



Women's wellness in the mountains: An exploration of medicinal plants among tibeto-burman groups in Thailand

Angkhana Inta^{a,*}, Jatupol Kampuansai^a, Wibhu Kutanan^b, Metawee Srikumool^c, Wittaya Pongamornkul^d, Prachaya Srisanga^d, Prateep Panyadee^d

^a Department of Biology, Faculty of Science, Chiang Mai University, Chiang Mai, 50200, Thailand

^b Faculty of Science, Naresuan University, Phitsanulok, Thailand

^c Department of Biochemistry, Faculty of Medical Science, Naresuan University, Phitsanulok, Thailand

^d Queen Sirikit Botanic Garden, The Botanical Garden Organization, Mae Rim, Chiang Mai 50180, Thailand

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ABSTRACT

Ethnopharmacological relevance: This study offers valuable insight into the traditional healing practices of women's healthcare within four Tibeto-Burman groups. By focusing on women's wellness, the research sheds light on the often-neglected yet significant contributions made by women in the field of traditional medicine.

Aims of the study: The study seeks to address the gap of studies on the ethnobotany of women healthcare of the Tibeto-Burman groups in Thailand and to analyse the factors that could affect the diversity of ethnobotanical knowledge.

Materials and methods: The study compiled data from 15 group-informants residing in 12 different villages. The information gathering process involved a combination of free-listing, semi-structured interviews, group discussion, and the walk-to-the-wood method. To analyze the data, the researchers used various methods such as use-reports, Relative Frequency of Citation (RFC), Relative Importance Index (RI), and Cluster analysis.

Results: This study identified 200 plant species used in traditional women's healthcare practices, with leaves being the most frequently used part. Drinking was the most common method for internal use, while bathing and steam were the most emphasized for external use. *Blumea balsamifera* and *Buddleja asiatica* had high RI and RFC. Cluster analysis revealed that group-informants were divided by ethnicity and geographical location.

Conclusion: This study contributes to the understanding of traditional healthcare practices among Tibeto-Burman groups in Thailand, with a particular focus on women's wellness. The results provide insight into the ethnobotanical knowledge of these communities and highlight the important role played by women in traditional medicine. The study underscores the need for continued research in this field to preserve and utilize this valuable knowledge.

1. Introduction

Medicinal plants have been integral to indigenous communities worldwide for centuries, used for maintaining health and treating various ailments [1], including those specific to women's health. In many cultures, women's health plays a critical role in ensuring

* Corresponding author.

E-mail address: angkhana.inta@cmu.ac.th (A. Inta).

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sustainable development and improving families' quality of life [2]. Medicinal plants usage for women's health is often based on generations of experience and handed down through traditional knowledge systems. This continued use of medicinal plants for women's health underscores the significance of these practices in maintaining cultural and community wellbeing, especially in instances when other effective healthcare options are not readily available to the population [3].

Despite modern medicine's advances, traditional knowledge of women's healthcare remains relevant. Numerous studies around the world focus on the subject of medicinal plants and women's health [e.g. Refs. [3–6]]. Furthermore, traditional women's healthcare practices often incorporate the use of medicinal plants to support and complement modern medical practices. Culturally competent care is essential in promoting patient satisfaction and health outcomes [7], especially for women in rural or remote areas with limited access to modern healthcare facilities. Thus, preserving and documenting traditional knowledge of women's healthcare is vital for maintaining the health and well-being of communities, as well as for supporting and enhancing modern medical practices.

Southeast Asia and surrounding countries, have a rich tradition of using medicinal plants for women's healthcare, with nearly 2000 different plant species reported to be used in over 5000 combinations [8]. This vast diversity highlights the potential for discovering new drugs. Numerous ethnobotanical studies in Thailand documented the use of medicinal plants in women's healthcare [e.g. Refs. [9–11]]. However, studies specifically focused on this topic are scarce.

Previous research on Hmong people have documented traditional knowledge of 79 medicinal plants used for women's healthcare [11]. This wealth of knowledge highlights the importance of medicinal plants in women's healthcare, although not all Hmong possess this information and there is evidence of erosion. This situation emphasizes the need for preservation and dissemination of this knowledge to younger generation [11]. A study on the Mien people in Thailand [13] found that medicinal plants play a significant role in primary healthcare of postpartum women. Among the 168 species of medicinal plants identified in the study, 77 species were specifically used for postpartum women's healthcare [13]. Similarly, Yunnanese Chinese in northern Thailand practice folk medicine for childbirth, which involves herbal steam baths and medicinal foods. Over 40 species of steam bath herbs, known as *xizao yao*, have been identified, which help restore women's health and prevent future diseases [14].

Although there has been extensive global research on medicinal plants for women's health and ethnobotany of the Tibeto-Burman groups in Thailand, studies specifically focused on medicinal plants for women's health in Thailand are scarce. This study aims to fill this gap by providing an in-depth examination of the medicinal plant practices and traditions among the four Tibeto-Burman groups in Thailand. By exploring the diversity and significance of medicinal plants for women's health, as well as the cultural, and other factors that influence these practices, this study contributes to a broader understanding of the role of medicinal plants in maintaining the health and wellbeing of indigenous communities, addressing an important gap in the current body of knowledge.

2. Material and methods

2.1. An overview of the cultural background of Karen, Lisu, Lahu, and Akha

The Karen people are an ethnic group with a distinct culture, language, and traditions. They are believed to have originated from Tibeto-Burman-speaking communities in mainland Southeast Asia. The Karen language is also part of the Tibeto-Burman language family and is spoken by the majority of Karen people in Thailand. They have maintained their language and traditions despite the influences of modern society, and their cultural heritage remains an important aspect of their identity. One example of their unique traditional practice is their animistic beliefs, which play a significant role in their daily lives and rituals. Compared to other ethnic groups in Thailand, the Karen community has the highest number of ethnobotanical studies conducted, highlighting their rich cultural heritage and significance in the field of traditional plant knowledge [15,16].

The Lisu are an ethnic group in Thailand, primarily residing in the northern regions of the country near the borders of Burma/Myanmar and Laos. With approximately 40,000 speakers in Thailand and over 1 million worldwide [17], the Lisu have a rich cultural heritage and a long history in the region. The Lisu are one of several non-Thai minority cultures found in northern Thailand and are known for their unique language, customs, and traditions. Their presence in the region dates back many years and they have maintained their cultural identity despite the influence of the surrounding cultures. They have a long history in Thailand, with evidence of their presence dating back to the late 19th century. Despite being a relatively small ethnic group, the Lisu have received significant attention in recent years, with several studies exploring their cultural practices and beliefs, including their traditional use of plants [17–19].

The Lahu people are an ethnic group primarily found in the mountainous regions of northern Thailand, as well as in Yunnan, China, and Laos. With a population of approximately 300,000 in Thailand, the Lahu have a rich cultural heritage and history. In the past, the Lahu people have solely relied on traditional medicine for their healthcare needs [20]. They have a unique language, which is part of the Tibeto-Burman family, and distinct traditional practices, including agriculture and animist beliefs. The Lahu people are well adapted to their natural surroundings. The study of Lahu people in Thailand and China demonstrates use of medicinal plants by the Lahu people is greatly influenced by the local environment, not only by the characteristics of resources within their cultural background but also by common local diseases [21].

The Akha are an ethnic group primarily located in the highland regions of Southeast Asia, including Thailand, Laos, Vietnam, and China. In Thailand, it is estimated that there are approximately 70,000 Akha speakers [22]. They have a rich cultural heritage and a unique traditional dress which includes elaborate silver-colored headpieces, black miniskirts, and decorated tunics [9]. This distinctive style of dress sets them apart from other ethnic groups in the region and is a symbol of their cultural identity. Despite the limited research on Akha ethnobotany, studies have shown that the Akha people possess a wealth of knowledge about the use of plants for various purposes [23,24].

The historical background of the four ethnic groups reveals distinct differences in their migration history and population sizes in Thailand. Although their languages are classified within the Tibeto-Burman group, each group has unique speech patterns and lifestyle variations that set them apart from one another. Despite these differences, they all share a common characteristic - their lives are intrinsically linked to natural resources and their traditional knowledge. This connection to nature plays a crucial role in shaping the cultures and practices of these communities, emphasizing the importance of preserving and understanding their unique heritage.

2.2. Study sites

The study was carried out in 12 villages located in Chiang Mai (5), Chiang Rai (3), and Mae Hong Son (4) provinces in northern Thailand (Fig. 1 and Table 1). The study sites were selected based on the presence of four ethnic groups, including Akha, Karen, Lahu, and Lisu. These groups were represented by 3, 3, 4, and 5 villages, respectively. The villages in the study had a range of household sizes from 8 to 180 and a range of population sizes from 68 to 750 individuals. The vegetation at the study sites primarily consisted of mixed deciduous forest, dipterocarp forest, and dry evergreen forest. The three different forest types occupy different, but somewhat overlapping parts among the forest types especially the tree species composition of dry dipterocarp forest had similar dominant trees with the mixed stand of deciduous dipterocarps [25]. The elevation of the study sites varied from 628 to 1409 m above sea level. The ages of the villages ranged from 41 to 82 years. Although the villages are relatively young, the ancestors of the local people had migrated to upper northern Thailand more than 200 years ago. Their traditional knowledge and lifestyle have been maintained as they moved to new habitats. Historically, these communities practiced a semi-nomadic lifestyle and did not settle in permanent villages, which is why the ages of the current villages are less than 100 years old.

There were 61 key informants in total including Akha (12) Lahu (13) Lisu (19) and Karen (17), of which 15 were males and 46 were females. All of them were farmers. The key informants were aged between 25 and 75 years and primarily followed Animism, Buddhism, and Christianity as their religion. Five key informants, or 8% of the total, had only completed elementary school, as opposed to the majority of key informants who had no formal education.

In the village of Pa Ya Sai, located in Chiang Mai, all four ethnic groups lived together. In this village, each ethnic group was separately interviewed to gather information on their traditional medicinal plant knowledge for women's healthcare practices.

2.3. Ethnobotanical investigation

The ethnobotanical investigation in this study was carried out with a focus on understanding the local knowledge and practices related to women's healthcare. The process began by explaining the objective of the study to the village head, who then suggested key informants for the research. A snow-ball sampling technique was used to find additional informants in the village, who were selected based on their knowledge and experience in the field of women's healthcare. The informants consisted of local healers and experienced villagers, all of whom were women. The goal of the ethnobotanical investigation was to gather in-depth information about the traditional use of medicinal plants and foods used for women's healthcare in the local communities.

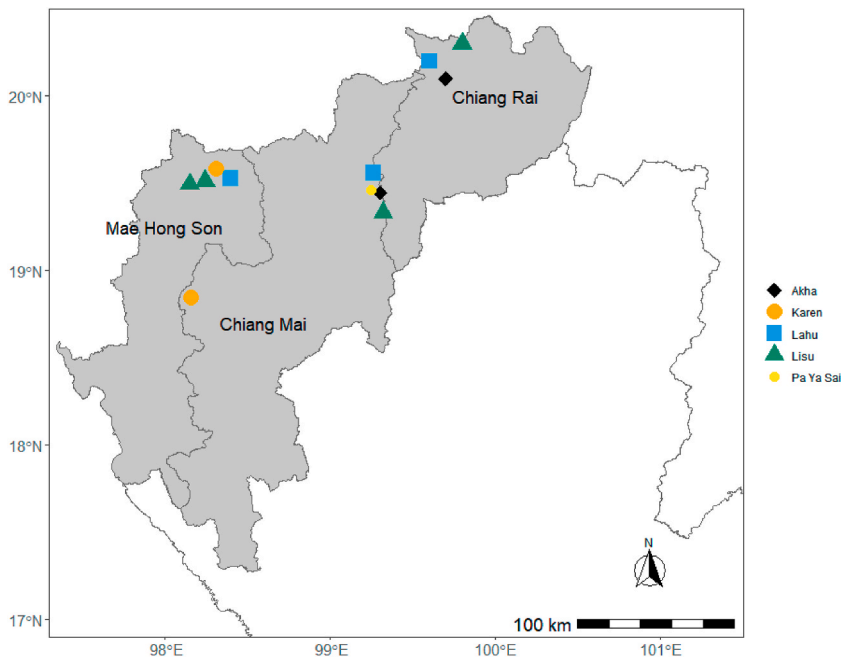


Fig. 1. The location of studied villages where the ethnobotanical survey of woman healthcare was conducted (Pa Ya Sai a village where four ethnic groups reside, other names refer to the specific ethnic group).

Table 1
Demographic and ecological characteristics of study villages.

Village	Age of village	District	Province	Religion	Elevation	Vegetation	Ethnicity	UR	Species	No. of informant (male/female)	Range of informant age	No. of household	No. of Population
A Ba	60	Mae Pha Luang	Chiang Rai	Animism, Buddhism, Christianity	861	Mixed deciduous forest	Akha	16	13	5 (1/4)	35–75	46	349
A Ya	50	Phrao	Chiang Mai	Animism, Buddhism, Christianity	1137	Dry evergreen forest	Akha	16	14	5 (2/3)	35–75	8	68
Ja Buu Si	60	Mae Pha Luang	Chiang Rai	Animism	907	Dry evergreen forest & mixed deciduous forest	Lahu	22	22	5 (1/4)	35–65	28	121
Khon Muang	50	Phrao	Chiang Mai	Animism, Christianity	628	Mixed deciduous forest and dipterocarp forest	Lahu	0	0	3 (0/3)	40–65	35	151
Khun Che	82	Phrao	Chiang Mai	Animism, Buddhism, Christianity	1409	Dry evergreen forest	Lisu	12	11	3 (0/3)	50–65	120	750
Mae Yaod	41	Mae Chaem	Chiang Mai	Animism, Buddhism, Christianity	1220	Dry evergreen forest	Karen	29	27	5 (1/4)	60–75	107	529
Mueang Pam	66	Pang Ma Pha	Mae Hong Son	Animism, Buddhism, Christianity	749	Mixed deciduous forest & dipterocarp forest	Karen	41	41	10 (5/5)	45–70	60	369
Nong Tong	45	Pang Ma Pha	Mae Hong Son	Animism, Buddhism	680	Mixed deciduous forest & dipterocarp forest	Lisu	37	35	4 (1/3)	25–70	105	400
Nong Pha Chum	45	Pang Ma Pha	Mae Hong Son	Animism, Buddhism	982	Mixed deciduous forest & dipterocarp forest	Lisu	24	21	3 (0/3)	35–60	180	464
Pa Ya Sai	50	Phrao	Chiang Mai	Animism, Buddhism, Christianity	687	Mixed deciduous forest & dipterocarp forest	Akha	1	1	2 (1/1)	60–70	8	48
							Karen	4	4	2 (1/1)	40–50	9	39
							Lahu	1	1	3 (1/2)	35–50	7	39
							Lisu	0	0	3 (1/2)	45–55	2	8
That	60	Mae Pha Luang	Chiang Rai	Animism, Buddhism	934	Dry evergreen forest & mixed deciduous forest	Lisu	35	28	6 (0/6)	45–75	23	134
Wana Luang	45	Pang Ma Pha	Mae Hong Son	Animism, Christianity	630	Dipterocarp forest	Lahu	85	71	2 (0/2)	45–60	131	387

The information gathering process was conducted using a combination of free-listing, semi-structured interviews, group discussion and the walk-to-the-wood method. This multi-faceted approach was selected to ensure a comprehensive understanding of the plants used for women's healthcare in the study area. The group of informants of the same ethnicity were asked to describe their perspectives on women's healthcare and the plants used in these practices. All information gathering processes were conducted with the consent of informants. According to principles in ethnobotany, this study designed the following questions for interviews.

1. How do your thoughts about women's healthcare and the plants used in these practices?
2. Have you ever used or collected the medicinal plants for women's healthcare?
3. Would you mind listing some plants you have used or collected for women's healthcare?
4. How to use this plant?
5. Which plant parts were used?
6. Why do you choose this particular species?
7. Is there any other uses of each plant?

The questions were designed to collect data on the (i) vernacular name of the plants, (ii) category of use, (iii) parts used, (iv) methods for preparation and administration, and (v) characteristics of the plant material.

A total of 61 informants were recruited in this study. The free-listing method was used to gather an initial list of plants used by the informants during group discussion. This was followed by semi-structured interviews, which allowed for a more in-depth exploration of the plants, including the parts used, preparation methods, and purposes of use. The walk-to-the-wood method involved accompanying the informants as they visited their home gardens, nearby forests, and other areas to collect specimens of the plants discussed. This hands-on approach provided an opportunity to observe the plants in their natural habitats and gather additional information from the informants.

The study was conducted with ethical consideration and approval from the Research Ethics Committee Faculty of Medicine, Chiang Mai University with document no. NONE-2565-08787. All participants provided informed consent prior to their participation in the study. The participants were fully informed about the purpose and procedures of the study and were free to withdraw at any time. Those who were literate provided written consent, while those who were illiterate provided verbal consent with a witness present.

2.4. Plant identification and categorization

The plant specimens collected during the field survey were deposited as voucher specimens in the Herbarium of Queen Sirikit Botanic Garden (QBG) and were accompanied by photographs taken during the survey. The accepted scientific names and families of the identified plant species were determined based on the Plants of the World Online Database (powo.science.kew.org), which is a comprehensive database that provides information on the current accepted name and family for plant species. In some cases, living specimens were collected to ensure future accurate identification and facilitate propagation efforts.

The classification of disorders and treatments in this study is based on an emic perspective. This means that the classification is derived from the participants' own self-reported experiences and perspectives, rather than being imposed by outside researchers or experts. This approach offers a deeper understanding of the cultural nuances and indigenous knowledge related to the disorders and treatments, and provides a culturally sensitive and relevant classification system. The emic perspective allows for a more culturally appropriate analysis and a better understanding of the population's experiences and perspectives on the disorders and treatments being studied.

2.5. Data analysis

2.5.1. Use-reports & group-informant

In the present study, the use-reports (URs) were collected as a key source of information for the ethnobotanical and ethnomedicinal investigation. The URs provide an in-depth understanding of the traditional knowledge and practices of a specific community with regards to the utilization of plant species for various purposes. The URs were obtained through group discussions with group-informants, who were members of the same ethnic group from a particular village. The term "group-informant" was used in this study as the ethnobotanical investigation was conducted through group discussions. During the study, a total of 15 group-informants were interviewed to gather the URs.

The choice of using group discussions in this study was based on several advantages it offered over individual interviews. Firstly, group discussions made the informants less afraid of the researchers, which was especially important in areas where trust between researchers and the community is a concern. Secondly, group discussions provided a platform for the exchange of knowledge among the informants, promoting the transmission of ethnobotanical knowledge within the community. Finally, the time constraints of the study made group discussions a more feasible option compared to individual interviews. The combination of these advantages led to the decision to use group discussions in this ethnobotanical investigation.

2.5.2. Relative Frequency of Citation (RFC)

The index used to determine the frequency of citation (FC) for a species is obtained by dividing the number of informants who mention its use by the total number of informants surveyed. This index does not take into account the variable use-category [26], and can be calculated using the following formula:

$$RFC = \frac{FC}{N}$$

To give an example, 9 out of 20 informants reported that species A is useful, so the RFC_A index for this species is 0.45 (9 divided by 20). The RFC_A index can range from 0 to 1, with 0 indicating that no one mentioned the species as useful, and 1 indicating that all informants mentioned the species as useful (which is highly unlikely).

2.5.3. Relative Importance Index (RI)

This index only considers the use-categories of a plant and not its subcategories. The formula for calculating the RI index is as follows.

$$RI = \frac{RFCs(max) + RUNs(max)}{2}$$

The RI index can range from 0 to 1. A score of 0 means that no one mentioned any use of the plant, while a score of 1 means that the plant was the most frequently mentioned as useful and in the maximum number of use-categories [26].

For instance, 9 informants mentioned that species X was useful, while species Y was cited by as many as 40 informants. Species X was utilized in 4 different use-categories, whereas species Z had the highest number of use-categories mentioned in the survey, which was 10. As a result, the Relative Importance Index (RI_x) was calculated as $(9/40 + 4/10)$ divided by 2, resulting in a value of 0.3125.

2.5.4. Cluster analysis

In this study, a cluster analysis was performed to group similar group-informants based on the frequency of plant use. The Bray-Curtis dissimilarity method was chosen to calculate the dissimilarity between the group-informants due to its ability to handle presence-absence data and its suitability for comparing community composition. The Ward's method was used as the algorithm for the cluster analysis due to its ability to minimize the variance in the distances between the groups. The analysis was performed using the vegan package in R 4.0.4, a powerful and widely used software for ecological and biodiversity analysis.

3. Results

3.1. An overview of medicinal plant diversity and treatments

The results of the study revealed a total of 200 plant species used in traditional women's healthcare practices (Appendix A). Out of these species, 171 were identified to the species level, 18 were only identified to the genus level, and 11 were only identified to the family level or as unknown. A total of 77 plant families were documented in the study.

The study identified a total of 323 use-reports, which were further categorized into 80 different treatments or use methods. These treatments were classified into 22 distinct categories. The most important categories, based on the number of use-reports, were Postpartum Care (110 use-reports, 81 species), Prepartum Care (21 use-reports, 17 species), Tonic (24 use-reports, 21 species), Urinary problems (23 use-reports, 19 species), and Genital problems (19 use-reports, 19 species) (Table 2).

Table 2
Number of taxa and use report (UR) for 22 categories of ailments in different ethnic groups.

Woman healthcare classification	Total Taxa	Total UR	Number of taxa				Number of use-reports			
			Akha	Karen	Lahu	Lisu	Akha	Karen	Lahu	Lisu
Postpartum Care	81	110	0	8	41	39	0	8	50	52
Tonic	21	24	3	11	6	4	3	11	6	4
Urinary problems	19	23	3	9	6	3	3	11	6	3
Prepartum Care	17	21	0	13	3	4	0	14	3	4
Genital problems	19	19	3	0	16	0	3	0	16	0
Constipation	10	15	3	4	4	3	3	4	5	3
Maternal Diet	11	15	0	1	6	8	0	1	6	8
Increase appetite	12	13	0	7	2	4	0	7	2	4
Breast milk stimulant	9	11	2	0	3	6	2	0	3	6
Beauty	7	9	0	3	2	4	0	3	2	4
Blood circulation	8	8	4	0	0	4	4	0	0	4
Blood pressure	6	8	1	3	1	3	1	3	1	3
Lom Phid Duen	8	8	1	2	4	1	1	2	4	1
Baby health care	7	7	3	0	0	4	3	0	0	4
Uterus involution	5	6	5	0	0	0	6	0	0	0
Blood nourishment	4	5	0	2	1	2	0	2	1	2
Childbirth	4	5	2	3	0	0	2	3	0	0
Dizziness	5	5	1	4	0	0	1	4	0	0
Menstrual cycle	4	4	0	0	0	4	0	0	0	4
Carminative	3	3	0	0	2	1	0	0	2	1
Fertility	3	3	0	1	1	1	0	1	1	1
Hemorrhoid	1	1	1	0	0	0	1	0	0	0

The “Lom Phid Duen” condition, commonly referred to in northern Thai, is a result of not adhering to postpartum restrictions, leading to disrupted internal blood flow and resulting in persistent discomfort. The symptoms of this condition include headaches, dizziness, abdominal pain, back pain, and facial swelling. There were eight species which were used to treat the ailments in this category.

In this study, the use of medicinal plants for women’s healthcare was investigated in various villages. The results showed significant differences in the use of medicinal plants between the villages, with some villages reporting zero use of such plants. Nevertheless, there were several villages with a high number of use reports. The highest number of use reports (UR) was found in the Wana Luang village in the Lahu ethnic group, with 85 UR and 71 species used. Other village with high number of use plant included Mueang Pam, Nong Tong, That, Mae Yaod, Nong Pha Chum, and Ja Buu Si. These village had a notable number of species used for women’s healthcare, ranging from 22 to 41 species.

It was noted that the use of medicine for baby healthcare was also considered as part of women’s healthcare medicine by the informants. A total of 7 use reports from 7 species were found for the baby healthcare category. The use reports included a compress pounded medicine for treating fever in babies, a herbal bath for newborn babies, a herbal bath for skinny babies, a herbal bath to help babies sleep comfortably, and a treatment for healing a baby’s umbilical stump (Appendix A).

3.2. Part of use

The results show that leaves were the most frequently used plant part, with 145 use reports and 84 species mentioned (Fig. 2 and Appendix A). The whole plant was the second most commonly used part, with 108 use reports and 77 species. The root was the third most commonly used part, with 78 use reports and 50 species. Other plant parts such as infructescence, stem, bark, inflorescence, rhizome, seed, bulb, bulbil, exudate, and tuber were used less frequently. Overall, the data suggests that leaves and whole plants are the most commonly used plant parts for medicinal purposes, while the use of other plant parts is relatively rare.

3.3. Application

The data shows that there are two ways of using medicinal plants, internal and external (Fig. 3 and Appendix A). For internal use, the most common application is drinking, with 107 use reports and 80 species. In comparison, eating as food and herbal liquor had 27 and 2 use reports, respectively. For external use, the most emphasized applications were bathing and steam, with 92 and 55 use reports, respectively, and 66 and 47 species, respectively. Other external uses, such as hot compress, poultice, and cleansing product, had 24, 6, and 5 use reports, respectively, with 22, 6, and 4 species, respectively.

3.4. Relative Frequency of Citation (RFC) and Relative Importance (RI)

The study assessed the Relative Frequency of Citation (RFC) and Relative Importance (RI) indices of 200 plant species surveyed. The RFC index values varied from 0.077 to 0.462 across the species. The plant species with the highest RFC value was *Buddleja asiatica* Lour., while *Blumea balsamifera* (L.) DC., *Clerodendrum colebrookianum* Walp., *Croton mangelong* Y.T.Chang, *Mimosa pudica* L., *Phyllanthus emblica* L., *Rhus chinensis* Mill., and *Sambucus javanica* Reinw. ex Blume were among the other species with high RFC values, all of which had an RFC value of 0.308 or higher (Appendix A).

Conversely, 150 plant species had an RFC value of 0.077, and these were the plant species that were only cited by a single informant group, resulting in the lowest RFC value for any of the plant species surveyed.

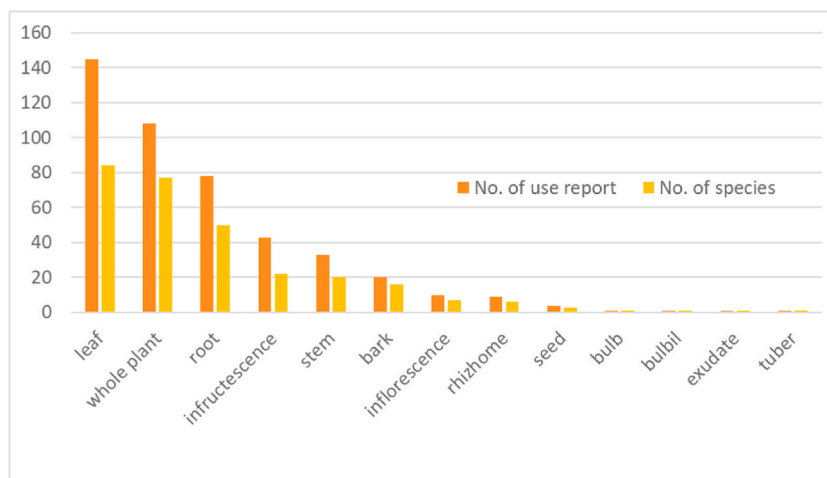


Fig. 2. Number of use-reports and species in each plant part utilization in women healthcare.

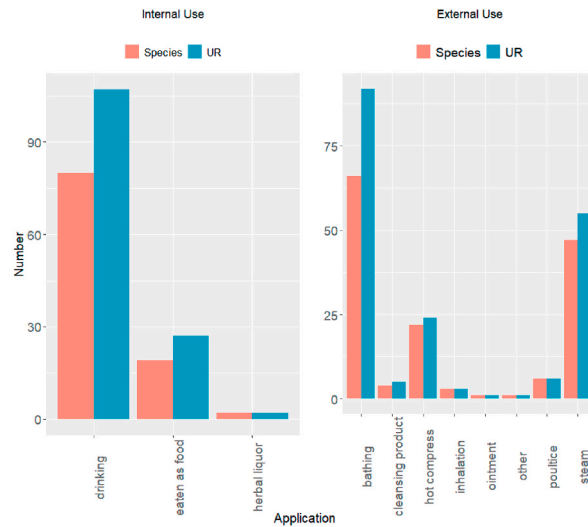


Fig. 3. Distribution of medicinal plant use by application method and number of use reports and species.

The RI index values ranged from 0.183 to 1, with *Clerodendrum colebrookianum* having the highest RI value. Other plant species with high RI values were *Blumea balsamifera*, *Buddleja asiatica*, *Clerodendrum villosum* Blume, and *Tinospora crispa* (L.) Hook. f. & Thomson, all of which had an RI value of 0.65 or higher.

In contrast, 139 plant species had an RI value of 0.183, which was the lowest value observed for any of the plant species surveyed.

3.5. Cluster analysis

The results of the cluster analysis revealed that the group-informants were divided into four distinct groups with varying compositions (Fig. 4). Group I comprised of group-informants from the same village, Pa Ya Sai (PYS), representing the Lahu, Akha, and Karen ethnic groups. In contrast, Group IV consisted solely of Lisu group-informants from various villages (Khun Che, Nong Pha Chum, and That village). Group II was a mixture of group-informants from different ethnic groups, including Lahu (Ja Buu Si village), Akha (A Ba village), and Karen (Mae Yaod village), from two villages in Chiang Rai province and one in Chiang Mai. Similarly, Group III was

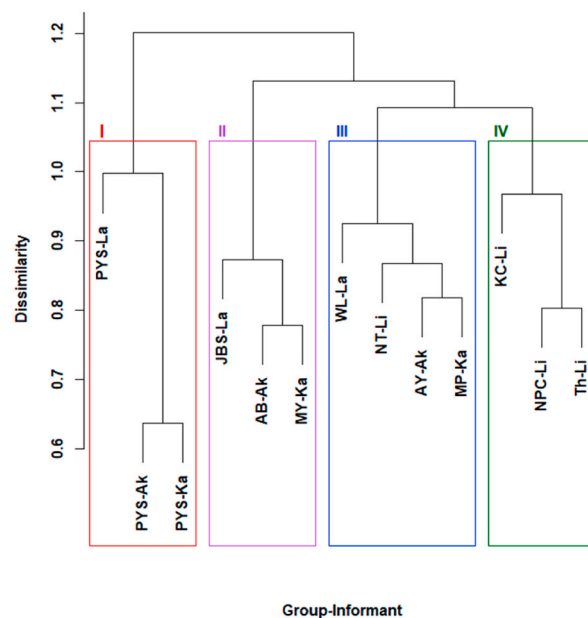


Fig. 4. Cluster analysis of group-informants based on frequency of plant use (village name: AB = A Ba, AY = A Ya, JBS = Ja Buu Si, KC=Khun Che, MP = Mueang Pam, MY = Mae Yaod, NPC=Nong Pha Chum, NT=Nong Tong, PYS=Pa Ya Sai, Th=That, WL=Wana Luang; Ethnicity: Ak = Akha, Ka = Karen, La = Lahu, Li = Lisu).

also a mixture of group-informants from different ethnic groups, hailing from three villages in Mae Hong Son province and one in Chiang Mai.

3.6. Additional uses of medicinal plants used in women healthcare

In this study, it was observed that 51 plant species, belonging to 29 families, had potential uses beyond their traditional applications in herbal medicines for women's healthcare (Appendix A). These plants could be employed for treating various other ailments. For instance, *Blumea balsamifera* was not only used for women's health but also for relieving muscle pain, sore throat, bloating, and malaria. Similarly, *Sambucus javanica*, which was used as an ingredient in herbal baths for postpartum women, was found to relieve pain and swelling on the body. Some species, such as *Elsholtzia stachyodes* (Link) Raizada & H.O.Saxena, *Dichrocephala integrifolia* (L.f.) Kuntze, and *Clerodendrum colebrookianum*, were also found to be consumed as food ingredients or desert fruit. Additionally, *Rhus chinensis* was believed to possess spiritual powers for warding off evil spirits (Appendix A).

4. Discussion

4.1. Exploring the variations in medicinal plant use for Women's healthcare across villages

The objective of this study was to conduct an ethnobotanical survey and explore the utilization of medicinal plants for women's health among the Tibeto-Burman ethnic groups residing in various villages in Thailand, who are one of the largest minority ethnic groups in the country. The findings revealed a total of 200 plant species used for traditional women's healthcare practices. This number is higher than previously reported in other studies conducted in Thailand [11–14] or other countries [27–29]. This was due to the expanded scope of the study, which included four different ethnic groups and a broader definition of women's healthcare based on an emic perspective. This expanded scope allowed for a more comprehensive understanding of the medicinal plant use for women's healthcare practices among the Tibeto-Burman ethnic groups in Thailand.

The results showed significant variations in the use of medicinal plants between the villages, with some villages reporting no use of such plants. However, several villages had a high number of use reports. The significant variations in the use of medicinal plants for women's healthcare practices among the various villages studied could be attributed to a number of factors, including differences in cultural practices [30,31], geographical location [10,32], accessibility to modern healthcare [33], and availability of plant resources [10].

The results of the cluster analysis also showed that the group-informants had varying compositions and characteristics, which were attributed to both ethnicity and geographical location. Among the four groups, Group IV, consisting of only Lisu group-informants, showed strong traditional conservation of ethnobotanical knowledge. On the other hand, the other groups, such as Group I, Group II, and Group III, seemed to be grouped according to their locality, particularly their province. This is evident in Group I, which was composed of group-informants from the same village, representing the Lahu, Akha, and Karen ethnic groups. The close proximity of these group-informants may have resulted in the sharing of similar ethnobotanical knowledge, as well as cultural and environmental factors affecting their use of medicinal plants. However, it should be noted that the dissimilarity among the group-informants was high, indicating the heterogeneity of ethnobotanical knowledge which could be caused by many factors, such as the sharing of language, overlap of living situations, and sharing of markets [18]. Moreover, traditional knowledge was typically not shared with other communities and was only passed down within a community's own generations [34,35]. Therefore, given the low overlap of used species among communities with distinct cultural and geographical backgrounds, it is crucial to continue ethnobotanical studies in order to document and preserve the traditional knowledge of each community [15,36], as well as to gain a deeper understanding of the relationships between plants and human culture.

Cultural practices and beliefs can significantly impact the use of medicinal plants, as well as the knowledge and use of these plants, which may vary among different ethnic groups. As an example, the Lahu ethnic group in the Wana Luang village had the highest number of reports on the use of medicinal plants for women's healthcare. One of the key informants in the village claimed to be an excellent local doctor, particularly as a birth attendant. This claim is a testament to the traditional knowledge and practices that continue to hold importance in the village. In contrast, other villages may not have key informants who claim to be expert healers or local doctors. The people in Wana Luang village still prefer traditional knowledge, especially for the postpartum period. This preference shows how cultural practices and beliefs influence the use of medicinal plants and the way in which healthcare is perceived and approached among different ethnic groups.

In the current global situation, the fact that some villages have reported little to no use of certain plants is a concerning indication of knowledge erosion over time [37,38]. This underscores the urgent need for continued ethnobotanical research to document and preserve traditional knowledge, as well as to identify and address the factors contributing to the loss of this invaluable cultural heritage. However, it is interesting to note that in other villages, such as the Wana Luang village in the Lahu ethnic group, traditional knowledge of medicinal plants is still preserved and actively used. This highlights the importance of conducting deeper comparison studies to better understand the causes of knowledge erosion in some areas and the preservation of traditional knowledge in other areas. Such studies could identify the key factors that contribute to the conservation of traditional medicinal plant use and inform strategies [39] for preserving and promoting traditional knowledge of medicinal plants.

The benefits of having traditional knowledge alongside modern knowledge are significant. Traditional medicinal plant knowledge can be complementary to modern medicine, and can provide alternative treatments for certain ailments [40–42]. In addition, traditional medicinal plants are often less expensive and more easily accessible than modern medicine, making them a viable option for

many communities, particularly those in remote areas or with limited financial resources. Moreover, the preservation of traditional knowledge of medicinal plants can also contribute to the conservation of biodiversity, as traditional knowledge is often closely linked to the natural environment and the sustainable use of resources [43]. Therefore, it is important to recognize the value of traditional medicinal plant knowledge and to promote its continued use and preservation alongside modern medicine.

4.2. Role of medicinal plants in baby healthcare as part of Women's healthcare

The results showed that a wide variety of ailments were treated using medicinal plants, with 80 different treatments or use methods identified. These treatments were classified into 22 distinct categories. The use of medicinal plants for baby healthcare being considered as part of women's healthcare medicine by the informants is likely due to the close relationship between mother and child during the early stages of life [44]. Traditional medicinal plant knowledge is often passed down from mother to daughter, and as such, mothers are likely the primary caregivers for babies and responsible for their healthcare. In addition, the treatments used for baby healthcare, such as herbal baths, compresses, and umbilical stump care, are closely linked to postpartum and prepartum care, and thus, considered part of the broader category of women's healthcare medicine [45,46]. However, it's worth noting that the number of plant species and use reports for baby healthcare was relatively low compared to other categories. This may be due to the fact that in modern times, many women in the area give birth at hospitals instead of at home, where traditional medicinal plant practices may be more commonly used. Nevertheless, the inclusion of baby healthcare in the study highlights the importance of considering the wider context and cultural practices surrounding medicinal plant use for women's healthcare, even if the number of plant species and use reports is relatively low in this category.

4.3. The importance of herbal bath and steam medicine for postpartum care

The present study revealed that postpartum care was the most important women's healthcare category, with the highest number of use-reports and species used. Herbal bath or steam medicine was identified as the one of most important treatment methods for postpartum care [47–49]. Generally, herbal medicines are carefully added to water and then decocted for an appropriate duration, resulting in a medicated liquid with a suitable temperature for bathing. The medicinal baths practice serves not only as a therapeutic approach to treating ailments, but also as a significant means of promoting overall health and well-being [50].

The significance of herbal bath or steam medicine for postpartum women may be attributed to its potential to alleviate postpartum pain, induce relaxation, and prevent postpartum infections. This can be particularly attributed to the presence of numerous aromatic plants in the remedy, which possess pharmacological properties that aid in the healing process [49]. The analysis of herbal plants used in Mien bath recipes has revealed the presence of potent antioxidants and antibacterial agents [51], which may be of great benefit in promoting postpartum care. These benefits are particularly important in rural areas, where access to modern medical facilities may be limited. In addition, herbal baths or steam medicines are often low-cost and easily accessible, making them a practical option for postpartum care in resource-limited settings. Moreover, the use of herbal bath or steam medicine for postpartum care is often deeply rooted in cultural practices, and may provide women with a sense of comfort and connection to traditional knowledge and practices. Therefore, promoting the use of herbal bath or steam medicine for postpartum care could help to preserve traditional medicinal plant knowledge, and provide women with a safe, low-cost, and accessible option for postpartum care.

In these treatments, various medicinal plants were used. Many of the formulas used in these treatments were designed to promote overall body relief, as the process of labor and delivery can cause significant pain and discomfort throughout the body [8]. The use of medicinal plants in these traditional remedies provides a natural and holistic approach to postpartum care that may complement or supplement modern medical treatments.

In the local culture, the practice of herbal bath or steam is believed to be an effective way to prevent the occurrence of "Lom Phid Duen" disorder, which may occur during or after the postpartum period. This disorder is not clearly defined scientifically and can present a range of symptoms, including both physical and mental symptoms. Examples of these symptoms may include feeling cold and shivering without a clear cause, a decreased tolerance to certain smells, or even temporary or permanent insanity. The disorder could be caused by the stress associated with childcare, highlighting the importance of mental health and stress management in the postpartum period. The belief that herbal baths or steam can help prevent this disorder also shows how traditional medicinal plant practices can relieve stress for the patient. This cultural practice highlights the importance of considering the impact of cultural beliefs and practices on healthcare practices and the need for further research in this area.

According to group discussion, finding and preparing medicinal plants for postpartum women is often viewed as a collective effort of all family members and kins, with the husband playing a significant role. This practice not only helps in finding the appropriate medicinal plants for postpartum care but also promotes the relationship and cooperation among family members and kins. The husband's involvement in the postpartum care of his wife also contributes to his deeper understanding of the postpartum experience and the importance of women's health. This cultural practice of sharing knowledge and taking collective responsibility for women's health is essential in rural areas where access to modern medical facilities is limited. Therefore, the preservation and promotion of traditional knowledge of medicinal plants for postpartum care can contribute to the improvement of women's health and the overall well-being of rural communities.

In this study, giving birth was considered the most important role of women's healthcare, and several categories of medicinal plants were found to be related to prepartum and postpartum care. The use of medicinal plants for prepartum care can help prepare the body for childbirth, while postpartum care helps to alleviate the physical and emotional stress of childbirth. In addition, the use of tonic plants can help to improve the overall health and well-being of women during the postpartum period. The findings of this study

highlight the importance of traditional knowledge in supporting women's health, particularly during the critical period of giving birth. By promoting the use of traditional medicinal plants, communities can support the health and well-being of women during this important time in their lives.

4.4. The benefits and limitations of group discussions in obtaining sensitive information on Women's healthcare practices

Sensitive questions, particularly those related to women's healthcare practices, may be challenging to ask during individual interviews due to cultural norms or privacy concerns. In such cases, group discussions can be a useful alternative method for obtaining information. Group discussions have the advantage of creating a more relaxed and comfortable atmosphere for the informants [52]. This is especially useful in situations where the research time is limited, and individual interviews may be too time-consuming. In group discussions, informants can feel less intimidated and more willing to share their knowledge and experiences. Furthermore, group discussions offer a platform for informants to exchange ideas, correct each other's misconceptions and validate their knowledge, leading to a more comprehensive and accurate understanding of the local knowledge system.

On the other hand, group discussions can also lead to the loss of detailed and specific information. This is because individual perspectives and experiences may not be fully represented in the group, leading to a lack of in-depth information. Additionally, group discussions may create social desirability bias, where informants may feel the need to conform to the dominant opinions or beliefs in the group. This can lead to a homogenization of the responses, and individual variations may be overlooked. Therefore, it is essential to consider the trade-offs between group discussions and individual interviews and to choose the most appropriate approach for the research question and context.

4.5. Evaluating medicinal plants for Women's health: the importance of RFC and RI indices

The results of the Relative Frequency of Citation (RFC) and Relative Importance (RI) indices of the 200 plant species surveyed revealed that some plant species were more important in traditional women's healthcare practices than others. Three species with highest RFC and RI included *Buddleja asiatica*, *Clerodendrum colebrookianum*, and *Blumea balsamifera*, indicating that these plant species were the most frequently cited and important in the study.

Blumea balsamifera, a species belonging to the Asteraceae family, is commonly used for women's healthcare in Southeast Asia [8]. It is found in a variety of locations throughout the region, including clearings near villages and in forested areas [53]. Therefore, it is easily accessible to local communities. The plant exhibits a variety of beneficial properties, including but not limited to antitumor, hepatoprotective, antioxidant, antimicrobial, anti-inflammatory, anti-plasmodial, anti-tyrosinase, platelet aggregation, and wound healing effects, as well as the ability to enhance percutaneous penetration, resist diseases and insects, and combat obesity [54]. These properties make *Blumea balsamifera* an important plant for women's healthcare, particularly during the postpartum period, when women are vulnerable to infection and inflammation. In light of its valuable medicinal properties and easy accessibility to local communities in Southeast Asia, *Blumea balsamifera* represents an ideal candidate for future drug development and should be recognized as an important plant for local healthcare.

Clerodendrum colebrookianum is a species of flowering plant that belongs to the Lamiaceae family. It is one of the most important wild vegetables among the ethnic groups in northern Thailand, known for its high protein content [55]. In this study, the plant was used to treat a variety of ailments, including postpartum care as a bathing medicine and hot compress for endometritis or uterus involution, as well as a decoction for activating blood circulation (Appendix 1). It has been reported to have antidiabetic, antihypertensive, and sedative properties [56], with the most common form of ethnomedicinal application being the use of young and tender leaves as a decoction for anti-hypertensive purposes [57]. Additionally, the ethno-medical importance of various species of the *Clerodendrum* genus has been reported in indigenous systems of medicine and as folk medicine, specifically in Indian, Chinese, Thai, Korean, and Japanese systems of medicine for the treatment of life-threatening diseases such as syphilis, typhoid, cancer, jaundice, and hypertension [56].

Buddleja asiatica (Scrophulariaceae) has been traditionally utilized for its therapeutic properties, including antipyretic, analgesic, hypotensive, antimicrobial, anti-inflammatory, and antifungal effects, as reported in a recent study [58]. The genus has a long history of use in various healing applications, including the treatment of liver diseases, bronchial complaints, and prevention of several other diseases due to its diuretic, sedative, analgesic, antirheumatic, antimicrobial, anti-hyperglycemic, and antioxidant properties [59]. In Thailand, the plant is widely used by various ethnic groups to treat a range of ailments, including tuberculosis and fever [24], burns [60], and postpartum healthcare [61]. The rich traditional knowledge and diverse medicinal properties of *Buddleja asiatica* make it an important candidate for further research and development in the field of traditional medicine.

In conclusion, the rich traditional knowledge of medicinal plants in women's healthcare practices, including the use of *Blumea balsamifera* or *Buddleja asiatica*, highlights the importance of ethnobotanical research for the preservation of this invaluable cultural heritage. However, some plant species may have limited effectiveness, cultural significance, or accessibility, which may lead to their loss and disappearance over time. Therefore, it is crucial for ethnobotanical investigations to document even minor-use plants and build a comprehensive database to promote their potential use in the future and safeguard traditional knowledge for generations to come.

It should be noted that while our study identified nearly 200 medicinal plant species used in women's healthcare, we acknowledge the presence of un-identified taxa in our inventory. We decided to retain these un-identified taxa with their vernacular names as a means of preserving traditional knowledge, and we have voucher specimens related to these taxa that will aid in their future identification. We recognize the limitations this may present; however, by maintaining these records, we enable future research to revise

and update the inventory as more plant samples become available. The inclusion of un-identified taxa also highlights the potential richness of undiscovered or undocumented medicinal plants in the region, underscoring the need for continued research in this area.

4.6. Plant part

To obtain a herbal drug of high quality and efficacy, it is crucial to collect it at the optimal stage of development, use the appropriate plant part, and harvest during the right season to maximize phytochemical content. Herbal medicines, derived from various parts of plants such as roots, leaves, barks, seeds, berries, and flowers, have been used traditionally for treating and preventing various illnesses. The use of different plant parts in traditional medicine has been reported.

The preference for leaves, whole plants, and roots over other plant parts such as stems, barks, and inflorescences can be attributed to their accessibility and availability, as well as their potency. Leaves are often easier to collect and prepare compared to other plant parts, such as roots, which require digging and removal from the ground. Therefore, leaf is a commonly utilized plant part in traditional medicine across Thailand [36] and other regions globally [62,63].

Plant roots, rhizomes, and stems are rich in secondary metabolites that are effective in treating illnesses, with roots containing the highest concentration of medicinal compounds [64,65]. Despite the challenges associated with harvesting, the use of these plant parts for medicinal purposes is important, especially since rhizomes are commonly found in specific plant families and are widely utilized as both food and medicine worldwide. However, roots are generally harder to harvest and may require digging up the entire plant, which can cause damage to survivors of the living plants and the ecosystem.

Furthermore, the use of whole plants, instead of just one specific part, can provide a more comprehensive range of medicinal properties, as the whole plant contains a variety of secondary metabolites.

In conclusion, the results of this study indicate that leaves, whole plants, and roots are the most preferred plant parts for medicinal use among the informants. The preference for these plant parts can be attributed to their accessibility, availability, potency, and the belief in their medicinal properties.

5. Conclusion

The findings of the present study aimed to document and investigate the use of medicinal plants for women's healthcare in various villages among Tibeto-Burman ethnic groups, which are the largest minority ethnic group in Thailand. A total of 200 plant species were used for traditional women's healthcare practices, which was higher than other studies conducted in the country or other countries. The increase in species was attributed to the scope of ethnic groups and the scope of women's healthcare defined by emic perspective, which enlarged the scope of the study compared to other studies.

The use of group-informants in ethnobotanical studies has proven to be a valuable approach in documenting and investigating the use of medicinal plants for women's healthcare. In further ethnobotanical studies, the use of group-informants can provide a more comprehensive understanding of the traditional medicinal practices in a specific community, as well as the diversity of ethnobotanical knowledge within a community. It allows for the documentation of collective knowledge, rather than relying solely on individual knowledge, which can often be limited. Additionally, the use of group-informants can facilitate the collection of data from remote and under-researched areas, where access to individual informants may be difficult. The use of group-informants in ethnobotanical studies has the potential to contribute to the preservation and documentation of traditional medicinal practices, as well as provide valuable information for the development of new and improved healthcare solutions.

In this study, both signs of knowledge erosion and conservation were observed among the group-informants. While the loss of traditional ethnobotanical knowledge is a global issue, it is important to also focus on the ways in which some communities are able to conserve their knowledge even in modern times. This highlights the importance of creating strategies to promote and conserve traditional knowledge, not just for the benefit of human beings, but also for the preservation of biodiversity. By doing so, future generations can continue to benefit from the rich cultural heritage and traditional wisdom of these communities.

In conclusion, the present study provides valuable insights into the use of medicinal plants for women's healthcare among Tibeto-Burman ethnic groups in Thailand. The results highlight the diversity of ethnobotanical knowledge and the importance of considering both cultural and geographical factors in ethnobotanical investigations. Further research is needed to explore the potential of these medicinal plants for the development of new healthcare products and to preserve traditional knowledge for future generations.

Author contribution statement

Angkhana Inta: conceived and designed the experiments; performed the experiments; analyzed and interpreted the data; contributed data; wrote the paper.

Jatupol Kampaunsai: contributed data; wrote the paper.

Wibhu Kutanan, Metawee Srikumool, Prachaya Srisanga: analyzed and interpreted the data; wrote the paper.

Wittaya Pongamornkul: performed the experiments; contributed data.

Prateep Panyadee: conceived and designed the experiments; analyzed and interpreted the data; wrote the paper.

Data availability statement

Data will be made available on request.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2023.e17722>.

Abbreviations

Ethnobotanical indices

UR	use-report
RFC	Relative Frequency of Citation
RI	Relative Importance Index
RUN	Relative Number of Use-category

Village name

AB	A Ba
AY	A Ya
JBS	Ja Buu Si
KC	Khun Che
MP	Mueang Pam
MY	Mae Yaod
NPC	Nong Pha Chum
NT	Nong Tong
PYS	Pa Ya Sai
Th	That
WL	Wana Luang

Ethnicity

Ak	Akha
Ka	Karen
La	Lahu
Li	Lisu

Plant part

r	root
s	stem
ba	bark
bb	bulbil
bu	bulb
ex	exudate
inf	inflorescence
infr	infructescence
l	leaf
rh	rhizome
se	seed
tu	tuber
wh	whole plant

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