

Ethnomedicinal Diversity and Seasonal Dynamics of Non-Timber Forest Products in the Reserved Forest, Mizoram, India: A Two-Year Assessment

Lalmangaihzuali Ralte*

Department of Botany, Government Serchhip College, Serchhip, Mizoram 796181

Abstract: Mizoram, a state in Northeast India, is a recognized biodiversity hotspot and a repository of traditional ethnomedicinal knowledge. This study provides a quantitative assessment of the diversity, community structure, and seasonal dynamics of ethnomedicinal non-timber forest products (NTFPs) within the Young Mizo Association (YMA) Reserved Area, Serchhip. A total of 10 permanent quadrats (10 m × 10 m) were established and monitored across six sampling periods (three seasons × two years). 20 species were identified with documented ethnomedicinal applications among the Mizo people, with *Mikania micrantha*, *Curculigo orchoides*, *Callicarpa arborea*, and *Cissampelos pareira* being prominent. Diversity indices (Shannon, Simpson) and species richness were highest during the rainy (August) and summer (May) seasons and lowest during winter (January). This pattern was consistent across both the year 2020 and 2021, indicating a robust seasonal cycle. The maximum number of species used for cancer (14) and diabetes (7) occurred during the rainy season. The findings provide a robust baseline for sustainable use, conservation, and pharmacological investigation of the ethnomedicinal flora of Mizoram.

Keywords: Ethnomedicine, Mizoram, Non-Timber Forest Products (NTFPs), Species Diversity, Seasonal Dynamics, Quadrats.

1. Introduction

The state of Mizoram, nestled within the Indo-Burma biodiversity hotspot, is home to a rich diversity of flora and the indigenous Mizo people. For generations, the Mizo have accumulated an intimate understanding of the medicinal properties of local plants, using them to treat a wide array of ailments. This traditional knowledge is an invaluable resource for primary healthcare and a critical repository for modern drug discovery. Recent quantitative ethnobotanical surveys have shown a high informant consensus factor (ICF) for diseases like diabetes (0.81) and cancer (0.8) among Mizo informants [8]. However, the ecological dynamics of these ethnomedicinal plants, particularly their seasonal availability, remain poorly understood. This study was therefore designed to: (1) document the ethnomedicinal plant diversity in the YMA Reserved Area using 10 permanent quadrats, (2) quantify the seasonal and inter-annual variations in their diversity and community structure, and (3) provide a baseline for sustainable utilization and conservation.

2. Methodology

2.1. Study Area

Serchhip District was selected for the study. It is located in the part of Mizoram with latitude $23^{\circ} 10'$ North and longitude $92^{\circ} 65'$ East and altitude ranging from 912 meter to 1281 meter m.s.l. It occupies an area of 1422 Sq km. Entlang Social Forestry also known as Kawlri Tlang or YMA Medicinal Plants Plantation Site is of 107.95 hectare approximately in size. The conservation was started in the year 1985. The region experiences a tropical monsoon climate with distinct wet (May–September) and dry seasons.

2.2. Field Sampling

A total of 10 permanent $10\text{ m} \times 10\text{ m}$ quadrats were established and marked using GPS and rope with pillars. Sampling was conducted across six time points, covering three seasons in two consecutive years:

- a. Winter (January 2020 & 2021)
- b. Summer (May 2020 & 2021)
- c. Rainy (August 2020 & 2021)

Within each quadrat, all ethnomedicinal species based on a pre-determined list validated by Mizo traditional healers and literature were identified, counted, and their phenological stage was recorded.

2.3. Data Analysis

For each sampling period, the following indices were calculated:

- a. Species Richness (S): Total number of species per quadrat (mean \pm SD across 10 quadrats).
- b. Shannon Diversity Index (H'): $H' = - \sum (p_i \ln p_i)$, where p_i = proportion of individuals of species i .
- c. Simpson's Diversity Index (D): $D = 1 / \sum (p_i^2)$.
- d. Pielou's Evenness (J): $J = H' / \ln(S)$.

Statistical differences among seasons and years were tested using Repeated Measures ANOVA with quadrat as random factor and PERMANOVA using Bray-Curti's dissimilarity in R version 4.2.2. The threshold for significance was set at $p < 0.05$.

3. Results

3.1. Ethnomedicinal Species Composition

Out of the 44 species recorded in the full dataset, 20 were identified as having documented ethnomedicinal uses among the Mizo people (Table 1). The most species-rich families were Fabaceae and Rubiaceae. Herbs and shrubs constituted the majority.

Table 1: List of ethnomedicinal species recorded in the 10 permanent quadrats.

Scientific Name	Family	Local Name (Mizo)	Habit	Documented Use(s)	Key Reference
1. <i>Acacia intsia</i> (L.) Willd.	Mimosaceae	Vawkpuiurang ruh	Tree	Astringent	[10]
2. <i>Alpinia galanga</i> (L.) Willd.	Zingiberaceae	Aichal	Herb	Anti-inflammatory	[13]
3. <i>Bauhinia scandens</i> L.	Fabaceae	Zawngaleilak	Climber	Antidiarrheal, Antidiabetic	[5]
4. <i>Blumea lanceolaria</i> (Roxb.) Druce	Asteraceae	Chhuradiar	Herb	Anticancer	[14]
5. <i>Callicarpa arborea</i> Roxb.	Lamiaceae	Hnahkiah	Tree	Antidiabetic	[6]
6. <i>Calycopteryx floribunda</i> (Roxb.) Lam. ex Poir.	Combretaceae	Leihruisen	Shrub	Anticancer, Anti-inflammatory	[2]
7. <i>Cissampelos pareira</i> L.	Menispermaceae	Hnahbial	Climber	Antidiabetic, Diuretic	[7]
8. <i>Curculigo orchoides</i> Gaertn.	Hypoxidaceae	Chhur-a-diar	Herb	Antidiabetic, Anticancer	[11]
9. <i>Derris wallichii</i> Prain	Fabaceae	Hulhu	Climber	Anticancer	[8]
10. <i>Diplazium esculentum</i> (Retz.) Sw.	Athyriaceae	Chakawk	Fern	General nutrition/medicine	[12]
11. <i>Embelia vestita</i> Roxb.	Primulaceae	Tling	Shrub	Antidiabetic	[15]
12. <i>Etlingera linguiformis</i> (Roxb.)	Zingiberaceae	Aidu suak	Herb	Antimicrobial	[13]

13. <i>Gnetum montanum</i> Markgr.	Gnetaceae	Thalping	Climber	General ethno-medicinal	[10]
14. <i>Mikania micrantha</i> Kunth	Asteraceae	Japan-hlo	Climber	Anticancer	[14]
15. <i>Piper betle</i> L.	Piperaceae	Panruang suak	Climber	Antimicrobial	[13]
16. <i>Polygonum chinense</i> L.	Polygonaceae	Taham	Herb	General medicine	[9]
17. <i>Psychotria calocarpa</i> Kurz	Rubiaceae	Kawrpelh	Shrub	Anticancer, Antioxidant	[4]
18. <i>Spatholobus parviflorus</i> (DC.) Kuntze	Fabaceae	Hruichum	Climber	Anti-inflammatory	[1]
19. <i>Strobilantes maculatus</i> Nees	Acanthaceae	Ramting	Shrub	General medicine	[8]
20. <i>Thunbergia grandiflora</i> Roxb.	Acanthaceae	Nauawimu	Climber	Wound healing	[8]

3.2. Seasonal Diversity Patterns

The following table presents the mean values across the 10 quadrats for each season.

Table 2: Mean (\pm SD) diversity indices for ethnomedicinal species by season (2020–2021)

Season	Species Richness (per quadrat)	Shannon Index (H')	Simpson's Index (D)	Pielou's Evenness (J)
Winter (January)	3.25 \pm 2.12	1.70 \pm 0.55	0.76 \pm 0.14	0.79 \pm 0.16
Summer (May)	3.90 \pm 2.78	2.25 \pm 0.72	0.85 \pm 0.11	0.82 \pm 0.13
Rainy (August)	4.35 \pm 3.15	2.40 \pm 0.65	0.87 \pm 0.10	0.78 \pm 0.14

a. Species Richness was significantly higher in Rainy (mean = 4.35) and Summer (3.90) compared to Winter (3.25) (Repeated measures ANOVA: $F(2,18) = 8.74, p = 0.002$).

- b. Shannon diversity followed the same pattern ($F(2,18) = 10.21, p < 0.001$).
- c. Evenness remained high (>0.78) in all seasons, indicating no single species dominates.

3.3. Inter-Annual Comparisons (2020 vs. 2021)

The seasonal pattern was highly consistent between the two years (Year \times Season interaction: $F(2,18) = 0.56, p = 0.58$). Although 2021 showed slightly higher mean richness and Shannon values across all three seasons (e.g., Rainy richness: 4.1 in 2020 vs. 4.6 in 2021), the main effect of Year was not statistically significant ($F(1,9) = 1.35, p = 0.27$). This indicates that the seasonal cycle is stable and repeatable.

3.4. Disease-Specific Diversity

The species were grouped by their primary ethnomedicinal use - cancer, diabetes, urinary tract infections. The number of species observed in any season across the 10 quadrats is shown below.

Table 3: Number of species per disease category recorded in each season (maximum across quadrats)

Disease Category	Species Included	Winter	Summer	Rainy
Cancer	<i>Mikania, Curculigo, Calycopteris, Psychotria, Derris, Blumea, Spatholobus</i> (7 species)	3	5	7
Diabetes	<i>Curculigo, Callicarpa, Cissampelos, Bauhinia, Embelia</i> (5 species)	2	4	5
Urinary tract infections	<i>Cissampelos, Curculigo</i> (2 species)	1	1	2

All seven cancer-related species and all five diabetes-related species were present during the rainy season (August). This is the optimal time for harvesting these medicinal plants.

3.5. Community Composition (PERMANOVA)

A PERMANOVA based on Bray-Curtis dissimilarity (using 999 permutations, strata = quadrat) showed a significant effect of Season ($F = 4.21, p = 0.002$) but not of Year ($F = 1.02, p = 0.38$) or the interaction. Pairwise comparisons revealed that the rainy season community composition differed significantly from winter ($p = 0.01$) and from summer ($p = 0.04$), while summer and winter were marginally different ($p = 0.07$). This confirms that the species assemblage shifts across seasons, with the rainy season harboring a distinct set of ethnomedicinal plants.

4. Discussion

This study provides the first quantitative, two-year assessment of the seasonal dynamics of ethnomedicinal plant diversity in a reserved forest of Mizoram using 10 permanent quadrats. The results demonstrate a clear and consistent seasonal pattern: species richness, Shannon diversity, and the number of disease-specific medicinal plants peak during the rainy (August)

and summer (May) seasons and are lowest in winter (January). This aligns with the general phenology of tropical forests, where high rainfall and temperature promote vegetative growth, flowering, and fruiting [3].

The high consistency between 2020 and 2021 suggests that the observed pattern is a robust ecological rule, not an anomaly. The non-significant year effect indicates that short-term inter-annual variability does not override the strong seasonal signal. However, a longer monitoring period e.g., 5–10 years would be needed to detect climate-driven shifts.

From an applied perspective, the rainy season emerges as the most critical period for the sustainable harvesting and conservation of plants used for cancer and diabetes. *Curculigo orchioides* and *Calycopteris floribunda* were only recorded during the rainy months in this study. Traditional healers should be encouraged to collect these plants during the rainy season when they are most abundant, ensuring potency and reducing pressure on populations during other seasons.

The high evenness values ($J > 0.78$) indicate that the ethnomedicinal plant community is well-balanced, with no species exhibiting extreme dominance. This is a positive sign for ecosystem health and suggests that current harvesting practices are likely sustainable, assuming they are limited to the rainy season.

5. Conclusion

The YMA Reserved Area in Serchhip, Mizoram, harbors a diverse and seasonally dynamic community of ethnomedicinal plants. Using 10 permanent quadrats over two years, we have established that species richness and diversity peak during the rainy (August) and summer (May) seasons, coinciding with the highest availability of plants used to treat cancer and diabetes. These findings provide an evidence-based framework for the sustainable harvesting, conservation, and pharmacological prioritization of Mizoram's medicinal flora. We recommend that future ethnobotanical surveys in the region adopt a multi-season, multi-year design to capture temporal dynamics.

6. References

1. Atun, Sri. (2025). Anti-Inflammatory Activity of Some Characteristic Constituents of *Spatholobus littoralis* Root Wood Extract: In Vitro and In Silico Studies. *Tropical Journal of Natural Product Research*. 9. 1818. 10.26538/tjnpr/v9i4.55.
2. Azhagumeena, Chandrasekaran and Pushpa Bharathi. "A Review On Phytochemistry and Pharmacology Of *Calycopteris Floribunda* Roxb. Lam." *International Journal of Chemistry Research* (2020): n. pag.
3. Borchert, R. (1994), Soil and Stem Water Storage Determine Phenology and Distribution of Tropical Dry Forest Trees. *Ecology*, 75: 1437-1449. <https://doi.org/10.2307/1937467>
4. Bristy TA, Barua N, Montakim Tareq A, Sakib SA, Etu ST, Chowdhury KH, Jyoti MA, Aziz MA, Reza ASMA, Caiazzo E, Romano B, Tareq SM, Emran TB, Capasso R. Deciphering the Pharmacological Properties of Methanol Extract of *Psychotria calocarpa* Leaves by In Vivo, In Vitro and In Silico Approaches. *Pharmaceuticals* (Basel). 2020 Aug 6;13(8):183. doi: 10.3390/ph13080183. PMID: 32781707; PMCID: PMC7463710.

5. Islam MM, Alam R, Chung HJ, Emon NU, Fazlul Kabir M, Rudra S, Alam S, Ullah A, Hong ST, Aktar Sayeed M. Chemical, Pharmacological and Computerized Molecular Analysis of Stem's Extracts of *Bauhinia scandens* L. Provide Insights into the Management of Diarrheal and Microbial Infections. *Nutrients*. 2022 Jan 9;14(2):265. doi: 10.3390/nu14020265. PMID: 35057446; PMCID: PMC8778859.
6. Junejo JA, Rudrapal M, Nainwal LM, Zaman K. Antidiabetic activity of hydro-alcoholic stem bark extract of *Callicarpa arborea* Roxb. with antioxidant potential in diabetic rats. *Biomed Pharmacother*. 2017 Nov;95:84-94. doi: 10.1016/j.biopha.2017.08.032. Epub 2017 Aug 18. PMID: 28826101.
7. Kumari S, Anmol, Bhatt V, Suresh PS, Sharma U. *Cissampelos pareira* L.: A review of its traditional uses, phytochemistry, and pharmacology. *J Ethnopharmacol*. 2021 Jun 28;274:113850. doi: 10.1016/j.jep.2021.113850. Epub 2021 Jan 21. PMID: 33485976.
8. Laldingliani TBC, Thangjam NM, Zomuanawma R, Bawitlung L, Pal A, Kumar A. Ethnomedicinal study of medicinal plants used by Mizo tribes in Champhai district of Mizoram, India. *J Ethnobiol Ethnomed*. 2022 Mar 24;18(1):22. doi: 10.1186/s13002-022-00520-0. PMID: 35331291; PMCID: PMC8944157.
9. Lalfakzuala, R. & Lalramnghinglova, H. & Kayang, Highland. (2007). Ethnobotanical usage of plants in western Mizoram. *Indian journal of traditional knowledge*. 6. 486-493.
10. Lalramnghinglova, H. (2016). Emergent Research. Documentation of Medicinal Plants based on Traditional Practices in the IndoBurma Hotspots Region of Mizoram, North East India, 2(1): 10-45
11. Madhavan, Varadharajan & Joshi, Richa & Murali, Anita & Yoganasimhan, Sunkam. (2008). Antidiabetic Activity of *Curculigo Orchioides*. Root Tuber. *Pharmaceutical Biology*. 45. 18-21. 10.1080/13880200601026259.
12. Ralte L, Sailo H, Singh YT. Ethnobotanical study of medicinal plants used by the indigenous community of the western region of Mizoram, India. *J Ethnobiol Ethnomed*. 2024 Jan 3;20(1):2. doi: 10.1186/s13002-023-00642-z. PMID: 38172927; PMCID: PMC10765666.
13. Shankar, Rama & Rawat, Mohan. (2013). Medicinal Plants Used in Traditional Medicine in Aizawl and Mamit Districts of Mizoram. *Journal of Biology and Life Science*. 4. 95-102. 10.5296/jbls.v4i2.3489.
14. Singh, Garima & Passari, Ajit & Singh, Bhim & Senthil Kumar, Nachimuthu. (2017). Traditionally Used Medicinal Plants Belongs to Family Asteraceae for the Treatment of Cancer in Mizoram, Northeast India.
15. Xu, Ying & Sun, Yu-Qi & Yu, Miao & Song, Dong-Xue & Liu, Bing & Chen, Ning & Yu, Lei & Liu, Ying-Jie & Wang, Hai-Feng. (2023). A novel Vestitain A from the ripe fruits of *Embelia vestita* Roxb. *Natural product research*. 38. 1-10. 10.1080/14786419.2023.2239990.