324/9781315060385-6

43 Alexiades M N & Sheldon J W, *Selected Guidelines for Ethnobotanical Research: A Field Manual*, (Institute of Economic Botany, New York Botanical Garden, Bronx, NY), (1996).

44 Albuquerque U P, de Lucena R F P, da Cunha L V F C & Alves R R N, *Methods and Techniques in Ethnobiology and Ethnoecology*, (Springer, Humana Press, New York), 2019.

45 Ghimire S K, McKey D & Aumeeruddy-Thomas Y, Himalayan medicinal plant diversity in an ecologically complex high altitude anthropogenic landscape, Dolpo, Nepal, *Environ Conserv*, 32 (2) (2006) 128-140. https://doi.org/10.1017/50376892906002943