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Research Article

Ethnobotany of Hmong ethnic groups in Bolikhamxay province, central Laos PDR

Kajonesuk PHENGMALA[1], Surapon SAENSOUK[1]*, Piyaporn SAENSOUK[2], Phetlasy SOULADETH[3]

[1]*Mahasarakham University, Walai Rukhavej Botanical Research Institute, Diversity of Family Zingiberaceae and Vascular Plant for Its Applications Research Unit, Biodiversity Program, Kantarawichai, Maha Sarakham, 44150, Thailand; surapon.s@msu.ac.th (*corresponding author); 64016651002@msu.ac.th*
[2]*Mahasarakham University, Faculty of Science, Department of Biology, Diversity of Family Zingiberaceae and Vascular Plant for Its Applications Research Unit, Kantarawichai, Maha Sarakham, 44150, Thailand; pcornukaempferia@yahoo.com*
[3]*National University of Laos, Faculty of Forest Science, Vientiane Capital, Laos; p.souladeth@nuol.edu.la*

Abstract

Results from an ethnobotany study of Hmong ethnic groups in Bolikhamxay Province, Laos PDR between 2021 and 2023 identifies plant uses for 133 species, 104 genera, and 50 families. The research focusses on specific plant uses. Quantitative analyses are applied with Use Value (UV), Fidelity Level (FL), and Informant Agreement Ratio (IAR). Cluster analysis based on the Jaccard's Similarity Index (JI) are calculated for the similarity of edible plant used in three areas as follows: cultivated, from the forest, and in the market. The most important plant species are *Imperata cylindrica* (L.) Raeusch. with a UV of 3.45 followed by *Calamus viminalis* Willd. (2.85) and *Curcuma zedoaria* (Christm.) Roscoe (2.83). The highest FL value for 23 plant species with 100% FL. The highest consensus within ailment categories is for urinary system symptoms, neurological symptoms and oral syndrome (IAR=1.00). The JI varies between 0.1013 and 0.2981; the highest JI is for pairs of cultivated and in the market. UPGMA cluster analysis indicates that the plants are collected from isolated forests with low similarity to other areas. Considering the numerous useful plants that have been documented, along with the identification of culturally and historically significant species, as well as their distribution and conservation status, it becomes evident that forest conservation is crucial for preserving the livelihoods and associated ethnobotanical knowledge of the local and indigenous people in Bolikhamxay Province.

Keywords: Bolikhamxay province; herbal medicines; inventory; plants utilization; traditional knowledge

Introduction

Laos is a very prosperous country located in Southeast Asia, in the heart of the Indochina Peninsula. In the Greater Mekong Sub-Region, the total area is about 236,800 square kilometers, with approximately 40% of the area covered by forests. Additionally, there is an abundant water source (Lao Statistics Bureau and The

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World Bank, 2014). Laos PDR has a long history of utilizing plants for food, traditional herbal medicine, health maintenance, disease healing, and healing rituals, as reported in past documentation since colonial times (Sydara, 2014). The French botanist (Vidal, 1958) was the first researcher to report the diversity of plant species in Laos, while (Pottier, 1971) was the first researcher to report on the therapeutic use of plants in Laos.

The Hmong ethnic group has been residing in Laos since the mid-19th century after migrating from Tibet, Siberia, and Mongolia through China. They settled at the bottom of the Yellow River (Huangha) due to war, and then migrated southward into Vietnam, Laos, and the Kingdom of Thailand. The Hmong are divided into four main ethnic groups based on the distinctive color of their clothing: White Hmong, Striped Hmong, Red Hmong, and Black Hmong. The Hmong ethnic groups living in Laos have a total population of 451,964 (with 224,257 women), representing 8.0% of the country's population (Lao Statistics Bureau, 2005). Most Hmong-speaking ethnic Hmong-Iu Mien individuals practice animism and continue to worship their Chinese ancestors, although some follow Taoism, Buddhism, or Christianity. They engage in agriculture, cultivating rice, corn, and various vegetables for daily use. They also work in rice farming and trading in the plains (Minority Rights Group, 2018).

The Hmong ethnic group, with its large population, holds a wealth of local wisdom, particularly in the field of indigenous botany. They have discovered various uses of plants, including as local food, plants of religious significance, and herbs for treating various diseases. The knowledge of indigenous botany and the use of most plants has been passed down through generations orally, as there are no written records. However, it has been observed that the younger generation is currently less interested in learning about the folk botanical studies that have been part of their heritage. Modern technology has caused these individuals to overlook and ignore this valuable wisdom. As a result, the knowledge and wisdom of plant utilization are gradually disappearing. Therefore, it is necessary to conduct studies and compile a database to document and preserve this valuable local knowledge before it is lost.

Materials and Methods

Study area

Study the diversity of species, conservation status, and utilization of local vegetables in various fields. In Ban Thongnami area, located at 18.22288°N latitudes and 104.19938°E longitudes, 162 meters above sea level, Pakkading District, Bolikhamxay Province, Central Laos PDR (Figure 1, Table 1). The choice to study only one village, Ban Thongnami, was made due to several factors. Ban Thongnami is renowned for its extensive use of plants, both historically and in contemporary times. The village has a rich tradition of treating ailments with plants and trading traditional medicines. It holds the distinction of being the most famous village in central Lao PDR. Additionally, the Hmong ethnic group in Ban Thongnami village diligently preserves their traditional customs and tribal identity. Another noteworthy aspect is the Kin Jiang Festival (Noj Peb Caug Hmong Lao) celebrated here. (Booklets on Ethnic Groups in Laos, 2015).

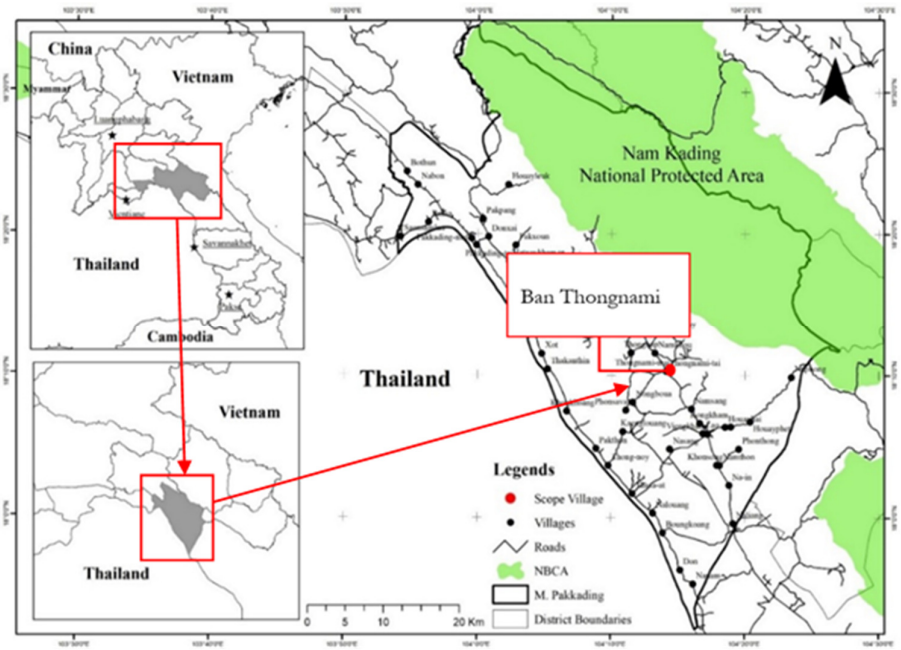

Figure 1. Place of study Ban Thongnami, Pakkading District, Bolikhamxay Province, Central Laos PDR (Faculty of Forest Sciences, National University of Laos .Arc map. 2023)

Table 1. Demographic characteristics of the informants of Ban Thongnami (Natural Resources and Environment of Pakkading District, 2023)

Demographic characteristics	Information
Ethnicity	Hmong
Religion	Christian
Co-ordinates	18.1704° N, 104.23872° E
Elevation (m) *a.s.l.*	162
Households	1285
Population (males/females)	8890 (4521/4369)
Distance to the nearest town (km)	23
Total size area (ha)	4004
Agricultural area (ha)	3058
Permanent cash crops	Rubber tree (*Hevea brasiliensis* (Willd. ex A.Juss.) Müll.Arg.) Rice (*Oryza sativa* L.) Cassava (*Manihot esculenta* Crantz.)

Data collections

An ethnobotanical study was undertaken to gather traditional knowledge from representative resident informants chosen from the study area. Traditional essential information was collected from 40 informants, selected randomly across various age groups (ranging from 20 to over 60) (Table 2). The methodology involved conducting semi-structured interviews and focus group discussions as outlined by (Phatlamphu *et al*., 2021) to gather information on common names, local names, and character traits and take notes on plant utilization.

Table 2. Information of selected informants

Population	Number of informants	Age range		
		20-40	41-60	Over 60
Males	18	6	9	3
Females	22	9	11	2

Species identification

Plant parts in the form of dry samples were collected. The plant specimens were identified by a taxonomist and confirmed through published available literature (cite references), and verified with the Plants of the World Online or POWO (Kew Science 2021) database. Samples were also Alcoholic samples as voucher specimens for the Herbarium at the National University of Laos Faculty of Forest Science (Laos) and Mahasarakham University Herbarium (Thailand).

Statistical analysis

The data collected were analysed by using different quantitative ethnobotanical indices like, Use Value (UV), Informant Agreement Ratio (IAR), Fidelity Level (%FL), and Jaccard's Similarity Index (JI)

Use value

Use Value as an index indicating the importance of this plant at the locality (Phillips *et al*., 1994).

$$UV = \sum Ui / N \quad (1)$$

Ui is the number of use reports for each plant species and N is the total number of informants.

Informant agreement ratio

The informant Agreement Ratio is an index used to measure acceptance or consensus. among informants and plant utilization for each symptom group (Trotter and Logan., 1986).

$$IAR = (Nur - Nt) / (Nur - 1) \quad (2)$$

Nur is the number of reports of the specific use of plant species in each syndrome and Nt is the number of plant species used in each syndrome.

The fidelity level

The Fidelity Level the percentage of informants who mentioned the uses of particular plants to cure a particular ailment in the study area (Friedman *et al.*, 1986).

$$FL (\%) = NP / N \times 100 \quad (3)$$

Where "Np" is the specific number of informants for a specific disease, and 'N' is the total number of participants cited the plants for any ailments

Jaccard's similarity index

Jaccard's Similarity Index was calculated to compare the edible plant utilization in three areas as follows: cultivated, from the forest, and in the market. This will help to focus on differences in plant utilization between the three areas located and species similarities among were analysed with UPGMA cluster analysis (Hammer *et al.*, 2001).

$$JI = c / (a + b + c) \quad (4)$$

When a is the number of edible plant species used in area A, b is in area B and c is the number of edible plant species used in both areas A and B

Results

Diversity of plants and their other uses in the Hmong ethics group in Pakkading District, Bolikhamxay Province, Central Laos PDR.

There were 133 plant species and 104 genera in 50 families that the Hmong ethnic group used in their daily lives (Table 3). The families with the highest number of use-reports were Zingiberaceae and Fabaceae, each comprising 14 species (11% each), followed by Cucurbitaceae with 8 species (6%), and Amaryllidaceae and Poaceae with 7 species each (5% each). Apiaceae, Arecaceae, and Solanaceae had 5 species each (4% each), while Asteraceae, Basellaceae, Dioscoreaceae, Malvaceae, Rutaceae, and Araceae each had 4 species (3% each). Lamiaceae and Menispermaceae had three species each (2% each) (Table 4). Dipterocarpaceae, Pandanaceae, Phyllanthaceae, and Sapindaceae each had two species, while the remaining families were represented by one species each. This finding aligns with the study by Dubost *et al*., (2019), which stated that Fabaceae and Zingiberaceae had the highest number of species used in Hmong herbal medicine and by herbalists in Laos PDR.

Table 3. Families and plant species used in the Hmong ethics group in Pakkading District, Bolikhamxay Province, Central Laos PDR

Family	Scientific name	Local name	Common name	Plant uses	UV	Conservation Status		Source of plant			Coll No.
						IUCN	POWO				
Acanthaceae	*Andrographis paniculata* (Burm.f.) Nees	La-sa-bi	Bitterweed	M	0.53		IN	CV	MK		KC001
Acoraceae	*Acorus calamus* var. *angustatus* Besser	Ya-di-tom-kai	Calamus and sweet flag.	M	1.85		N	CV	MK		KC132
Amaranthaceae	*Iresine diffusa* f. *herbstii* (Hook.) Pedersen	Ya-di-tom-kai	Bloodleaf, Beefsteak Plant	E, M	1.8			CV	MK		KC133
Amaryllidaceae	*Allium ascalonicum* L.	Phuk-hom-bua-deng	Shallot	E, M	1		IN	CV	MK		KC011
	A. cepa L.	Phuk-hom-bua-yai	Onion	E	1		IN	CV	MK		KC012
	A. tuberosum Rottler ex Spreng.	Phuk-pen	Garlic chives	E	1		IN	CV	MK		KC091
	A. sativum L.	Phuk-tieam	Garlic	E	1		IN	CV	MK		KC094
	Hymenocallis littoralis Salisb.	Wan-son	Beach spider lily	M	0.8		IN	CV	MK		KC120
Anacardiaceae	*Mangifera caloneura* Kurz	Mak-muang-ka-sor	Mango tree	E	1		N	CV	MK		KC054
	M. indica L.	Mak-muang	Mango	E	1		IN	CV	MK		KC053
	Spondias pinnata (L. f.) Kurz	Mak-kok	Hog Plum	E	1		N	CV	MK	F	KC050
Annonaceae	*Annona squamosa* L.	Ton-mak-khieam	Custard Apple	E	1		IN	CV	MK		KC046
Apiaceae	*Centella asiatica* (L.) Urb.	Phuk-nok	Asiatic pennywort	E	1		N	CV	MK	F	KC090
	Coriandrum sativum L.	Hom-pom	Coriander	E, S	1.58		IN	CV	MK		KC013
	Daucus carota L.	Hua-ka-lod	Wild Carrot	E	1	LC	IN		MK		KC014
	Eryngium foetidum L.	Phuk-hom-pae	Culantro	E, S	1.65		IN	CV	MK		KC084
	Foeniculum vulgare Mill.	Phuk-si	Fennel	E, S	1.7		IN	CV	MK		KC097
Apocynaceae	*Tabernaemontana divaricata* (L.) R.Br. ex Roem. & Schult.	Dok-phoud	Pinwheel flower	C	0.3		N	CV			KC006
Araceae	*Alocasia macrorrhizos* (L.) G.Don	Kok-ka-pouk	Elephant Ear	M	0.63		IN	CV			KC019
	Colocasia esculenta (L.) Schott	Phue-jek	Taro	E	1		N	CV	MK		KC082
	Lasia spinosa (L.) Thwaites	Phuk-bon-nam	Spiny Lasia	E	1		N	CV	MK	F	KC003
	Leucocasia gigantea (Blume) Schott	Phuk-kan-toun	Giant Elephant Ear	E	1		N	CV	MK	F	KC020
Arecaceae	*Arenga westerhoutii* Griff.	Mak-tao	Westerhout's Sugar Palm	E, T, H	2.08		N	CV	MK		KC063
	Calamus rhabdocladus Burret	Nor-boun	Sweet Rattan	E	1		N	CV	MK	F	KC079
	C. viminalis Willd.	Wai	Calamus	E, T, H, F	2.85		N	CV	MK	F	KC111
	Cocos nucifera L.	Ton-mak-phao	Coconut tree	E, H	1.8		IN	CV	MK		KC058
	Livistona speciosa Kurz	Mak-khor	Taraw palm	E, H	1.65		N		MK		KC047

Aspleniaceae	*Stenochlaena palustris* (Burm.f.) Bedd.	Phuk-khod-deng	Swamp Fern	E	1		N		MK	F	KC034
Asteraceae	*Acmella oleracea* (L.) R.K.Jansen	Phuk-kad	Toothache plant	E, M	1.23		N	CV	MK	F	KC088
	Artemisia lactiflora Wall. ex DC.	Ya-di-tom-kai	White mugwort	E	1.68		N	CV	MK		KC122
	Gynura bicolor (Roxb. ex Willd.) DC.	Ya-di-tom-kai	Velvet Plant	E	1.58			CV	MK		KC134
	Lactuca sativa L.	Phuk-sa-lad	Lettuce	E	1		IN	CV	MK		KC093
Athyriaceae	*Diplazium esculentum* (Retz.) Sw.	Phuk-koud	Fiddlehead fern	E	1		N		MK	F	KC089
Basellaceae	*Basella alba* L.	Phuk-pang	Malabar spinach	E, CL	1.35		N	CV	MK		KC092
	Brassica juncea (L.) Czern.	Phuk-kad-tod	Mustard greens	E, M	1		IN	CV	MK		KC087
	B. oleracea L.	Phuk-ka-lum	Cabbage	E	1		IN	CV	MK		KC085
	B. rapa L.	Phuk-kad-som	Lettuce	E, M	1		IN	CV	MK		KC086
Bignoniaceae	*Markhamia stipulata* (Wall.) Seem.	Kea-ban	Dok Khae	E	1	LC	N	CV	MK		KC022
Bromeliaceae	*Ananas comosus* (L.) Merr.	Mak-nud	Pineapple	E	1		IN	CV	MK		KC056
Campanulaceae	*Codonopsis javanica* (Blume) Hook.f. & Thomson	Som	Dang shen	E, M	1.95		N		MK		KC100
Cannabaceae	*Cannabis sativa* L. ssp. *sativa*	Dua (kun-song)	Hemp	M, F, C	1.7			CV	MK		KC009
Caricaceae	*Carica papaya* L.	Mak-houng	Papaya	E	1		IN	CV	MK		KC040
Convolvulaceae	*Ipomoea batatas* (L.) Lam.	Mun-dang	Sweet Potato	E	1	DD	IN	CV	MK		KC075
Cucurbitaceae	*Benincasa hispida* (Thunb.) Cogn	Mak-ton	Winter melon	E	1		IN	CV	MK		KC060
	Coccinia grandis (L.) Voigt	Phuk-tum-nin	Ivy gourd	E, M	1.85		N	CV	MK		KC104
	Cucumis melo L.	Mak-buap	Musk melon	E	1		IN	CV	MK		KC039
	C. sativus L.	Mak-teng	Cucumber	E	1		IN	CV	MK		KC059
	Cucurbita pepo L.	Mak-ue	Pumpkin	E	1		IN	CV	MK		KC064
	Luffa acutangula (L.) Roxb.	Mak-kha-noy	Chinese okra	E	1		IN	CV	MK		KC042
	Momordica charantia L.	Phuk-xai	Balsam apple	E	1		IN	CV	MK	F	KC096
	Sicyos edulis Jacq.	Mak-su	Chayote	E	1		IN	CV	MK		KC066
Cupressaceae	*Fokienia hodginsii* (Dunn) A.Henry & H H.Thomas	Mai-long-leng	Fujian cypress	T, C	0.85	VU	N		MK		KC038
Dioscoreaceae	*Dioscorea alata* L.	Mun-phao-muang	Purple yam	E	1		N	CV	MK		KC071
	D. esculenta (Lour.) Burkill	Mun-uan	Asiatic yam	E	1		N	CV	MK		KC070
	D. hispida Dennst.	Hua-koy	Asiatic Bitter Yam	E	1		N		MK	F	KC036
	D. polystachya Turcz.	Mun-keap	Chinese yam	E	0.88		IN	CV	MK		KC069
Dipterocarpaceae	*Hopea odorata* Roxb.	Ton-kean	Ironwood	T	1	VU	N			F	KC025
	Shorea roxburghii G.Don	Kean-kha-yom	White Meranti	T	1	VU	N			F	KC026
Eriocaulaceae	*Eriocaulon cinereum* R.Br.	Ya-ka-taiy	Pipewort	M	0.15	LC	N		MK	F	KC124
Euphorbiaceae	*Manihot esculenta* Crantz	Mun-ton	Cassava	E	1		IN	CV	MK		KC072
Fabaceae	*Afzelia xylocarpa* (Kurz) Craib	Tea	Black rosewood	T	1.23	EN	N	CV		F	KC103
	Arachis hypogaea L.	Ton-mak-thua-din	Groundnut	E	1		IN	CV	MK		KC107
	Biancaea sappan (L.) Tod.	Ton-fang-deng	Sappanwood	M, CL	1.08	LC	N	CV	MK	F	KC099
	Canavalia gladiata (Jacq.) DC.	Mak-thua	Sword Bean	M	0.58		N	CV	MK		KC135
	Entada glandulosa Gagnep.	Mak-ka-ba	Callingcard vine	M	0.63		N		MK	F	KC041
	Lablab purpureus (L.) Sweet	Mak-peap	Hyacinth bean	E	1		IN	CV	MK		KC057
	Lysiphyllum strychnifolium (Craib) A.Schmitz	Ya-nang-deng	Ya nang daeng	M, CL	1.63		N		MK	F	KC128
	Tamarindus indica L.	Mak-kham	Tamarind	E	1	LC	IN	CV	MK		KC045
	Parasenegalia visco (Lorentz ex Griseb.) Seigler & Ebinger	Phuk-som-poy	Soap-Pod	E	0.6		IN	CV	MK	F	KC102
	Phaseolus vulgaris L.	Thua-khek	Common bean	E	1	LC	IN	CV	MK		KC109
	Pterocarpus macrocarpus Kurz	Mai-dou	Burma padauk	T	1	EN	N	CV		F	KC007
	Psophocarpus tetragonolobus (L.) DC.	Mak-thua-phu	Winged bean	E	1		IN	CV	MK		KC110

	Sesbania grandiflora (L.) Pers.	Dok-kea-khao	Vegetable hummingbird	E	1		IN	CV	MK		KC023
	Vigna unguiculata (L.) Walp.	Mak-thua-hai	black-eyed pea	E	1		IN	CV	MK		KC108
Iridaceae	*Eleutherine bulbosa* (Mill.) Urb.	Warn-jod	Red Tuber Iris	M	1		IN	CV	MK		KC116
Lamiaceae	*Ocimum* × *africanum* Lour.	Phuk-i-tou	Lemon basil	E	1		N	CV	MK		KC083
	O. basilicum L.	Bua-la-pha	Basil	E	1		N	CV	MK		KC005
	O. tenuiflorum L.	Phuk-ka-phoa	Holy Basil	E	1		N	CV	MK		KC018
Lauraceae	*Litsea cubeba* Pers.	Hua-si-kai	Mountain Pepper	M	0.93	LC	N		MK	F	KC016
Malvaceae	*Ceiba pentandra* (L.) Gaertn.	Ton-ngiew	Kapok Tree	E, H, F	1.78	LC	N	CV			KC078
	Helicteres isora L.	Por-bid	Indian Screw Tree	M, F	0.6		N		MK	F	KC098
	Hibiscus sabdariffa L.	Som-phor-di	Roselle	E	1		IN	CV	MK		KC130
	Pentace burmanica Kurz	Siead	Melunak	M	1	DD	N		MK	F	KC131
Marantaceae	*Donax canniformis* (G.Forst.) K.Schum.	Warn-su-kum-lung	West Indian Arrow-Root	M	1			CV	MK		KC121
Meliaceae	*Sandoricum koetjape* (Burm.f.) Merr.	Mak-tong	Sentul, Santol, Red sentol, Yellow sentol	E, T	1.3		IN	CV	MK		KC061
Menispermaceae	*Cissampelos pareira* L.	Mor-noy	velvetleaf	E	1		N	CV	MK		KC074
	Coscinium fenestratum (Goetgh.) Colebr.	Hem	Berberine	M	0.35	DD	N		MK	F	KC010
	Tiliacora triandra Diels	Ya-nang	Ya nang	E	1		N	CV	MK	F	KC127
Moraceae	*Artocarpus heterophyllus* Lam.	Mak-mi	Jackfruit	E	1		IN	CV	MK		KC052
Oleaceae	*Schrebera swietenioides* Roxb.	Mak-sop-ped	Weaver's Beam Tree	M	1		N		MK	F	KC065
Pandanaceae	*Pandanus amaryllifolius* Roxb. ex Lindl.	Bai-teoy	Fragrant pandan	E	1			CV	MK		KC105
	Pandanus fibrosus Gagnep.	Teoy	Pandanus	E, T, H	2.18		N		MK	F	KC106
Pedaliaceae	*Sesamum indicum* L.	Mak-nga-dum	Black Sesame Seeds	E, M	1.53		IN	CV	MK		KC076
Phyllanthaceae	*Breynia androgyna* (L.) Chakrab. & N.P.Balakr.	Phuk-wan-ban	Sweet Leaf Gooseberry	E	1	LC	N	CV	MK		KC095
	Phyllanthus emblica L.	Mak-kham-pom	Indian gooseberry	E	1	LC	N	CV	MK	F	KC027
Pinaceae	*Pinus* sp.	Ton-peak	Pine	H	1		N		MK		KC081
Poaceae	*Centotheca lappacea* (L.) Desv.	Ya-li-phea	Barbed grass	M	0.63		N		MK	F	KC126
	Cymbopogon citratus (DC.) Stapf	Hua-si-kai	Lemon Grass	E, S	2		IN	CV	MK		KC015
	Gigantochloa parviflora (Keng f.) Keng f.	Nor-mai-xod	Membranous Bamboo	E, T	1.85				MK	F	KC080
	Imperata cylindrica (L.) Raeusch.	Ya-kha	Cogongrass	M, T, H, F, C	3.45		IN			F	KC125
	Saccharum officinarum L.	Aoi	Sugar Can	E	1		IN	CV	MK		KC002
	Thysanolaena latifolia (Roxb. ex Hornem.) Honda	khem	Broomgrass	E, H	2		N		MK	F	KC024
	Zea mays L.	Sa-ly	Corn	E	1	LC	IN	CV	MK		KC129
Pteridaceae	*Ceratopteris thalictroides* (L.) Brongn.	Phuk-koud-deng	Swamp Fern	E	1		N		MK	F	KC035
Rubiaceae	*Mussaenda sanderiana* Ridl.	Dok-meng-ka-biea	Butterfly Flower	M	0.9		N		MK	F	KC008
Rutaceae	*Aegle marmelos* (L.) Corrêa	Ton-mak-toum	Bael Fruit	E, M	1.6	NT	IN		MK	F	KC062
	Citrus × *aurantiifolia* (Christm.) Swingle	Mak-nao	Key lime	E	1		IN	CV	MK		KC055
	C. hystrix DC.	Bai-khi-houd	Kaffir lime	E, S	1.35		IN	CV	MK		KC028
	Zanthoxylum rhetsa (Roxb.) DC.	Mak-khen	Indian prickly ash	E, S	1.7	LC	N		MK	F	KC043
Sapindaceae	*Dimocarpus longan* Lour.	Mak-lum-yai	Longan	E	1	DD	N	CV	MK		KC037
	Sapindus rarak A. DC	Mak-suk-kheang	Soap Nut Tree	M	0.58	LC	N		MK	F	KC067
Sapotaceae	*Pouteria campechiana* (Kunth) Baehni.	Mak-mon-khai	Canistel	E	1	LC	IN	CV	MK		KC073
Smilacaceae	*Smilax glabra* Roxb.	Ya-hua	China Root	M	0.35		N		MK	F	KC123
Solanaceae	*Solanum aculeatissimum* Jacq.	Mak-kheay-khuen	Cock Roach Berry	E	1		IN	CV	MK	F	KC049
	S. lasiocarpum Dunal	Mak-khaiy	Hairy Eggplant	E	1		N	CV	MK		KC044
	S. lycopersicum L.	Mak-len	Tomato	E	1		IN	CV	MK		KC051

	S. tuberosum Mill.	Mun-fa-lung	Potato	E	1		IN		MK		KC068
	S. virginianum L.	Mak-kheay-khao	Egg Plant	E	1		N	CV	MK		KC048
Talinaceae	*Talinum paniculatum* (Jacq.) Gaertn.	Som-nok-an	Fameflower	E, M	1		IN		MK		KC101
Zingiberaceae	*Alpinia galanga* (L.) Willd.	Kha	Galangal	E, M, S	2.50		N	CV	MK		KC021
	Curcuma amarissima Roscoe	Warn-jai-dum	Mango ginger	M	0.43		IN	CV	MK		KC115
	C. aurantiaca Zijp.	Warn-lueng	Rainbow Ginger	M, C	1.28	DD	N	CV	MK		KC119
	C. comosa Roxb.	Ka-jiew-kao	Wan Chak Motluk	E, M	1.33		N		MK	F	KC017
	C. longa L.	Khi-min-sun	Turmeric	E, M, S	2.75	DD	IN	CV	MK		KC030
	C. mangga Valeton & Zijp	Warn-khiew	Mango Ginger	M	1.1	DD		CV	MK		KC118
	C. rangjued Saensouk & Boonma	Warn-jued	Rang-Jued-Khamin	M	0.6			CV	MK		KC117
	C. zanthorrhiza Roxb.	Warn-suk-mod-louk	Javanese turmeric	M	0.58	DD		CV	MK		KC136
	C. zedoaria (Christm.) Roscoe	Khi-min-khuen	Zedoary	E, M, S	2.83	DD	IN	CV	MK		KC029
	Kaempferia galanga L.	Warn-hom	Aromatic Ginger	M, C	1.45	DD	N	CV	MK		KC114
	K. parviflora Wall. ex Baker	Khing-dum	Black Ginger	E, M	0.95	DD	N	CV	MK		KC032
	Zingiber montanum (J.König) Link ex A.Dietr.	Warn-fai	Cassumunar ginger	M	0.95		N	CV	MK		KC113
	Z. officinale Roscoe	Khing	Ginger	E, M, S	2.33	DD	IN	CV	MK		KC031
	Z. thorelii Gagnep.	Khing-pi-din	Red Ginger	E, M	1.65		N	CV	MK	F	KC033

*E = Edible (Vegetables and Food), M = Medicine (used in various forms, such as dried herbs, teas, oils, and more), T = Timbering (build material from wood), H = Household (devices to assist with various tasks and functions within a household), S = Spice (Spices are flavored or aromatic portions of plants used as flavorings,), F = Fiber (Processed to create textiles, ropes, and various other products), C = Cultural (Plants are used in various religious ceremonies.), CL = Color (Color derived from plants) (FAO, 2000)

*LC = Least Concern, DD= Data Deficient, NT= Near Threatened, EN= Endangered, VU= Vulnerable, IN= Introduced, N= Native

*CV = Cultivated, Mk = Market, F = Forest

Table 4. Most common plant families used by the Hmong ethnic from the Hmong ethics group in Pakkading District, Bolikhamxay Province, Central Laos, Lao PDR

No.	Families	Species in each family	Numbers of species	Percentage in each family
1	Fabaceae, Zingiberaceae	14	28	21
2	Cucurbitaceae	8	8	6
3	Amaryllidaceae, Poaceae	7	14	11
4	Apiaceae, Arecaceae, Solanaceae	5	15	11
5	Asteraceae, Araceae, Basellaceae, Dioscoreaceae, Malvaceae, Rutaceae	4	24	18
6	Lamiaceae, Menispermaceae	3	6	5
7	Dipterocarpaceae, Pandanaceae, Phyllanthaceae, Sapindaceae	2	8	6
8	Acanthaceae, Acoraceae, Amaranthaceae, Anacardiaceae, Annonaceae, Apocynaceae, Aspleniaceae, Athyriaceae, Bignoniaceae, Bromeliaceae, Campanulaceae, Cannabaceae, Caricaceae, Convolvulaceae, Cupressaceae, Eriocaulaceae, Euphorbiaceae, Iridaceae, Lauraceae, Marantaceae, Meliaceae, Moraeeae, Oleaceae, Pedaliaceae, Pinaceae, Pteridaceae, Rubiaceae, Sapotaceae, Smilacaceae, Talinaceae	1	30	23

The number of plant species in each category in Figure 2 shows that most plants were used for edible (101 species) followed by medicine (41 species), timbering (11 species), household (8 species), spice (8 species), fiber (5 species), cultural (5 species) and color (3 species) respectively.

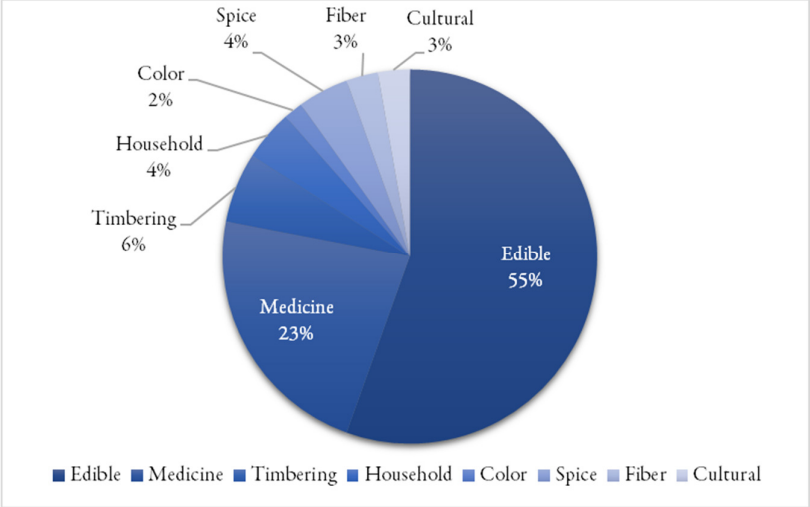

Figure 2. Number of plant species in each category from the Hmong ethics group in Pakkading District, Bolikhamxay Province, Central Laos, Lao PDR

Use value (UV)

The plant with the highest Use Value (UV) was *Imperata cylindrica* (UV = 3.45), followed by *Calamus viminalis* (UV = 2.85) and *Curcuma zedoaria* (UV = 2.83) (Table 5). In Figure 3 it is shown the percentage of plant parts used from the Hmong ethics group. *Imperata cylindrica* is primarily used for its roots and stems, which are consumed for nourishment. Additionally, it is utilized for reducing fever and alleviating symptoms of diarrhea. The plant is also employed for roofing purposes in traditional housing and holds cultural significance as a protective talisman against negative influences. *Calamus viminalis*, on the other hand, is used as both food and a binding material for *Imperata cylindrica*, particularly in the construction of roofs. Furthermore, it serves as a source of fiber, which is commonly used for weaving sticky rice baskets. *Curcuma zedoaria* is known for its medicinal properties in treating dyspepsia and is utilized to add aroma to food.

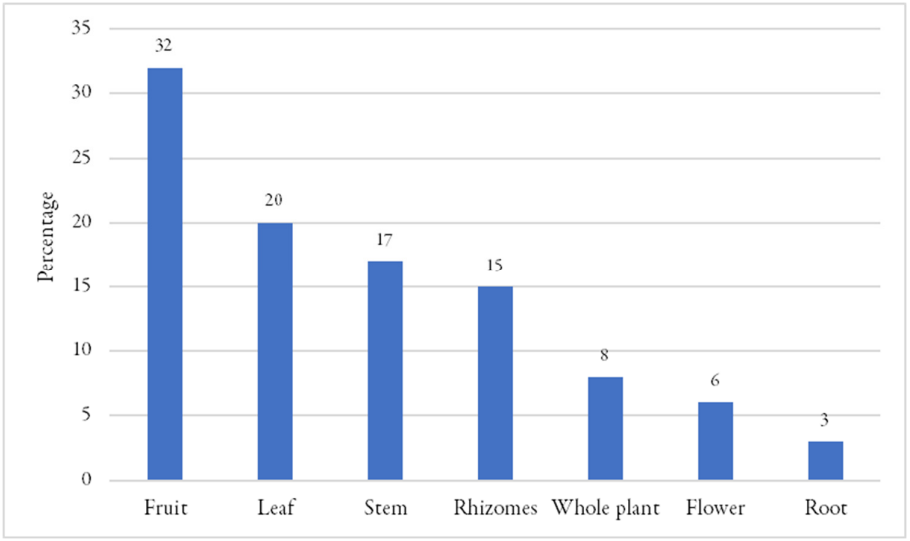

Figure 3. The Percentage of plant parts used from the Hmong ethics group in Pakkading District, Bolikhamxay Province, Central Laos PDR (Standard deviation (SD) ± 15.44)

Table 5. Use Value (UV) of the 10 most important plant species in the Hmong ethnic from the Hmong ethics group in Pakkading District, Bolikhamxay Province, Central Laos, Lao PDR

No.	Plants species	Plant uses							UV
		E	M	T	H	S	F	C	
1	*Imperata cylindrica* (L.) Raeusch.		34		40			24	3.45
2	*Calamus viminalis* Willd.	40			34			40	2.85
3	*Curcuma zedoaria* (Christm.) Roscoe	40	35			38			2.83
4	*C. longa* L.	34			36				2.75
5	*Alpinia galanga* (L.) Willd.	24			36				2.50
6	*Zingiber officinale* Roscoe	13			40				2.33
7	*Thysanolaena latifolia* (Roxb. ex Hornem.) Honda	40			40				2.00
8	*Cymbopogon citratus* (DC.) Stapf	40				40			2.00
9	*Codonopsis javanica* (Blume) Hook.f. & Thomson	40	38						1.95
10	*Acorus calamus* var. *angustatus* Besser	40	34						1.85

*E = Edible, M = Medicine, T = Timbering, H = Household, S = Spice, F = Fiber, C = Cultural

Informant Agreement Ratio

Edible plants are utilized by the community as traditional medicinal remedies, accounting for 23% of the total edible species found in the study area. These plants are employed to treat various diseases and symptoms, categorized into 10 major ailment classes based on the National Essential Medicines List (Natural Drug Information, 2013) (Table 6).

Table 6. IAR of medical categories in the Hmong ethnics group

No.	Medical category	Nur	Nt	IAR
1	Urinary system symptoms	21	1	1.00
2	Neurological symptoms	9	1	1.00
3	Eye Symptoms	6	1	1.00
4	Symptoms of skin	48	2	0.98
5	Nourish blood	41	2	0.98
6	Obstetrics gynecology symptoms	68	3	0.97
7	Musculoskeletal system symptoms	154	6	0.97
8	Nourish	344	15	0.96
9	Gastrointestinal system symptoms	321	15	0.96
10	Fever	168	9	0.95

Many species were used for treating symptoms. The Hmong used 15 species, including *Andrographis paniculata*, *Acorus calamus* var. *angustatus*, *Iresine diffusa* f. *herbstii*, *Artemisia lactiflora*, *Gynura bicolor*, *Codonopsis javanica*, *Cannabis sativa* ssp. *sativa*, *Biancaea sappan*, *Lysiphyllum strychnifolium*, *Helicteres isora*, *Maranta arundinacea*, *Imperata cylindrica*, *Mussaenda sanderiana*, *Aegle marmelos*, *Talinum paniculatum* to Nourish, 12 species including *Zingiber montanum*, *C. comosa*, *Curcuma amarissima*, *C. zedoaria*, *C. longa*, *Curcuma aurantiaca*, *Curcuma mangga*, *Alpinia galanga*, *Kaempferia parviflora*, *Z. thorelii*, *Z. officinale*, *C. rangjued* used to treat Gastritis, seven species to treat the fever, including *Eleutherine bulbosa*, *Litsea cubeba*, *Coscinium fenestratum*, *Imperata cylindrica*, *Smilax glabra*, *Curcuma mangga*, *Zingiber thorelii*, etc., as shown in Figure 4.

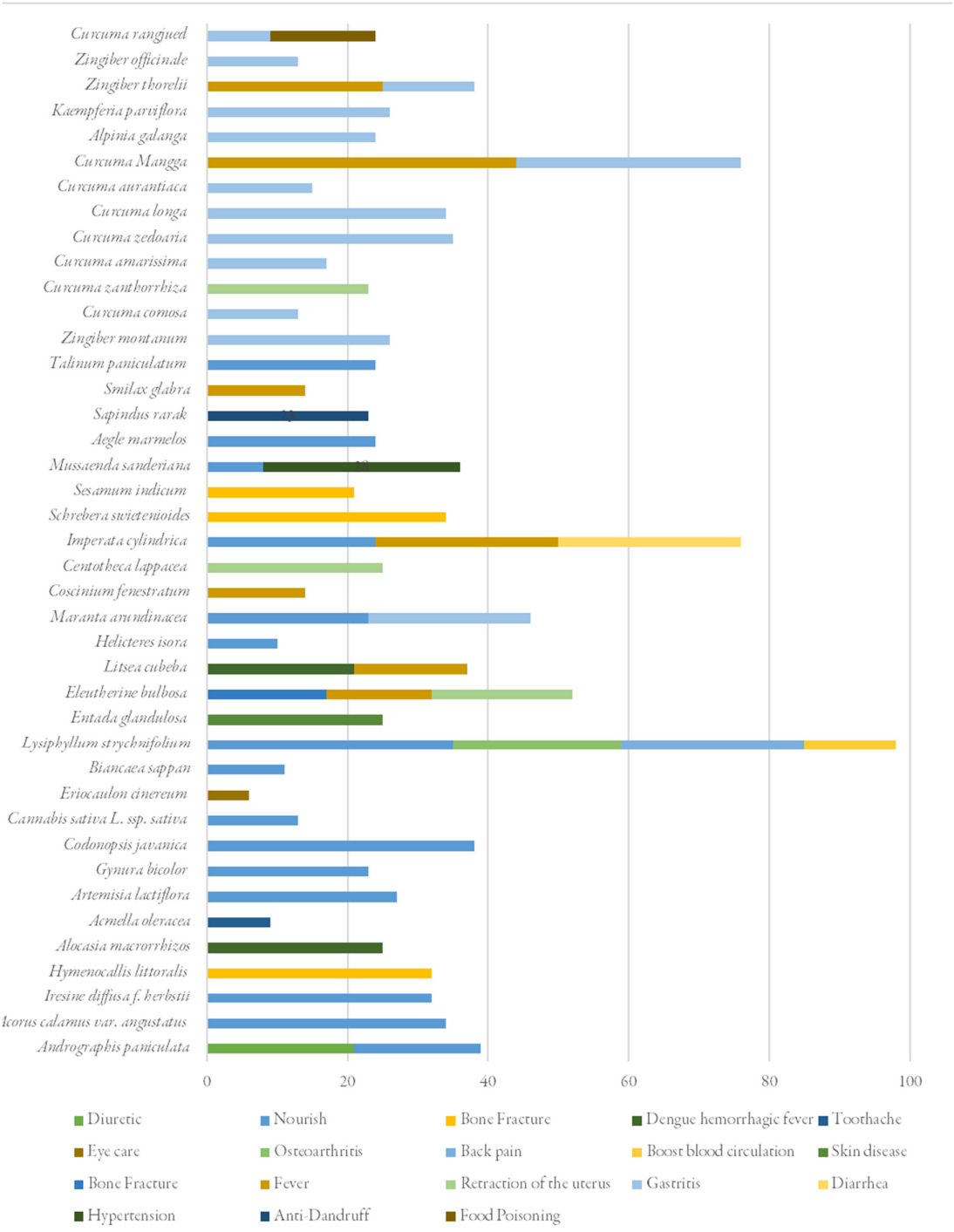

Figure 4. The numbers of use reports for the medicine species of the Hmong ethics group in Pakkading District, Bolikhamxay Province, Central Laos PDR

The fidelity level

The highest fidelity level values (%FL) of 100% were recorded for 23 species, including *Mussaenda sanderiana* (78%), consistently used for hypertension; *Curcuma aurantiaca* (73%), consistently used for gastritis; and *Zingiber thorelii* (66%).

These species, which were consistently used for uterine retraction (Table 7) should all be subject to comprehensive studies to evaluate their efficacy, safety, and phytochemical composition. These studies should include pharmacological trials, bioactivity trials, and toxicity studies. The repeated use of these plants suggests a strong healing potential. It is presumed that plants utilized repeatedly are more likely to possess significant biological activity.

Table 7. Mostly used medicinal plant species for medical categories based on the fidelity level

Disorder and treatments	Categories symptoms and species	%FL
Nourish		
Nourish body	*Aegle marmelos* (L.) Corrêa	100%
	Andrographis paniculata (Burm.f.) Nees	46%
	Imperata cylindrica (L.) Raeusch.	32%
	Lysiphyllum strychnifolium (Craib) A.Schmitz	36%
	Maranta arundinacea L.	50%
	Mussaenda sanderiana Ridl.	22%
	Sesamum indicum L.	100%
	Talinum paniculatum (Jacq.) Gaertn.	100%
Urinary system symptoms		
Diuretic	*Andrographis paniculata* (Burm.f.) Nees	54%
Oral syndrome		
Toothache	*Acmella oleracea* (L.) R.K.Jansen	100%
Neurological symptoms		
Eye care	*Eriocaulon cinereum* R.Br.	100%
Symptoms of skin		
Skin disease	*Entada glandulosa* Gagnep.	100%
Anti-dandruff	*Sapindus rarak* A. DC	100%
Nourish blood		
Boost blood circulation	*Lysiphyllum strychnifolium* (Craib) A.Schmitz	13%
Hypertension	*Mussaenda sanderiana* Ridl.	78%
Obstetrics gynecology symptoms		
Retraction of the uterus	*Curcuma zanthorrhiza* Roxb.	100%
	Centotheca lappacea (L.) Desv.	100%
	Eleutherine bulbosa (Mill.) Urb.	38%
Musculoskeletal system symptoms		
Bone fracture	*Eleutherine bulbosa* (Mill.) Urb.	33%
	Sesamum orientale L.	100%
	Schrebera swietenioides Roxb.	100%
Osteoarthritis	*Lysiphyllum strychnifolium* (Craib) A.Schmitz	24%
Back pain	*L. strychnifolium* (Craib) A.Schmitz	27%
Gastrointestinal system symptoms		
Gastritis	*Alpinia galanga* (L.) Willd.	100%
	Curcuma amarissima Roscoe	100%
	C. aurantiaca Zijp.	73%

	C. comosa Roxb.	100%
	C. longa L.	100%
	C. mangga Valeton & Zijp	100%
	C. rangjued Saensouk & Boonma	100%
	C. zedoaria (Christm.) Roscoe	100%
	Kaempferia parviflora Wall. ex Baker	34%
	Zingiber montanum (J.König) Link ex A.Dietr.	100%
	Z. officinale Roscoe	38%
	Z. thorelii Roscoe	100%
Food poisoning	*Zingiber officinale* Roscoe	63%
Diarrhea	*Imperata cylindrica* (L.) Raeusch.	34%
Fever		
Dengue hemorrhagic fever	*Alocasia macrorrhizos* (L.) G.Don	100%
	Litsea cubeba Pers.	57%
Fever	*Coscinium fenestratum* (Goetgh.) Colebr.	100%
	Eleutherine bulbosa (Mill.) Urb.	29%
	Litsea cubeba Pers.	43%
	Smilax glabra Roxb.	100%
	Zingiber thorelii Roscoe	66%

Jaccard's similarity index

The percentage of plant sourcing depicted in Figure 5 indicates that the majority of plants were obtained from the market (125 species, 47%), followed by cultivated sources in home gardens and agricultural land (101 species, 38%), and the forest (41 species, 15%). Typically, women frequently visit the marketplace to sell their products, thus becoming familiar with the plants available for sale, including cultivated plants.

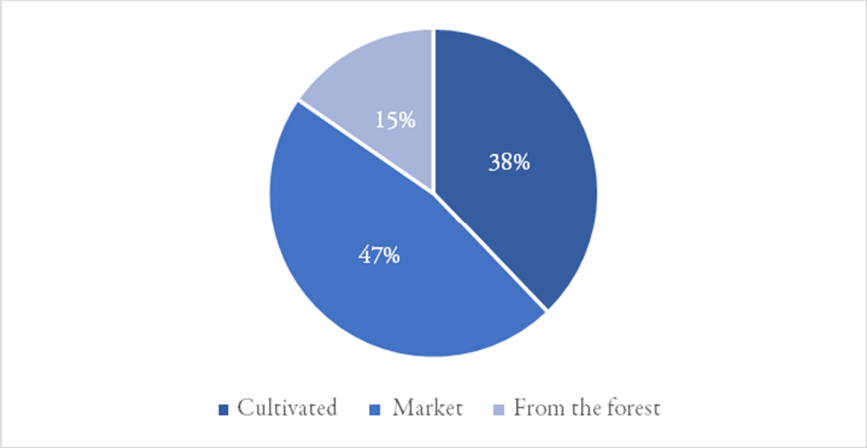

Figure 5. The plants in three areas used by Hmong ethnics group

Table 8. Jaccard's Similarity Index of Areas in the sample of plants used in the Hmong ethics group in Pakkading District, Bolikhamxay Province, Central Laos PDR

	Forest	Market
Cultivated	0.1013	0.2981
From the forest	-	0.1782

Figure 6 showed the similarities among plants in three areas: cultivated, market, and forest. The cultivated plants and plants in the market exhibited the highest similarity index (0.2981) (Table 8), with 96 species found in both areas. This is because many cultivated plants are also sold in the market, which is centrally located in Pakkading district. As a result, numerous plant species are available for sale in the market.

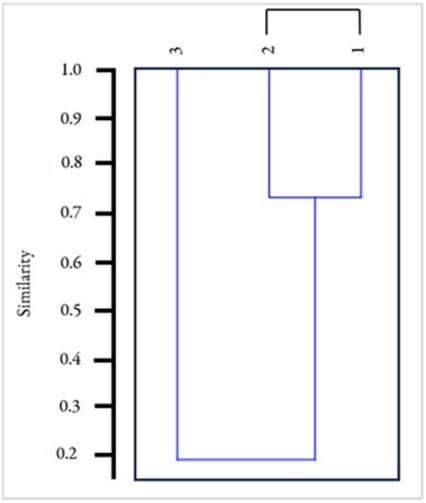

Figure 6. UPGMA cluster analysis of edible plant species used in the Hmong ethics group in Pakkading District, Bolikhamxay Province, Central Laos PDR based on Jaccard's Similarity Index. 1: Cultivated, 2: Market, 3: From the forest

Discussion

Ethnobotany in Hmong Thongnami village

Edible group: there were 101 species classified into two main categories: wild plants such as *Dioscorea polystachya*, *Diplazium esculentum*, *Phyllanthus emblica*, *Sandoricum koetjape*, *Thysanolaena latifolia*, *Zanthoxylum rhetsa*, and more; and cultivated plants such as *Annona squamosa*, *Arachis hypogaea*, *Artemisia lactiflora*, *Gynura bicolor*, *Leucocasia gigantea*, *Mangifera caloneura*, *Sesamum indicum*, *Sicyos edulis*, and others. The Zingiberaceae family includes species like *Alpinia galanga*, *Curcuma amarissima*, *C. aurantiaca*, *C. comosa*, *C. longa*, *C. mangga*, *C. rangjued*, *C. zanthorrhiza*, *Kaempferia galanga*, *K. parviflora*, *Zingiber montanum*, *Z. officinale*, and *Z. thorelii*. As for food plants, the Hmong people have a preference for Taro (*Colocasia esculenta*), Pumpkin (*Cucurbita moschata*), and Corn (*Zea mays*). Yarnvudhi *et al.* (2016) reported that the Hmong Hmong Doi Pui Village in Doi Suthep-Pui National Park, Chiang Mai Province, used *Phyllanthus emblica* and *Diplazium esculentum* for food.

Medicine group: There were 41 species, most of which were traditionally used as medicine to nourish the body. These plants can be further classified based on their specific uses, such as restorative purposes (e.g., *Aegle marmelos*, *Andrographis paniculata*, *Imperata cylindrica*, and *Talinum paniculatum*), retraction of the uterus (e.g., *Curcuma zanthorrhiza*, *Centotheca lappacea*, etc.), and treating gastritis (e.g., *Curcuma amarissima*,

C. zedoaria, and all species of the Zingiberaceae family). and studies in Thailand have reported the medicinal use of *Andrographis paniculata*, *Curcuma comosa*, *C. longa*, and *Zingiber montanum* (Phatlamphu *et al*., 2021). Previous studies conducted among Hmong communities in Laos have also revealed the medicinal use of *Alpinia galanga* (Whitney *et al*., 2014).

Timbering: there were 11 species, most of which were found in the natural forest adjacent to the village. For instance, *Hopea odorata*, *Sandoricum koetjape*, and *Anthoshorea roxburghii.* Nakamura (2006) There are reports of Antho *Anthoshorea roxburghii* being brought in as timber. were commonly used for construction purposes; however, the wood of these species had low strength.

Household: there were 8 species that were used for making a house broom, including *Arenga westerhoutii*, *Cocos nucifera*, *Livistona speciosa*, and *Thysanolaena latifolia*. Niveditha (2016) reported *Thysanolaena latifolia* use as broom grass tribals of Srikakulam District, Andhra Pradesh in India.

Spice: there were eight species used to enhance the aroma of food and eliminate the fishy smell from dishes (e.g *Alpinia galanga* Darriet (2007) reported that *Alpinia galanga* was used as a spice*, Coriandrum sativum* Mandal *et al*. (2015) reported *Coriandrum sativum* was essential oil-bearing spices*, Curcuma longa, C. zedoaria, Cymbopogon citratus, Eryngium foetidum, Foeniculum vulgare*, and *Zingiber officinale*)

Fiber: there were five species (e.g., *Calamus viminali, Helicteres isora, Imperata cylindrica*, etc.) that were also used for making a rope. (Baja-Lapis, 2009).

Cultural: there were five species used for specific purposes: *Curcuma aurantiaca* and *Imperata cylindrica* as talismans for protection against negative influences, and *Fokienia hodginsii* to construct coffins, believed to ensure a peaceful passage for the deceased. This is the first report.

Color: there were three species used for coloration purposes: *Basella alba* (Mitra and Das, 2015), *Biancaea sappan (*Abu, 2019), and *Lysiphyllum strychnifolium*, known for producing a red color.

Table 9. Species richness and ethnobotany index in Hmong ethnic groups compared to period study

Locality	Species richness	Ethnobotany index			Most important families
		UV	IAR	%FL	
Bolikhamxay province, Lao PDR	133	3.45	1.00	100%	Fabaceae, Zingiberaceae
Luang Prabang province, Lao PDR	74	-	-	-	Polygonaceae, Araceae
Bokeo province, Xieng Khouang province, and Vientiane province, Lao PDR	333	-	-	-	Fabaceae, Zingiberaceae
Nan province, Thailand	69	-	-	-	Asteraceae, Amaranthaceae, Solanaceae
Nan province, Thailand	277	-	-	-	Poaceae, Fabaceae
Chiang Mai province, Thailand	130	-	-	-	Asteracea, Amaranthaceae, Cucurbitaceae and Solanaceae

Table 9 displays a comparison of ethnobotanical usage among the Hmong ethnic group based on recent studies. Dubost *et al.* (2019) reported on plants from three provinces in Lao PDR: Bokeo province, Xieng Khouang province, and Vientiane province. Their study identified a total of 333 species, indicating the highest species richness due to the inclusion of these diverse provinces. In contrast, Nguanchoo *et al.* (2019) focused on Nan province, Thailand, and reported a species richness of 69 species. This discrepancy is attributed to their study's specific focus on exotic plants. In comparison to these previous studies, our research demonstrates significantly greater species richness. Our study encompasses 133 species, even though it was conducted within a single village. Notably, this is the inaugural report providing an ethnobotany index that incorporates UV, IAR, and %FL to analyse ethnobotanical usage within the Hmong ethnic group. The two most significant plant families in ethnobotanical usage by the Hmong ethnic group are Fabaceae and Zingiberaceae. Despite the different areas, these two families remain consistently utilized. However, our study does not provide much

information. Nevertheless, it highlights the importance of certain plants within the Hmong ethnic group, which belong to two families. This is consistent with the findings of Dubost *et al*. (2019), as shown in Table 9.

Conclusions

The results of this ethnobotany survey have likely revealed the richness of indigenous knowledge, particularly in the common use of traditional plants among rural populations in Bolikhamxay Province. There is no written documentation of this traditional knowledge, and its transmission to future generations only occurs orally. Traditional knowledge and the utilization of plants continue to hold great importance. Currently, there is no evidence of a decline in traditional knowledge. However, with lifestyle changes and a growing population, the significance of plants is decreasing. Consequently, there is a concern that Hmong ethnobotanical knowledge may become considerably limited or even disappear in the foreseeable future. Nevertheless, it is important to acknowledge that the Hmong community is the rightful owner of this traditional knowledge, and any potential benefits derived from its use should be directed towards their community.

Authors' Contributions

The article was initiated by KP, who recorded and analysed data and prepared the first draft of the manuscript. SS critically edited and shaped subsequent versions. PS and PS have read and approved the final version of the manuscript. All authors have read and approved the final manuscript.

Ethical approval (for researches involving animals or humans)

Not applicable.

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Conflict of Interests

The authors declare that there are no conflicts of interest related to this article.

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