



Quantitative assessment of ethnomedicinal plants utilized by the Eastern Himalayan tea garden workers, India

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Research

Abstract

Background: The Eastern Himalaya is rich in diverse flora and is home to indigenous communities. The present study was undertaken to document the understudied traditional medicinal wisdom of tea garden workers in the Eastern Himalayas, India.

Methods: Ethnomedicinal surveys and interviews were conducted between 2019 and 2024, involving 127 informants (92 male and 35 female) aged 20-90 years. Data analysis utilised quantitative indices, statistical tools, and the Jaccard index (JI) and Rehman's Similarity Index (RSI).

Results: Informants reported 193 ethnomedicinal plants used to treat 15 disease categories. Leaves represented the most commonly utilised plant part and were generally prepared as decoctions. The highest Informant Consensus Factor (ICF) was associated with bone-related disorders (0.65). *Ocimum tenuiflorum* demonstrated the highest Use Value (UV) at 0.078. Among the documented plants, 84 showed 100% Fidelity Level (FL), indicating exclusive use; *Ocimum tenuiflorum* had the lowest FL (7.14%), indicating versatile use.

Conclusions: The plants with high Use Value and Fidelity Level can be subjected to further pharmacological studies to validate ethnomedicinal knowledge of the tea garden workers of the Eastern Himalaya.

Keywords: Quantitative study, ethnomedicines, tea garden workers, indigenous community, Eastern Himalaya

Background

Ethnobotanical studies of the indigenous communities are the global practice to explore and document the traditional uses of medicinal plants (Thirumalai *et al.* 2009; Sarkar *et al.* 2025a). The World health organization also supports the documentation and conservation of traditional knowledge of the indigenous communities (Buragohain 2011). It has been reported that less than 10% of the global medicinal plant species have been studied scientifically and more than 50% of the pharmacologically important active compounds have been discovered through ethnomedicinal sources (Redouan *et al.* 2022). India, being one of the 12 mega diversity countries represents nearly 8% of the global biodiversity, and 2 % endemism. Additionally, it is rich in 550 different ethnic identities and more than 5000 tribal communities make 15 % of the total Indian

population (Ahirwar & Gupta 2024). The combination of biodiversity and ethnic communities help to flourish traditional medicines in any corner of the globe as the indigenous communities depends on the forest resources for their health care. These people know the sustainable use and conservation of medicinal plant resources (Baidya *et al.* 2020; Sarkar *et al.* 2025b).

The tea gardens of Darjeeling, Kalimpong, and Sikkim Himalayas are nestled in the lap of Mount Kunchenjunga and rich in associated diverse plant habitats due to close vicinity of Singalila National Park, Senchel Wild Life Sanctuary, Mahananda Wild Life Sanctuary and Neora Valley National Park of Eastern Himalaya. The tea garden workers represent diverse assemblage of *Nepali* ethnic communities like *Khas*, *Kirat*, *Tamang*, *Gurung*, *Mangar*, *Newar*, *Bahun*, *Bhujel*, *Mukhia*, *Limbu*, *Yolmo*, and scheduled castes as well as *Lapche (Lepcha)*, *Sherpa*, and *Bhutia*. Their coexistence in this serene place contributes significantly to its diverse culture and social richness. These Himalayan tea garden workers live close to the Nature and uses traditional natural remedies for their primary health care (Chettri & Chowdhury, 2018).

The tea garden workers are paid low remuneration; with soaring prices they find difficult to meet the basic necessities of life. Modern health care services are beyond their reach; even the hospitals and dispensaries are undermanaged. Traditional medicines on the other hand derived from their age-old traditions, free of cost, easily available, and most importantly they have complete faith on it. All these factors contribute to their dependency on ethnomedicines.

The ethnomedicinal practices of the tea garden people not only uphold the local traditions but have significant ramifications for worldwide conservation and bio-cultural preservation. Exploring these traditionally rich yet underrepresented communities offers important insights into sustainable resource management, and their distinct expertise could help to guide global initiatives in fair benefit-sharing and natural product research.

From our study and previous records it is observed that the tea garden workers suffer mostly from gastrointestinal disorders including piles, jaundice, food poisoning, stomach pain, and gastritis as well as bone related disorders mainly bone fractures, and urological disorder like UTI (Chettri & Chowdhury, 2018; Chettri *et al.* 2024) They address these problems through traditional folk medicines prepared from the locally available ethnomedicinal plants. They use various plant parts such as leaves, roots, barks, flowers, fruits, seeds etc to make poly-herbal or mono-herbal formulations and administered as decoction, infusion, powder, juices, or apply as pastes.

There are copious previous literatures that simply document the ethnomedicinal plants and their uses (Chhetri *et al.* 2005; Tamang *et al.* 2023; Chhetri *et al.* 2024). None of the authors took up this kind of work covering vast tea gardens spreading over the two hilly districts of one state and the tea garden of neighbouring state. Previously, Quantitative approach seems to apply to the restricted area only (Subba *et al.* 2023). However, in the present study, endeavour has been made to imply quantitative indices and statistical tools to analyze the data collected from the herbal practitioners, and the healers from this region. Hence, the main objectives of the present study are to: i) document and conserve the age-old traditions of healing which has been threatened by gap in the inter-generational knowledge transfer due to lack of interest among youths ii) apply quantitative methods to the ethnomedicinal knowledge of the tea garden workers of Darjeeling, Kalimpong and Sikkim Himalaya iii) find out the homogeneity of the knowledge among the informants iv) compare the ethnomedicinal plants and their uses to treat the same ailment using JI and RSI respectively, v) explore and select the mostly cited plants to treat specific disorder and the plants having diverse use for further pharmacological study considering the intellectual property rights of the knowledge holders.

Materials and Methods

Study area

Historical profile

The hilly regions of Darjeeling, Kalimpong, and Sikkim, though now in separate Indian states share a historical connection, as parts of the ancient Sikkimese kingdom. Originally, Sikkim was home to indigenous communities like *Laapche (Lepcha)*, *Limbu* and *Mangar* (Subba, 2008). In 1642 the *Laapche* and *Limbu* (except *Mangar*) joined Bhutia settlers to establish Namgyal dynasty through 'Lho-Mun Tsong-Sum' agreement forming 'Greater Sikkim' encompassing present day Darjeeling and Kalimpong. With time, this region witnessed Bhutanese control, Nepal invasion, British colonial interventions, with Darjeeling ceded to British India in 1835 while Kalimpong in 1865 (Subba, 2008). Sikkim retained independence till it merged with India in 1975 (Arora, 2006).

Dr. Arthur Campbell and Major Crommelin during 1847 - 1850 initiated tea cultivation in Darjeeling in an experimental basis from the seeds imported from China. As the tea industry grew, it became a major economic activity, attracting labour from

tribal communities across India, and Nepal, who were drawn by promise of jobs in the tea gardens. This influx made Darjeeling's tea estates a vibrant cultural hub, alongside the original *Laapche* and Nepalese population (Khawas, 2006). In Sikkim, Temi tea estate was established by the Government of Sikkim during 1968- 1969 under the Refugee Rehabilitation program of United Nation Organisation (UNO) (Sharma, 2003).

Geography and Administrative blocks

Darjeeling, often called the 'Queen of the Hills' is nestled in the eastern Himalayas spanning latitudes 26° 27' 05" to 27° 13' 10" N and longitudes 87° 59' 30" to 88° 53' 22" E covering total area of 3,149 sq. Km. The region is crowned by the Mount Kunchenjunga, and traversed by rivers like Teesta, Rangeet, Balasun and Mahananda (Chettri *et al.* 2014). Its elevation ranges from 150 m to 3,600 m supporting diverse climates and vegetations. Tea cultivation thrives from lowlands to nearly 2,043 m (Raageroong T.E.). In Sikkim, the Temi tea garden (27° 14' 16" N & 88° 24' 44" E) stands as the sole tea estate located in South Sikkim at an average altitude of 1,623 m.

All the tea gardens are located in five different administrative blocks of Darjeeling hills like, Jorebunglow SukhiaPokhri, Darjeeling Pulbazar, Mirik, Kurseong, and TeestaRangeet; Gorubathan block of Kalimpong district and South Sikkim of the state of Sikkim (Fig. 1, Table 1).

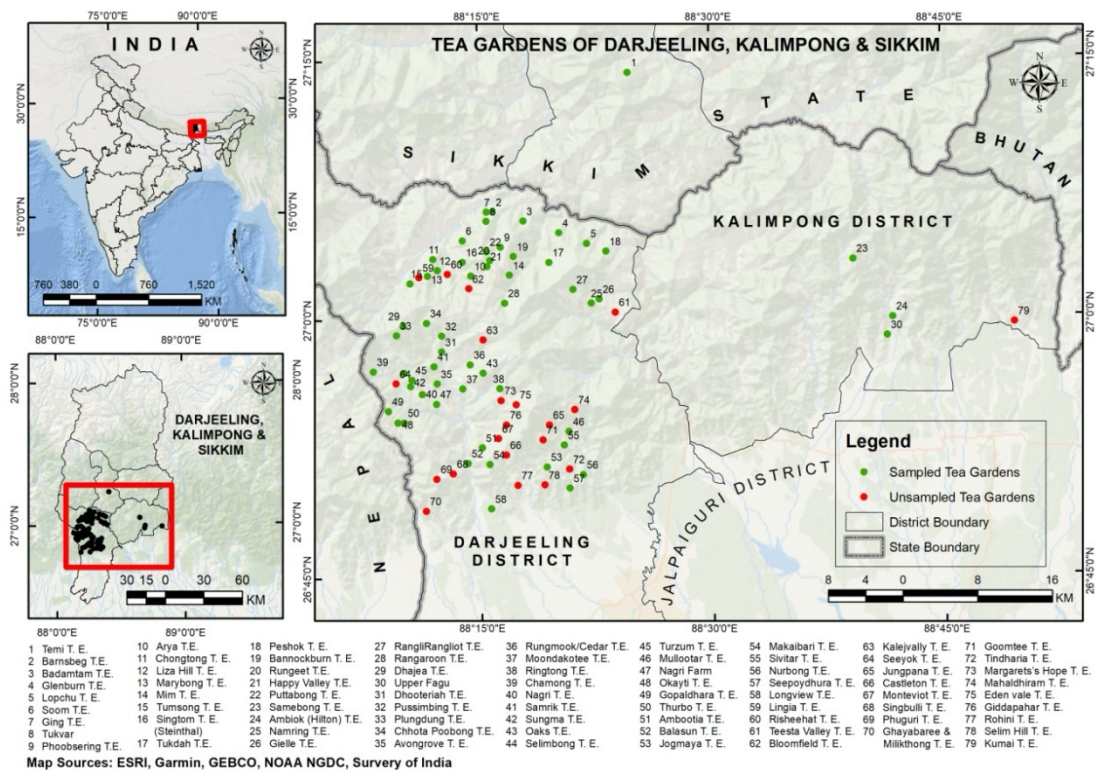


Figure 1. Map showing location of study area (tea gardens of West Bengal Himalaya and Sikkim), India [Source: SOI, SRTM DEM]

Table 1. List of the villages surveyed in 58 tea gardens

Tea Estates (T.E.)	Block	Lat	Long	Village Name	Mean Altitude (m)
Temi T. E.	South Sikkim	27.237778	88.412222	1 No. Dhura	1623
Barnsbeg T.E.	Darjeeling Pulbazar	27.104167	88.264722	Limbu Busty	795
Badamtam T.E.	Darjeeling Pulbazar	27.095	88.297778	Thado line, Himali Gaon, Dhade Gaon	634
Glenburn T.E.	RangliRangliot	27.083333	88.336389	Bara Gaon	892
Lopchu T. E.	RangliRangliot	27.072778	88.366389	Dara Gaon, Lopchu Bajar	819
Soom T.E.	Darjeeling Pulbazar	27.076389	88.231944	Top Line	1174

Ging T.E.	Darjeeling Pulbazar	27.103889	88.258333	Mandir Gaon	494
Tukvar	Darjeeling Pulbazar	27.095	88.258056	Lapche Busty, 1 no.	924
Phoobsering T.E.	Darjeeling Pulbazar	27.07	88.273056	Naya Busty, 15 no.	1376
Arya T.E.	Darjeeling Pulbazar	27.042222	88.241111	Tamang Gaon	1557
Chongtong T. E.	Darjeeling Pulbazar	27.058611	88.200278	Salla Bari	1126
Liza Hill T. E.	Darjeeling Pulbazar	27.047778	88.204722	Mansidhura	1153
Marybong T. E.	Darjeeling Pulbazar	27.0425	88.194167	Gumba Dara	1409
Mim T. E.	JorebunglowSukhiapokhri	27.042778	88.2825	School Gaon, Kalu Kaman	1288
Tumsong T. E.	JorebunglowSukhiapokhri	27.035278	88.175278	LorungDhura	1278
Singtom T. E. (Steinthal)	Darjeeling Pulbazar	27.055556	88.231944	Chhatiwan 11 No.	1405
Tukdah T.E.	RangliRangliot Block	27.054722	88.325556	Tukdah 9 no.	1186
Peshok T. E.	RangliRangliot	27.065	88.386944	Kharbaari	1301
Bannockburn T. E.	Darjeeling Pulbazar	27.060833	88.286944	Kalu Gaon	1462
Rungeet T.E.	Darjeeling Pulbazar	27.057222	88.261667	Rungeet	1814
Happy Valley T.E.	Darjeeling Pulbazar	27.051389	88.258333	Lungtham	1909
Puttabong T. E.	Darjeeling Pulbazar	27.065556	88.258056	Puttabong	1742
Samebong T. E.	Gorubathan	27.055556	88.653611	Kolbong, Sunwar Gaon	1695
Ambiok (Hilton) T.E.	Gorubathan	26.999444	88.695833	Dhipdara	473
Namring T.E.	RangliRangliot	27.015	88.370833	Naya Dhura	1037
Gielle T.E.	RangliRangliot	27.018889	88.379444	Pipli Dara	867
RangliRangliot T.E.	RangliRangliot	27.028333	88.351111	Rungli	1353
Rangaroon T.E.	Jorebunglow-Sukiapokhri	27.015833	88.277222	Dhuppi Dara	1583
Dhajea T.E.	JorebunglowSukhiapokhri	26.994444	88.167222	Hope, Raniban, 9 No. Dhajea Busty	2118
Upper Fagu	Gorubathan	26.981667	88.689722	Factory Line	481
Dhooteriah T.E.	Jorebunglow-Sukiapokhri	26.969167	88.208889	Balasan gaon	1435
Pussimbing T. E.	JorebunglowSukhiapokhri	26.984444	88.208889	School Dara	1448
Plungdung T.E.	Jorebunglow-Sukiapokhri	26.985278	88.16	Bich Gaon	2006
Chhota Poobong T.E.	Jorebunglow-Sukiapokhri	26.996944	88.192778	Dhajea Dara	1773
Avongrove T. E.	JorebunglowSukhiapokhri	26.938333	88.203611	MalotPulbajar, Shikari Busty	1208
Rungmook/Cedar T.E.	JorebunglowSukhiapokhri	26.956389	88.239167	Mathlo Cedar, School Gaon	1092
Moondakotee T.E.	JorebunglowSukhiapokhri	26.933056	88.231389	Baas ghaari, Moodakhothi	990
Ringtong T.E.	JorebunglowSukhiapokhri	26.933056	88.271111	Chhota Ringtong	1342
Chamong T. E.	JorebunglowSukhiapokhri	26.950278	88.134722	Maletini	1494

Nagri T. E.	JorebunglowSuk hiaPokhri	26.928056	88.1875	Neeze Gaon, Theeng Gaon, Bahun Gaon	1345
Samrik T.E.	JorebunglowSuk hiaPokhri	26.955	88.200278	17 no. village	1222
Sungma T.E.	JorebunglowSuk hiaPokhri	26.935833	88.175	Sungma Raniban	1315
Oaks T.E.	JorebunglowSuk hiaPokhri	26.948333	88.253333	Butta kheti	1585
Selimbong T. E.	JorebunglowSuk hiaPokhri	26.948611	88.167778	Uttishbaari	1457
Turzum T. E.	JorebunglowSuk hiaPokhri	26.941944	88.176389	Pachpan Hatta	1360
Mullootar T. E.	Kurseong	26.891111	88.345556	Gairi Gaon	559
Nagri Farm	JorebunglowSuk hiaPokhri	26.918611	88.202778	Ujir Gaon	1185
Okayti T. E.	Mirik	26.900833	88.161111	Barpipal Dara	1566
Gopaldhara T. E.	Jorebunglow- Sukiapokhri	26.911944	88.150833	Mathlo Gaon, Kothi Gaon, Tukrey	1734
Thurbo T. E.	Mirik	26.900833	88.167778	Pratap Gaon	1480
Ambootia T.E.	Kurseong	26.876111	88.251667	PaanchGharey, Jucksingh	880
Balasan T. E.	Kurseong	26.861111	88.236111	NehurBalasun (Mathilo gaon),	381
Jogmaya T. E.	Kurseong	26.856944	88.321389	Factory Gaon, Baukaman	816
Makaibari T. E.	Kurseong	26.859722	88.259722	Koila Paani	1185
Sivitar T. E.	Kurseong	26.878056	88.34	Baagmara (Mathlo gaon)	788
Nurbong T.E.	Kurseong	26.849167	88.360278	Kothidara, Chhokade, Shivakhola	496
Seepoydhura T. E.	Kurseong	26.836389	88.345833	Thulo Gaon	496
Longview T.E.	Kurseong	26.816944	88.261111	Busty, Plain Line, GodamDhura	279

Ethnomedicinal survey and collection of data

First of all, the tea gardens that fall under different altitudinal ranges up to 500 masl, 500 - 1000 masl, 1000 - 1500 masl, and 1500 - 2000 masl and above were selected for the convenience of the study. Initially, random preliminary visits to the tea gardens of above mentioned altitudinal zones were conducted to get acquainted with the local people followed by door to door ethnomedicinal survey. Such visits resulted in the identification of the key informants with help of the local sources. Throughout the field work prior informant consent (CBD 1992, Nagoya protocol, 2014) was taken into consideration and interviews were conducted through open ended semi structured questionnaire (Jain & Mudgal, 1999) in their mother dialect (Nepali). A total of 127 informants were interviewed aged between 20-90 yrs having educational background elementary to the post graduation level. Other socio-demographic factors of the informants like occupation, ethnicity, religions etc. were also considered.

Ethnomedicinal information like name of the disease treated, local name of the plants, parts used, mode of use, source of information, efficacy were all documented. Photographs of the plants or plant parts of the preserved samples spotted by the healers were taken and specimen were collected and processed following herbarium techniques (Paul *et al.* 2020). The scientific names were validated by consulting local flora, (Grierson & Long 1983-1987; 1991, 1999, 2001) and popular websites (POWO, The World Flora Online). The voucher specimens were deposited to the NBU herbarium.

Documentation and quantitative study

The collected information was arranged disease wise in Microsoft excel, as a preliminary data and SPSS software version (22.0) was used for statistics analysis. For quantitative study, all the diseases were categorized into 15 disease categories and quantitative indices like Informant Consensus Factor (ICF), Fidelity Level (FL), Use Value (UV), and Relative Frequency of Citation (RFC) were considered to analyze the collected ethnomedicinal data and calculated manually. Jaccard Index (JI) and Rehman's Similarity Index (RSI) were also calculated manually to assess the similarity and differences in the availability of common plants and their ethnomedicinal usage across the other regions of India (Sarkar et al 2023).

Informant Consensus Factor (ICF)

Informant consensus factor was calculated to see the homogeneity of ethnomedicinal knowledge among the informants; it is calculated as (Trotter & Logan, 1986)

$$\text{Informant Consensus Factor (ICF)} = \frac{Nur - Nt}{Nur - 1}$$

Where, Nur = Number of use reports for a particular disease category; Nt = Number of taxa used by the informants for that disease category. Its value ranges from 0 - 1; high value near to 1 denotes that a large number of informants agree with the usage of plant for the particular ailment category while the low value (near to zero) denotes disagreement among the informants regarding the usage of plants for treating the given ailment category.

Fidelity Level (FL) (%)

Fidelity level is the percentage of the informants who cites the particular plant for treating the given disease category and the total number of informants mentioning the usage of same plant for treating the any other disease. It is calculated as (Friedman *et al.* 1986).

$$\text{Fidelity Level (FL)} = \frac{Np}{N} \times 100$$

Where, Np is the number of informants citing the use of the plant for a particular disease category and N is the total number of informants citing for any other disease categories. Fidelity level of 100% denotes exclusive use of the plants for a particular disease category whereas decreasing value indicates its versatile uses (Arya *et al.* 2021).

Use value (UV)

The use value indicates the relative importance of the plants used to treat the disorders. It is calculated by the formula

$$UV = \sum \frac{U_i}{N} \quad (\text{Gazzaneo } et al. 2005)$$

Where, U_i refers to the number of uses cited by the informants for a particular plant and N refers to the total number of informants interviewed. The higher use value indicates the higher uses of the plant as mentioned by the informants and lower use value indicates lower use as highlighted by the informants.

Frequency of Citation (FC)

The frequency of citation is the number of informants mentioning the medicinal uses of the plants. It is obtained by counting the number of informants interviewed in the survey who mention the use of the particular plant (Tardio & Pardo-de Santayana 2008).

Relative frequency of citation (RFC)

This index is calculated by the number of informants mentioning the usefulness of species (frequency of citation, FC) divided by the total number of informants interviewed. Its value ranges from 0 to 1; RFC is 0 when nobody refers to the plant as useful and 1 when everyone mentions the usefulness of the plant. It is calculated as

$$RFC = \frac{FC}{N} \quad (\text{Tardio \& Pardo-de Santayana 2008})$$

Where, FC refers to the frequency of citation and N refers to the total number of informants in the survey.

Jaccard Index (JI)

Jaccard Index was calculated to find the similar plants in the tea gardens of different altitudinal variations of the regions like Darjeeling, and Kalimpong hills of West Bengal and Sikkim, and previously published data from different regions. JI was calculated as

$$JI = \frac{C \times 100}{A + B - C} \quad (\text{González-Tejero } et al. 2008)$$

Where, A refers to number of species in the current study area (a), B refers to the number of species in another study area (b), and C refers to the number of species found in both the area (a) and (b).

Rehman's Similarity Index (RSI)

Rehman's Similarity Index (RSI) was calculated to see the homogeneity in the usage of the plants treating the common disease. It is calculated by the formula

$$RSI = \frac{d}{a+b+c-d} \times 100 \quad (\text{Asiimwe } et al. 2021).$$

Where, a represents the number of plants unique to the study area A; b represents the number of plants unique to the study area B; c represents the plants common to both the area; d represents the number of common plants used to treat the same ailment.

Pearson Correlation Coefficient (PCC)

Pearson correlation coefficient denotes that how closely the variables are related linearly. For our study, inter-item Pearson correlation was calculated to see the relationships between the demographic factors and the traditional medicine factors like source of knowledge (SOK), number of formulations known or shared (NOF) and the number of medicinal plants (NOM) and also to find out the relationship between FL, FC and ICF values.

Results

Survey and socio demography of the informants

Among the 87 registered tea gardens, ethnomedicinal exploration was carried out in 79 tea gardens but the information could be gathered from 58 tea gardens. The reasons for unsuccessful documentation were absence of healers in those tea gardens, their dependency on nearby tea gardens for their primary healthcare, or reluctance of the knowledge holders to disclose their knowledge.

Most of the informants were retired and current tea garden workers (75, or 49%), followed by retired and current government job holders (18, or 14.2%), small proportion of the population were self employed (7, or 5.51%) while others were engaged in other occupations such as business, medicinal practice, carpentry (Table 2)

The literacy level of the informants showed that 35 (27.6%) had completed the elementary education, having completed class V. However, 31 (24.4%) were illiterate and 30 (23.6%) had studied up to the secondary level. Fewer, 4 or 3.1 % had studied senior secondary level but there were slightly increase in representation at the graduate level (5, or 39%) and again slight decrease in post-graduate level (3, or 2.4%).

The majority of the informants followed Hinduism, followed by Buddhism, Christianity, and one followed Jainism. Some of them were Shamans like *jhaakri*, *baidang*, *lama*, and *purohit*. They have acquired ethnomedicinal knowledge from over the years from elders, inheritance, gurus, friends, trial and error, and studying literature (Table 2).

Table 2. Socio-demography of the informants of studied Tea garden villeges

		Frequency	Percent	Valid Percent	Cumulative Percentage
Gender	Male	92	72.4	72.4	72.4
	Female	35	27.6	27.6	27.6
	Total	127	100	100	100
Age	20-40	11	8.7	8.7	8.7
	41-50	21	16.5	16.5	25.2
	51-60	29	22.8	22.8	48
	61-70	34	26.8	26.8	74.8
	71-80	25	19.7	19.7	94.5
	81 above	7	5.5	5.5	100
	Total	127	100	100	
Education	Illiterate	31	24.4	24.4	24.4
	Primary	35	27.6	27.6	52
	Upper Primary	30	23.6	23.6	75.6
	Secondary	19	15	15	90.6
	Senior Secondary	4	3.1	3.1	93.7
	Graduate	5	3.9	3.9	97.6
	Post Graduate	3	2.4	2.4	100
	Total	127	100	100	
Occupation	Unemployed	7	5.5	5.5	5.5
	Others	27	21.3	21.3	26.8
	Retd. TG worker	55	43.3	43.3	70.1
	TG worker	20	15.7	15.7	85.8

	Govt. servant	18	14.2	14.2	100
	Total	127	100	100	
Ethnicity	Khas	29	22.8	22.8	22.8
	Newar	17	13.4	13.4	36.2
	Tamang	20	15.7	15.7	52
	Kirat	16	12.6	12.6	64.6
	Bahun	8	6.3	6.3	70.9
	Mangar	8	6.3	6.3	77.2
	Others	29	22.8	22.8	100
	Total	127	100	100	
Source of knowledge	Elders	55	43.3	43.3	43.3
	Inherited	28	22	22	65.4
	Trial & error	6	4.7	4.7	70.1
	Friend or Guru	20	15.7	15.7	85.8
	Others	18	14.2	14.2	100
	Total	127	100	100	

Inter-item Pearson correlation matrix

The inter-item Pearson correlation matrix revealed several statistically significant and non-significant relationships between demographic factors and traditional medicine-related variables among the study participants (Table 3).

Gender showed a negative correlation with multiple variables, including source of knowledge (SOK) ($r = -0.321, p < 0.01, **$), plants (NOM) ($r = -0.216, p < 0.05, *$), age ($r = -0.158$), education ($r = -0.098$), occupation ($r = -0.052$), ethnicity ($r = -0.053$), and number of formulations (NOF) ($r = -0.06$). Similarly, age exhibited a statistically significant negative correlation with education ($r = -0.243, p < 0.01, **$). Significant positive correlations were observed between age and SOK ($r = 0.198, p < 0.05, *$) as well as between age and NOM ($r = 0.180, p < 0.05, *$), other correlations of age, such as with occupation ($r = 0.047$) and ethnicity ($r = -0.019$), were not statistically significant. Education showed statistically significant positive correlations with both occupation ($r = 0.201, p < 0.05, *$) and ethnicity ($r = 0.193, p < 0.05, *$). However, its correlations with SOK ($r = -0.003$), NOF ($r = -0.075$), and NOM ($r = -0.035$) were not significant. Occupation had a significant positive correlation only with education ($r = 0.201, p < 0.05, *$). Correlations with other variables such as gender, age, ethnicity, SOK, NOF, and NOM were not statistically significant. Ethnicity displayed a statistically significant positive correlation with education ($r = 0.193, p < 0.05, *$), while its relationships with gender, age, occupation, SOK, NOF, and NOM were not significant.

Source of Knowledge (SOK) was significantly negatively correlated with gender ($r = -0.321, p < 0.01, **$) and positively correlated with age ($r = 0.198, p < 0.05, *$). Correlations of SOK with education, occupation, ethnicity, NOF, and NOM were not significant. Number of Formulations (NOF) had a statistically significant positive correlation with age ($r = 0.215, p < 0.05, *$) and a strong positive correlation with NOM ($r = 0.699, p < 0.01, **$). Other correlations with NOF were not statistically significant. Finally, Number of Medicinal Plants (NOM) showed a strong positive correlation with NOF ($r = 0.699, p < 0.01, **$), and statistically significant positive correlation with age ($r = 0.180, p < 0.05, *$), and a negative correlation with gender ($r = -0.216, p < 0.05, *$). Other correlations involving NOM were not significant. These findings highlight the complex interplay between demographic variables and traditional medicine-related knowledge, suggesting that factors such as age, gender, education, and source of knowledge significantly influence the preservation and transmission of ethnomedicinal practices.

Table 3. Inter-item Pearson correlation matrix

	Gender	Age	Education	Occupation	Ethnicity	SOK*	NOF*	NOM*
Gender	1							
Age	-0.158	1						
Education	-0.098	-0.243**	1					
Occupation	-0.052	0.047	0.201*	1				
Ethnicity	-0.053	-0.019	0.193*	0.087	1			
SOK*	-0.321**	0.198*	-0.003	0.052	0.125	1		
NOF*	-0.06	0.215*	-0.075	0.089	0.035	0.135	1	
NOM*	-0.216*	0.180*	-0.035	0.013	0.1	0.276*	0.699**	193

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

*SOK; Source of Knowledge, *NOF; No. of formulations, *NOM; No. of medicinal plants.

Ethnomedicinal plants and herbal formulation

The present study explored the uses of 193 ethnomedicinal plants belonging to 82 families were using by the tea garden workers of Darjeeling, Kalimpong and Sikkim Himalaya. Dominant families with greater number of species used to cure different disease categories were Fabaceae (comprising of 12 different species) followed by Lamiaceae (11 species), Asteraceae (9 species), Zingiberaceae (8 species), Solanaceae, Apiaceae, and Poaceae (7 species each), Rutaceae, Moraceae, Malvaceae, and Rosaceae (5 species each), Phyllanthaceae, Apocynaceae, and Brassicaceae (4 species each), Myrtaceae, Amaranthaceae, Amaryllidaceae, Acanthaceae, Piperaceae, and Euphorbiaceae (3 species each), Asparagaceae, Saxifragaceae, Berberidaceae, Cyperaceae, Rubiaceae, Menispermaceae, Arecaceae, Caryophyllaceae, Polypodiaceae, Urticaceae, Araliaceae, Lauraceae, Polygonaceae, Plantaginaceae, and Combretaceae (2 species each).

Among the plant parts used in the preparation of ethnomedicinal formulations leaves were the most dominant parts were the leaves (64%) followed by the roots (36%), bark (27%), seeds (25%), fruits (16%), rhizome (14%), stem (12%), whole plant (9%), inflorescence (6%), twigs (4%), bulb (3%), fronds (1%), thallus (1%) (Fig. 2). The conservation status of these recorded 193 ethnomedicinal plants was checked through IUCN red list of threatened species as well as by observation during field trip. However, not all the plants possess data in IUCN redlist of threatened species; this study recorded one near threatened species (*Aegle marmelos*) 62 plant species under Least Concerned (LC) category, 3 Endangered (EN), and 5 as Data Deficient (DD). Alternatively, with regular field trip and interaction with the herbal healers, it was noticed that 34 wild plant species were locally sparse some of which are *Podophyllum hexandrum*, *Viscum articulatum*, *Tetrataenium wallichii* etc. 32 cultivated ethnomedicinal plants were often used as vegetables, ornamental, or spices or condiments (Table 5).

This study explored the various ways of preparation of ethnomedicines by the traditional healers of various tea gardens of Darjeeling, Kalimpong and Sikkim Himalaya of which infusion was the widely preferred method followed by decoction, powder, paste, poultice, raw, and juice. The other least followed methods of preparation were latex, fumes, oil, crude extract, roasting, making small herbal balls, and ashes. It was found that poultice, latex, and oil were used for topical application (18%) whereas infusion, decoction, powder, juice, raw, and paste were administered orally (80%) and nearly 2 % of the formulations were inhaled (Fig. 3)

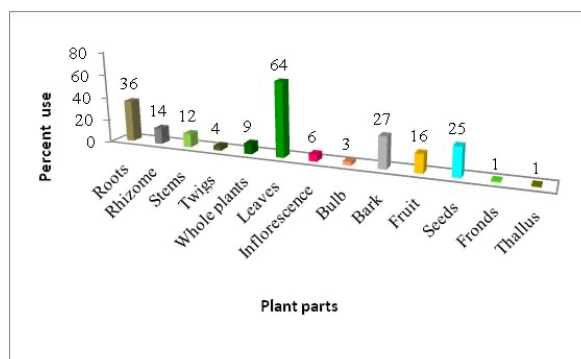


Figure 2. Plant parts (%) used in the ethnomedicinal formulations

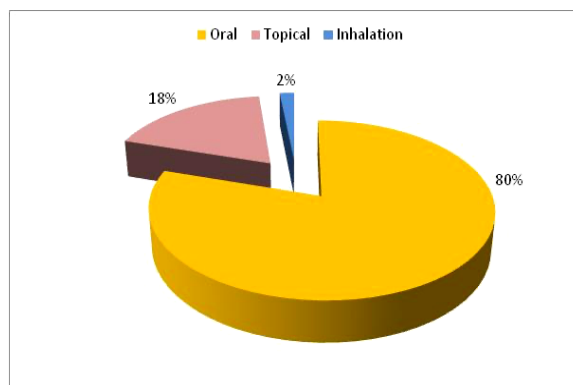


Figure 3. Routes of administration of ethnomedicinal formulations

Table 4. Disease categories and Informant Consensus Factor

Disease categories	Diseases/Symptoms	*Nur	*Nt	*ICF
Gastrointestinal disorders	Stomach pain, indigestion, constipation, food poisoning, diarrhea, dysentery, piles, fistula, gastritis, jaundice, hepatitis	260	109	0.583
ENT- related disorders	Swelling gums, bleeding gums, tooth ache, bad breath, sore throat, eye disorders	80	36	0.556
Dermatological disorders	Cuts and wounds, boils, burns, ring worms, eczema, allergy, vitiligo	43	26	0.404
Bone related disorders	Bone fracture, ligament tearing, swelling, gout, arthritis	147	52	0.65
Kidney and urinary trouble	Burning with urination, urine blockage, urinary tract infection, kidney stones, kidney infection	93	41	0.565
Respiratory disorders	Cough, sinusitis, asthma, bronchitis, pneumonia	46	37	0.2
Reproductive disorders	Menstrual cramps, irregular discharge, Menorrhagia (heavy urine flow), infertility, spermatorrhoea, and leucorrhoea)	34	26	0.242
Diabetes	All types	37	27	0.277
Poisonous bites	Snake bite, dog bite, poisonous sting, (<i>dokhrey</i> infection)	36	19	0.485
Circulatory disorder	Hypertension	12	8	0.363
Viral diseases	Chicken pox, measles, Shingles (Herpes Zoster)	6	5	0.2
Fever	Elevated body temperature followed by headache, sweating, tasteless mouth	11	9	0.2
Nerve related disorders	Pain and inflammation in the limbs	3	3	0
Sleeping disorder	Unable to fall asleep	1	1	0
Miscellaneous	Tuberculosis, ascariasis, body ache, headache, postpartum	20	16	0.21

***Nur**: Number of use reports for disease category; ***Nt**: Total plant taxa, ***ICF**: Informant Consensus Factor

Table 5. Traditional uses and quantitative study of the reported ethnomedicinal plants

Ethnomedicinal Plants [Family] Local Name (Nep) Voucher no.; Acc. No.	Parts used; Preparation techniques	Disorder treated	Conser v. status	UR	TI	UV	FC	RFC	FL
<i>Achyranthes bidentata</i> Bl. [Amaranthaceae] Aapumarga/ Datiwan 50039; NBU00010750	Roots as infusion	Repr, Kid & Uri	NE	2	127	0.015	2	0.016	50
<i>Acmella uliginosa</i> (Sw.) Cass.[Asteraceae] Pahelotaaueky/ Parparye jhaar 0005; NBU00010759	Twigs/inflorescence/shoot/ whole plant as Paste/raw/decoction	GID, ENT, Kid &Uri,Pbi, Res,Vir	LC	6	127	0.047	12	0.094	23.07
<i>Acorus calamus</i> L.[Acoraceae] Bojho 0130	Rhizome as raw	BR, Res, ENT	LC	3	127	0.023	3	0.024	33.33
<i>Aegle marmelos</i> (L.) Corrêa[Rutaceae] Bael 0126	Fruits as juice/ paste /poultice(Topical)	GID, BR, Repr	NT	3	127	0.023	3	0.024	33.33
<i>Ageratina adenophora</i> (Spreng.) R.M.King&H.Rob.[Asteraceae] Kalo jhaar/ kalo Banmara 0018;NBU00010782	Leaves as juice (topical)	GID, BR, Der, ENT, Pbi	NE	5	127	0.039	17	0.134	35.29
<i>Allium cepa</i> L.[Amaryllidaceae] Pyaj 0113	Tunicated bulb as infusion	GID	NE	1	127	0.007	1	0.008	100
<i>Allium sativum</i> L. [Amaryllidaceae] Lasun 0093	Bulb as Powder/paste	Dia, Pbi, Repr	NE	3	127	0.023	3	0.024	33.33
<i>Alnus nepalensis</i> D.Don [Betulaceae] Uttish 0131	Bark as decoction	GID	LC	1	127	0.007	1	0.008	100
<i>Aloe vera</i> (L.) Burm.f. [Asphodelaceae] Gheu kumari 0027	Leaves as powder/paste/poultice/ raw	GID, BR, Der, Dia, ENT, Kid & Uri	NE	6	127	0.047	12	0.094	40
<i>Alternanthera brasiliiana</i> (L.)Kuntz[Amaranthaceae] Lali jhar 0111	Leaves as paste/ poultice/ juice	BR, Der	NE	2	127	0.015	2	0.015	50
<i>Amomum subulatum</i> Roxb.[Zingiberaceae] Alaichii/ Bharlang 0132	Seeds/fruits as infusion/powder	Kid & Uri, Res	DD	2	127	0.015	2	0.016	50
<i>Angiopteris evecta</i> (G.Forst.) Hoffm. [Marattiaceae] Gaikhurey 0121	Rhizome as infusion	Kid & Uri	LC	1	127	0.007	1	0.008	100
<i>Artemisia dubia</i> Wall. ex Besser[Asteraceae] Titepati 0122	Leaves as infusion/juice	GID, Cir, ENT	NE	3	127	0.023	7	0.055	66.66
<i>Artemisia vulgaris</i> L.[Asteraceae] Titepati 0019	Leaves as powder	GID	NE	1	127	0.007	1	0.008	100
<i>Asparagus racemosus</i> Willd. [Asparagaceae] Kurilo 0133	Roots as powder/ paste/ poultice	GID, BR	NE	2	127	0.015	2	0.015	50
<i>Astilbe rivularis</i> Buch.–Ham. ex D. Don[Saxifragaceae] Budo okhati/ Ban Supari 0063;NBU00010778	Rhizome as powder/raw oral /decoction	BR, Misc, Repr	NE	4	127	0.031	15	0.118	35.71
<i>Athyrium filix-femina</i> (L.) Roth. [Aspleniaceae] Othreyuniew 0058	Fronds as paste/juice	Der, Misc	NE	3	127	0.023	3	0.024	33.33

<i>Azadirachta indica</i> A.Juss. [Meliaceae] Neem 0134	Leaves as powder/decoction	GID, Fevr, Kid & UTI	LC	3	127	0.023	3	0.024	33.33
<i>Bauhinia variegata</i> L. [Fabaceae] Taaki 0036;NBU00010764	Bark as decoction	Dia	LC	1	127	0.007	1	0.008	100
<i>Berberis napaulensis</i> (DC.) Spreng. [Berberidaceae] Chutro/Kesari 0086	Stem/bark as decoction	GID, Dia, ENT, Misc	NE	4	127	0.031	5	0.039	40
<i>Bergenia ciliata</i> (Haw.) Sternb.[Saxifragaceae] Pakhan bet 0077; NBU00010684	Leaf/rhizome as powder/paste/poultice/raw/decoction	BR, Der, ENT,Misc,Repr, Res	LC	7	127	0.055	27	0.212	14.81
<i>Bischofia javanica</i> Bl. [Phyllanthaceae] Kainjal 0135	Bark as infusion/poultice/decoction	GID, BR, Dia	LC	3	127	0.023	4	0.031	50
<i>Bixa orellana</i> L. [Bixaceae] Sindoor 0076; NBU00010685	Fruit as poultice	BR	LC	1	127	0.007	1	0.007	100
<i>Bombax ceiba</i> L. [Malvaceae] Simul 0136	Roots/bark as powder/infusion/	GID, Repr, Res	LC	3	127	0.023	4	0.031	50
<i>Bonnaya ruelloides</i> (Colsm.) Spreng. [Linderniaceae] Laharey Phul 0140	Shoot/whole plant as decoction	GID	NE	1	127	0.007	2	0.016	100
<i>Bridelia retusa</i> (L.) A.Juss. Euphorb. [Phyllanthaceae] Gaayo 0083	Bark as powder	GID	LC	1	127	0.007	1	0.008	100
<i>Cajanus cajan</i> (L.) Huth [Fabaceae] Rahari dal 0116	Twigs as decoction	GID	NT	1	127	0.007	2	0.016	100
<i>Callianthe picta</i> (Gillies ex Hook. & Arn.) Donnell. [Malvaceae] Ghanti phul 0137	Flower as raw/powder	Repr, Kid & Uri	NE	2	127	0.015	2	0.016	50
<i>Callicarpa longifolia</i> Lam.[Lamiaceae] Guelo/ Bhaate guelo 0150	Flower/leaves/stem/roots as raw/ powder	GID, ENT	LC	2	127	0.015	4	0.031	25
<i>Calotropis gigantea</i> W.T.Aiton [Apocynaceae] Aankh 0074	Leaves/roots/stems as latex	GID, BR, ENT, NR	NE	4	127	0.031	6	0.047	50
<i>Capsicum annuum</i> L. [Solanaceae] Dalley khorsani 0098	Fruits/ seeds as raw	Pbi	LC	1	127	0.007	1	0.008	50
<i>Carex cruciata</i> Wahlenb. [Cyperaceae] Bansilam 0038; NBU00010757	Stem/roots as poultice/infusion	BR, Kid & Uri	NE	2	127	0.015	2	0.015	50
<i>Carica papaya</i> L.[Caricaceae] Mewa 0106	Fruit/ leaves as decoction	GID, Fevr, Kid & Uri	DD	3	127	0.023	4	0.031	25
<i>Catharanthus roseus</i> (L.) G.Don Gen. [Apocynaceae] Sadabahr 0141	Leaves as powder	Dia	NE	1	127	0.007	1	0.008	100
<i>Centella asiatica</i> (L.) Urb. [Apiaceae] Ghoda taprey 0100	Leaves/shoot as juice/decoction/paste/poultice	GID,BR, ENT, Fevr,Kid& Uri, Pbi, Repr, Res	LC	7	127	0.055	25	0.197	3.8
<i>Chenopodium album</i> L.[Amaranthaceae] Bethu 0114	Leaves / seeds	GID	NE	1	127	0.007	1	0.008	100

<i>Chonemorpha fragrans</i> Alston [Apocynaceae] Gothalay Lahara 0139	Leaves as powder/poultice	BR	NE	1	127	0.007	1	0.008	100
<i>Cinchona calisaya</i> Wedd. [Rubiaceae] Qulen 0153	Bark as powder	GID	LC	1	127	0.007	1	0.008	100
<i>Cissampelos pariera</i> L. [Menispermaceae] Baatulipaatey 0029; NBU0001077	Leaves as juice/decoction/infusion	Der, Kid & Uri, Repr	NE	4	127	0.031	6	0.0472	33.33
<i>Cissus quadrangularis</i> L. [Vitaceae] Hadjora 0142	Leaves as Poultice	BR	NE	1	127	0.007	3	0.024	100
<i>Citrus × aurantiifolia</i> (Christm.) Swingle [Rutaceae] Nimbu 0160	Fruit as juice	BR	NE	2	127	0.015	2	0.016	50
<i>Citrus reticulata</i> Blanco. [Rutaceae] Suntala 0168	Leaves as raw	ENT	NE	1	127	0.007	1	0.008	100
<i>Clematis buchananiana</i> DC. [Ranunculaceae] Pinasey lahara 0043; NBU00010766	Leaves as fumes (by boiling)	Res	NE	1	127	0.007	3	0.024	100
<i>Clerodendrum infortunatum</i> L.[Lamiaceae] Haatidaabrey 0186	Watery latex as raw	ENT, Kid & Uri	LC	2	127	0.015	2	0.016	50
<i>Clinopodium umbrosum</i> (M.Bieb.) K.Koch [Lamiaceae] Furkeyjhaar 0049; NBU0009893	Leaves as paste/ poultice	Der, BR	NE	2	127	0.015	3	0.023	33.33
<i>Cocos nucifera</i> L. [Arecaceae] Nariyal 0199	Roots as powder	GID	NE	1	127	0.007	1	0.008	100
<i>Colocasia esculenta</i> (L.) Schott. [Arecaceae] Pidalu 0154	Corm as paste	Pbi	LC	1	127	0.007	1	0.008	100
<i>Coriandrum sativum</i> L. [Apiaceae] Dhania 0226	Leaves/ seeds as powder/ infusion	GID, Kid & Uri	NE	2	127	0.015	2	0.016	50
<i>Crassocephalum crepidioides</i> (Benth.) S.Moore[Asteraceae] Bungbungejhaar 0007	Leaves as juice	Der	NE	1	127	0.007	1	0.008	100
<i>Crassula ovata</i> (Mill.) Druce [Crassulaceae] Jade plant 0013	Leaves as juice	GID	NE	1	127	0.007	1	0.008	100
<i>Crinum asiaticum</i> L. [Amaryllidaceae] Asaarey Phul 0227	Bulb as infusion/ paste	GID, Der	NE	2	127	0.015	2	0.016	50
<i>Crocus sativus</i> L. [Iridaceae] Kesar 0233	Stamen as paste	BR	NE	1	127	0.007	1	0.008	100
<i>Curculigo capitulata</i> (Lour.) Kuntze [Hypoxidaceae] ThuloDhotisara 0047; NBU00010781	Shoot/ rhizome as infusion/paste/poultice	GID, Der, BR	NE	3	127	0.023	3	0.023	33.33
<i>Cucurbita pepo</i> L. [Cucurbitaceae] Farsi 0060	Leaves as juice	Pbi	LC	1	127	0.007	1	0.008	100
<i>Curcuma aromatica</i> Salisb. [Zingiberaceae] Fachyang 0155	Rhizome as infusion	GID, Fevr	NE	3	127	0.023	4	0.031	50
<i>Curcuma caesia</i> Roxb. [Zingiberaceae] Kalo hardi 0010; NBU00010771	Rhizome as raw	GID, BR, Res	NE	3	127	0.023	20	0.157	90
<i>Curcuma longa</i> L. [Zingiberaceae] Hardi / Besaar 0162	Rhizome as raw/paste/powder	BR, Pbi, Res	DD	4	127	0.031	12	0.094	75

<i>Curcuma zedoaria</i> (Christm.) Roscoe [Zingiberaceae] Pahelohaledo0163	Rhizome as raw/powder	GID,Res	DD	2	127	0.015	8	0.062	87.5
<i>Cuscuta reflexa</i> Roxb.[Convolvulaceae] Aakashey lahara/ Pahelo lahara0081; NBU00010773	Shoot as infusion/decoction	GID	LC	3	127	0.023	16	0.126	6.25
<i>Cynodon dactylon</i> (L.) Pers.[Poaceae] Jaatdubo 0167	Shoot as powder/juice/decoction/infusion/raw/infusion/	GID, Der, ENT, Kid & Uri, Res	NE	5	127	0.039	11	0.086	45.45
<i>Cyperus cyperoides</i> (L.) Kuntze [Cyperaceae] Motheyjhaar 0011; NBU00010768	Roots as paste	Der	LC	1	127	0.007	1	0.008	100
<i>Datura metel</i> L.[Solanaceae] Dhaturo0024; NBU00010710	Leaves/seeds as roasted/oil	BR, ENT, Pbi	NE	4	127	0.031	6	0.0472	33.33
<i>Dendrocalamus hamiltonii</i> Nees & Arn. ex Munro [Poaceae] ChoyaBaans 0050	Stem as raw	BR	NE	1	127	0.007	2	0.016	100
<i>Dimetia scandens</i> (Roxb.) R.J.Wang [Rubiaceae] Bakhra Kaney 0040; NBU00010762	Roots as powder/infusion	GID, Dia, BR, Kid & Uri, Repr	NE	5	127	0.039	15	0.118	60
<i>Drymaria cordata</i> (L.) Willd. ex Schult. [Caryophyllaceae] Abhijaalo0158	Shoot/ whole plant as infusion/inhalation	BR, Res	NE	1	127	0.007	3	0.024	100
<i>Drymaria diandra</i> Bl. [Caryophyllaceae] Abhijaalo0157	Whole plant /leaves as infusion	GID, ENT, Kid &Uri,Pbi	NE	4	127	0.031	8	0.063	12.5
<i>Drynaria quercifolia</i> (L.) J.Sm [Polypodiaceae] Rukh unieu 0125	Rhizome as infusion	Kid & Uri	NE	1	127	0.007	1	0.008	100
<i>Eclipta prostrata</i> (L.) L. [Asteraceae] Bhringaraj 0229	Leaves as juices	Der	LC	1	127	0.007	1	0.008	100
<i>Elaeocarpus sphaericus</i> (Gaertn.) Heer [Elaeocarpaceae] Rudraksha/ Dana0161	Fruit (dried) as Paste(ointment)	Fvr	NE	1	127	0.007	1	0.008	100
<i>Elettaria cardamomum</i> (L.) Maton [Zingiberaceae] Chhota alaichi0138	Seeds as infusion	GID, Kid & Uri	NE	2	127	0.015	6	0.047	16.66
<i>Elstholzia blanda</i> (Benth.) Benth. [Lamiaceae] Mirreypati0075	Leaves as juice	Der	NE	1	127	0.007	2	0.016	100
<i>Equisetum diffusum</i> D.Don [Equisetaceae] Kurkureyjhaar/Sallibisally0012	Whole plant/rhizome/tuber as decoction/infusion	GID, Der, Kid &Uri, Repr, Res	NE	5	127	0.039	18	0.142	5.55
<i>Euphorbia hirta</i> L. [Euphorbiaceae] Dhudey jhaar 0084	Leaves as latex	ENT	NE	1	127	0.007	1	0.0078	100
<i>Euphorbia pulcherrima</i> Willd. ex Klotzsch [Euphorbiaceae] Laalu Paatey 0253	Roots as infusion	GID	LC	1	127	0.007	1	0.008	100
<i>Ferula narthex</i> Boiss. [Apiaceae] Hing 0231	Roots as powder	GID	LC	1	127	0.007	1	0.008	100
<i>Ficus auriculata</i> Lour. [Moraceae] Nebhara 0143	Leaves/ Fruit latex as raw (oral)	GID, Dia	LC	2	127	0.015	2	0.016	100

<i>Ficus auriculata</i> Lour. [Moraceae] Bahr0248	Leaves/latex as raw	ENT	LC	1	127	0.007	1	0.008	100
<i>Ficus elmeri</i> Merr. [Moraceae] Khanew0223	Milky latex as raw	BR	LC	1	127	0.007	1	0.008	100
<i>Ficus religiosa</i> L. [Moraceae] Peepal 0224	Fruit as powder	GID, Kid & Uri, Repr	LC	4	127	0.031	5	0.039	33.33
<i>Foeniculum vulgare</i> Mill. [Apiaceae] Saunf0242	Seeds as infusion	GID, Kid & Uri, Misc	NE	3	127	0.023	3	0.024	33.33
<i>Fraxinus floribunda</i> Wall. [Oleaceae] Lakuri0166	Bark as infusion/ poultice	GID, BR	LC	2	127	0.015	5	0.039	80
<i>Glycyrrhiza glabra</i> L. [Fabaceae] Jethimadhu0239	Roots as decoction	Res	LC	1	127	0.007	1	0.008	100
<i>Gmelina arborea</i> Roxb. ex Sm. [Lamiaceae] Khamri0072	Bark as infusion	GID	LC	1	127	0.007	2	0.016	100
<i>Gonostegia hirta</i> (Blume) Miq. [Urticaceae] ChipleY 0017	Roots/ shoots as paste/poultice infusion	Repr, BR, Pbi	NE	3	127	0.023	13	0.102	76.92
<i>Hellenia speciosa</i> (J.Koenig) S.R.Dutta [Costaceae] Betlauri0035	Stem as infusion	GID, Kid & Uri, Repr	LC	3	127	0.023	33	0.259	66.66
<i>Heynea trijuga</i> Roxb. ex Sims [Meliaceae] AankhaTaruwa0101	Bark as poultice	BR	LC	1	127	0.007	1	0.008	100
<i>Hibiscus rosa sinensis</i> L. [Malvaceae] Jaba Kusum0228	Flower as infusion	Der, Kid & Uri	NE	4	127	0.031	6	0.047	50
<i>Holarrhena pubescens</i> Wall. ex G.Don [Apocynaceae] Khirra0211	Bark as powder/ball	GID	LC	1	127	0.007	2	0.016	100
<i>Hydrangea febrifuga</i> Lour.) Y.De Smet & Granados [Hydrangeaceae] Basak0119	Bark as poultice	BR	NE	1	127	0.007	1	0.008	100
<i>Hydrocotyle himalaica</i> P.K.Mukh. [Araliaceae] Ghoda taprey 0120	Shoot/Leaves as decoction/powder	GID, Res	NE	2	127	0.015	4	0.031	75
<i>Hypoestes phyllostachya</i> Baker [Acanthaceae] Tiktikey Jhaar 0102	Shoot/leaves as paste/juice	GID, Der	NE	2	127	0.015	2	0.016	50
<i>Imperata cylindrica</i> (L.) Raeusch. [Poaceae] Siru0112, NBU00010843	Roots as infusion/ raw (topical)	Misc, Pbi	NE	2	127	0.015	2	0.016	50
<i>Indigofera tinctoria</i> L. [Fabaceae] Aamaru0115	Roots as decoction/paste	GID, ENT	NE	2	127	0.015	1	0.008	50
<i>Justicia adhatoda</i> L. [Acanthaceae] Asuro0123	Inflorescence as decoction	GID, Res	LC	2	127	0.015	3	0.024	33.33
<i>Kaempferia rotunda</i> L. [Zingiberaceae] Bhui Champa 0032; NBU0009894	Rhizome as poultice	BR	NE	1	127	0.007	16	0.126	100
<i>Lepidium sativum</i> L. [Brassicaceae] Chausoor 0028; NBU0009898	Seeds as poultice	BR	NE	1	127	0.007	4	0.031	100
<i>Lindera pulcherrima</i> (Nees) Benth. ex Hook.f. [Lauraceae] Fushrey0241	Leaves as poultice	BR	LC	1	127	0.007	1	0.007	100

<i>Litsea cubeba</i> (Lour.) Pers. [Lauraceae] Sil timbur 0087	Fruits as raw/ infusion/ decoction	GID, BR	LC	2	127	0.015	5	0.039	80
<i>Lobelia nummularia</i> Lam. [Campanulaceae] Aalu jhar 0144	Shoot as juice	Der	NE	1	127	0.007	1	0.008	100
<i>Lycopodium clavatum</i> L. [Lycopodiaceae] Naagbeli 0164	Roots as infusion	GID	NE	1	127	0.007	1	0.008	100
<i>Lygodium japonicum</i> (Thunb.) Sw. [Schizaeaceae] Parewaaandrey 0222	Leaves as juice	Der	NE	1	127	0.007	1	0.008	100
<i>Macropanax undulatus</i> (Wall. ex G.Don) Seem. [Araliaceae] Chindey 0159	Bark/leaves as decoction	Dia, Kid & Uri	NE	2	127	0.015	3	0.024	33.33
<i>Macrotyloma uniflorum</i> (Lam.) Verdc. [Fabaceae] Gahath 0143	Seeds as soup	Vir	LC	1	127	0.007	1	0.008	100
<i>Malvaviscus arboreus</i> Dill. ex Cav. [Malvaceae] Deviphul 0070; NBU00010840	Leaves/ flower as decoction	BR, Repr, Kid & Uri	LC	3	127	0.023	4	0.031	25
<i>Mangifera indica</i> L.[Anacardiaceae] Aap 0221	Bark as decoction	GID	DD	1	127	0.007	2	0.016	100
<i>Mentha spicata</i> subsp. <i>spicata</i> L. [Lamiaceae] Padina 0146	Leaves as raw/powder/ juice/ infusion	GID, Cir, Kid & Uri, Res	LC	5	127	0.039	9	0.07	33.33
<i>Mimosa pudica</i> L. [Fabaceae] Lajjawati 0145	Roots as infusion/juice	GID	LC	1	127	0.007	4	0.031	100
<i>Monosis volkameriifolia</i> (DC.) H.Rob. & Skvarla [Asteraceae] Nun Dhiki 0169	Bark as poultice	BR	LC	1	127	0.007	1	0.008	100
<i>Mucuna interrupta</i> Gagnep. [Fabaceae] Baldengra 0210	Seeds as powder	GID	NE	1	127	0.007	1	0.008	100
<i>Muehlenbeckia platyclada</i> (F. Muell) Meisn. [Polygonaceae] BhuiHarchur 0147	Leaves as paste/poultice/ juice	BR, Res	NE	2	127	0.015	4	0.031	75
<i>Musa acuminata</i> Colla [Musaceae] Ban Kera 0171	Fruit/stem earthwormsas raw	GID, Kid & Uri, Repr, Vir	LC	4	127	0.031	7	0.055	62.5
<i>Mussaenda roxburghii</i> Hook.f.[Rubiaceae] Dhobini 0188	Roots as raw	Res	NE	1	127	0.007	1	0.008	100
<i>Mutarda nigra</i> (L.) Bernh. [Brassicaceae] Tori 0191	Seedsas oil	Pbi	LC	1	127	0.007	1	0.008	100
<i>Myrica esculanta</i> Buch.-Ham. ex D.Don [Myricaceae] Kafal 0089	Bark as infusion/ decoction/ powder	GID, Res	NE	2	127	0.015	3	0.024	66.66
<i>Myristica fragrans</i> Houtt. [Myristicaceae] Jaiphal 0190	Seeds as powder	Sld, Misc	DD	2	127	0.015	2	0.017	50
<i>Nasturtium officinale</i> W.T. Aiton [Brassicaceae] Simrayo 0172	Shoot as decoction/infusion	GID, Cir	LC	2	127	0.015	2	0.017	50
<i>Nephrolepis cordifolia</i> (L.) C.Presl[Polypodiaceae] Paani Amala 0075; NBU00010337	Tuber/leaves as raw/ infusion	Dia, Kid & Uri	NE	2	127	0.015	4	0.031	75
<i>Nicotiana tabacum</i> L. [Solanaceae] Shurti 0240	Leaves as juice	Vir	NE	1	127	0.007	1	0.008	100
<i>Nigella sativa</i> L. [Ranunculaceae] Kaalo Jeera 0237	Seeds as powder/ infusion	Gid, Kid & Uri	NE	2	127	0.015	2	0.016	50

<i>Nyctanthes arbor-tristis</i> L. [Oleaceae] Paarijaat 0193	Leaves as powder/decoction	BR, NR	LC	2	127	0.015	3	0.024	33.33
<i>Ocimum tenuiflorum</i> L. [Lamiaceae] Tulasi/ Kalo Tulasi 0080	Leaves/ inflorescence as juice/raw/ decoction/ infusion	GID,Cir, Dia, ENT, Fevr, Kid & Uri, Misc, NR, Repr, Res	LC	10	127	0.078	12	0.094	7.14
<i>Ophiopogon japonicus</i> (Thunb.) Ker Gawl. [Asparagaceae] JhumkeyJhaar 0197	Shoots as infusion	GID	NE	1	127	0.007	1	0.008	100
<i>Oroxylum indicum</i> (L.) Kurz[Bignoniaceae] Totola 0022	Bark/seeds as decoction/paste/ash	GID,Der, ENT,	LC	3	127	0.023	11	0.086	36.36
<i>Oryza sativa</i> L.[Poaceae] Dhaan 0207	Seeds as infusion/ powder	GID, Kid & Uri, Misc	LC	3	127	0.023	2	0.016	25
<i>Ostodes paniculata</i> Bl. [Euphorbiaceae] Bepaari 0197	Leaves as decoction	GID	LC	1	127	0.007	1	0.008	100
<i>Oxalis corniculata</i> L. [Oxalidaceae] Chari-amilo 0148	Roots/ leaves as infusion/juice/ paste	GID, ENT, Pbi	NE	3	127	0.023	3	0.024	50
<i>Paedera foetida</i> L. [Rubiaceae] Paadey Lahara 0197	Shoot/ whole plant as decoction/juice	GID, BR	LC	2	127	0.015	3	0.024	66.66
<i>Phanera vahlii</i> (Wight & Arn.) Benth.[Fabaceae] Bharla 0178	Bark/ roots as infusion/juice	GID, Cir	LC	2	127	0.015	3	0.024	33.33
<i>Phlogacanthus thyriformis</i> (Roxb. ex Hardw.) Mabb. [Acanthaceae] Chuwa/ Titey 0177	Leaves as decoction	Der, Res, Cir	NE	3	127	0.023	5	0.039	20
<i>Phoebe lanceolata</i> (Nees) Nees [Lauraceae] Jaatkaaulo 0197	Bark as decoction	GID, BR	LC	2	127	0.015	5	0.039	20
<i>Phyllanthus emblica</i> L. [Phyllanthaceae] Amala 0201	Fruit/ bark as powder/decoction	GID, Res, Dia	LC	3	127	0.023	9	0.071	66.66
<i>Phyllanthus urinaria</i> L. [Phyllanthaceae] Bhui Amala 0184	Leaves/roots as fruits/ powder	GID, Kid & Uri	NE	2	127	0.015	2	0.016	50
<i>Physalis peruviana</i> L. [Solanaceae] Fakfakey 0066; NBU00010335	Leaves/ fruit as juice/ raw	GID, ENT	LC	2	127	0.015	3	0.024	33.33
<i>Phytolacca acinosa</i> Roxb. [Phytolaccaceae] Jaringo 0031	Flower/seeds/ roots as rawbt chewed	GID, Res	NE	1	127	0.007	1	0.008	50
<i>Piper betle</i> L.[Piperaceae] Paan 0208	Leaves as decoction	Dia	NE	1	127	0.007	1	0.008	100
<i>Piper nigrum</i> L. [Piperaceae] Gol marich 0207	Fruits as powder/ infusion	BR, Dia, Misc	NE	4	127	0.031	5	0.039	20
<i>Piper betleoides</i> C.DC. [Piperaceae] Jungli Paan 0177	Roots/ leaves as infusion/ decoction/ raw	GID, Dia, ENT, Res	NE	4	127	0.031	5	0.039	20

<i>Plagiogyria euphlebia</i> (Kunze) Mett. [Cyatheaceae] Uniew0205	Rhizome as raw	Repr	NE	1	127	0.007	1	0.008	100
<i>Plantago asiatica ssp erosa</i> (Wall.) Z.Yu Li. [Plantaginaceae] JibreyaHaar/ MasaleyHaar 0014; NBU00010702	Leaves/inflorescence as powder/juice/ infusion	GID, Der, ENT,Kid& Uri, Pbi, Res, Vir	NE	6	127	0.047	20	0.016	10
<i>Plumbago zeylanica</i> L. [Plumbaginaceae] Chitu0088	Roots/ stem as decoction/ infusion/raw	GID, BR, Repr	NE	3	127	0.023	6	0.047	50
<i>Podophyllum hexandrum</i> Royle [Berberidaceae] Bankakri0234	Tuber/root as infusion/decoction	GID, Repr	EN	2	127	0.015	3	0.024	33.33
<i>Poranopsis paniculata</i> (Roxb.) Roberty [Convolvulaceae] Shikari Lahara 0085	Leaves/ bark as juice/ paste	Der, BR	NE	2	127	0.015	6	0.047	33.33
<i>Premna scandens</i> Roxb. [Lamiaceae] Ginari 0186	Shoot as infusion	Kid & Uri trouble	NE	1	127	0.007	1	0.008	100
<i>Prunus campanulata</i> Maxim. [Rosaceae] Paiyun 0215	Bark as decoction	GID, BR	LC	2	127	0.015	2	0.0157	50
<i>Psidium guajava</i> L.[Myrtaceae] Ambak 0183	Bark/twigs as infusion/crude extract/decoction	GID, Dia, Kid & Uri	LC	3	127	0.023	9	0.071	55.55
<i>Pteris biaurita</i> L.[Pteridaceae] Thade unieu 001; NBU00010767	Leaves as juice	Der	NE	1	127	0.007	2	0.016	100
<i>Pterocarpus santalinus</i> L.[Fabaceae] Rakta chandan 0182	Bark as decoction	GID	EN	1	127	0.007	1	0.008	100
<i>Punica granatum</i> L. [Lythraceae] Anaar / Daarim 0181	Seeds as raw	GID	LC	1	127	0.007	1	0.008	100
<i>Quercus lamellose</i> Sm. [Fagaceae] Book 0215	Bark as decoction	Misc	LC	1	127	0.007	1	0.008	100
<i>Raphanus raphanistrum subsp. sativus</i> (L.) Schmalh. [Brassicaceae] Mulaa 0185	Roots/leaves as juice	ENT	NE	1	127	0.007	1	0.008	100
<i>Rhododendron arboreum</i> Sm. [Ericaceae] Lali Guras 0067	Flower as fresh	GID	LC	1	127	0.007	1	0.007	100
<i>Rosa × alba</i> L. [Rosaceae] Seto gulab 0187	Stem as juice	Repr	NE	1	127	0.007	1	0.008	100
<i>Rubus ellipticus</i> Sm. [Rosaceae] Aiselu 0015, NBU00010708	Twigs/roots as infusion/raw	GID, ENT, Pbi	LC	1	127	0.007	1	0.008	25
<i>Rubus buergeri</i> Miq. [Rosaceae] Aiselu 0016, NBU00010709	Roots as decoction	GID	NE	1	127	0.007	1	0.008	100
<i>Rubus treutleri</i> Hook.f. [Rosaceae] Aiselu 0238	Roots as paste	ENT	NE	1	127	0.007	1	0.008	100
<i>Rumex nepalensis</i> Spreng. [Polygonaceae] Halhaley 0095	Leaves/ roots as paste/ infusion	GID	NE	1	127	0.007	2	0.016	100
<i>Saccharum officinarum</i> L. [Poaceae] Kaaloukhoo/ Gewarey Ukhoo 0180	Stem as infusion/ decoction	GID,Kid& Uri, Repr	NE	3	127	0.023	8	0.063	50
<i>Salvia splendens</i> Sellow ex Nees [Lamiaceae] Neem jeera 0213	Flower/leaves/root as raw/ decoction	ENT, Dia	NE	2	127	0.015	3	0.0236	33.33

<i>Scoparia dulcis</i> L. [Plantaginaceae] Chini Jhaar/ Mishiri Jhaar 0004	Shoot/leaves as juice	GID, ENT, Kid & Uri, Res	NE	4	127	0.031	9	0.071	18.18
<i>Senegalia catechu</i> (L.f.) P.J.H.Hurter&Mabb.[Fabaceae] Khayer 0217	Leaves/bark as decoction/powder	GID, BR, Kid & Uri, Misc, Res	LC	5	127	0.039	6	0.047	16.66
<i>Sesamum indicum</i> L. [Pedaliaceae] Til 0212	Seeds as oil	ENT	NE	1	127	0.007	1	0.008	100
<i>Shorea robusta</i> C.F.Gaertn. [Dipterocarpaceae] Shaal 0062	Bark as smoke (Burnt)	Pbi	NT	1	127	0.007	1	0.008	100
<i>Sida acuta</i> Burm.f. [Malvaceae] 0243 Kharetojhaar	Leaves as infusion	Kid & Uri	NE	1	127	0.007	1	0.008	100
<i>Solanum lycopersicum</i> L. [Solanaceae] Tamater 0198	Leaves/ shoot as juice/ paste	Der, Pbi	NE	2	127	0.015	3	0.024	33.33
<i>Solanum torvum</i> Sw. [Solanaceae] Jungli bee 0026	Seeds; smoke	ENT	NE	1	127	0.007	2	0.016	100
<i>Sonchus maritimus</i> L. [Asteraceae] Mula paatey 0149	Leaves as roots; paste/poultice/raw/decoction/juice/ infusion	GID, BR, Cir, ENT, Fevr, Pbi, Res	NE	7	127	0.055	13	0.102	14.28
<i>Sphagnum fimbriatum</i> Wilson [Sphagnaceae] Jhyau 0236	Plant as raw	BR	LC	1	127	0.007	1	0.008	100
<i>Stephania rotunda</i> Lour. [Menispermaceae] Tamarkey 0170	Roots/ fruit as powder	BR, Dia	NE	3	127	0.023	3	0.024	33.33
<i>Strobilanthes capitata</i> (Nees) T.Anderson [Acanthaceae] Aankhley 0064	Stem as raw (topical)	GID	NE	1	127	0.007	1	0.008	100
<i>Syzygium formosum</i> (Wall.) Mason [Myrtaceae] Ambakey 0179	Leaves as infusion	GID	LC	1	127	0.007	1	0.008	100
<i>Syzygium kurzii</i> (Duthie)N.P.Balacr. [Myrtaceae] Jamuna 0174	Bark as infusion	GID	NE	1	127	0.007	1	0.008	100
<i>Syzygium nervosum</i> DC.[Myrtaceae] Kyamuna 0173	Leaves as raw	Res	LC	1	127	0.007	1	0.008	100
<i>Swertia chirayita</i> (Roxb.) H.Karst.[Gentianaceae] Chirauto 0218	Whole plant/ shoot/ as decoction	Fvr, Res, Misc	NE	3	127	0.023	4	0.031	25
<i>Tagetes erecta</i> L. [Asteraceae] Sayapatri 0245	Leaves as raw	ENT	NE	1	127	0.007	1	0.008	100
<i>Tectaria coadunata</i> (J.Sm.) C.Chr. [Polypodiaceae] Kutruka 0108	Rhizome as infusion	GID, Kid & Uri	NE	2	127	0.015	7	0.055	85.71
<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn. [Combretaceae] Arjun 0202	Bark as decoction	Dia	LC	1	127	0.007	1	0.008	100
<i>Terminalia bellirica</i> (Gaertn.) Roxb. [Combretaceae] Barra 0204	Fruit as powder/ infusion/decoction	GID, Dia, Res	LC	3	127	0.023	5	0.039	60
<i>Terminalia chebula</i> Retz. [Combretaceae] Harra 0206	Fruit as powder/ infusion/decoction	GID, Dia, Res	LC	3	127	0.023	7	0.055	57.14
<i>Tetradium fraxinifolium</i> (Hook.) T.G.Hartley [Rutaceae] Khanakpa 0200	Seeds as paste	GID	LC	1	127	0.007	2	0.016	100

<i>Tetrataenium wallichii</i> (DC.) Manden. [Apiaceae] Chimphing 0127	Seeds as powder/infusion	GID	NE	1	127	0.007	2	0.016	100
<i>Tinospora cordifolia</i> (Willd.) Hook.f. & Thomson [Menispermaceae] Gurjo 0203	Stem/roots as powder/poultice/decoction	Dia, BR, Fvr, Res	NE	4	127	0.031	7	0.055	57.14
<i>Trachyspermum ammi</i> (L.) Sprague [Apiaceae] Juwano 0196	Seeds as powder	GID	NE	1	127	0.007	3	0.024	100
<i>Trigonella foenum-graecum</i> L. [Fabaceae] Methi 0189	Seeds as powder	GID, Dia	NE	3	127	0.023	3	0.024	33.33
<i>Triticum aestivum</i> L. [Poaceae] Gau 0209	Seeds as powder	Dia	NE	1	127	0.007	1	0.0078	100
<i>Tropaeolum majus</i> L. [Tropaeolaceae] Lahareyphul 0195	Leaves as raw	GID	NE	1	127	0.007	1	0.008	100
<i>Urtica dioica</i> L. [Urticaceae] Shishnu 0044	Roots/ inflorescence as poultice/decoction	BR, Cir	LC	2	127	0.015	19	0.149	95
<i>Vigna mungo</i> (L.) Hepper [Fabaceae] Kaalo Daal 0232	Seeds as infusion	GID	NE	1	127	0.007	1	0.008	100
<i>Viscum articulatum</i> Burm.f. [Santalaceae] Harchur 0220	Whole plant as poultice/powder/decoction	BR, Mis	N3E	2	127	0.015	12	0.094	8.33
<i>Visnaga daucooides</i> Gaertn. [Apiaceae] Saunf 0194	Shoot as powder	Misc	NE	1	127	0.007	1	0.008	100
<i>Withania somnifera</i> (L.) Dunal [Solanaceae] Ashwagandha 0235	Whole plant as powder	BR	NE	1	127	0.007	2	0.016	100
<i>Zanthoxylum acanthopodium</i> DC. [Rutaceae] Bokeytimbur 0128	Roots/fruits as infusion/paste	ENT, BR	LC	2	127	0.015	2	0.016	50
<i>Zea mays</i> L. [Poaceae] Makai 0225	Inflorescence as powder	Dia	LC	1	127	0.007	1	0.008	100
<i>Zingiber officinale</i> Roscoe [Zingiberaceae] Aduwa 0175	Rhizome as raw/powder/paste	GID, Dia, ENT, Repr, Res	DD	5	127	0.039	5	0.039	20

[Abbreviations: GID = Gastro intestinal disorder; ENT = Ear, nose, and tongue related disorder; BR = Bone related disorder; Dia = Diabetes; Repr = Reproductive; Res = Respiratory disorder; Fevr = Fever; Pbi = poisonous bite; Kid & uri = Kidney and urinary trouble Cir = Circulatory disorder; Der = Dermatological disorder; Misc = Miscellaneous; NR = Nerve related disorder; Sld = Sleeping disorder; Vir = Viral diseases. LC = Least concern; DD = Data deficient; NT = Near Threatened; NE = Not evaluated; FL = Fidelity Level; TI = Total informants]

Quantitative Study

For quantitative study, collected formulations treating various diseases were categorized into 15 disease categories. The ethnomedicinal plants used in ethnomedicinal formulations were statistically analyzed using different quantitative indices, the results of which are mentioned below.

Informant consensus factor (ICF): The highest ICF values (0.650), approaching 1, was recorded for bone-related disorders and this was closely followed by gastrointestinal disorder (0.585), kidney and urinary troubles (0.565), and ENT related disorders achieving an ICF of 0.556. This indicates a strong consensus among informants on the use of the plant species for treating these conditions in the study area. Conversely, nerve-related and sleep disorders exhibited the lowest ICF value of 0, suggesting minimal shared knowledge among informants regarding plant treatments for these conditions (Table 4).

Fidelity Level (FL): The fidelity level of the 193 recorded ethnomedicinal plants varies from 3.84 % to 100%. The lowest FL of 7.14% was shown by *Ocimum tenuiflorum* which is used to treat GID, Cir, Dia, ENT, Fevr, Kid & Uri, Misc, NR, Repr, Resp disorders. Similarly, FL of 8% was shown by *Centella asiatica* indicating its versatile uses for treating disorders such as GID, BR, ENT, Fevr, Kid&Uri, Pbi, Repr, Res as reported by the informants (Table 5). A total of 84 plants among 193 plants showed 100% FL indicating their exclusive use in treating the particular disease category (Table 5).

Use Value (UV): Among the 193 plants reported by interviewing 127 informants from the tea gardens of Darjeeling, and Kalimpong hills of West Bengal and Sikkim, India, the highest use value of 0.078 shown by *Ocimum tenuiflorum* followed by 0.055 shown by *Centella asiatica*, *Bergenia ciliata*, and *sonchus maritimus* while the lowest UV (0.007) was shown by many plants such as *Allium cepa*, *Alnus nepalensis*, and *Pteris biaurita*, etc. (Table 5).

Frequency of Citation (FC): The highest frequency of citations were shown by *Hellenia speciosa* (FC = 33) followed by *Bergenia ciliata* (FC = 27), *Centella asiatica* (FC = 25), *Curcuma caesia* and *Plantago asiatica spp. erosa* (FC = 20 each), *Urtica dioica* (FC = 19), *Equisetum diffusum* (FC = 18), *Ageratina adenophora* (FC = 17), *Kaempferia rotunda* and *Cuscuta reflexa* (FC = 16 each), *Dimetia scandens*, *Astilbe rivularis* (FC = 15 each), *Sonchus maritimus* and *Gonoestegia hirta* (FC = 13 each), *Acmella ulliginosa*, *Aloe vera*, *Curcuma longa*, *Ocimum tenuiflorum*, *Viscum articulatum* (FC = 12 each), and *Cynodon dactylon*, and *Oroxylum indicum* with FC = 11 each. On the contrary, the remaining plants showed FC below 11 up to 1 (Table 5).

Relative Frequency of citation (RFC): The RFC value of the ethnomedicinal plants reported from the study area ranges from 0.007 - 0.26. The highest RFC value was attained by *Hellenia speciosa* (0.26), followed by, *Bergenia ciliata* (0.2), *Centella asiatica* (0.197), *Curcuma caesia* (0.16), *Urtica dioica* (0.149), *Equisetum diffusum* (0.13), and *Kaempferia rotunda*, and *Cuscuta reflexa* (0.12 each), *Ageratina adenophora*, and *Dimetia scandens* (0.11 each), *Sonchus maritimus* (0.102), *Acmella uliginosa*, *Aloe vera*, *Ocimum tenuiflorum* and *Viscum articulatum*, (0.094 each), and *Oroxylum indicum* (0.086). The lowest RFC is achieved by *Lygodium japonicum* (0.008), *Bixa orellana* (0.007) and others (Table 5).

Jaccard Index (JI): Jaccard Index was computed by comparing the present study with the similar studies carried out in the five different regions of India such as Assam, Kashmir, Western and Central Himalaya, and Western Ghats. The highest JI was reported from the Kani tribes of Western Ghats (JI = 10.61%) followed by Central Himalaya (9.62%) and the lowest from Kashmir (1.36%) (Table 6).

Rehman's Similarity Index (RSI): The RSI value ranges from 0.44 - 2.13%. The highest RSI (2.13%) was shown by the Central Himalaya followed by Western Himalaya (2.10%), Western Ghats (1.74%) and the lowest was shown by Kashmir (0.44%) (Table 6).

Table 6. Comparison of the study area to the other regions of India using JI and RSI

Study area	Other regions (India)	JI Indices				RSI Indices					References
		A	B	C	JI (%)	a	b	c	d	RSI (%)	
Easter n Himalayan	Kashmir	193	29	3	1.36	33	190	3	1	0.44	Asif et al. 2021

Tea gardens (Darjeeling-Kalimping of W.B. & Sikkim Himalaya), India	Assam	193	37	13	5.99	180	24	13	3	0.10	Baidya <i>et al.</i> 2020
	Central Himalaya	193	69	23	9.62	170	46	23	5	2.13	Ojha <i>et al.</i> 2020
	Western Himalaya	193	121	22	6.54	99	171	22	6	2.09	Singh <i>et al.</i> 2020
	Western Ghats	193	130	31	10.6	162	99	31	5	1.74	Sukumaran <i>et al.</i> 2021

[JI = Jaccard Index, A = Total plants from my study area, B = Number of plants in another study area, C = Common plants in both the area. RSI = Rehman's Similarity Index, d = Number of common plants used to treat the same ailment, a = Number of plants unique to the study area A, b = Number of plants unique to study area B, c = Number of common plants in both the area]

Pearson Correlation Coefficient (PCC)

Pearson correlation Coefficient (r) between FL and FC is 0.597 which is significant at $p < 0.05$. Similarly, PCC between FL and ICF is 0.545, significant at $p < 0.05$. A very strong positive correlation ($r = 0.956$) exists between FC and ICF at $p < 0.01$. Conversely, there is no significant relationship ($r = -0.19$) exist between FL and disease categories. A moderate negative correlation (-0.544) exists between FC and disease categories. Similarly, moderate negative correlation ($r = -0.579$) exist between ICF and disease categories (Table 7).

Table 7. Pearson correlation of disease categories with the FL, FC and ICF values

	Disease Category	FL	FC	ICF
Disease Category	1			
FL	-0.19	1		
FC	-0.544*	0.597*	1	
ICF	-0.579*	0.545*	0.956**	1

* Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed)

Discussion

Survey and Socio-demography of the informants

The ethnomedicinal information gathered from 58 tea gardens involved active participation of 192 informants of which the number of male informants (92) outnumbers the female informants (35). This clearly revealed that the females of the tea gardens of the study area are also the repository of ethnomedicinal knowledge though less in number. The main reason for the lesser female participation is due to their commitment to the household chores, and family care along with their profession as TG worker. Interestingly, majority of the medicinal practitioners belonged to different ethnic identities of Nepali communities and some of the key informants were exorcist like *Jhakri*, and *Baidang*, few of them were *Matas*, *Lamas*, etc. reflecting their unique ways of healing using ethnomedicinal plants. The informants were belonged to the age groups between 20 - 90 years but the majority lies to the age group 61-70 years reflecting declining interest of the youth in practicing ethnomedicines (Table 3). This is quite alarming and calls for the urgent action to protect the community access of traditional wisdom of ethnomedicinal knowledge through awareness on the importance of their cultural heritage. In such cases, the present kind of study stands as key approach to preserve such valuable knowledge supporting the long term viability and maintaining its integrity.

Pearson correlation matrix

Pearson correlation study demonstrated the importance of demographic factors such as gender, age, education, occupation and source of knowledge in the both transmission and practice of ethnomedicinal knowledge among the participants. Gender showed statistically inverse relationship with the source of knowledge, age, education, occupation, ethnicity, and number of formulations indicating gender based variations in the ethnomedicinal practices. A negative correlation of age with education while its positive correlation with the number of plants known suggest that the older population are low in formal education

yet possess great ethnomedicinal wisdom. Education is statistically correlated with occupation and ethnicity but showed negligible effect on ethnomedicinal knowledge. Statistical significant relationships of number of formulations to number of medicinal plants suggest that individuals with greater knowledge of medicinal plants tend to report more ethnomedicinal formulation. Most of the other relationships were not significant suggesting the variable role of the demographic factors in the preservation, practice, and transmission of ethnomedicinal knowledge.

Ethnomedicinal plants and herbal formulation

The recorded 193 ethnomedicinal plants belonged to 82 families of which 35 families contained more than one plant species. Among the 82 plant families, Fabaceae with 12 species was the highest used families regarding the number of species followed by Lamiaceae (11 species). These findings are same as the findings of other parts of India (Ahirwar & Gupta 2024). The cosmopolitan distribution of Fabaceae, with a huge number of species, may be due to its rigorous ecological adaptability, nitrogen fixation through symbiotic relationships with leguminous plants, and attractive insect pollination and lucid dispersal mechanisms (Xu *et al.* 2017; Saikia *et al.* 2020). Lamiaceae also contain diverse and widely distributed aromatic species of globally economic importance (Chrysargyries 2024). Previous studies in the study area have also listed Fabaceae and Lamiaceae as 15 among the dominant families in terms of both generic and species richness (Mallick 2020).

Among the plant parts used the leaves showed the highest percentage of use (27%) this coincides with the similar studies carried out in other regions of our country and across the globe (Anwar *et al.* 2025; Faruque *et al.* 2018). Leaves being easy to collect and site of many physiological reactions and are rich in pharmacological components greatly used in ethnomedicinal practices (Baidya *et al.* 2020). Other plant parts used dominantly in the ethnomedicinal formulations are roots (15%), bark (13%), and seeds (11%) also coinciding with the global trends. Roots being rich in bioactive compounds use in traditional medicinal formulation while the other plant parts are used due to their cultural belief (Redouan *et al.* 2022; Kacholi & Mvungi 2022; Aruna *et al.* 2015; Bezzera *et al.* 2022; Miya *et al.* 2020)

Healers though they did not have idea of IUCN list of threatened species categories, they planted some rare species in their kitchen garden to use sustainably to prepare medicine. This shows their decent sense towards conservation of ethnomedicinal plant resources. It was also found that in some cases they use plants which are not found locally for instance, *Crocus sativus*, so they bought the required plant parts for medicine purpose.

The oral administration (80%) was the dominant over topical (18%) and inhalation (2%) this is also recorded by previous studies (Byeon 2019). Infusion was the mostly preferred method of preparation of herbal medicines as it is rich in flavonoids and polyphenols (Etheridge & Derbyshire 2020).

Quantitative Study

Informant consensus factor (ICF): The highest ICF (0.650) shown by bone related disorders, gastrointestinal disorder (0.585), kidney and urinary troubles (0.565), and ENT related disorders (0.556) suggest that there is quite agreement among the healers of different tea gardens of the study area regarding the usage of plants in treating these disorders. Whereas, the nerve related and sleep disorders with the lowest ICF (0) indicates complete disagreement among the healers regarding the plant usage to treat these two disorders.

Fidelity Level (FL%): From the current study it is known that fidelity level is the expression of extent of plant usage in the treatment of various disorders as reported by the informants. Among the 193 ethnomedicinal plants, used by the tea garden people of the study area, the lowest FL were shown by *Ocimum tenuiflorum* (7.14%) and *Centella asiatica* (8%) indicating its versatile uses in treating GID, Cir, Dia, ENT, Fevr, Kid & Uri, Misc, NR, Repr, Resp, BR, and pbi. *Ocimum tenuiflorum* is referred as 'Herbal Queen' as it is rich in diverse biologically active compounds traditionally used in India to treat various disorders (Marathe *et al.* 2022). Similarly, *Centella asiatica*, another herb possessing nearly 139 biological compounds of which asiaticoside, madecassoside, and asiaticoside B are prominent triterpenoid saponins possessing wound - healing and skin - protective properties (Kunjumon *et al.* 2022; Zhou *et al.* 2025). These findings suggest that the wide distribution of these herbs and their medicinal uses across the globe. There were many plants (84) which showed 100 % FL suggesting their exclusive use in the recorded 15 disease categories.

Use Value (UV): Several ethnomedicinal plants showed significant use value among them *Ocimum tenuiflorum* exhibited highest (0.078), followed by other plants proving their potency in the traditional medicines. The plants with the highest use value are culturally accepted and hence mostly utilised. The present result coincides with previous studies from different regions of our country (Rai *et al.* 2018, Sarkar 2023) (Table 8).

Table 8. Comparison of high UV species from the present study to the previously validated species

Species from study area	UV	Ethnomedicinal uses	Previously validated plants	Pharmacological properties	References
<i>Ocimum tenuiflorum</i>	0.078	GID,Cir, Dia, ENT,Fevr, Kid & Uri, Misc, NR, Repr, Res	<i>Ocimum tenuiflorum</i>	Anti-inflammatory, anti-bacterial	Varghese et al. 2024; Sharma et al., 2024
<i>Centella asiatica</i>	0.055	GID,BR, ENT, Fevr,Kid& Uri, Pbi, Repr, Res	<i>Centella asiatica</i>	Wound healing, anti-oxidant, anti-bacterial	Arribas-López et al. 2022; Taghizadeh et al. 2024
<i>Bergenia ciliata</i>	0.055	BR, Der, ENT, Misc,Repr, Res	<i>Bergenia ciliata</i>	Anti-malarial anti-oxidant, anti-microbial	Walter et al. 2013 Singh et al., 2017
<i>sonchus martimus</i>	0.055	GID,BR, Cir, ENT, Fevr, Pbi, Res	<i>sonchus martimus</i>	Anti-diabetic	Chetehouna et al. 2024

[Abbreviations: GID = Gastro intestinal disorder; ENT = Ear, nose, and tongue related disorder; BR = Bone related disorder; Dia = Diabetes; Repr = Reproductive; Res = Respiratory disorder;Fevr = Fever; Pbi = poisonous bite; Kid & uri = Kidney and urinary trouble Cir = Circulatory disorder; Der = Dermatological disorder; Misc =Miscellaneous; NR = Nerve related disorder]

Frequency of Citation (FC): Frequency of citation is the number of times the informants mention the use of particular plants in the survey to treat various disorders. There were more than 20 ethnomedicinal plants exhibiting higher frequency of citations name of which is already discussed in the results section. These plants with highest frequency of citations are significant in various ways such as they possess high ethnomedicinal importance, abundance in distribution, and cultural significance. Such plants may contain potential biologically active compounds and hence further detailed pharmacological research becomes an utmost necessary.

Relative Frequency of citation (RFC): The relative frequency of citations estimates how frequently a particular plant is cited relative to the total number of informants of the study. It highlights the most prominent plant species in the community.

Jaccard Index (JI): In ethnomedicinal works, Jaccard Index as already mentioned estimates the extent of similarity of species between the two study areas. In the present study, none of the regions showed greater homogeneity with the floras of my study area, JI shown by the Kani tribes indicates that only 10.61% of plant species are found in both the areas. Similarly, same is the case with the other regions and this could be due to unique ecology, and culture arising from isolated geography and linguistic barrier of my study area and the other regions of India.

Rehman's Silmilarity Index (RSI):

There was substantially low RSI between my study area to other regions which is different from other research (Misganaw et al. 2025).The RSI value of 0 indicates no similarity, while 100 % indicates common species usage In the present study, the relatively higher RSI was observed in the Central Himalayas followed by the Western Himalaya indicating considerable cultural similarity in the plant usage for the same purposes. While, the lowest RSI was noted in Kashmir (Table 6) indicating that the smaller number of common plants share similar medicinal usage across these areas. Such diversity occurs as result of distinct environmental factors, ecological and cultural diversities across my study area and the communities of other regions.

Pearson correlation coefficient (PCC) on quantitative study:

The strong FC - ICF correlation suggests that the plants that were frequently cited by the informants also possess high ICF. This clearly suggests that these plants are widely recognized and commonly used to treat particular diseases prioritizing the plants for pharmacological validation.

Moderate FL - FC and FL - ICF correlations suggest that the plants that were specifically used to treat a particular disease (high FL) in my study area is mentioned by many informants (high FC) and agreed upon by them (high ICF).

A negative correlation between disease number and FC/ICF suggests dilution of specificity as the number of diseases for which a particular plant is used increases, the frequency of citation and consensus among the informants also decreases. This negative correlation also emphasizes on targeted documentation of plant - disease use for accurate pharmacological research.

Conclusion

The present study encompasses the majority of the tea gardens (79) spread over the Eastern Himalayas. From the study it was evident that the people of Eastern Himalayan tea gardens belong to different ethnic identities and still prefer ethnomedicines for their basic health care, this dependency may be due to the high cost of allopathic treatments, or the total faith in their age-old medicinal knowledge. However, the study area is also no exception of the low interest of the youth in traditional medicines which is also quite alarming. So, such kind of documentation becomes essential to preserve their traditional wisdom of medicines.

This study documented 193 ethnomedicinal plants belonging to 82 families of which Fabaceae, Lamiaceae, Zingiberaceae, and Asteraceae were notable in terms of the number of species used. These ethnomedicinal plants were employed to treat 15 disease categories. Further, Quantitative approach, statistical analysis, and comparative study using JI and RSI provide robust structure by crossing the conventional documentation method. Such a comparison helps to find out the ecological and cultural significance of ethnomedicinal plants among the compared communities of two different study areas. The quantitative approach may help to find out potential plant for treating particular disorder. For instance, plants with high FL (100%), use value, and RFC can be employed for further pharmacological studies and may stand as new drug candidate for treating various human ailments for which scientific validation with further elaborative study is highly recommended considering the property rights of the knowledge holders.

Plants like *Tetrataenium wallichii*, *Tetradium farxinifolium*, *Vigna mungo*, *Tectaria coadunata*, *Sida acuta*, *Rumex nepalensis*, *Ostedes paniculata*, *Mucuna interrupta*, etc. can be studied further to extract drug for treating gastrointestinal disorder. Similarly, *Urtica dioica*, and *Heynea trijuga*, for bone related disorder and *Lobelia nummularia*, *Lygodium japonicum* for dermatological problems. Similarly, some of the plants with the highest RFC and UV are *Hellenia speciosa*, *Bergenia ciliata*, *Curcuma caesia*, *Equisetum diffusum*, *Viscum articulatum*, *Dimetia scandens*, *Sonchus maritimus*, *Acmella ullaiginosa*, *Aloe vera*, *Ocimum tenuiflorum*, and *Centella asiatica* and many other plants discussed in the result section can be explored further and new drugs treating various disorders can be obtained from these plants.

Declarations

List of abbreviations: SOI = Survey of India, SRTM = Shuttle Radar Topography Mission, DEM = Digital Elevation Model; GID = Gastro intestinal disorder; ENT = Ear, nose, and tongue related disorder; BR = Bone related disorder; Dia = Diabetes; Repr = Reproductive; Res = Respiratory disorder; Fevr = Fever; Pbi = poisonous bite; Kid & uri = Kidney and urinary trouble Cir = Circulatory disorder; Der = Dermatological disorder; Misc = Miscellaneous; NR = Nerve related disorder; Sld = Sleeping disorder; Vir = Viral diseases. IUCN = International union for nature and natural resources, LC = Least concern; DD = Data deficient; Th = Threatened; NE = Not evaluated; WHO = World Health Organisation, POWO = Plants of the world online. ICF = Informant Consensus factor, FC = Frequency of citation, RFC = Relative frequency of citations, FL = Fidelity Level, UV = Use value, TI = Total informants, PCC = Pearson correlation coefficient, JI = Jaccard index, RSI = Rehman's similarity index

Ethics approval and consent to participate: The present study does not involve experiment on animal and plant materials. All the information was obtained by taking prior permission from the informants (verbal as well as filling up prior informant's consent form).

Consent for publication: Oral and written consent was obtained from the knowledge holders.

Availability of data and materials: All the figures and tables are original, the outcomes of this work.

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Literature cited

Ahirwar RK, Gupta V. 2024. Quantitative ethnomedicinal investigation of medicinal plants used by traditional healers to treat various diseases in the district Dindori, Madhya Pradesh, India. *Ethnobotany Research and Applications* 28: 1-31.

- Anwar T, Qureshi H, Naeem H, Batool N. 2025. Quantitative assessment of the ethnomedicinal knowledge of wild plants used to treat human ailments. *Vegetos* 38(1): 292-306.
- Arora V. 2006. The forest of symbols embodied in the Tholung sacred landscape of North Sikkim, India. *Conservation and Society* 4(1):55-83.
- Arribas-López E, Zand N, Ojo O, Snowden MJ, Kochhar T. 2022. A systematic review of the effect of *Centella asiatica* on wound healing. *International Journal of Environmental Research and Public Health* 19(6): 3266.
- Aruna K, Syamala D, Rao JP, Suneetha J, Venkaiah M. 2015. Ethno medicinal plants used by Jatapu Women in Eastern Ghats of Andhra Pradesh, India. *The Journal of Ethnobiology and Traditional Medicine* 124: 958-969.
- Asif M, Haq SM, Yaqoob U, Hassan M, Jan HA. 2021. Ethnobotanical study of indigenous knowledge on medicinal plants used by the tribal communities in tehsil "karnah" of district kupwara (Jammu and kashmir) india. *Ethnobotany Research and Applications* 21:1-14.
- Baidya S, Thakur B, Devi A. 2020. Ethnomedicinal plants of the sacred groves and their uses by Karbi tribe in Karbi Anglong district of Assam, Northeast India. *Indian Journal of Traditional Knowledge* 19(2): 277-287.
- Bezerra JLL, Pinheiro, AAV, de Oliveira Barreto E. 2022. Medicinal plants used in the treatment of asthma in different regions of Brazil: A comprehensive review of ethnomedicinal evidence, preclinical pharmacology and clinical trials. *Phytomedicine Plus* 2(4):100376.
- Buragohain J. 2011. Ethnomedicinal plants used by the ethnic communities of Tinsukia district of Assam, India. *Recent research in Science and Technology* 3(9).
- Byeon JC, Ahn JB, Jang WS, Lee SE, Choi JS, Park JS. 2019. Recent formulation approaches to oral delivery of herbal medicines. *Journal of Pharmaceutical Investigation* 49(1):17-2.
- Chetehouna S, Derouiche S, Réggami Y. 2024. In Vitro Antioxidant and Antidiabetic properties of leaves aqueous extract of *Sonchus maritimus*. *International Journal of Chemical and Biochemical Science* 25 (19): 1-8.
- Chettri D, Moktan S, Das AP. 2014. Ethnobotanical studies on the tea garden workers of Darjiling Hills. *Pleione* 8 (1): 124 - 132.
- Chettri D, Chowdhury M. 2018. Ethnomedicinal approach against bone fracture among the tea garden workers of Darjeeling Hills. *Indian Journal of Traditional Knowledge (IJTK)* 17 (3): 512-517.
- Chhetri G, Pandey A, Gaira KS, Joshi R. 2024. Traditional Knowledge, Ethnic Foods, and Their Conservation of Indigenous Laapche Community of Darjeeling and Sikkim Himalaya. In: *Sustainable Management and Conservation of Environmental Resources in India*, Apple Academic Press Pp. 413- 434.
- Chrysargyris A. 2024. It runs in the Family: The importance of the Lamiaceae family species. *Agronomy*, publisher MDPI 14(6): 1274.
- Etheridge CJ, Derbyshire E. 2020. Herbal infusions and health: A review of findings from human studies, mechanisms and future research directions. *Nutrition and Food Science* 50(5): 969 - 985. doi: 10.1108/NFS-08-2019-0263.
- Faruque MO, Uddin SB, Barlow JW, Hu S, Dong S, Cai Q, Li X, Hu X. 2018. Quantitative ethnobotany of medicinal plants used by indigenous communities in the Bandarban District of Bangladesh. *Frontiers in Pharmacology* 9:40.
- Friedman J, Yaniv Z, Dafni A, Palewitch D. 1986. A preliminary classification of the healing potential of medicinal plants, based on the rational analysis of an ethnopharmacological field survey among Bedouins in Negev Desert, Israel. *Journal of Ethnopharmacology* 16: 275-287.
- Gazzaneo LRS, de Lucena RFP, de Albuquerque UP. 2005. Knowledge and use of medicinal plants by local specialists in a region of Atlantic Forest in the state of Pernambuco (Northeastern Brazil). *Journal of Ethnobiology and Ethnomedicine* 1:1-8.
- González-Tejero MR, Casares-Porcel M, Sánchez-Rojas CP, Ramiro-Gutiérrez JM, Molero-Mesa J, Pieroni A, Giusti ME, Censorii E, de Pasquale C, Della A. 2008. Medicinal plants in the Mediterranean area: synthesis of the results of the project Rubia. *Journal of Ethnopharmacology* 116 (2):341-357.
- Grierson AJC, Long DG. 1983-1987. *Flora of Bhutan*. Royal Botanic Garden, Edinburgh, U.K. Vol. 1, pts 1-3.
- Grierson AJC, Long DG. 1991, 1999, 2001. *Flora of Bhutan*, Royal Botanic Garden, Edinburgh, U.K. Vol. 2, Pts 1, 2 & 3.

- Jain SK, Mudgal V. 1999. A handbook of ethnobotany. Bishen Singh Mahendra Pal Singh.
- Kacholi DS, Mvungi HA. 2022. Ethnomedicinal survey of anti-diarrheal plants of the Nyamwezi people of Nsenda ward in Urambo District, central western Tanzania. *Ethnobotany Research and Applications* 24:1-14.
- Khawas V. 2006. Status of tea garden labourers in eastern Himalaya: a case of Darjeeling tea industry. In: *Socio-Economic Conditions of Resident Tea Garden Labourers in Darjeeling Hills- A Pilot Study*, Council for Social Development, New Delhi.
- Kunjumon R, Johnson AJ, Baby S. 2022. *Centella asiatica*: Secondary metabolites, biological activities and biomass sources. *Phytomedicine Plus* 2(1):100176.
- Marathe SB, Mali N, Shaikh AZ. 2022. The therapeutic action of queen of herb (*Ocimum tenuiflorum*). *Research Journal of Pharmacognosy and Phytochemistry* 14(3):192-194.
- Mallick JK. 2020. An annotated checklist of Dicotyledonous Angiosperms in Darjeeling Himalayas and foothills, West Bengal, India. *Journal on New Biological Reports* 9(2): 94-208.
- Misganaw W, Masresha G, Alemu A, Lulekal E. 2025. Ethnobotanical study of medicinal plants used to treat human and livestock ailments in Addi Arkay district, northwest Ethiopia. *Journal of Ethnobiology and Ethnomedicine* 21(1):31.
- Miya M S, Timilsina S, Chhetri A. 2020. Ethnomedicinal uses of plants by major ethnic groups of Hilly Districts in Nepal: A review. *Journal of Medicinal Botany* 4: 24-37.
- Morinaka Y, Takamura, Y. 2017. Recent developments in Japanese implementation of the Nagoya Protocol. *Journal of International Relations and Area Studies* 46: 13-23.
- Ojha SN, Tiwari D, Anand A, Sundriyal RC. 2020. Ethnomedicinal knowledge of a marginal hill community of Central Himalaya: Diversity, usage pattern, and conservation concerns. *Journal of Ethnobiology and Ethnomedicine* 16(1). doi: 10.1186/s13002-020-00381-5
- Paul P, Dhar S, Chowdhury M, Das D. 2020. Herbarium technique: evolution from conventional to digitization. OrangeBooks Publication.
- Plants of the World Online. 2023. Facilitated by the Royal Botanic Gardens, Kew, U.K. published on the Internet <http://www.plantsoftheworldonline.org/> (Accessed 15/05/ 2025).
- Raj AJ, Biswakarma S, Pala NA. 2018. Indigenous uses of ethnomedicinal plants among forest-dependent communities of Northern Bengal, India. *Journal of Ethnobiology and Ethnomedicine* 14: 8. doi: 10.1186/s13002-018-0208-9
- Redouan FZ, Yebouk C, Crisafulli A, Picone RM, & Merzouki A. 2022. Ethnopharmacological preparations used for digestive system disorders in Talassemtane National Park, North of Morocco. *Ethnobotany Research and Applications* 24:1-25.
- Saikia P, Nag A, Anurag S, Chatterjee S, Khan ML. 2020. Tropical legumes: Status, distribution, biology and importance. *The Plant Family Fabaceae: Biology and Physiological Responses to Environmental Stresses* 27-41.
- Sarkar K, Roy P, Panda S, Choudhuri C, Chowdhury, M. 2023. Ethnobotanical study on plant resources from sacred groves of Dakshin Dinajpur district, West Bengal, India. *Ethnobotany Research and Applications*, 25, 1-35. doi: 10.32859/era.25.32.1-35
- Sarkar K, Dey S, Farhat Z, Kumar A, Choudhuri C, Chowdhury M. 2025a. Ag/ZnO nanodots from *Artemisia austroyunnanensis* as antibacterial and anticancer agents against human neuroblastoma cells. *Scientific Reports* 15, 22598. doi: 10.1038/s41598-025-07251-8
- Sarkar K, Mondal S, Mallick D, Chowdhury M. 2025b. Ecological Impact of Tropical Invasive Alien Species on the Indigenous Vegetation of Sursuti MPCA of Gorumara National Park, India. In: Roy S, Mathur P, Chowdhury M, Bhandari JB (eds). *Recent Trends and Applications in Plants, Microbes and Agricultural Sciences. APMAS 2023. Sustainable Landscape Planning and Natural Resources Management*. Springer, Cham. doi: 10.1007/978-3-031-90139-3_6
- Singh, M, Pandey N, Agnihotri V, Singh KK, Pandey A. 2017. Antioxidant, antimicrobial activity and bioactive compounds of *Bergenia ciliata* Sternb.: A valuable medicinal herb of Sikkim Himalaya. *Journal of Traditional and Complementary Medicine* 7(2):152-157.
- Sharma TR, Lachungpa U. 2003. Status, distribution and management of mountain ungulates in Sikkim, India. *ENVIS Bulletin: Wildlife and Protected Areas* 38-49.

- Sharma, S, Rolta R, Salaria D, Dev K. 2024. In vitro antibacterial and antifungal potentials of *Ocimum tenuiflorum* and *Ocimum gratissimum* essential oil. *Pharmacological Research-Natural Products* 4:100065.
- Subba JR. 2008. *History, Culture and Customs of Sikkim*. India. Gyan Publishing, New Delhi, India.
- Sukumaran S, Sujin RM, Geetha VS, Jeeva S. 2021. Ethnobotanical study of medicinal plants used by the Kani tribes of Pechiparai Hills, Western Ghats, India. *Acta Ecologica Sinica* 41(5):365-376. doi: 10.1016/J.CHNAES.2020.04.005
- Taghizadeh M, Jalili S. 2024. Phytochemical content, antioxidant properties, and antibacterial activities of *Centella asiatica* L. *Natural Product Research* 38 (20):3693 -3698.
- Tamang S, Singh A, Bussmann RW, Shukla V, Nautiyal MC. 2023. Ethno-medicinal plants of tribal people: A case study in Pakyong subdivision of East Sikkim, India. *Acta Ecologica Sinica* 43(1): 34-46.
- Tardío J, Pardo-de-Santayana M. 2008. Cultural importance indices: a comparative analysis based on the useful wild plants of Southern Cantabria, Northern Spain. *Economic Botany* 62: 24-39.
- Thirumalai T, Kelumalai E, Senthilkumar B, David E. 2009. Ethnobotanical study of medicinal plants used by the local people in Vellore District, Tamilnadu, India. *Ethnobotanical leaflets* 10:10.
- Trotter RT, Logan MH. 1986. Informant consensus: a new approach for identifying potentially effective medicinal plants. N. L. Etkin, ed., *Plants in indigenous medicine and diet*. Redgrave Publishing Company, Bedford Hill, New York, U.S., Pp.91-112.
- United Nations. 1992. *Convention on Biological Diversity*, Rio de Janeiro, Brazil. United Nations Treaty Series 79.
- Varghese RM, Kumar A, Shanmugam R. 2024. Comparative anti-inflammatory activity of silver and zinc oxide nanoparticles synthesized using *Ocimum tenuiflorum* and *Ocimum gratissimum* herbal formulations. *Cureus* 16(1).
- Xu Z, Deng M. 2017. Fabaceae or leguminosae. In *Identification and Control of Common Weeds: Volume 2*, Springer Dordrecht, Netherlands, Pp. 547-615.
- Walter NS, Bagai U, Kalia S. 2013. Antimalarial activity of *Bergenia ciliata* (Haw.) Sternb. against *Plasmodium berghei*. *Parasitology Research* 112(9): 3123 - 3128.
- World Flora Online. 2025. <http://www.worldfloraonline.org>.-2025-05 (Accessed 10/05/ 2025).
- Zhou P, Yang P, Zhang K, Guo H, Du J, Huang L, Jin D, Alolga RN, Wang H, Li J. 2025. Discovery and engineering of the asiaticoside, madecassoside and asiaticoside B biosynthetic pathway. *Plant Physiology and Biochemistry* 223: 109864