

Ethnobotanical study of medicinal plants used by Lao ethnic group in Central Laos

Kajonesuk PHENGMALA¹, Surapon SAENSOUK^{1*},
Piyaporn SAENSOUK², Phetlasy SOULADETH³

¹Maharakham University, Walai Rukhvej Botanical Research Institute, Diversity of Family Zingiberaceae and Vascular Plant for Its Applications Research Unit, Biodiversity Program, Kantarawichai, Maha Sarakham, 44150, Thailand; 64016651002@msu.ac.th; surapon.s@msu.ac.th (*corresponding author)

²Maharakham 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

³National University of Laos, Faculty of Forest Science, Vientiane Capital, Laos; p.souladeth@nuol.edu.la

Abstract

Results from an ethnobotanical study of medicinal plants used by Lao ethnic group between 2021 and 2023 identifying the medicinal plants use of 76 species 68 genera 43 families. The primary emphasis of the study was on the medicinal plants, we tested the differences between informant knowledge and informant age using linear regression. The most important medicinal plant species, including *Blumea balsamifera*, *Chromolaena odorata*, *Smilax glabra*, and *Zingiber montanum* (all with a Use Value of 1.00), were followed by *Phyllanthus emblica* (0.95) and *Cucumis sativus* (0.88). Remarkably, 65 plant species achieved the highest Fidelity Level with a 100% FL value. Within ailment categories, Respiratory system symptoms garnered the highest Informant Agreement Ratio value of 1.00. The Jaccard's Similarity Index ranged from 0.0581 to 0.2690, with the highest JI observed between cultivated and market plants. The UPGMA cluster analysis indicated that wild plants exhibited lower similarity to the other areas. There were no significant differences in the number of plants known among different informants based on their age. In this research, we found that two plant species, *Solanum lasiocarpum* (used for nourishing the body) and *Morinda coreia* (employed in treating amenorrhea), have never been reported for their medicinal use before. These findings underscore the risk of traditional knowledge erosion, driven by the absence of written documentation and the influence of modern medical practices. The data obtained from this study is of immense value in formulating conservation strategies that can benefit both the Bolikhamxay province and the nation as a whole.

Keywords: Central Laos; Bolikhamxay Province; Lao ethnic groups; medicine; traditional knowledge

Introduction

Laos, located in the central part of the Indochina region of Southeast Asia, is a nation renowned for its significant affluence. The Greater Mekong Sub-Region covers an area of around 236,800 square kilometers, with forests occupying around 40% of this country (Lao Statistics Bureau, 2005). The country has an

Received: 17 Jan 2024. Received in revised form: 05 Mar 2024. Accepted: 11 Jun 2024. Published online: 18 Jun 2024.

From Volume 49, Issue 1, 2021, Notulae Botanicae Horti Agrobotanici Cluj-Napoca journal uses article numbers in place of the traditional method of continuous pagination through the volume. The journal will continue to appear quarterly, as before, with four annual numbers.

abundance of the Mekong River (The World Bank, 2014). Vidal (1958) was responsible for the first extensive documentation of plant species diversity in Laos. Pottier (1971) played a crucial role in documenting the medicinal uses of plants in the country.

Laos is distinguished as the most culturally diverse country in Southeast Asia. Its population consists of four main linguistic groups: Lao-Tai, which makes up 62.4%, Mon-Khmer at 23.7%, Hmong-Iu Mien accounting for 9.7%, and China-Tibetan contributing 2.9% (Lao Statistics Bureau, 2005). The source of this information is the Lao Statistics Bureau, specifically from the year 2005. The Lao ethnic group, which has resided in Laos for centuries, is one of the most ancient and is present in all provinces of the country. Additionally, they can be found in Vietnam, Thailand, and Cambodia. The Lao ethnic community is the largest ethnic group in Laos, with a population of 3,067,005 individuals. The total population reported by the Lao Statistics Bureau in 2005 was comprised of 1,738,736 females, which accounts for 54.6% of the nation's population. The Lao ethnic group utilizes the Lao-Tai language and possesses several customs, traditions, and cultures that are centered on Buddhism. Temples are significant as they serve as focal points for communal cohesion and repositories of religious traditions and doctrines. The main occupations of the Lao ethnic group encompass a wide range of activities, such as rice cultivation, the farming of sticky rice, and the cultivation of vegetables (Minority Rights Group, 2018).

The Bolikhamxay Province possesses a significant historical background and a deep cultural legacy, characterized by a tradition of customs that have been transmitted across successive generations. This province serves as a storehouse of native knowledge, particularly in the field of traditional plant-based medicine, where plants have been utilized for numerous medicinal purposes. This knowledge has been transmitted verbally through several generations, without being documented in written form. Unfortunately, in the contemporary era characterized by rapid change, the younger cohort seems to exhibit diminished enthusiasm for the conservation and acquisition of these long-established customs. The influx of modern technology has diverted their focus away from these precious legacies. In addition, a significant number of forested areas have been deforested to accommodate agricultural activities and cultivate profitable crops, resulting in a reduction in the variety of plant species. As a result, the knowledge and wisdom related to the utilization of plants are gradually diminishing. Undertaking research and creating a thorough database are essential for preserving and documenting these precious local traditions to avoid their permanent disappearance (Delang, 2007).

Materials and Methods

Study area

A research study was conducted to explore the variety of medicinal plant species, their conservation status, and the existence of medicinal plants in Na Kua Nok Village. This village is positioned at geographical coordinates of (18.22343° N and 104.20282° E), 159 m above sea level. Na Kua Nok Village is situated in the Pakkading District within the Bolikhamxay Province in Laos, as indicated in (Figure 1 and Table 1).

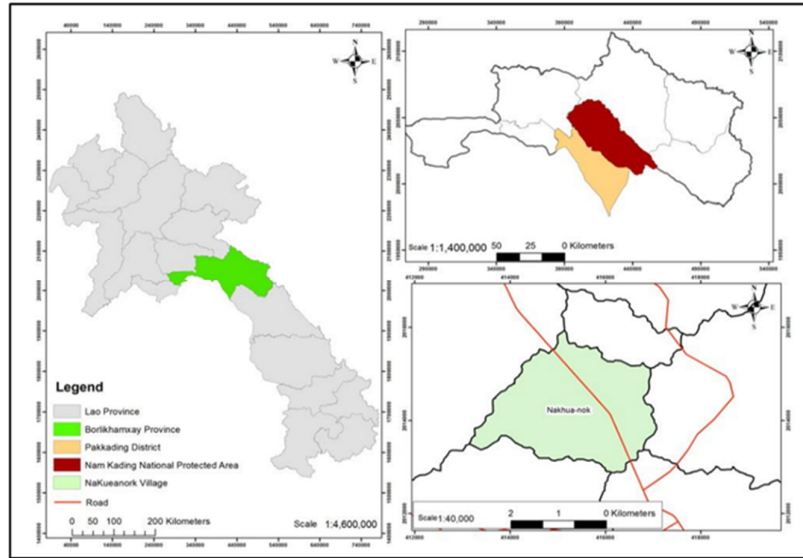


Figure 1. Place of Study Na Khua Nok village, Pakkading District, Bolikhamxay Province, Central Laos (Forest Inventory and Planning Division, Laos (2023))

Table 1. Demographic characteristics of the informants of Na Khua Nok village (Natural Resources and Environment of Pakkading District, 2023)

Ethnicity	Religion	Co-ordinates	Elevation (m)	Households	Population males/females	Total size area (ha)	Agricultural area (ha)
Lao	Buddhism	18.22343° N, 104.20282° E	152	193	935(293/642)	417	397

A research investigation was conducted to gather data on traditional medicinal plants from a heterogeneous cohort of inhabitants in the study area. The data was collected from a sample of 40 persons, as specified in Table 2, who were chosen randomly from various age groups spanning from 20 to over 60 years old (Table 2). The research approach involved semi-structured interviews and focus group discussions, adhering to the techniques outlined by Phatlamphu *et al.* (2021). The objective was to gather data pertaining to the nomenclature, characteristics, and curative applications of medicinal flora in Laos.

Table 2. Information of selected informants

Population	Number of informants	Age range		
		20-40	41-60	Over 60
Males	18	5	9	3
Females	22	10	11	2

Species identification

We collected plant constituents in the form of desiccated specimens. The plant specimens were analysed and identified by comparing them with the Plants of the World Online (2023). The taxonomist evaluated the conservation status of the species by following the guidelines from the IUCN website. The assessment criteria were based on Ragsasilp *et al.* (2022) and Saensouk and Saensouk (2021), which categorized the conservation status into common and rare species in the research area. Furthermore, we created alcoholic samples to voucher specimens, which were deposited in the herbarium at the Faculty of Forest Science, National University of Laos, and the herbarium at Walai Rukhavej Botanical Research Institute, Mahasarakham University, Thailand.

Data and statistical analyses

Use Value: UV

Use Value as a measure signifying the significance of a plant (Phillips *et al.*, 1994).

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

Where U_i is the report of using each species and N is the total number of informants participating in the study.

Informant Agreement Ratio: IAR

The Informant Agreement Ratio is a measure employed to assess the level of agreement or consensus among informants about the utilization of medicinal plants for specific symptom groups (Trotter and Logan, 1986).

$$IAR = (N_{ur} - N_t) / (N_{ur} - 1) \quad (2)$$

Where, N_{ur} is the number of use records in each use category and N_t is the number of taxa used in each use category.

The Fidelity Level: %FL

The Fidelity Level refers to the percentage of informants who reported the specific usage of certain plants for treating specific ailments in the research area (Friedman *et al.*, 1986).

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

Where N_p is denotes the count of reports of medicinal plant species used for that particular ailment, and N is representing the total number of medicinal plant species associated with that ailment.

Jaccard's Similarity Index

The Jaccard's Similarity Index was calculated to evaluate the similarity of medicinal plants in three separate regions. The objective of this investigation was to identify differences in plant utilization among these three regions. It involved studying the similarities between species using the Unweighted Pair Group Method with Arithmetic cluster analysis. The reference is from Hammer *et al.* (2001).

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

In this context, "a" stands for the count of species in area A, "b" corresponds to the count of species in area B, and "c" represents the number of species that are shared by both areas A and B.

A linear regression analysis was performed to study the relationship between the quantities of medicinal plants recognized by the informants and the continuous variable of informant age. The disparity in medicinal plant knowledge between females and males was assessed through Chi-square statistics, t-tests, and analysis of variance in SPSS version 29 (Teklehaymanot, 2009).

Results

Ethnobotanical study of medicinal plants used by Lao ethnic group

Medicinal plants

A total of 76 species of medicinal plants were identified, belonging to 68 different genera and 43 families. Table 3. The families that exhibited the highest variety of medicinal species collected were Zingiberaceae (6

species), followed by Acanthaceae and Fabaceae (5 species), Asteraceae, Menispermaceae, Phyllanthaceae, and Poaceae (4 species each), Combretaceae and Solanaceae (3 species each), Cucurbitaceae, Moraceae, Myrtaceae, and Rubiaceae (2 species each) (Table 3 and Figure 2). Other families had only one species (Table 3). The treatment preparations utilize various plant parts, including leaves from 25 species, whole plants from 11 species, roots from 9 species, fruit and rhizome from 6 species, barks from 4 species, seeds from 3 species, stems from 2 species, and corm and flowers from 1 species (Figure 3). The plant parts utilized in the preparations for treatment include: boiling 42 species, using fresh 31 species, pickling 8 species, grilling 3 species, and smoking 1 species (Figure 4).

Table 3. Families and medicinal plants used by Lao ethnic group

Family	Scientific name	Lao name	Parts used	Preparation	Ailments treated	UV	Voucher No.
Acanthaceae	<i>Andrographis paniculata</i> (Burm.f.) Wall. ex Nees	La-Sa-Bee	l	Boil	Diuretic	0.08	KS004
	<i>Barleria prionitis</i> L.	Aung-Karp-Nou	s	Boil	Liver Cancer	0.08	KS006
	<i>Clinacanthus nutans</i> (Burm. f.) Lindau	Dee-Pak-Bew	l	Boil	Crooked mouth	0.13	KS020
	<i>Dicliptera tinctoria</i> (Nees) Kostel.	Kam-Lung-Xarng-San	w	Boil or pickled	Nourish the body	0.15	KS028
	<i>Phlogacanthus pulcherrimus</i> T.Anderson	Bee-Pa-Kung	w	Boil	Nourish the body	0.25	KS056
Amaryllidaceae	<i>Hymenocallis littoralis</i> Salisb.	Wan-Zon	l	Grill	Joint pain	0.38	KS036
Anacardiaceae	<i>Spondias pinnata</i> (L. f.) Kurz	Mak-Kok	b	Grill	Wound repair	0.5.	KS066
Apiaceae	<i>Centella asiatica</i> (L.) Urb.	Phuk-Nok	l	Fresh	Apthous Ulcers	0.63	KS014
Araceae	<i>Alocasia macrorrhizos</i> (L.) G.Don	Ka-Phuk	co	Boil	Dengue fever	0.73	KS002
Arecaceae	<i>Wallaceodoxa raja-ampat</i> Heatubun & W.J.Baker	Mak	f	Fresh	Healthy teeth	0.5.	KS073
Asteraceae	<i>Acmella oleracea</i> (L.) R.K.Jansen	Phuk-Khad	l	Fresh	Toothache	0.23	KS001
	<i>Blumea balsamifera</i> (L.) DC.	Nard	l	Grill	Make the bones attach quickly Postpartum recovery	1.00	KS009
	<i>Chromolaena odorata</i> (L.) R.M.King & H.Rob.	Ya-Kiew	l	Fresh	Diarrhea Eliminate parasitic worms Stop the bleed	1.00	KS016
	<i>Elephantopus scaber</i> L.	Khing-Fai-Nok-Khoum	w	Boil	Viral Exanthem	0.55	KS032
Basellaceae	<i>Basella alba</i> L.	Phuk-Pung	l	Fresh	Viral Exanthem	0.43	KS007
Bignoniaceae	<i>Mansoa alliacea</i> (Lam.) A.H. Gentry.	Ka-Thiam-Kue	l, s, r	Boil or fresh	Insect bites Cough	0.50	KS044
Boraginaceae	<i>Heliotropium indicum</i> L.	Nguang-Xarng	fl	Boil	muscle aches	0.15	KS035
Campanulaceae	<i>Codonopsis javanica</i> (Blume) Hook.f. & Thomson	Shom	r	Boil or pickled	Nourish the body	0.45	KS022
Combretaceae	<i>Combretum pilosum</i> Roxb. ex G.Don	Ka-Deng	l	Fresh	Stop the bleed	0.23	KS008
	<i>Terminalia chebula</i> Retz.	Som-Mor	f	Pickled	Nourish the body	0.20	KS023
Cucurbitaceae	<i>Benincasa hispida</i> (Thunb.) Cogn	Mak-Ton	f	Fresh	Hiccups	0.23	KS070

Family	Scientific name	Lao name	Parts used	Preparation	Ailments treated	UV	Voucher No.
	<i>Coccinia grandis</i> (L.) Voigt	Phuk-Tam-Nin	r	Boil	Nourish the body	0.70	KS021
	<i>Cucumis sativus</i> L.	Mak-Taeng	f	Fresh	Glowing Skin	0.88	KS025
Cyperaceae	<i>Cyperus rotundus</i> L.	Ya-Heo-Mou	w	Boil	Blisters	0.15	KS027
Dipterocarpaceae	<i>Dipterocarpus tuberculatus</i> Roxb.	Ton-Koung	l	Fresh	Bloated Stomach	0.33	KS030
Ebenaceae	<i>Diospyros brandisiana</i> Kurz	Mak-Mor	b	Boil	Postpartum recovery	0.50	KS029
Elaeocarpaceae	<i>Elaeocarpus floribundus</i> Blume	Mak-Moun	r	Fresh	Fever	0.33	KS031
Euphorbiaceae	<i>Jatropha podagrica</i> Hook.	Mai-Khun-Thao-Pha-Lue-Sy	l	Boil	Acute Pancreatitis	0.43	KS038
Fabaceae	<i>Cassia fistula</i> L.	Ton-Khoun	r	Boil	Healthy teeth	0.40	KS013
	<i>Lysiphyllum strychnifolium</i> (Craib) A.Schmitz	Ya-Nang-Daeng	s	Boil	Nourish the body	0.53	KS043
	<i>Mimosa pudica</i> L.	Ya-Youp	w	Boil	Nourish blood	0.63	KS045
	<i>Sesbania grandiflora</i> (L.) Pers.	Kok-Dok-Khae-Khaow	b	Boil	Apthous Ulcers Cough	0.78	KS062
	<i>Tamarindus indica</i> L.	Mak-Kham	s, l	Boil	Apthous Ulcers Postpartum recovery	0.50	KS069
Lamiaceae	<i>Perilla frutescens</i> (L.) Britton	Nga-Jieng	sd	Fresh	Make the bones attach quickly	0.80	KS054
Lauraceae	<i>Litsea cubeba</i> Pers.	Hua-See-Khai-Ton	w	Boil	Bloated Stomach	0.40	KS042
Liliaceae	<i>Aloe vera</i> (L.) Burm.f.	Wan-Khae	l	Fresh	Insect bites	0.68	KS003
Lythraceae	<i>Lagerstroemia speciosa</i> (L.) Pers.	Ka-Kah-Lao	f	Boil	Cough	0.10	KS040
Malvaceae	<i>Pentace burmanica</i> Kurz	Siet	b	Fresh	Healthy teeth	0.25	KS053
Menispermaceae	<i>Coscinium fenestratum</i> (Goetgh.) Colebr.	Heam	s	Boil	Gastroenteritis	0.38	KS018
	<i>Cissampelos pareira</i> L.	Mor-Noy	l	Fresh	Gastroenteritis, Bloated Stomach	0.38	KS024
	<i>Tiliacora triandra</i> Diels	Ya-Narng	l	Fresh	Apthous Ulcers Difficult to pass Gastroenteritis Bloated Stomach	0.53	KS071
	<i>Tinospora crispa</i> (L.) Hook. f. & Thomson	Khue-Khao-Hor	s	Pickled	Cough	0.40	KS072
	Moraceae	<i>Artocarpus heterophyllus</i> Lam.	Mak-Mee	f	Boil	Low milk supply	0.58
<i>Morus alba</i> L.		Ton-Mone	l	Boil	Nourish the body	0.23	KS048
Muntingiaceae	<i>Muntingia calabura</i> L.	Ton-Ta-Kob	f	Fresh	Eyesight	0.35	KS049
Myrtaceae	<i>Psidium guajava</i> L.	Mak-See-Da	l	Boil	Vaginal discharge	0.63	KS060
	<i>Syzygium antisepticum</i> (Blume) Merr. & L.M.Perry	Kha-Mek	l	Boil	Acute Pancreatitis Gastroenteritis	0.63	KS067

Family	Scientific name	Lao name	Parts used	Preparation	Ailments treated	UV	Voucher No.
Pedaliaceae	<i>Sesamum indicum</i> L.	Nga-Dam	sd	Fresh	Make the bones attach quickly	0.40	KS061
Phyllanthaceae	<i>Flueggea virosa</i> (Roxb. ex Willd.) Royle	Kok-Kang-Pa	l	Boil	Viral Exanthem	0.50	KS034
	<i>Phyllanthus amarus</i> Schumach. & Thonn.	Tai-Bai-Khaow	w	Boil	Nourish the body	0.18	KS051
	<i>P. emblica</i> L.	Mak-Kham-Pom	f	Pickled, fresh	Cough	0.95	KS052
	<i>P. urinaria</i> L.	Tai-Bai-Daeng	w	Boil	Difficult to pass	0.25	KS057
Piperaceae	<i>Piper betle</i> L.	Phu	l	Fresh	Healthy teeth	0.63	KS058
Plumbaginaceae	<i>Plumbago indica</i> L.	Piy-Pee-Daeng	l, r	Boil	Gastroenteritis	0.13	KS059
Poaceae	<i>Centotheca lappacea</i> (L.) Desv.	Ya-Lee-Phae	w	Boil	Vaginal discharge	0.33	KS012
	<i>Chrysopogon aciculatus</i> (Retz.) Trin.	Ya-Khuak	w	Boil	Vaginal discharge	0.23	KS015
	<i>C. nardus</i> (L.) Rendle	Hua-See-Khai-Khg	l	Boil	Vaginal discharge	0.40	KS017
	<i>Imperata cylindrica</i> (L.) Rausch.	Ya-Kha	l	Boil	Vaginal discharge	0.30	KS037
Polygonaceae	<i>Persicaria odorata</i> (Lour.) Soják	Phuk-Pheo	l	Fresh	Diarrhea	0.18	KS055
Rhamnaceae	<i>Ziziphus attopensis</i> Pierre	Kam-Lung-Suea-Khong	s	Boil	Nourish the body	0.25	KS076
Rubiaceae	<i>Morinda coreia</i> Buch.-Ham.	Yor-Pa	f	Boil	Amenorrhea	0.20	KS046
	<i>Morinda citrifolia</i> L.	Yor	f	Boil	Gastroenteritis Amenorrhea	0.63	KS047
Rutaceae	<i>Citrus hystrix</i> DC.	Khee-Hoot	f	Boil, Fresh	Hair loss Cold	0.45	KS019
Scrophulariaceae	<i>Limnophila geoffrayi</i> Bonati.	Sa-Ngaeng-Na	w	Boil, Fresh	Hypertension	0.35	KS041
Simaroubaceae	<i>Eurycoma longifolia</i> Jack	Yik-Br-Thong	r	Pickled	Nourish the body	0.38	KS033
Smilacaceae	<i>Smilax glabra</i> Roxb.	Ya-Hua	r	Boil	Nourish the body	1.00	KS063
Solanaceae	<i>Nicotiana tabacum</i> L.	Ya-Soup	l	Smoking	Nourish the body	0.33	KS050
	<i>Solanum lasiocarpum</i> Dunal	Mak-Khaiy	f	Fresh	Nourish the body	0.30	KS064
	<i>Solanum lycopersicum</i> L.	Mak-Len	f	Fresh	Glowing Skin	0.38	KS065
Talinaceae	<i>Talinum paniculatum</i> (Jacq.) Gaertn.	Shom-Nok-Aen	r	Boil or pickled	Nourish the body	0.45	KS068
Zingiberaceae	<i>Curcuma longa</i> L.	Khee-Min-Xun	rh	Fresh	Gastroenteritis	0.45	KS010
	<i>C. rangued</i> Saensouk & Boonma	Wan-Jued	rh	Fresh, pickled	Nourish the body	0.38	KS011
	<i>C. zedoaria</i> (Christm.) Roscoe	Khee-Min-Khuen	rh	Fresh	Nourish the body	0.45	KS026
	<i>Keamferia parviflora</i> Wall. ex Baker	Khing-Dam	rh	Fresh	Nourish the body	0.73	KS039
	<i>Zingiber officinale</i> Roscoe	Khing	rh	Fresh	Bloated Stomach	0.60	KS074
	<i>Z. montanum</i> (J.Koenig) Link ex A.Dietr.	Wan-Fai	rh	Fresh or boil	Bloated Stomach Diabetes Cough	1.00	KS075

Notes b=bark, co= corm, f= fruit, fl=flowers, l=leaves, r=root, rh= rhizome, s= stem, sd=seed, w= whole plant

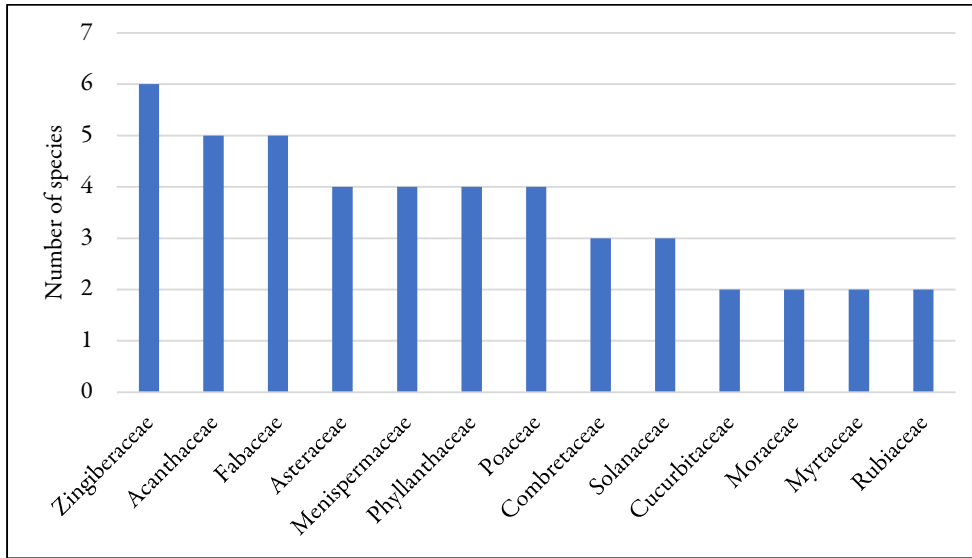


Figure 2. Number of medicinal plants used by plant family by Lao ethnic group that show 2 to 6 species

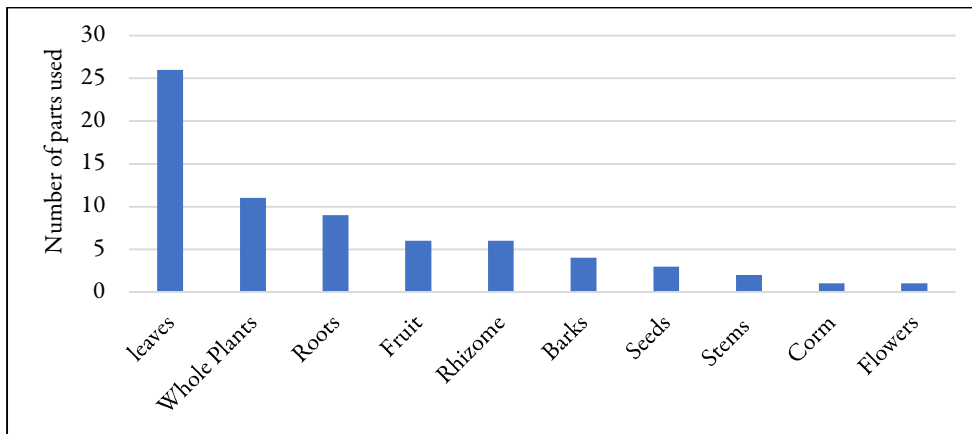


Figure 3. Parts used of medicinal plants by Lao ethnic group

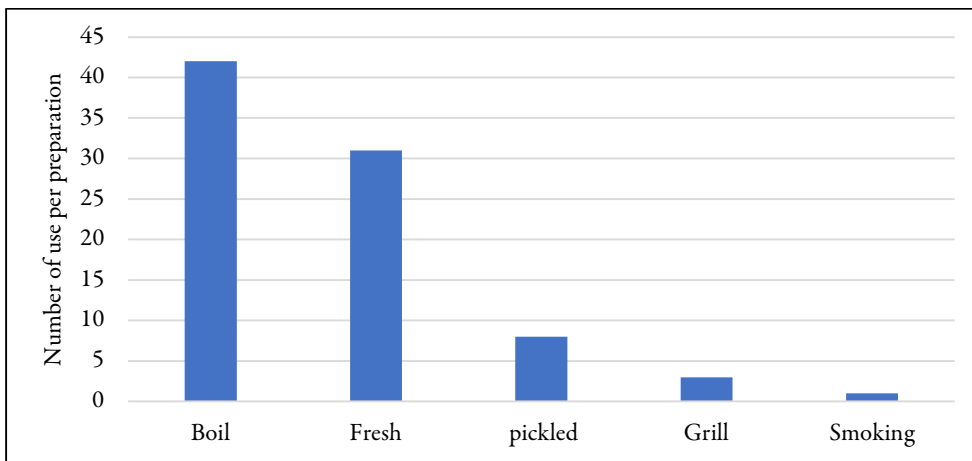


Figure 4. The Preparation of medicinal plants by Lao ethnic group

Use values

Plants that have a large number of practical applications showed an increase in reports of their usage. *Blumea balsamifera*, *Chromolaena odorata*, *Smilax glabra*, *Zingiber montanum*, *Phyllanthus emblica*, *Cucumis sativus*, *Dialium indum*, *Perilla frutescens*, *Sesbania grandiflora*, *Alocasia macrorrhizos*, *Kaempferia parviflora*, *Coccinia grandis*, and *Aloe vera* were among the most commonly used medicinal plants, with varying degrees of usage ranging from 1.00 to 0.68. The medicinal plants were employed to treat a range of health conditions, such as Aphthous Ulcers, Dengue fever, Fever, Viral Exanthem, Gastroenteritis, Bloating Stomach, Cough, Body nourishment, Postpartum recovery, Amenorrhea, Eyesight improvement, Crooked mouth, Glowing Skin, Toothache, and others (as indicated in Table 3, Figure 5, and Figure 8).

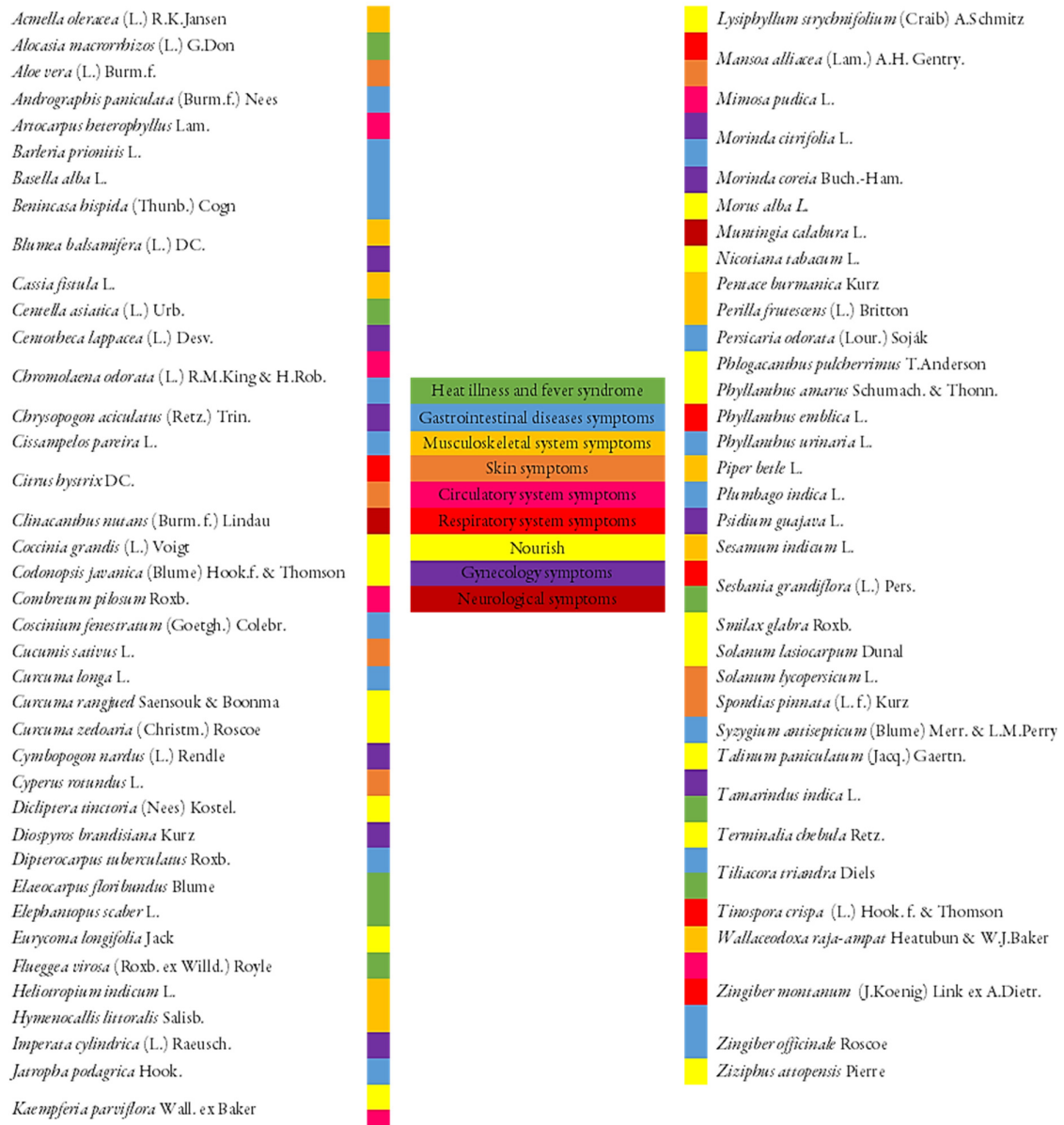


Figure 5. The use reports for the 76 medicinal plants used to treat symptoms

Conservation status and distribution

As per the evaluation criteria set forth by a search on the IUCN website are used to determine the conservation status. *Dipterocarpus tuberculatus* is designated as Near threatened (NT), signifying the highest risk of endangerment. Additionally, eleven species come under the category of least concern (LC), reflecting a lower danger level. The species mentioned are *Cyperus rotundus*, *Cassia fistula*, *Mimosa pudica*, *Tamarindus indica*, *Perilla frutescens*, *Litsea cubeba*, *Morus alba*, *Psidium guajava*, *Flueggea virosa*, *Phyllanthus emblica*, and *Limnophila geoffrayi*. There are seven species that are categorized as Data deficient (DD), namely *Pentace burmanica*, *Coscinium fenestratum*, *Curcuma longa*, *C. rangjued*, *C. zedoaria*, *Kaempferia parviflora*, and *Zingiber officinale* (Table 4). In addition, after comparing the distribution data from Plants of the World Online, it was found that out of the medicinal plants utilized by the Lao ethnic group, 46 plants are native, which accounts for 61% of the total. There are also 30 introduced plants, making up 38% of the total. The authors also assessed the conservation status of plant species in the survey area, dividing them into two categories: common species and rare species. It was found that 64 common species and 12 rare species were identified. The information provided in Table 4.

Table 4. Conservation status, distribution and source of medicinal plants by Lao ethnic group

Scientific name	Distribution (POWO)	Conservation status (IUCN)	Conservation status (By Authors)	Source of medicinal plants		
				c	w	m
<i>Andrographis paniculata</i> (Burm.f.) Wall. ex Nees	i		Cm	c		m
<i>Barleria prionitis</i> L.	n		Cm	c		m
<i>Clinacanthus nutans</i> (Burm. f.) Lindau	n		Cm	c		m
<i>Dicliptera tinctoria</i> (Nees) Kostel.	n		Cm	c		
<i>Phlogacanthus pulcherrimus</i> T.Anderson	n		Cm	c		m
<i>Hymenocallis littoralis</i> Salisb.	i		Cm	c		
<i>Spondias pinnata</i> (L. f.) Kurz	n		R		w	m
<i>Centella asiatica</i> (L.) Urb.	n		Cm		w	m
<i>Alocasia macrorrhizos</i> (L.) G.Don	i		Cm	c		m
<i>Wallaceodoxa raja-ampat</i> Heatubun & W.J.Baker	i		Cm	c		m
<i>Acmella oleracea</i> (L.) R.K.Jansen	n		Cm		w	m
<i>Blumea balsamifera</i> (L.) DC.	n		Cm	c	w	
<i>Chromolaena odorata</i> (L.) R.M.King & H.Rob.	i		Cm		w	
<i>Elephantopus scaber</i> L.	n		Cm		w	
<i>Basella alba</i> L.	n		Cm	c		m
<i>Mansoa alliacea</i> (Lam.) A.H. Gentry.	n		R	c		m
<i>Heliotropium indicum</i> L.	i		Cm		w	m
<i>Codonopsis javanica</i> (Blume) Hook.f. & Thomson	n		R		w	m
<i>Combretum pilosum</i> Roxb. ex G.Don	n		Cm		w	
<i>Terminalia chebula</i> Retz.	n		R		w	m
<i>Benincasa hispida</i> (Thunb.) Cogn	i		Cm	c		m
<i>Coccinia grandis</i> (L.) Voigt	n		Cm	c		m
<i>C. sativus</i> L.	i		Cm	c		m
<i>Cyperus rotundus</i> L.	n	LC	Cm		w	m
<i>Dipterocarpus tuberculatus</i> Roxb.	n	NT	Cm		w	
<i>Diospyros brandisiana</i> Kurz	n		R		w	m
<i>Elaeocarpus floribundus</i> Blume	n		Cm		w	
<i>Jatropha podagrica</i> Hook.	i		Cm	c		

Scientific name	Distribution (POWO)	Conservation status (IUCN)	Conservation status (By Authors)	Source of medicinal plants		
<i>Cassia fistula</i> L.	i	LC	Cm	c		m
<i>Lysiphyllum strychnifolium</i> (Craib) A.Schmitz	n		R		w	m
<i>Mimosa pudica</i> L.	i	LC	Cm		w	
<i>Sesbania grandiflora</i> (L.) Pers.	i		Cm	c		m
<i>Tamarindus indica</i> L.	i	LC	Cm	c		m
<i>Perilla frutescens</i> (L.) Britton	n	LC	Cm	c		m
<i>Litsea cubeba</i> Pers.	n	LC	R		w	m
<i>Aloe vera</i> (L.) Burm.f.	i		Cm	c		m
<i>Lagerstroemia speciosa</i> (L.) Pers.	n		Cm	c	w	
<i>Pentace burmanica</i> Kurz	n	DD	R		w	m
<i>Coscinium fenestratum</i> (Goetgh.) Colebr.	n	DD	R		w	m
<i>Cissampelos pareira</i> L.	n		Cm	c		m
<i>Tiliacora triandra</i> Diels	n		Cm	c	w	m
<i>Timospora crispa</i> (L.) Hook. f. & Thomson	n		Cm	c		m
<i>Artocarpus heterophyllus</i> Lam.	i		Cm	c		m
<i>Morus alba</i> L.	i	LC	Cm	c		m
<i>Muntingia calabura</i> L.	i		Cm	c		
<i>Psidium guajava</i> L.	i	LC	Cm	c		m
<i>Syzygium antisepticum</i> (Blume) Merr. & L.M.Perry	n		Cm		w	m
<i>Sesamum indicum</i> L.	i		Cm	c		m
<i>Flueggea virosa</i> (Roxb. ex Willd.) Royle	n	LC	Cm		w	
<i>Phyllanthus amarus</i> Schumach. & Thonn.	i		Cm		w	
<i>P. emblica</i> L.	n	LC	Cm		w	m
<i>P. urinaria</i> L.	n		Cm		w	
<i>Piper betle</i> L.	n		Cm	c		m
<i>Plumbago indica</i> L.	n		Cm	c		m
<i>Centotheca lappacea</i> (L.) Desv.	n		Cm		w	m
<i>Chrysopogon aciculatus</i> (Retz.) Trin.	n		Cm	c	w	m
<i>C. nardus</i> (L.) Rendle	i		Cm	c		m
<i>Imperata cylindrica</i> (L.) Raeusch.	i		Cm		w	m
<i>Persicaria odorata</i> (Lour.) Soják	n		Cm	c		m
<i>Ziziphus attopensis</i> Pierre	n		Cm		w	m
<i>Morinda coreia</i> Buch. -Ham.	n		Cm		w	m
<i>Morinda citrifolia</i> L.	n		Cm	c		m
<i>Citrus hystrix</i> DC.	i		Cm	c		m
<i>Limnophila geoffrayi</i> Bonati.	n	LC	Cm	c	w	m
<i>Eurycoma longifolia</i> Jack	n		R		w	m
<i>Smilax glabra</i> Roxb.	n		R		w	m
<i>Nicotiana tabacum</i> L.	i		Cm	c		m
<i>Sonlanum lasiocarpum</i> Dunal	n		Cm	c		m
<i>S. lycopersicum</i> L.	i		Cm		w	m
<i>Talinum paniculatum</i> (Jacq.) Gaertn.	i		R		w	m
<i>Curcuma longa</i> L.	i	DD	Cm	c		m
<i>C. rangjued</i> Saensouk & Boonma	i	DD	Cm	c		m

Scientific name	Distribution (POWO)	Conservation status (IUCN)	Conservation status (By Authors)	Source of medicinal plants		
				c		m
<i>C. zedoaria</i> (Christm.) Roscoe	i	DD	Cm	c		m
<i>Keamferia parviflora</i> Wall. ex Baker	n	DD	Cm	c		m
<i>Zingiber officinale</i> Roscoe	i	DD	Cm	c		m
<i>Z. montanum</i> (J.Koenig) Link ex A.Dietr.	n		Cm	c		m

*Notes c= Cultivated plants, Cm = Common, DD= Data deficient i= Introduced, LC = Least concern, m = Market n= Native, NT= Near threatened, R = Rare, w= Wild plants

Informant agreement ratio

Table 5 presents 8 Informant Agreement Ratio (IAR) and Figure 5 for different symptom categories. Out of all the categories, the respiratory system symptoms category showed the highest level of agreement, with an IAR value of 1.00. Despite a limited number of usage reports and plant species, this specific group demonstrated a significant level of agreement, as seen by the high IAR values. Furthermore, there are other categories of use, including circulatory system symptoms (101 reports of use, involving 5 species), skin symptoms (128 reports of use, involving 6 species), gastrointestinal diseases symptoms (372 reports of use, involving 25 species), nourish the body (338 reports of use, involving 20 species), musculoskeletal system symptoms (179 reports of use, involving 11 species), and gynaecology symptoms (108 reports of use, involving 7 species). All the results showed a significant agreement, with IAR values exceeding 0.94. These studies collectively demonstrate a significant degree of agreement.

Table 5. Informant Agreement Ratio by Lao ethnic group in Central Laos

Medical category	Number of use-report (N _{ur})	Number of species (N _t)	IAR
Gastrointestinal diseases symptoms	372	25	0.94
Nourish the body	338	20	0.94
Musculoskeletal system symptoms	179	11	0.94
Heat illness and fever syndrome	190	8	0.96
Skin symptoms	128	6	0.96
Gynecology symptoms	108	7	0.94
Circulatory system symptoms	101	5	0.96
Respiratory system symptoms	13	1	1.00

Fidelity level

Out of the 65 species seen, a fidelity level of 100% was recorded, showing the utmost level of loyalty. The species mentioned in Table 6 are *Tamarindus indica* L. (76%), which is regularly used to treat Aphthous Ulcers, *Mansoa alliacea* (Lam.) A.H. Gentry (75%), commonly employed for Insect bites, *Cissampelos pareira* L. (74%), frequently applied for Gastroenteritis, and *Sesbania grandiflora* (L.) Pers. (74%), commonly utilized to address Aphthous Ulcers.

Plant species showing a fidelity level of 100% (as indicated in Table 6) should undergo thorough scrutiny to assess their efficacy, safety, and phytochemical composition. The regular and persistent utilization of these plants implies a robust potential for therapeutic purposes, which is indicative of substantial biological efficacy.

Table 6. Mostly used medicinal plant species for medical categories based on the fidelity level

Categories symptoms	Disorder and treatments	Species	%FL
Heat illness and fever syndrome	Apthous Ulcers	<i>Centella asiatica</i> (L.) Urb.	100%
		<i>Sesbania grandiflora</i> (L.) Pers.	74%
		<i>Tamarindus indica</i> L.	76%
		<i>Tiliacora triandra</i> Diels	52%
	Dengue fever	<i>Alocasia macrorrhizos</i> (L.) G.Don	100%
	Fever	<i>Elaeocarpus floribundus</i> Blume	100%
	Viral Exanthem	<i>Flueggea virosa</i> (Roxb. ex Willd.) Royle	100%
<i>Elephantopus scaber</i> Linn.		100%	
Gastrointestinal diseases symptoms	Facilitate easy excretion	<i>Phyllanthus urinaria</i> L.	100%
		<i>Tiliacora triandra</i> Diels	11%
	Gastroenteritis	<i>Cissampelos pareira</i> L.	74%
		<i>Coscinium fenestratum</i> (Goetgh.) Colebr.	100%
		<i>Curcuma longa</i> L.	100%
		<i>Morinda citrifolia</i> L.	45%
		<i>Plumbago indica</i> L.	100%
		<i>Syzygium antisepticum</i> (Blume) Merr. & L.M.Perry	48%
		<i>Tiliacora triandra</i> Diels	30%
	Bloated Stomach	<i>Cissampelos pareira</i> L.	26%
		<i>Dipterocarpus tuberculatus</i> Roxb.	100%
		<i>Litsea cubeba</i> Pers.	100%
		<i>Tiliacora triandra</i> Diels	8%
		<i>Zingiber montanum</i> (J.Koenig) Link ex A.Dietr.	39%
		<i>Zingiber officinale</i> Roscoe	100%
	Acute Pancreatitis	<i>Jatropha podagrica</i> Hook.	100%
		<i>Syzygium antisepticum</i> (Blume) Merr. & L.M.Perry	52%
	Enteritis	<i>Basella alba</i> L.	100%
	Hiccups	<i>Benincasa hispida</i> (Thunb.) Cogn	100%
	Diarrhea	<i>Chromolaena odorata</i> (L.) R.M.King & H.Rob.	15%
		<i>Persicaria odorata</i> (Lour.) Soják	100%
	Liver Cancer	<i>Barleria prionitis</i> L.	100%
Diuretic	<i>Andrographis paniculata</i> (Burm.f.) Nees	100%	
Eliminate parasitic worms.	<i>Chromolaena odorata</i> (L.) R.M.King & H.Rob.	23%	
Musculoskeletal system symptoms	Make the bones attach quickly	<i>Blumea balsamifera</i> (L.) DC.	50%
		<i>Perilla frutescens</i> (L.) Britton	100%
		<i>Sesamum indicum</i> L.	100%
	Healthy teeth	<i>Cassia fistula</i> L.	100%
		<i>Pentace burmanica</i> Kurz	100%
		<i>Piper betle</i> L.	100%

Categories symptoms	Disorder and treatments	Species	%FL
		<i>Wallaceodoxa raja-ampat</i> Heatubun & W.J.Baker	100%
	Toothache	<i>Acmella oleracea</i> (L.) R.K.Jansen	100%
	Joint pain	<i>Hymenocallis littoralis</i> Salisb.	100%
	muscle aches	<i>Heliotropium indicum</i> L.	100%
Skin symptoms	Hair loss	<i>Citrus hystrix</i> DC.	70%
	Wound repair	<i>Spondias pinnata</i> (L. f.) Kurz	100%
	Glowing Skin	<i>Cucumis sativus</i> L.	100%
		<i>Solanum lycopersicum</i> L.	100%
	Insect bites	<i>Aloe vera</i> (L.) Burm.f.	100%
		<i>Mansoa alliacea</i> (Lam.) A.H. Gentry.	75%
Blisters	<i>Cyperus rotundus</i> L.	100%	
Circulatory system symptoms	Hypertension	<i>Limnophila geoffrayi</i> Bonati.	
		<i>Kaempferia parviflora</i> Wall. ex Baker	100%
	Diabetes	<i>Zingiber montanum</i> (J.Koenig) Link ex A.Dietr.	39%
	Stop the bleed	<i>Chromolaena odorata</i> (L.) R.M.King & H.Rob.	39%
		<i>Combretum pilosum</i> Roxb.	62%
	Nourish blood	<i>Mimosa pudica</i> L.	100%
Low milk supply	<i>Artocarpus heterophyllus</i> Lam.	100%	
Respiratory system symptoms	Cold	<i>Citrus hystrix</i> DC.	100%
	Cough	<i>Lagerstroemia speciosa</i> (L.) Pers.	30%
		<i>Phyllanthus emblica</i> L.	100%
		<i>Mansoa alliacea</i> (Lam.) A.H. Gentry.	100%
		<i>Sesbania grandiflora</i> (L.) Pers.	25%
		<i>Tinospora crispa</i> (L.) Hook. f. & Thomson	26%
		<i>Zingiber montanum</i> (J.Koenig) Link ex A.Dietr.	21%
Nourish	Nourish the body	<i>Biancaea sappan</i> (L.) Tod.	21%
		<i>Coccinia grandis</i> (L.) Voigt	100%
		<i>Codonopsis javanica</i> (Blume) Hook.f. & Thomson	100%
		<i>Curcuma rangjued</i> Saensouk & Boonma	100%
		<i>Curcuma zedoaria</i> (Christm.) Roscoe	100%
		<i>Dicliptera tinctoria</i> (Nees) Kostel.	100%
		<i>Eurycoma longifolia</i> Jack	100%
		<i>Talinum paniculatum</i> (Jacq.) Gaertn.	100%
		<i>Kaempferia parviflora</i> Wall. ex Baker	59%
		<i>Morus alba</i> L.	100%
		<i>Nicotiana tabacum</i> L.	100%
		<i>Lysiphyllum strychnifolium</i> (Craib) A.Schmitz	100%
<i>Phlogacanthus pulcherrimus</i> T.Anderson	100%		

Categories symptoms	Disorder and treatments	Species	%FL
		<i>Phyllanthus amarus</i> Schumach. & Thonn.	100%
		<i>Smilax glabra</i> Roxb.	100%
		<i>Solanum lasiocarpum</i> Dunal	100%
		<i>Terminalia chebula</i> Retz.	100%
		<i>Ziziphus attopensis</i> Pierre	100%
Gynecology symptoms	Postpartum recovery	<i>Blumea balsamifera</i> (L.) DC.	50%
		<i>Diospyros brandisiana</i> Kurz	100%
		<i>Tamarindus indica</i> L.	24%
	Vaginal discharge	<i>Centotheca lappacea</i> (L.) Desv.	100%
		<i>Chrysopogon aciculatus</i> (Retz.) Trin.	100%
		<i>Cymbopogon nardus</i> (L.) Rendle	100%
		<i>Imperata cylindrica</i> (L.) Raeusch.	100%
	Amenorrhea	<i>Psidium guajava</i> L.	100%
		<i>Morinda coreia</i> Buch.-Ham.	100%
Neurological symptoms	Eyesight	<i>Muntingia calabura</i> L.	100%
	Crooked mouth	<i>Clinacanthus nutans</i> (Burm. f.) Lindau	100%

Jaccard's Similarity Index

Figure 6 and Table 4 show that most of medicinal plants (61 species, constituting 43%) were acquired from the market. 45 species (32%) were attributed to cultivated plants, whereas wild plants accounted for 36 species (25%). Typically, women regularly attend the market to sell their medicinal plants, which makes them familiar with the plants available, especially those that are grown.

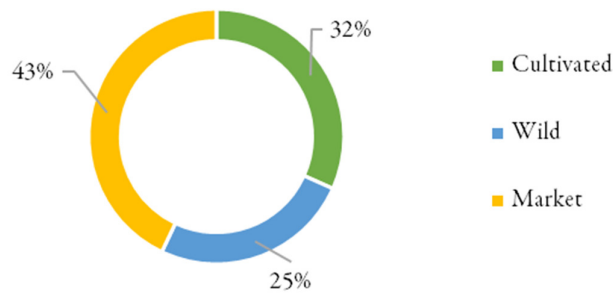


Figure 6. The plants in three areas used by Lao ethnic group in Central Laos

Table 7. Jaccard's Similarity Index of Areas in the sample of plants used in Lao ethnic group in Central Laos

Plant type	Wild plants	Market
Cultivated plants	0.0581	0.2690
Wild plants	-	0.2049

The similarities throughout plants in three specific domains (as depicted in Figure 7 and Table 7). The highest similarity index (0.2690) was found between farmed and market-sourced plants, with a total of 39 species shared between these two categories. This phenomenon arises from the commercialization of numerous

grown medical plants, leading to a diverse array of therapeutic plant species being readily accessible for purchase in the market.

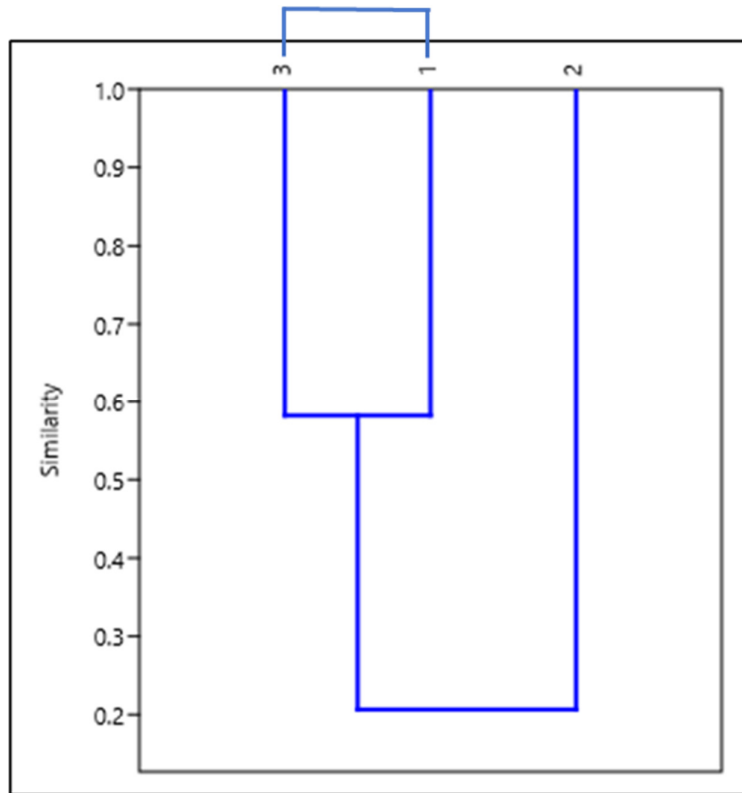


Figure 7. Unweighted Pair Group Method with Arithmetic cluster analysis of edible plant species used in the Lao ethnic group in Central Laos, based on Jaccard's Similarity Index. 1: Cultivated plants, 2: Market, 3: Wild plants

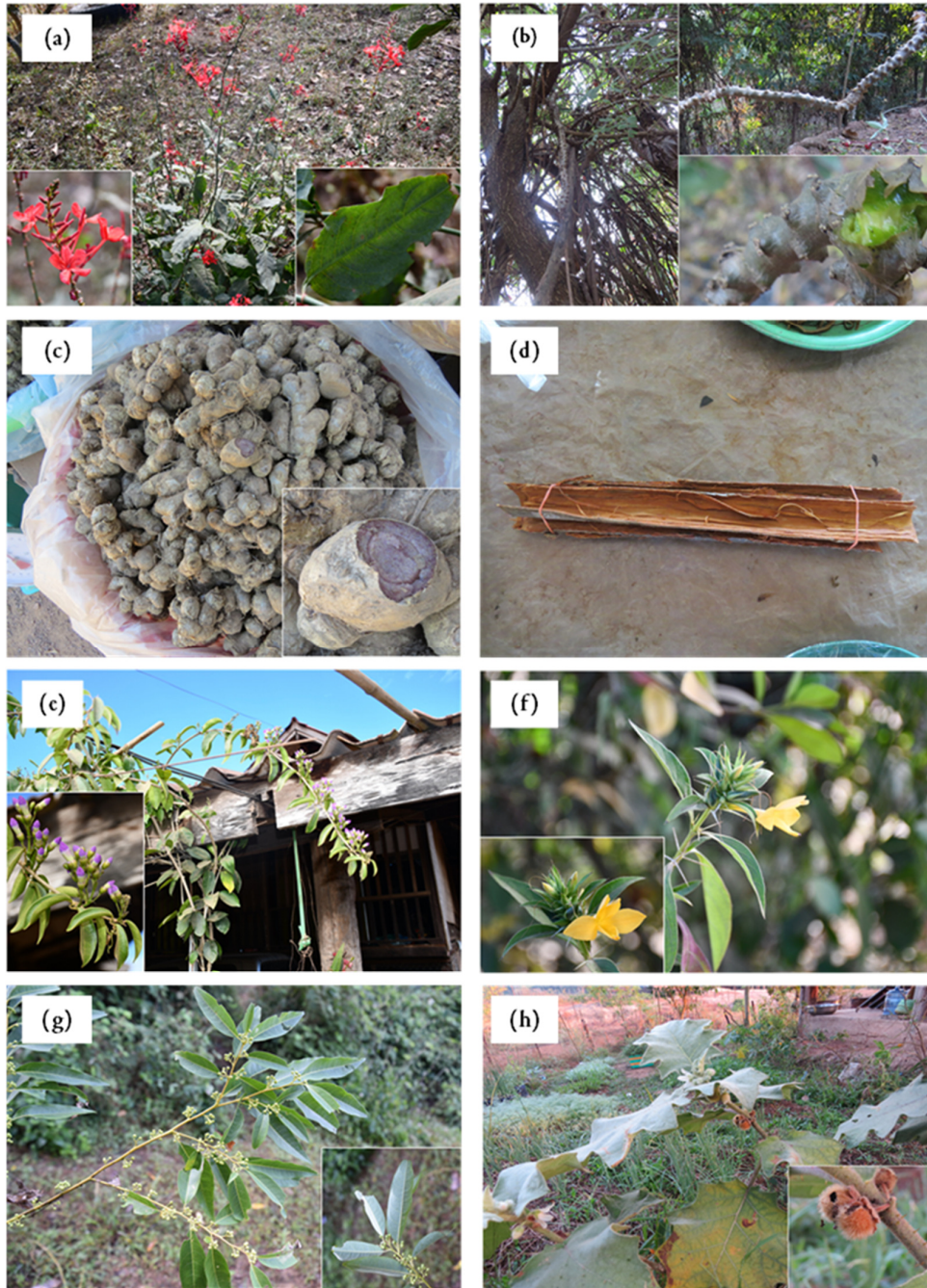


Figure 8. Medicinal plants use by Lao ethnic group both cultivated and wild medicinal plants, which are available for purchase in local markets: (a) *Plumbago indica*; (b) *Tinospora crispa*; (c) *Kaemferia parviflora*; (d) *Pentace burmanica*; (e) *Mansoa alliacea*; (f) *Barleria prionitis*; (g) *Litsea cubeba*; (h) *Solanum lasiocarpum*

Comparing the medicinal plants knowledge

Through the utilization of chi-square, t-tests, and analysis of variance, we conducted an investigation into the understanding of medicinal plants among a group of 18 males and 22 females. Our findings indicate that there were no significant differences in their knowledge. Essentially, the knowledge regarding medicinal plants showed a somewhat same level of consistency across both females and males. In addition, the dataset was subjected to linear regression analysis to investigate the relationship between the informants' age and the number of plants they knew. The analysis showed a statistically significant positive link ($R^2=0.678$, $P < 0.05$) (Figure 9).

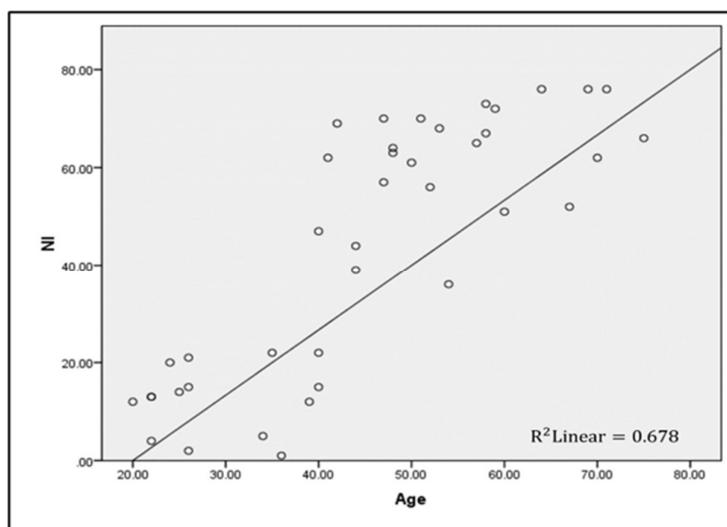


Figure 9. The relationship between the age of informants and the number of medicinal plants known by the informants. ($R^2=0.678$, $P < 0.05$)

Discussion

The ethnobotanical study of medicinal plants utilized by the Lao ethnic group provides a thorough catalog of 76 species, encompassing 68 genera and 43 families. The abundance of plant families is apparent, with leaves being the predominant component, contributing to the utilization of 25 species, a conclusion corroborated by earlier research (Kantastila *et al.*, 2017; Panyadee *et al.*, 2019). Boiling has been identified as the predominant method for preparing medicine, which aligns with prior research findings (Khuankaew *et al.*, 2014; Panyadee *et al.*, 2019). These reveal the complex knowledge and customs deeply rooted in the community's traditional medicine.

Plant diversity and use

The diversity among families and the prevalence of certain species, such as *Blumea balsamifera* and *Chromolaena odorata*, reflects their significance in addressing a wide array of health issues, ranging from aphthous ulcers to dengue fever and gastrointestinal problems.

Lao ethnic groups have been the focus of numerous ethnobotanical studies, as evidenced by research conducted by (Delang *et al.*, 2007; Soejarto *et al.*, 2012; De Boer *et al.*, 2012; Sydara *et al.*, 2014; Elkington *et al.*, 2014; Dubost *et al.*, 2019). Furthermore, the use of certain plants extends beyond Lao ethnic groups to include other ethnic communities such as the Hmong (Dubost *et al.*, 2019), and Kry (Lamxay *et al.*, 2011), Brou, Saek, and more.

The use of many medicinal plant species has also been reported in neighboring countries. For instance, *Zingiber montanum* is used to treat diarrhea (Ragsasilp *et al.*, 2022), *Citrus hystrix* is employed for addressing hair loss (Gerdprasert *et al.*, 2008), *Phyllanthus emblica* is used to alleviate cough (Booncharoen *et al.*, 2022), and *Smilax glabra* is used to nourish the body (by Li *et al.*, 2023), among others.

In this study, two plant species are introduced: *Solanum lasiocarpum*, which is used for nourishing the body, and *Morinda coreia*, employed in treating amenorrhea. This marks the first documented use of these plants for medicinal purposes.

Conservation and distribution insights

The assessment of the conservation status, which involves determining the vulnerability of species and classifying them as either endangered or of low concern, highlights the need of safeguarding specific plant species. Moreover, comprehending the ratio of indigenous vs non-native species assists in identifying the adjustment and assimilation of different plants within the nearby ecosystem. The authors conducted a specific assessment of plant species in the survey area, categorizing them into common and rare species. The findings indicate the presence of 64 common species and 12 rare species, providing valuable insights for local conservation efforts.

Overall, the conclusions emphasize the importance of targeted conservation strategies, particularly for species designated as Near Threatened and those with limited data. The inclusion of cultural considerations, such as the use of medicinal plants by the Lao ethnic group, underscores the need for a holistic approach to biodiversity conservation.

Informant consensus and fidelity

The high Informant Agreement Ratios (IAR) in several health categories and the fidelity level of select species at 100% indicate a strong consensus within the community regarding the efficacy of these medicinal plants for certain health conditions. Further inquiry is warranted on the medicinal potential and phytochemical makeup of these plants, given their consistent and regular use.

Market sources and similarities

The study sheds light on the sources of medicinal plants, with a significant number obtained from markets. The similarity between cultivated and market-sourced plants emphasizes the commercial availability of cultivated species in local markets.

Knowledge and demographic insights

The results suggest that there is a highly consistent understanding of medicinal plants among both males and females, with no notable differences detected between the two genders. Furthermore, the correlation between the informants' age and the number of plants they are familiar with implies that knowledge increases as individuals get more experience and time passes.

Conclusions

This comprehensive study not only aims to record the abundant cultural legacy of traditional medicine within the Lao ethnic group, but also underscores the imperative of conservation initiatives to protect at-risk species. The strong agreement on the use of plants and their effectiveness in treating different health problems highlights the possibility for additional investigation and potential utilization in contemporary medicine. The presence of specific cultivated species in local markets and the gender-neutral transfer of information indicate the cultural importance and widespread awareness of these medicinal plants among the population.

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 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.

Acknowledgements

This research project was financially supported by Mahasarakham University. We fully acknowledge the key informants of Pakkading District, Bolikhamxay Province, Laos for sharing their local knowledge on the use of plants. We are extremely grateful to Walai Rukhavej Botanical Research Institute, Mahasarakham University for allowing us to use their facilities during the field work. Without their contribution, this study would have been impossible.

Conflict of Interests

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

References

- Booncharoen P, Thepnorat P, Akarasereenont P (2022). The medicinal uses of *Phyllanthus emblica* L. (Indian gooseberry): An evidence-based. Siriraj Medical Bulletin 15(3):146-154. <https://doi.org/10.33192/smb.v15i3.256321>
- De Boer, H, Lamxay V (2009). Plants used during pregnancy, childbirth and postpartum healthcare in Lao PDR: A comparative study of the Brou, Sack and Kry ethnic groups. Journal of Ethnobiology and Ethnomedicine 5:1-10. <https://doi.org/10.1186/1746-4269-5-25>
- Delang CO (2007). The role of medicinal plants in the provision of health care in Lao PDR. Journal of Medicinal Plants Research 1(3):5-59.
- Dubost J M, Phakeovilay C, Her C, Bochaton A, Elliott E, Deharo E, Bouamanivongand S, Bourdy G (2019). Hmong herbal medicine and herbalists in Lao PDR: pharmacopeia and knowledge transmission. Journal of Ethnobiology and Ethnomedicine 15:1-15. <https://doi.org/10.1186/s13002-019-0307-2>
- Elkington BG, Phiapalath P, Sydara K, Somsamouth V, Goodsmith NI, Soejarto DD (2014). Assessment of the importance of medicinal plants among communities around Khiat Ngong of southern Laos. Journal of Environmental Biology 35(4):607.
- Gerdprasert OG, Laupattarakasem P, Tankitiwat UT, Jareonsuppaperch EO, Padungchaichot P (2008). Effect of crude extracts from Thai herbs on growth of cultured human hair follicle: A pilot study. Journal of Medicine and Health Sciences 15(1).
- Friedman J, Yaniv Z, Dafni A, Palewitch D (1986). A preliminary classification of the healing potential of medicinal plants, based on a rational analysis of an ethnopharmacological field survey among Bedouins in the Negev desert, Israel. Journal of Ethnopharmacology 16:275-287. [https://doi.org/10.1016/0378-8741\(86\)90094-2](https://doi.org/10.1016/0378-8741(86)90094-2)
- Forest Inventory and Planning Division, Lao PDR (2023). Retrieved 2023 March 13 from: <http://dof.maf.gov.la>

- Hammer Ø, Harper DAT, Ryan PD (2001). PAST: Paleontological statistics software package for education and data analysis. *Palaentologia Electronica* 4:1-9.
- IUCN (2023). The International Union for Conservation of Nature. The IUCN red List of threatened species. Version 2022-2. Retrieved 2023 March 16 from: <https://www.iucnredlist.org/>
- Kantasrila R, Pongamornkul W, Panyadee P, Inta A (2017). Ethnobotany of medicinal plants used by Karen, Tak province in Thailand. *Thai Journal of Botany* 193-216.
- Khuankaew S, Srithi K, Tiansawat P, Jampeetong A, Inta A, Wangpakapattanawong P (2014). Ethnobotanical study of medicinal plants used by Tai Yai in Northern Thailand. *Journal of Ethnopharmacology* 151(2):829-838. <https://doi.org/10.1016/j.jep.2013.11.033>
- Lamxay V, de Boer H J, Björk L (2011). Traditions and plant use during pregnancy, childbirth and postpartum recovery by the Kry ethnic group in Lao PDR. *Journal of Ethnobiology and Ethnomedicine* 7:1-16. <https://doi.org/10.1186/1746-4269-7-14>
- Lao Statistics Bureau (2005). Results of Population and Housing Census. Retrieved 2022 March 3 from: <https://data.laos.opendevelopmentmekong.net/en/dataset/iv-2015>
- Li J, Zhang Y, Jin W, Wang Y, Yang L, Zhang Z, Yan Z (2023). Preparation and characterization of zein–lecithin–total flavonoids from *Smilax glabra* complex nanoparticles and the study of their antioxidant activity on HepG2 cells. *Food Chemistry X* 17:100579 <https://doi.org/10.1016/j.fochx.2023.100579>
- Minority Rights Group (2018). World Directory of Minorities and Indigenous Peoples: Laos. Retrieved 2022 July 3 from: <https://www.refworld.org/docid/49749cf4b.html>
- Panyadee P, Balslev H, Wangpakapattanawong P, Inta A (2019). Medicinal plants in homegardens of four ethnic groups in Thailand. *Journal of Ethnopharmacology* 239:111927. <https://doi.org/10.1016/j.jep.2019.111927>
- Phatlamphu N, Saensouk S, Saensouk P, Jungsongduang A (2021). Ethnobotany of edible plants in Muang District, Kalasin Province, Thailand. *Biodiversitas* 22:5425-5431. <https://doi.org/10.13057/biodiv/d221226>
- Phillips O, Gentry AH, Reynel C, Wilkin P, Galvez-Durand BC (1994). Quantitative ethnobotany and Amazonian conservation. *Conservation Biology* 8:225-248. <http://dx.doi.org/10.1046/j.1523-1739.1994.08010225.x>
- Pottier R (1971). Le végétal dans la pharmacopée traditionnelle lao, *Bulletin de la Société Botanique de France* 118:263-273. <https://doi.org/10.1080/00378941.1971.10838897>
- POWO (2023). Plants of the World Online. Retrieved 2023 March 16 from: <https://powo.science.kew.org/>
- Ragsasilp A, Saensouk P, Pholhiamhan R, Saensouk S (2022). Ethnobotany of Zingiberaceae for the Phu Thai Ethnic Group in Nakhon Phanom Province, Thailand. *Engineering Access* 8(2):172-178.
- Ragsasilp A, Saensouk P, and Saensouk, S (2022). Ginger family from Bueng Kan Province, Thailand: Diversity, conservation status, and traditional uses. *Biodiversitas Journal of Biological Diversity* 23(5). <https://doi.org/10.13057/biodiv/d230556>
- Saensouk P, and Saensouk S (2021). Diversity, traditional uses and conservation status of Zingiberaceae in Udorn Thani Province, Thailand. *Biodiversitas Journal of Biological Diversity* 22(8). <http://dx.doi.org/10.13057/biodiv/d220801>
- Soejarto DD, Gyllenhaal C, Kadushin MR, Southavong B, Sydara K, Bouamanivong S, Waller DP (2012). An ethnobotanical survey of medicinal plants of Laos toward the discovery of bioactive compounds as potential candidates for pharmaceutical development. *Pharmaceutical Biology* 50(1):42-60. <https://doi.org/10.3109/13880209.2011.619700>
- Sydara K, Xayvue M, Souliya O, Elkington BG, Soejarto DD (2014). Inventory of medicinal plants of the Lao People's Democratic Republic: A mini review. *Journal of Medicinal Plants Research* 8(43):1262-1274. <http://dx.doi.org/10.13057/biodiv/d220801>
- Teklehaymanot T (2009). Ethnobotanical study of knowledge and medicinal plants use by the people in Dek Island in Ethiopia. *Journal of Ethnopharmacology* 124(1):69-78. <https://doi.org/10.1016/j.jep.2009.04.005>
- The World bank (2014). Poverty profile in Lao PDR, Poverty report for the Lao consumption and expenditure survey 2012-2013, Vientiane, Ministry of Planning and Investment and World Bank. Retrieved 2021 March 11 from: <https://documents1.worldbank.org/curated/en/868521467998508506/pdf/Poverty-profile-in-Lao-PDR-poverty-report-for-the-Lao-consumption-and-expenditure-survey-2012-2013.pdf>

Trotter RT, Logan MH (2019). Informants' consensus: A new approach for identifying potentially effective medicinal plants. In: Etkin NL (Ed). *Plants in Indigenous Medicine and Diet*. Redgrave Publishing, New York, Bedford Hill. <https://doi.org/10.4324/9781315060385>

Vidal J (1958). La thérapeutique par les plantes au Laos. *Journal d'Agriculture Tropicale et de Botanique Appliquée* 5:601-616.



The journal offers free, immediate, and unrestricted access to peer-reviewed research and scholarly work. Users are allowed to read, download, copy, distribute, print, search, or link to the full texts of the articles, or use them for any other lawful purpose, without asking prior permission from the publisher or the author.



License - Articles published in *Notulae Botanicae Horti Agrobotanici Cluj-Napoca* are Open-Access, distributed under the terms and conditions of the Creative Commons Attribution (CC BY 4.0) License.

© Articles by the authors; Licensee UASVM and SHST, Cluj-Napoca, Romania. The journal allows the author(s) to hold the copyright/to retain publishing rights without restriction.

Notes:

- **Material disclaimer:** The authors are fully responsible for their work and they hold sole responsibility for the articles published in the journal.
- **Maps and affiliations:** The publisher stay neutral with regard to jurisdictional claims in published maps and institutional affiliations.
- **Responsibilities:** The editors, editorial board and publisher do not assume any responsibility for the article's contents and for the authors' views expressed in their contributions. The statements and opinions published represent the views of the authors or persons to whom they are credited. Publication of research information does not constitute a recommendation or endorsement of products involved.