Diversity and conservation status of medicinal plant resources from Northwest region of Vietnam

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Đa dạng và hiện trạng bảo tồn tài nguyên cây thuốc vùng Tây Bắc Việt Nam

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ABSTRACT

This study documented 2,149 medicinal plant species from the Northwest region of Vietnam, belonging to 999 genera and 221 families across six phyla of vascular plants: Psilotophyta, Lycopodiophyta, Equisetophyta, Polypodiophyta, Pinophyta, and Magnoliophyta. Among these, 188 species are of high conservation priority, being listed in the Vietnam Red Data Book (2007), the Red List of Medicinal Plants in Vietnam (2007 and 2019), and in Decree No. 84/2021/NĐ-CP. The medicinal flora was classified based on life forms of medicinal plants into five groups: herbs (850 species, 39.55%), shrubs/subshrubs (431 species, 20.06%), climbers (382 species, 17.77%), woody trees (470 species, 21.87%), and columnar plants (16 species, 0.74%). Analysis of plant parts used revealed that leaves, roots, stems and whole plants are the most common components in traditional remedies. Furthermore, the study identified 16 disease groups treated using the traditional knowledge of local ethnic minority communities, with the highest in gastrointestinal, dermatological, and cardiovascular/hematological disorders. These findings establish a robust foundation for the conservation and sustainable development of medicinal plant resources in the Northwest region.

Từ khóa:
Công dụng chữa bệnh, đa dạng cây thuốc, giá trị bảo tồn, Tây Bắc Việt Nam, thực vật học dân tộc.

TÓM TẮT

Nghiên cứu tài nguyên cây thuốc vùng Tây Bắc - Việt Nam đã ghi nhận được 2,149 loài thuộc 999 chi, 221 họ của sáu ngành thực vật bậc cao có mạch. Trong đó, 188 loài được ghi nhận trong Sách Đỏ Việt Nam (2007), Danh lục Đỏ cây thuốc Việt Nam (2007 và 2019) và Nghị định số 84/2021/NĐ-CP của Chính phủ. Về dạng sống, nhóm thân thảo chiếm tỷ lệ cao nhất (39,55%) với 850 loài, tiếp theo là cây gỗ có 470 loài (21,87%), cây bụi/cây bụi nhỏ có 431 loài (20,06%), cây leo có 382 loài (17,77%), và (cây dạng cột có 16 loài (0,74%). Các bộ phận được sử dụnglàm thuốc phổ biến là lá, rễ, thân và toàn cây. Kết quả nghiên cứu cũng chỉ ra 16 nhóm bệnh được điều trị dựa trên kinh nghiệm của một số cộng đồng dân tộc thiểu số tại địa phương, trong đó các nhóm bệnh chiếm tỷ lệ cao nhất là bệnh về tiêu hóa, da liễu và tim mạch/huyết học. Nghiên cứu này cung cấp cơ sở khoa học quan trọng cho việc bảo tồn và phát triển bền vững nguồn tài nguyên cây thuốc vùng Tây Bắc.

1. INTRODUCTION

The Northwest region is a subzone of the Northern Midland and Mountainous Area of Vietnam, covering a natural area of approximately 50,000 km², with relatively large forested land. This region harbors one National Park (Hoang Lien National Park) and 13 Nature Reserves, namely: Muong La, Hang Kia – Pa Co, Muong Phang, Mu Cang Chai, Bat Xat, Na Hau, Phu Canh, Muong Nhe, Muong Te, Copia, Xuan Nha, Sop Cop, Ta Xua, Hoang Lien – Van Ban, and Ngoc Son – Ngo Luong. Before 2025, the Northwest comprised six provinces (Dien Bien, Lai Chau, Son La, Hoa Binh, Lao Cai, and Yen Bai). Following the administrative reorganization in 2025, the region was restructured into five provinces (Dien Bien, Lai Chau, Son La, Vinh Phuc, Lao Cai), which are considered highly important and particularly rich in medicinal plant resources of Vietnam.

Previous ethnobotanical studies in northern Vietnam have documented substantial

medicinal plant diversity across various ethnic communities and protected areas, though research remains fragmented and geographically limited. A comprehensive analysis of existing literature reveals significant achievements in documenting traditional medicinal knowledge, with studies reporting varying species richness depending on scope and methodology.

Protected area inventories have revealed even higher species diversity. The Na Hau Nature Reserve in Yen Bai province contains 529 medicinal species (383 genera, 145 families), with 31 species having significant conservation value according to national red lists [1]. Therapeutic applications consistently focus on several disease categories across studies. Gastrointestinal disorders, musculoskeletal conditions, respiratory ailments, and dermatological problems emerge as the most frequently treated conditions. Specialized studies, such as respiratory disease treatments among the Thai community in Muong La Nature Reserve, identified 105 species specifically used for respiratory ailments [2]. Community-based ethnobotanical inventories have documented impressive medicinal plant diversity. The Kho Mu community in Sop Cop special-use forest, Son La province, utilizes 389 species (294 genera, 109 families), with 28 species listed in Vietnam Red Data Book and gastrointestinal disorders representing the highest therapeutic category (102 species, 26.22%) [3]. Similarly, the Xinh Mun ethnic community at Phieng Pan commune, Mai Son district, Son La province, employs 362 species (269 genera, 110 families) for medicinal purposes, with skin diseases being the primary therapeutic focus (77 species, 21.27%) and 26 species appearing in national conservation lists [4]. Market-based studies provide insights into commercial medicinal plant trade. A comprehensive survey of 32 traditional markets in Son La province documented 99 species (88 genera, 57 families) being traded for treating 61 different diseases, with quantitative ethnobotanical indices revealing high consensus on certain remedies (Informant Consensus Factor: 0.84–1.0, Fidelity Level: 44.44%–100%) [5].

Nevertheless, research and publications concerning medicinal plant resources in this region remain scarce, fragmented, and mainly limited to a few localities. Furthermore, with ongoing economic development, biodiversity in the Northwest has been declining at an alarming rate, placing many valuable, rare, and economically important medicinal plant species at risk of endangerment, or even extinction, if appropriate conservation measures are not promptly implemented. The present study aims to: (1) conduct a comprehensive inventory of medicinal plant species diversity in the Northwest region, documenting taxonomic composition across all major plant groups; (2) categorize medicinal plants according to their therapeutic applications and plant parts used, based on traditional knowledge from ethnic minority communities; (3) identify and assess the conservation status of rare, endemic, and threatened medicinal species according to national and international red lists; (4) analyze the life form distribution and ecological preferences of medicinal plants to understand habitat requirements and conservation priorities; and (5) document traditional preparation methods and therapeutic practices across different ethnic communities to preserve indigenous knowledge systems.

2. RESEARCH METHODS

2.1. Material

Medicinal plant species distributed in the Northwest region of Vietnam. The specimens are deposited at the National Institute of Medicinal Materials Herbarium (NIMM), Hanoi, Vietnam.

2.2. Methods

Transect-based field investigation method: A combination of field surveys and interviews was applied, following the approaches described by Nguyen Tap (2006) [6] and Nguyen Nghia Thin (2007) [7]. From June 2023 to June 2025, extensive field surveys were conducted across six provinces–Dien Bien, Lai Chau, Son La, Hoa Binh, Lao Cai, and Yen Bai–particularly within 14 protected areas, including Hoang Lien National Park and the Muong La, Hang Kia – Pa Co, Muong Phang, Mu Cang Chai, Bat Xat, Na Hau, Phu Canh, Muong Nhe, Muong Te, Copia, Xuan Nha, Sop Cop, Ta Xua, Hoang Lien – Van Ban and Ngoc Son – Ngo Luong Nature Reserves. Surveys were conducted along transects in representative habitats, with the participation of local residents, to collect herbarium specimens,

medicinal materials, and genetic resources of medicinal plants, serving as the basis for taxonomic identification and the compilation of a species checklist.

Specimen processing and taxonomic identification: Upon return to the laboratory, herbarium specimens were further processed by oven-drying to facilitate long-term preservation and subsequent identification. The determination of scientific names and documentation of medicinal uses were carried out using comparative morphological methods, based on specialized botanical references such as An Illustrated Flora of Vietnam (by Pham Hoang Ho, 1999–2000) [8], Medicinal plant and animal in Vietnam (by Do Huu Bich, 2006) [9], Dictionary of Vietnamese Medicinal plants (by Vo Van Chi, 2012) [10], and Vietnamese medicinal plants and remedies (by Do Tat Loi, 2004) [11]. Specimens were also cross-checked and deposited in the Herbarium (NIMM) of the National Institute of Medicinal Materials. Scientific names of medicinal plants were updated according to Plants of the World Online [12], and the medicinal plant checklist was compiled following the system of Brummitt [13].

Inheritance method: Compilation, analysis, and collection of information from scientific works, rapid assessment survey results, books, journals, and other relevant scientific materials related to the study subject.

3. RESULTS AND DISCUSSION

3.1. Diversity of medicinal plant species composition

A total of 2,149 medicinal plant species were documented from the Northwest region of Vietnam, representing 999 genera and 221 families, and encompassing 6 plant phyla: Lycopodiophyta, Pteridophyta, Pinophyta, Cycadophyta, Gnetophyta and Magnoliophyta. In addition, Cycadophyta comprised one species in 1 genus and 1 family. Lycopodiophyta included 15 species in 4 genera and 2 families. Gnetophyta included 2 species in 1 genus and 1 family. Pteridophyta included 101 species in 54 genera and 24 families. Pinophyta was represented by 25 species in 17 genera and 5 families. Magnoliophyta was the most species-rich phylum, with 2005 species in 922 genera and 188 families, including 1,653 species in Magnoliopsida and 352 species in Liliopsida (Table 1).

Table 1. Distribution of taxa across plant phyla

Phylum	Family		Genus		Species	
	Qty	%	Qty	%	Qty	%
Lycopodiophyta	2	0.90	4	0.40	15	0.70
Pteridophyta	24	10.86	54	5.41	101	4.70
Pinophyta	5	2.26	17	1.70	25	1.16
Cycadophyta	1	0.45	1	0.10	1	0.05
Gnetophyta	1	0.45	1	0.10	2	0.09
Magnoliophyta	188	85.07	922	92.29	2005	93.30
Liliopsida	*35*	*15.84*	*166*	*16.62*	*352*	*16.38*
Magnoliopsida	*153*	*69.23*	*756*	*75.68*	*1653*	*76.92*
Total	**221**	**100**	**999**	**100**	**2,149**	**100**

Note: "Qty": quantity

A detailed analysis of the phylum Magnoliophyta reveals that the class Magnoliopsida predominates, comprising 1,653 species (76.92% of the total recorded species), 756 genera (75.68%), and 153 families (69.23%). In contrast, the class Liliopsida accounts for less than 20% of the taxa at each rank. The ratio of Magnoliopsida to Liliopsida is about 5:1. These results indicate that Magnoliopsida holds a dominant proportion of medicinal plant species within the angiosperms as well as in the overall flora of the study area.

The taxonomic distribution pattern observed, with Magnoliophyta comprising 93.30% of total species (2005 species), aligns closely with global patterns of angiosperm dominance in medicinal floras. This proportion is consistent with previous Vietnamese studies, where angiosperms typically represent 85-95% of medicinal plant inventories [5]. The 5:1 ratio between Magnoliopsida and Liliopsida observed in our study closely matches the 4:1 to 6:1 ratios reported in other tropical Asian medicinal plant surveys, reflecting the inherent diversity patterns of flowering plants in tropical montane ecosystems.

The documented diversity of 2,149 medicinal plant species from the Northwest region represents the most comprehensive medicinal flora inventory conducted in Vietnam to date, substantially exceeding all previous ethnobotanical studies in scope and taxonomic coverage. This finding significantly surpasses community-specific inventories, which typically report 59-529 species per study [1-4]. Compared with the Checklist of medicinal plants of Vietnam published in 2016 [14], which documented 5,045 species nationwide (excluding fungi and algae), the medicinal plant flora of the Northwestern highlands accounts for 42.42%. This indicates that the region is particularly rich and diverse in medicinal plant resources. Similarly, when compared with other ecological regions of Vietnam such as the Central Highlands (1,713 species belonging to 257 families of vascular plants) [15] and the Southeastern region (1,840 species, 915 genera, and 214 families of vascular plants across four divisions: Chlorophyta, Pteridopsida, Pinophyta and Magnoliophyta) [16], it is evident that the medicinal plant resources of the Northwestern highlands are considerably more diverse and abundant. In addition, a total of 657 medicinal plant species were recorded in Dien Bien province, 782 species in Lai Chau, 957 species in Lao Cai, 809 species in Son La, 545 species in Yen Bai, and 726 species in Hoa Binh.

The medicinal plant resources of the Northwest region of Vietnam are remarkably rich and diverse, as reflected in the abundance and taxonomic composition of species. Among these, many possess not only significant scientific value but also high economic potential, such as *Amomum aromaticum* Roxb., Arcangelisia flava (L.) Merr., *Ardisia silvestris* Pit., *Coscinium fenestratum* (Goetgh.) Colebr., *Homalomena occulta* (Lour.) Schott, *Asparagus cochinchinensis* (Lour.) Merr., *Gynostemma pentaphyllum* (Thunb.) Makino, *Nekemias cantoniensis* (Hook. & Arn.) J.Wen & Z.L.Nie, *Sarcandra glabra* (Thunb.) Nakai, and *Stemona tuberosa* Lour., among others.

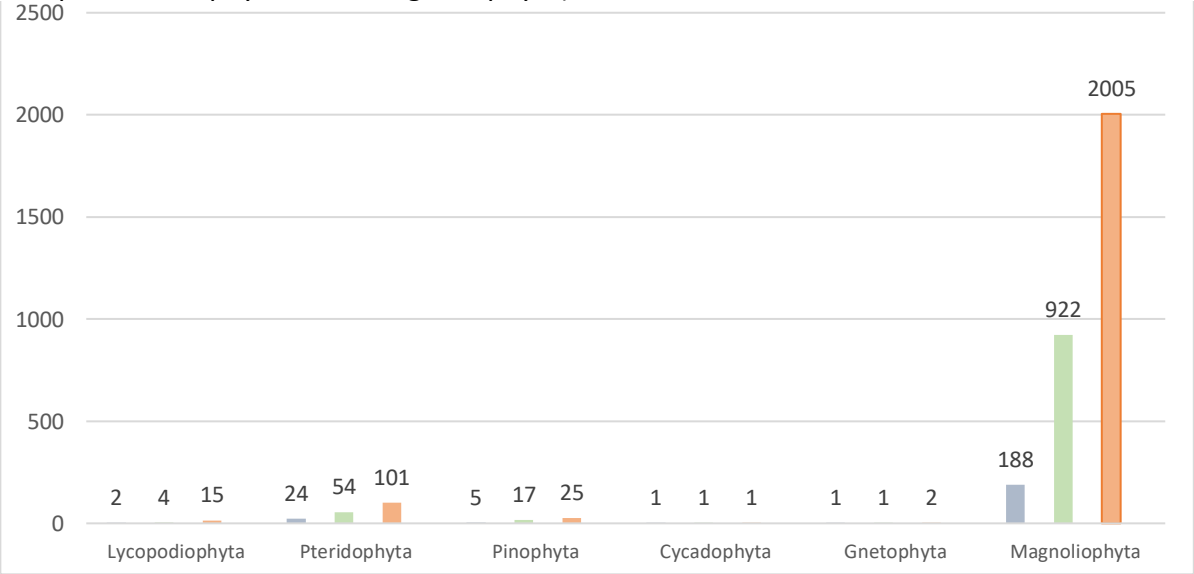

Figure 2. Chart of taxonomic ranks of medicinal plant species in the Northwest region
(Blue: families, Orange: genera, Gray: species)

In terms of species diversity at the family level, the results recorded 51 families represented by only a single species (accounting for 23,08% of the total species in the study area). The three families with the greatest number of medicinal plant species are Fabaceae (124 species, 5.77% of the total species in the study area), Asteraceae (104 species, 4.84%), and Euphorbiaceae (94 species, 4.37%). In addition, several other families are also notably rich in medicinal species, such as Araliaceae (43), Acanthaceae (19 species) and Annonaceae (26 species). These families are also among the most species-rich in the flora of Vietnam and contain numerous taxa of medicinal value. The family-level dominance patterns observed in our Northwest region inventory align closely with global trends in medicinal plant family representation, where Asteraceae, Fabaceae, Lamiaceae, and Euphorbiaceae typically rank among the most species-rich families in

tropical ethnobotanical inventories. Previous Vietnamese studies consistently report similar family dominance patterns, with Asteraceae contributing 8-15% of medicinal species across different regions and communities [3, 5, 16].

The genus-level diversity patterns, with an average of 2,149 species per genus across 999 genera, indicate relatively low generic redundancy compared to some tropical medicinal floras where certain genera contribute disproportionately large numbers of species. This pattern suggests that the Northwest region's medicinal flora draws broadly from diverse evolutionary lineages rather than concentrating within specific taxonomic groups, reflecting the region's position as a biogeographic transition zone. The results are summarized as follows: 548 monotypic genera account for 54.85% of the total genera surveyed. The genera with the highest number of medicinal plant species include *Dioscorea* (13 species), *Solanum* (12 species), *Clerodendrum* and *Blumea* (11 species) *Hediotis* (10 species). This indicates that species diversity within genera is generally low. Notably, these genera comprise many species commonly used in traditional medicine, such as *Ficus racemosa* L., *Smilax petelotii* T. Koyama, *Ardisia silvestris* Pitard, *Bauhinia variegata* L., *Dendrobium* nobile Lindl., *Dioscorea cirrhosa* Lour., *Solanum torvum* Sw., *Desmodium gangeticum* (L.) DC., *Cinnamomum balansae* H. Lecomte, and *Clematis fasciculiflora* Franch.

In addition to its genetic resource diversity, the medicinal plant flora of this region also possesses high utilization value as a source of raw materials for the extraction of bioactive natural compounds used in pharmaceuticals. For example, *Coscinium fenestratum* (Goetgh.) Colebr. is used for the extraction of berberine, while *Fibraurea recisa* Pierre is used for the extraction of palmatine. These alkaloid compounds are effective in the treatment of diarrhea, dysentery, and gastrointestinal infections. *Huperzia serrata* (Thunb.) Trevis is traditionally utilized as a source for the extraction of huperzine A (HupA), an alkaloid with notable neuroprotective properties that has been employed in the management of cognitive dysfunction and memory impairment, particularly in relation to Alzheimer's disease. *Schefflera heptaphylla* (L.) Frodin serves as a source of saponins with diuretic and anti-inflammatory activities. Moreover, many other medicinal plant species in the region contain natural compounds with therapeutic potential.

3.2. Diversity in growth forms of medicinal plants

According to the growth form classification proposed by Nguyen Nghia Thin (2007) [7], the medicinal plants of the Northwest region of Vietnam are categorized into five principal groups: herbaceous (1), shrubs/subshrubs (2), climbers (3), woody trees (4), and columnar forms (5). Among these, the herbaceous group (1) comprises the largest number of species, with 850 species accounting for 39.55% of the total recorded medicinal plant species; the shrub/subshrub group (2) includes 431 species (20.06%); the climbers group (3) contains 382 species (17.77%); the woody trees group (4) comprises 470 species (21.87%); and the columnar forms group (5) has 16 species (0.74%). The results presented in Table 2 indicate that the medicinal plant species in Northwest region exhibit relatively high diversity in growth forms.

Table 2. Diversity of growth forms of medicinal plants in the Northwest region

No.	Growth form	Number of species	Percentage (%)
1	Herbaceous	850	39.55
2	Shrub/Subshrub	431	20.06
3	Climbers	382	17.77
4	Woody trees	470	21.87
5	Columnar forms	16	0.74
	Total	**2,149**	**100**

The analysis of growth forms of medicinal plants recorded in the Northwest region shows that herbaceous species represent the largest proportion, with 850 species, accounting for 39.55% of the total. Representative taxa include *Patrinia scabiosaefolia*, *Tacca subflabellata*, *Primula chapaensis*, *Sedum sarmentosum*, and *Achyranthes aspera*. Shrubs constitute the second largest group, comprising 431 species (20.06%), exemplified by *Rauvolfia verticillata*, *Sambucus javanica*, *Vaccinium dunalianum*, *Cajanus cajan*, and

Leea indica. Woody trees account for 470 species (21.87%), represented by *Hydnocarpus ilicifolia*, *Dialium cochinchinense*, *Cornus controversa Mallotus barbatus*, *Garcinia oblongifolia*, *Itoa orientalis*, *Sterculia pexa*, *Stewartia sinensis*, and *Thuja orientalis*. The least represented growth form is columnar plants, with only 16 species (0.74%), mainly belonging to the families Arecaceae and Cyatheaceae.

The substantial representation of woody plants (41.93% combined trees and shrubs) in our study aligns more closely with botanical surveys from protected areas and forest reserves, where woody species comprise 35-50% of medicinal plant inventories. This pattern reflects the Northwest region's extensive forest cover and the inclusion of traditional forest-based medicinal practices alongside village-level herbaceous remedies. Northwest region's diverse topography and elevation gradients (500-3,143 m), which support distinct vegetation zones from lowland forests to alpine shrublands. The higher elevation zones contribute disproportionately to shrub and subshrub diversity, while the extensive montane forests support the large woody plant component observed in our study. These results demonstrate that the medicinal plant resources of the Northwestern highlands are both rich and diverse in terms of growth forms.

3.3. Diversity in the utilization values of medicinal plants

The analysis of medicinal plant parts used revealed 12 distinct categories. Among them, leaves were the most frequently utilized, with 1,280 species, accounting for 59.56%. The preference for leaves reflects their ease of collection and the minimal impact on plant growth and regeneration compared with harvesting other parts. Roots (including roots, rhizomes and tuberous roots) constituted the second most common category, represented by 857 species (39.88%). However, the use of whole plants, rhizomes, roots, and stems at a high proportion may pose serious threats to conservation and sustainable management of medicinal plant resources, as such practices can lead to the loss of valuable genetic resources. Other parts such as flowers, fruits, and seeds were also recorded at relatively high frequencies, with 136, 223, and 169 species, corresponding to 6.33%, 10.38%, and 7.86%, respectively. The higher the proportion of reproductive organs utilized, the greater the impact on the natural regeneration capacity of the species. Additional parts, such as latex and thorns or tendrils, were used only occasionally, accounting for only 1.86% and 0.32%, respectively (Table 3).

Table 3. Frequency of plant parts used in traditional medicine in the Northwest region

No.	Plant parts used	Number of medicinal plant species	
		Number of records	Proportion (%)
1	Leaves	1280	59.56
2	Root (root, rhizome, tuberous root)	857	39.88
3	Whole plant	661	30.76
4	Stems	828	38.53
5	Stem bark, root bark	228	10.61
6	Branches	437	20.34
7	Flowers	136	6.33
8	Fruits	223	10.38
9	Seeds	169	7.86
10	Aerial parts	124	5.77
11	Latex, sap	40	1.86
12	Thorns, tendrils	7	0.32

The predominant use of leaves (identified as the most commonly used plant part) in our study strongly aligns with previous Vietnamese ethnobotanical research, where leaves consistently represent 40-48% of medicinal plant preparations across different communities and regions [2, 4, 5]. This consistency reflects both practical and biochemical factors that make leaves the preferred medicinal plant part across diverse cultural contexts.

Each medicinal plant species may be utilized for one or multiple parts for therapeutic purposes. Due to various subjective and objective factors, many species that were traditionally harvested only for their roots or tuberous roots to achieve optimal medicinal efficacy are now being exploited for stems or

lianas, or even substituted with other medicinal plants of similar but less effective uses as a result of resource scarcity. This indicates that the medicinal plant resources of the Northwest region are showing clear signs of decline in both quantity and quality.

3.4. Diversity of medicinal use categories

According to traditional medicinal knowledge, a single medicinal plant species may be used to treat multiple ailments, and conversely, the treatment of a single ailment may involve a combination of several medicinal plant species. Based on references from various authors, including Pham Hoang Ho [8], Do Huu Bich [9], Vo Van Chi [10] and Do Tat Loi [11], as well as findings from our field investigations, interviews with traditional healers, practitioners and local residents, medicinal plants from the Northwest region of Vietnam were categorized into 16 therapeutic groups (Table 4).

The identification of 16 disease categories treatable by Northwest region medicinal plants demonstrates remarkable consistency with previous Vietnamese ethnobotanical studies, which typically document 15-20 therapeutic categories across different communities and regions [3-5]. This convergence suggests fundamental patterns in traditional medicinal plant applications that transcend specific ethnic groups and geographic localities.

Table 4. Therapeutic groups treated with medicinal plants

No.	Therapeutic use categories of medicinal plants	Number of records	Proportion (%)
1	Dermatological disorders: boils, skin rashes, pruritus, etc.	519	24.15
2	Musculoskeletal disorders: rheumatism, joint pain, body aches, etc.	308	14.33
3	Gastrointestinal disorders: dysentery, diarrhea, etc.	569	26.48
4	Respiratory disorders: cough, asthma, pneumonia, etc.	259	12,05
5	Gynecological and obstetric disorders: childbirth, postpartum care, menstrual irregularities, etc.	201	9.35
6	Weather-related ailments: common cold, fever, headache, etc.	246	11.45
7	Hepatic disorders: hepatitis, cirrhosis, liver cancer, etc.	144	6.70
8	Renal and urinary disorders: diuresis, bile flow disorders, kidney stones, etc.	325	15.12
9	General tonic and nutritional uses: hematinic, body strengthening, improvement of general health, etc.	87	4.05
10	Neurological disorders: insomnia, headache, neurasthenia, etc.	221	10.28
11	Animal bites and stings: snake, centipede, leech bites, etc.	183	8.52
12	Ophthalmic disorders: conjunctivitis, trachoma, etc.	118	5.49
13	Oral diseases	79	3.67
14	Male reproductive disorders: infections, etc.	175	8.14
15	Cardiovascular and hematological disorders: heart disease, hypertension, blood-related disorders, etc.	388	18.05
16	Pediatric disorders: malnutrition, skin infections, night crying, etc.	158	7.35

The table above demonstrates the diversity of therapeutic use categories of medicinal plants, comprising 16 groups. Among these, gastrointestinal disorders (e.g., dysentery, diarrhea, gastric pain) were the most common, with 569 species, accounting for 26.59% of the total recorded. This was followed by dermatological disorders (e.g., infections, wounds, scabies, boils, allergies, eczema), represented by 519 species (24.15%). Cardiovascular and hematological disorders (e.g., hypertension, heart failure, septicemia) accounted for 18.05%, while renal and urinary disorders (e.g., kidney stones, nephritis, edema, urinary tract infections) comprised 15.12%. Other categories were less represented, such as weather-related ailments, general tonic and nutritional uses, and oral diseases, most of which contributed less than 5% each.. Several medicinal plant species are commonly employed by traditional healers, practitioners, and local communities for therapeutic purposes, including *Spatholobus suberectus* Dunn., *Clerodendrum chinense* (Obeck) Mabb., *Bischofia javanica* Blume, *Sambucus javanica* Reinw. ex Blume, *Homalomena occulta* (Lour.) Schott, *Schisandra chinensis* (Turcz.) K. Koch, *Schefflera heptaphylla* (L.) Frodin, *Codonopsis javanica* (Blume) Hook.f. & Thomson…

The dominance of gastrointestinal disorders, dermatological disorders, and cardiovascular/hematological disorders as the top three therapeutic categories aligns closely with previous studies across northern Vietnam. The Kho Mu community study reported gastrointestinal diseases as the highest category (26.22% of species), while the Xinh Mun inventory identified skin diseases as predominant (21.27% of species) [3, 4]. Our findings confirm these patterns at a regional scale, suggesting that these disease categories represent universal health priorities across Northwest ethnic communities.

However, our study reveals a more balanced distribution across therapeutic categories compared to community-specific studies, which often show extreme dominance of 1-2 categories. This difference reflects the comprehensive multi-community approach that captures diverse healing traditions and health priorities. Single-community studies may reflect local health challenges, healer specializations, or specific cultural emphases that create apparent category dominance.

3.5. Diversity of valuable and rare genetic resources of medicinal plants

In addition to assessing overall biodiversity, evaluating species at risk of extinction in the study area is of critical importance, as it provides a scientific basis for setting conservation priorities. Multiple factors contribute to the threatened status of species, including deforestation, timber extraction, illegal or unsustainable harvesting of medicinal plants, and collection for fuelwood or charcoal production. These activities have led to a reduction in forest cover, accompanied by ecological risks, ultimately increasing the number of species facing the threat of extinction.

To establish effective conservation policies and prioritize protection measures for medicinal plant resources, it is essential to assess the threat status of medicinal plant species within the study area. According to the Vietnam Red Data Book (2007) [17], the Red List of Medicinal Plants of Vietnam (2019) [18], and Government Decree No. 84/2021/NĐ-CP [19], the Northwest region of Vietnam harbors 188 threatened medicinal plant species (accounting for 8.79% of the total medicinal flora recorded in the region) belonging to 124 genera and 72 families were identified as threatened. Specifically, 121 species are listed in the Vietnam Red Data Book (2007), including 16 Critically Endangered (CR), 40 Endangered (EN) and 65 Vulnerable (VU) species. Eighty-four species are included in the Vietnamese Red List of Medicinal Plants (2019): 13 CR, 55 EN and 16 VU. Eleven species are classified under Group IA of Decree No. 84/2021 (prohibiting commercial exploitation of forest plant and animal species at risk of extinction and species listed in CITES Appendix I occurring in Vietnam), while 53 species are placed in Group IIA of the same Decree (species not yet endangered but potentially threatened if not strictly managed, including species in CITES Appendix II with natural distribution in Vietnam).

The identification of 188 species (8.79% of total inventory) listed in national conservation documents represents a significantly higher absolute number but similar proportional representation compared to previous Vietnamese ethnobotanical studies. Community-specific studies typically report 1.6-7.2% of documented species appearing in national red lists, with absolute numbers ranging from 2-31 species per study [1, 3, 4]. Our finding of 8.79% falls within the upper range of these proportions while representing an unprecedented absolute count of threatened medicinal species. The higher absolute number of threatened species in our study reflects the comprehensive geographic and taxonomic scope that captures rare and endemic species not documented in locality-specific inventories. Many of the threatened species identified are montane endemics or forest specialists that occur only in specific habitats within the Northwest region's protected areas, explaining their absence from community-based studies focused on accessible medicinal plants.

At present, the Northwest region of Vietnam holds substantial potential for ecotourism development. However, the planning and expansion of tourism infrastructure, along with the construction of other facilities, have resulted in habitat loss and fragmentation, thereby adversely impacting the region’s natural resources, particularly its medicinal plant resources.

4. CONCLUSION

The results of the present study indicate that the medicinal plant resources of the Northwest region of Vietnam comprise 2,149 species, 999 genera, and 221 families belonging to six phyla/groups of vascular plants: Pteridophyta, Lycopodiophyta, Pinophyta, Cycadophyta Gnetophyta and Magnoliophyta. These taxa are represented by five principal life-form groups, 12 categories of plant parts used, and sixteen therapeutic categories. In addition, the study identifies 188 medicinal plant species of conservation concern, as evaluated according to the Vietnam Red Data Book, the Red List of Medicinal Plants of Vietnam, and Government Decree No. 84/2021/NĐ-CP. Overall, the medicinal flora of this region not only harbors remarkable genetic diversity but also constitutes a valuable source of bioactive natural compounds, underscoring its significant potential for pharmaceutical development. These findings provide an essential scientific basis for future strategies on conservation, sustainable utilization, and pharmaceutical exploitation of medicinal plant resources in the Northwest region.

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