

# Medicinal Plants Used by Tai Lao Healers in Roi Et Thailand

**Auemporn Junsongduang** (✉ [a.junsongduang@gmail.com](mailto:a.junsongduang@gmail.com))

Roi Et Rajabhat University <https://orcid.org/0000-0001-7695-7966>

**Onuma Nabundit**

Roi Et Rajabhat University

**Pimrudee Chinnawong**

Roi Et Rajabhat University

**Wattana Tanming**

Queen Sirikit Botanic Garden

**Henrik Balslev**

Aarhus University

---

## Research

**Keywords:** Ethnobotany, Ethnic group, Herbalist, Northeastern, Thailand, Roi Et, traditional knowledge

**Posted Date:** October 20th, 2021

**DOI:** <https://doi.org/10.21203/rs.3.rs-957563/v1>

**License:**   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

---

# Abstract

**Background:** Local knowledge of herbal medicine in rural communities is rich. This part of cultures plays an important role in societies where knowledge of indigenous medicine and folk healing has been passed down from generation to generation. Most of the knowledge was never written down and much such knowledge has disappeared over time when it was presented orally and through memorization. The objective of this study was to compile knowledge related to medicinal plants used by Tai Lao traditional healers in Roi et province and identify their explicit use in order to preserve the useful wisdom for the people.

**Methodology:** In this study we identify and document medicinal plants and associated ethnobotanical knowledge held by 14 traditional Tai Lao healers. They were selected by snowball and purposive sampling and questioned using semi-structured interviews. Interviews about their knowledge, covered their training, the ailments they treated, the techniques they used, their methods of preparation and, in addition, several healing sessions were observed. During walks in the fields, we searched for the medicinal plant with help from the healers to review and document their availability at each locality and in different habitats around the villages. Use Values (UV) were calculated to estimate the importance of each medicinal plant and Informant Agreement Ratios (IAR) were calculated to understand how widely known the uses were among the healers.

**Results:** We found 146 species of medicinal plants in 127 genera and 60 plant families that were used for medicinal purposes by the 14 traditional healers interviewed. The family with most medicinal plants was Fabaceae (12 spp., 8%) followed by Poaceae (9 spp., 6%) and Zingiberaceae (8 spp., 5%). The most important and widely used medicinal plants were the sedge *Cyperus rotundus* (UV=0.71) followed by the dicot tree *Salacia dongnaiensis* (UV=0.64) and the palm *Borassus flabellifer* (UV=0.42). The most common preparation method was decoction, which was done for 99 species (68%) followed by grinding with water to produce a drink for 29 species (20%). The 14 healers together used medicinal plants to treat 53 specific conditions. Itching had the highest informant agreement ratio (IAR) value among the specific conditions with 0.33 (4 use-reports, 3 spp.). The general category of digestive system disorders had an informant agreement ratio (IAR) value of 0.35 (57 use-reports, 37 spp.) and this category of treatments also had the highest degree of consensus. The most common life form among the medicinal plants was trees (56 spp., 38%), followed by herbs (41 spp., 28%). The medicinal plants were mostly collected in homegardens (60 spp., 41%). The most commonly used plant parts for medicine was the stem which was used for almost half of the species (69 spp., 48%), followed by the roots (54 spp., 37%). The age of the Tai Lao healers varied from 26–87 years. All of them were male. Their age and educations were not correlated with the number of known medicinal plants. The highest number of known medicinal plants was held by a 70 years old healer (55 spp.).

**Conclusion:** Considering the richness of the healers' pharmacopeia, and the fact that their profession is not being perpetuated, this study points to the urgent need to document the traditional knowledge from the old herbalists before it disappears with the last practitioners in the rural communities.

# Introduction

Thai people began using medicinal plants for the treatment of various health symptoms and diseases and for maintaining good health before the Sukhothai period which started 1238 A.D. The Kingdom of Thailand, as a consequence, has its own system of traditional medicine which is called “Thai traditional medicine” (TTM) [1]. The Thai traditional medicinal (TTM) system is deeply rooted and has played a key role in Thai culture. It has been the means of health care for the Thai people up until the early 20th century [1]. The diverse way of life and culture in each region of Thailand has led to a parallel diversity of local health care system with a variety of local folk remedies and traditional medicines that are used to meet peoples’ needs and to treat different diseases [2]. Local herbal medicine is therefore the standard primary health care and health promotion among Thai people in rural areas and it is consistent with their culture [3]. Presently however, modern westernized medicine is becoming dominant in the mainstream healthcare system, and Thai traditional medicine (TTM) has attained a status of nonconventional or alternative medicine [4]. It has, nevertheless, been recognized that modern medicine is probably not the answer to all aspects of good health of Thai people. This attitude has been helped by the realization that a large proportion of the country’s healthcare budget was being spent on the treatment of diseases with high-priced sophisticated equipment and imported new drugs rather than on the prevention of diseases and health promotion [5]. In addition, despite all the advancement of medical technologies and the pharmaceutical industry, modern medicine cannot successfully cure many of the chronic lifestyle-related diseases, which are major health problems of today’s world, including diabetes, hypertension, cardiovascular diseases, and various types of cancer [4]. It is now accepted that the current medical plan alone does not solve all health problems. The high-cost medical system, as a side effect, rely on medical supplies and medical equipment from abroad which is a major limitation that prevents modern medicine from serving the public thoroughly and equally [5–6]. However, traditional medicinal knowledge and practice have not been adequately studied, exploited, or documented [7]. Turning to the wisdom of indigenous medicine in all dimensions we can recover additional knowledge that is still valid in the time we live in and make the most of it. Thai traditional medicine in different parts of the country has its own heritage that differs according to its origin, ecosystem, and culture. The long abandonment of the wisdom of folk medicine by the lack of research and continuous development has hampered the development of this knowledge. In many developing countries, traditional knowledge of indigenous people is being widely threatened by current trends of economic globalization. Many researchers have reported that traditional knowledge systems, that were either lost or transmitted orally from one generation to the next among traditional health practitioners, are in danger due to poor relations between the older and younger generations [8–12]. Therefore, it is urgently needed to study, research, and develop our knowledge of traditional medicinal systems.

Traditional healers still play an important role in the health care of villagers in many parts of Thailand [2–3, 12–15]. Their knowledge is more vulnerable than the documented traditional knowledge. In the past, ethnobotanical studies among traditional societies indicated that the level of idiosyncratic knowledge is very high [16]. To uncover the cultural truth or generalized knowledge, quantitative ethnobotany may provide the answers [17]. Quantitative approaches have been used in ethnobotanical studies to measure

the degree of consensus concerning the use of a particular medicinal plant. The consensus analyses have been used to test falsifiable hypotheses on the use of plants and also as a tool for selecting medicinal plants for further research [18–19] thus, such quantitative approaches are helpful for the extraction of higher-level conclusions from the data available in ethnobotanical surveys [20].

When studying traditional knowledge of ethnomedicinal uses to improve the health in the concerned communities, it is useful to look at both the specific conditions and diseases and also at broader categories. The *specific conditions* could be diseases such as cancer and diabetes and it could also be problems with lactation and similar situations which may be an inconvenience or abnormality. To be able to make meaningful comparisons with other studies, the specific conditions must be classified in a system of *broader categories* such as for example digestive system disorders, blood system disorders, and endocrine system disorders.

The northeastern part of Thailand, corresponding to the Isan region, is by far the poorest part of the country. Approximately 30% of the Thai population live in the region [21]. The Isan people are an ethno-regional group native to northeastern Thailand with an estimated population of about 22 million [22] and they are ethnically of Tai Lao origin, constituting one of the largest minorities in the country. The main languages spoken are Thai, Lao, and some ethnic languages [23]. Most northeastern Thais speak a dialect of Lao mixed with some influences from Thai [24]. In the last decades ethnobotanical study has received more attention. However, many uses and practices linked to plants from all over the world remain unknown, not documented or evaluated. According to the uniqueness of Thai traditional medicine with its own heritage in each ethnic group [3–6, 12] and the traditional knowledge of many ethnic communities it depends on natural resources which are being widely threatened by current trends of economic globalization [25]. Such relevant and specific knowledge is facing different threats and may disappear from many countries all over the world. It is urgently needed to document the traditional knowledge possessed by the old herbalists before it disappears from the rural communities in Thailand [12]. This study focusses on the plants used by a group of Tai Lao traditional healers as part of an ongoing study on herbal therapies for primary health care in their communities. In this context we aim at answering the following general question: What is the traditional knowledge used by healers for curing their patients? Specifically, we asked: (1) How many medicinal plants do they know and use for treating patients in their community and what are the vernacular names of the species? (2) Which species are most used? (3) How many and which ailments are treated with traditional medicinal plants? (4) Which plant parts are commonly used for medicine? (5) Which life-forms of plants are represented among the medicinal plants, (6) Which preparation methods are available? (7) What are the habitats from which the healers derive their medicinal plants?

## Material And Methods

### Study area

Roi Et is one of the 17 provinces in northeastern Thailand with a geographical extension of 8299 km<sup>2</sup>, located at 16°03 N latitude and 103°39 E longitude (Fig. 1). We selected 14 traditional Tai Lao healers who still practice traditional healing. The data were collected in seven districts in Roi Et province (Fig. 1).

### The traditional healers

The 14 Tai Lao healers together knew 146 species of medicinal plants belonging to 127 genera in 60 families. Each Tai Lao healer knew from 12–55 medicinal plant species. The average number of medicinal plants known by the healers was 24 species. The age of the healers varied from 26–87 years. The age and their educations were not correlated with the number of medicinal plants that they knew. The highest number of known medicinal plants was by a 70 years old healer from Kaset Wisai followed by an 87 years old healer from the same district. The lowest number of medicinal plants known was by a 76 years old healer also in Kaset Wisai (Table 1).

**Table 1** Profiles of 14 Tai Lao healers interviewed in Roi Et province, Thailand, and the number of medicinal plants they knew.

Healer	Occupation	Education	Age (years)	Known Medicinal species	District
1	Farmer	None	64	15	Suwannaphum
2	Farmer	Primary	65	12	Suwannaphum
3	Farmer	Primary	60	16	Kaset Wisai
4	Farmer	Primary	76	10	Kaset Wisai
5	Farmer	Primary	76	17	Kaset Wisai
6	Farmer	None	77	25	Kaset Wisai
7	Farmer	None	87	53	Kaset Wisai
8	Farmer	By temple	70	55	Kaset Wisai
9	Farmer	Primary	66	36	Changan
10	Farmer	Primary	68	12	Changan
11	Farmer	Primary	26	29	Phon Thong
12	Farmer	None	74	13	Phon Thong
13	Farmer	High school	76	17	Phanom Phrai
14	Farmer	Primary	76	27	Phanom Phrai
<b>Average</b>			<b>68.6</b>	<b>24</b>	

## **Field survey and data collection**

Data and plant specimens were collected from April 2015–April 2016. Purposive sampling was used to choose the respondents who met the study criteria and could provide rich data relevant to the study [26]. A snowball sampling technique was used to expand the number of respondents [27]. Finally, we had only fourteen traditional Tai Lao healers. Each healer was visited and interviewed in his house and informal meetings were held in Isan or Lao languages. With permission from the participants, semi-structured interviews were performed to collect quantitative and qualitative data on the traditional knowledge of medicinal plants used by them. All respondents were interviewed about their training knowledge, ailments, treatment techniques, and method of preparation. Field-walk-surveys searching for the medicinal plants were made to review and document the availability of medicinal plants in different habitats. We recorded information about vernacular names of the plants, purposes of utilization, plant parts used for treatments, health conditions treated, method of preparation, administration, and the habitats of medicinal plants.

## **Plant Identification**

Voucher specimens were collected to document the botanical identifications. Preliminary identifications of medicinal species using vernacular names were made by the healers in the field. Tem Smitinand's Thai Plant Names [28] was used for species initially identified on the basis of their common names. For taxonomic confirmation, comparison with existing collections was performed by one of the authors (W.T.) Voucher specimens were collected in the study sites including the community forests, rice fields, surroundings of the villages and/or in their home gardens. Vouchers are kept in the Department of Science and Technology, Roi Et Rajabhat University, Roi Et province, Thailand.

## **Data analysis**

### **Medicinal disorder terminology**

The use of medicinal plant species within each category, follow standardized descriptors and terms from the Economic Botany Data Collection Standard [29].

### **Quantitative analysis of ethnomedicinal data**

The ethnobotanical data was tested for homogeneity using the Informant Agreement Ratio (IAR), which was performed for each category of disease, and calculated as [30].

$$\text{IAR} = \text{Nur} - \text{Nt} / \text{Nur} - 1$$

where, Nur is the number of use citations from informants for a particular plant-use category, and Nt refers to the number of taxa or species used by all informants for that specific plant use category. IAR

values range between 0 and 1, where 1 indicates the highest level of informant consensus and 0 the lowest.

Use value, which is a quantitative measure that demonstrates the relative importance of plant species known locally, was calculated as [31].

$$UV = \frac{\sum U_i}{N}$$

where, UV is the use value of a species,  $U_i$  is the number of citations for each plant species, and  $N$  is the number of informants. A high use value indicates the potential importance of the plant species reported.

## Results

### Medicinal plants used

A total of 146 species in 127 genera and 60 families of medicinal plants were used for medicinal purposes by 14 traditional healers in this study. The best represented plant families were Fabaceae, which had 12 spp. of medicinal plants (8%), Poaceae (10 spp., 6%), Zingiberaceae and Lamiaceae (8 spp., 5% each), Solanaceae (6 spp., 4% each), Acanthaceae, Amaranthaceae, Annonaceae, Rubiaceae and Euphorbiaceae (5 spp., 3% each), Apocynaceae, Asteraceae, Rutaceae and Menispermaceae (4 spp., 3% each). The remaining families had three (2%) or fewer species. The vernacular names are given for each species in Additional data 1.

### Most used plants

The most important and widely used medicinal plants were *Cyperus rotundus* L. (Cyperaceae) with a use value (UV) of 0.71. The healers used the roots and stems of *Cyperus rotundus* for curing digestive system disorders such as gallstones and flatulence. Furthermore, they used these plants for genitourinary system disorders such as diuretic and venereal disease. The second most important species was *Salacia dongnaiensis* Pierre (Celastraceae) (UV 0.64). They prepared medicine from this plant by decoction of the stem to treat digestive system disorders such as gastritis, diarrhea and as a laxative and to treat flatulence and muscular skeletal system disorders for example as a muscular relaxant. The third most important medicinal species was the palm tree *Borassus flabellifer* L. (Arecaceae) (UV 0.42). They decocted its petiole and inflorescence to treat genitourinary system disorders such as female infertility or they ground the fruit with water to prepare a drink to treat pregnancy/birth/puerperium disorders and as a lactation stimulant (Additional data 1).

### Ailments treated and Informant Agreement Ratio (IAR)

The 14 healers together used medicinal plants to treat 53 specific conditions and ailments. Of these, the category of plants used to treat itching had the highest informant agreement ratio (IAR) value of 0.33

(4 use-reports, 3 spp.), followed by pain with an IAR value of 0.30 (21 use-reports, 15 spp.), and the third was female infertility with an IAR value of 0.25 (13 use-reports, 10 spp.) (Additional data 2). This study found 23 categories of ailments that were treated. The category of plants used to treat digestive system disorders had an informant agreement ratio (IAR) value of 0.35 (57 use-reports, 37 spp.) and this category of treatments also had the highest degree of consensus. The second most important category was pain with an IAR value of 0.31 (21 use-reports, 15 spp.), and the third was genitourinary system disorders with an IAR value of 0.28 (36 use-reports, 26 spp.) (Additional data 3).

### **Parts used**

The most commonly used plant part was the stem, which was used for almost half of the species (69 spp., 48%), followed by the roots (54 spp., 37%), leaves (23 spp., 16%), fruits and whole plants in equal numbers (14 spp., 10%), bark (9 spp., 6%), rhizome (4 spp., 3%), and flowers (3 spp., 2%). Petioles, branches and seeds were used from only 1 species each (<1%) (Additional data 1).

### **Life-forms**

Medicinal plants used by the 14 healers represented five different life-forms, the most common one being trees (including a palm tree and a climbing tree) that were represented by 64 spp. (44%) followed by herbs including exotic herbs (42 spp., 28%), shrubs including some exotic shrubs (20 spp., 14%), vines (18 spp., 9%), grass including a few exotics (7 spp., 5%) (Additional data 1).

### **Preparation**

The healers described 19 different methods that they used to prepare plant medicines. The most common preparation method was decoction of fresh or dried plants (99 spp., 68%), followed by grinding with water (29 spp., 10%), and inhalation (6 spp., 4%) (Table 2).

**Table 2** Preparation of medicinal plants used by 14 healers in Roi Et, Thailand



Preparation methods	Number of species	%
Decoction (fresh/dry parts)	99	68
Grinding with water	29	20
Inhalation	7	5
Eaten fresh incl. dry seed	6	4
Pounded and applied to skin/wound	5	3
Soaked to produce a bath or a drink	5	3
Grinding with water and applied to skin	5	3
Compressed	4	3
Boiled (bath/steaming)	4	3
Grinding with lemon juice as a drink	4	3
Fermented as a drink	3	2
Crushed to cover skin or wound	3	2
Crushed with water as a drink	3	2
Boiled with sugar, fermented and drunk	2	1
Ground to powder	1	<1
Ground with water and mixed with cuttlebone and decocted	1	<1
Pounded with coconut juice and drunk	1	<1
Gel to cover a wound	1	<1
Hair wash	1	<1

### Habitats and status of medicinal plants

The healers collected most of their medicinal plants from their home gardens (60 spp., 41%) followed by the community forest (53 spp., 36%), around their villages (24 spp., 16%), and in rice fields (10 spp., 6%). Buying the plants from other villages was the least used “habitat” for collecting medicinal plants and done for only 3 spp. (2%). The majority of medicinal plants were native to Thailand, while 3 spp. were exotic grasses (3%) and shrubs 2 spp. (1%) (Additional data 1).

## Discussions

### The traditional healers

Traditional healers are an important aspect of life in rural communities around the world [32-37]. Spiritual healing also includes activities taking place within a formal religious context in rural settings in many countries [38]. The type of healer available for consultation, may be traditional or religious, and they are also part of the individual's culture [39] as found in Thailand. The traditional healers who were interviewed for this study were all males. In Thailand, traditional healers are predominantly males as reported in many studies from different parts of the country [2-3,12,40]. Thai culture assumes the traditional role of the man in a family as a leader and primary breadwinner, so men are expected to provide for their families [12]. The number of medicinal plant species known was not related to the healer's age and some herbalists treated only certain ailments such as cancer or postpartum conditions in women as already reported [12]. Herbalists who treat only certain conditions such as cancer, hemorrhoids, or muscular-skeletal disorders may have their knowledge from their parents. Knowledge of traditional healers in Sakornakorn province in northern Thailand was transmitted from their ancestors or parents and was not recorded in written documents [38]. The traditional healers always depended on their memory and familiarity with the plants to use or choose as medicinal plants from the surrounding areas for curing ailments. Some of them had joined training courses provided by the government. It appears that the use of plants in indigenous communities is associated to biological, ecological, and socio-cultural factors, including production techniques and practices, religion, gender, and age [40-41]. Furthermore, Tai Lao healers also used animals and mineral substances for curing ailments, they practiced incantations and held ceremonies as part of the treatments as has also been reported among other cultures [12,38,42]. Medicinal knowledge of healers aims to heal not only physical illness, but also the mind and soul [40]. From the local healers' point of view lack of successors, erosion of knowledge, conflicts with mainstream knowledge, lack of recognition, restrictive regulations for collecting medicinal materials, lack of adequate intellectual property protection, incompatibility of local ownership values with contemporary laws are some of their concerns [43].

### **Numbers of medicinal plants**

The best represented plant family among the medicinal plants was Fabaceae as also found in some other studies [2,12,44]. Fabaceae is a large tropical family and they are common and species rich and much used for medicinal purposes in Thailand [12]. Surprisingly, in this study Poaceae occupied the second most important place among the medicinal plant families of Tai Lao. Normally Poaceae is used for food such as in the case of *Bambusa bambos* (L.) Voss, *Cymbopogon citratus* (DC.) Stapf, and *Zea mays* L. but The Tai Lao healers used this family to treat various ailments such as diabetes, gallstones or jaundice. Some species of Poaceae such as *Bambusa vulgaris* Schrad. ex J.C.Wendl. was used as a decoration tool, *Chrysopogon zizanioides* (L.) Roberty was weedy and used as animal feed but the Tai Lao healers used these species as medicine to treat jaundice and diabetes respectively. This traditional knowledge of healers is unique and it is part of their own traditional health care system, which is different and depends on their origin and cultural pattern. A good example of traditional knowledge was the vernacular names for each species given in Additional data 1. They document one aspect of the Tai Lao traditional knowledge. The vernacular names use a language or dialect which is native to a region or country rather than a literary, cultured, or foreign language. As such vernacular names are related to a

plant or an animal in the common native speech as distinguished from the Latin nomenclature of scientific classification. Most vernacular names were related to or characteristic of a disease, a place, or a group of plants.

### **Most used medicinal plants**

The medicinal plants most used by the Tai Lao healers were entirely different from the most important medicinal plants used by the related and geographically close Phu Tai [12] where *Rothmannia wittii* (Craib) Bremek. had the highest UV and was used to treat jaundice. Similarly, a study among the hill tribes in northern Thailand found differences of traditional knowledge of the Karen and Lawa, who live in adjacent villages within the same habitat and with the same forest resources but they used different species of medicinal plants for the same purposes [45]. This finding resonates with the fact that differences in traditional knowledge is driven by many factors, including cultural, historical and ecological ones [45-46]. The comparison of use of medicinal plants among ethnic groups throughout Thailand found the similarity in the use of plants was not larger for villages inhabited by the same ethnic groups or from the same region than it was for villages inhabited by different ethnic groups or from the different regions. Instead, it appeared that each village had, at least in part, developed its own ethnomedicinal knowledge [47].

### **Ailments or disorder treated and Informant Agreement Ratio (IAR)**

Globally, digestive system disorders have a substantial effect on morbidity and mortality rates, and especially so in developing countries including in Thailand, where the majority of rural areas lack proper sanitation and awareness of disease prevention. This has led to prevalence of different types of digestive diseases [45,48]. This is true in both southern [2,14] and northern Thailand [45,48] and beyond Thailand, such as reported by Naxi healers for farmers in northwestern Yunnan in China [35]. The medicinal plant species used to treat digestive system disorders are mostly different in each ethnic group such as in different hill tribe in northern Thailand, where Karen and Lua use *Leea indica* (Burm. f.) Merr. (Leeaceae) for diarrhea [45] and the Karen use *Zingiber montanum* (J. König) Link ex A. Dietr. (Zingiberaceae) [48] to treat the same condition. In Phatthalung in southern Thailand Zingiberaceae is the most used family including species such as *Boesenbergia rotunda* (L.) Mansf., *Kaempferia galanga* L., *Zingiber officinale* Roscoe, and *Curcuma longa* L. [2]. Furthermore, a total of 37 spp. were used to treat digestive system disorders including *Alpinia galanga* (L.) Willd. which is used as a carminative, *Curcuma longa* L. for flatulence, and *Clausena wallichii* Oliv. and *Croton crassifolius* Geisel. for stomach disorders. However, different patterns can be found in different areas or among different ethnic groups as demonstrated for the Phu Tai healers [12], among whom most medicinal plants are used for treatments of tonic. Pholhiamhan et al. [44] who studied the same ethnic minority group but in a different part of the Nakhon Phanom province found that most medicinal plants were used for injuries. A study among hill tribes in northern Thailand [15] found that skin and subcutaneous cellular tissue disorders were the conditions treated by most plants. Srithi et al. [49] found the use categories with most use-reports were for birth-related conditions. In Jashpur district of Chhattisgarh, India, skin diseases, diabetes, and

weakness were the most common disorders reported [36]. In the indigenous knowledge on medicinal plant use by traditional healers in Oshikoto region, Namibia, disorders with the highest number of species being used were mental diseases followed by skin infection and external injuries [50].

### **Plant parts used**

Among the different parts of the medicinal plants, the stem was most frequently used for making medicines, followed by roots and leaves. This agrees with other studies in northern and northeastern Thailand [12]. Traditionally different parts of plants such as stem, roots, fruit, leaves, and seeds are being used for the treatment of different ailments [51]. The therapeutic potential of different plant parts is attributed to differences in concentrations in different plant parts of phytochemical compounds such as tannins, terpenoids, alkaloids, etc. [52]. Dried wood or roots can maintain their bioactive compounds for a longer time after harvesting than leaves can [53]. However, local healers are often concerned about how the use of different plant parts may affect the survival of the medicinal plants' populations [54]. Traditionally, leaves have been the most favored part used for medicinal purposes in many parts of the world for example in Singapore [51], India [55], Turkey [56], and Ethiopia [57]. This may be because leaves are soft, easy to use, their drug contents can be readily extracted, and they can be harvested in every season [54]. On the other hand, a study conducted in India [36] showed that roots were the most commonly used part followed by leaves. This discrepancy is probably due to the diversity of plants, weather conditions, and chemical compounds present in the plant parts in different geographic areas. In southern Thailand underground parts were also the most used part of medicinal plants. These differences can be explained by environmental conditions and cultural patterns in the traditional uses of plants by each ethnic minority [12]. However, further and detailed phytochemical screenings of medicinal herbs are required. For traditional knowledge, it is essential to have proper documentation of the plants involved and to know their potential for the improvement of health. Accepting traditional knowledge in a modern context will depend on the scientific backup of the reported effects. Importance should be given to the potential of ethnomedicinal studies as these can be an important base for the discovery of useful medicinally active compounds in plants [36].

### **Life forms of medicinal plants**

Five life forms of medicinal plants were used by the 14 healers, the most common one being trees (including a tree palm and a climbing tree) followed by herbs, shrubs, vines, and grasses. The same life forms were most commonly represented among medicinal plants used by the the closely related ethnic minority group, the Phu Tai [12] and in Namibia [48] but healers in Phatthalung in Peninsular Thailand [2] most commonly used shrubs as medicinal plants. In China the majority of medicinal plants in Naxi homegardens were herbaceous followed by trees shrubs, and lianas [35] and in India herbs are commonly used as medicinal plants [36].

### **Preparation of medicinal plants**

The Tai Lao healers interviewed here described 19 different methods that they used to prepare plant medicines. These results differ from the Phu Tai ethnic group [12] in total numbers of methods. However, the most common preparation method, which was decoction was also the most common method reported in previous ethnomedicinal studies in Thailand [2,12,45,53] and also in Singapore [51], Nigeria [58], and India [59]. The frequent use of oral ingestion of a decoction is most likely because it is an easy way to administer the medicine [60] and it makes it possible to adjust the taste of the medicine for individual patients. Other methods recorded here and in other studies was inhalation and fermentation. The Tai Lao healers used leaves of *Allium ascalonicum* L. to treat fevers or *Allium cepa* L. and *Nicotiana tabacum* L. to treat nasal polyps by inhalation. This method was commonly used to treat respiratory or circulatory system disorders. The Tai Lao healers also fermented fruit of *Phyllanthus emblica* L. to treat goiter and mumps. *Tinospora crispa* (L.) Hook. f. & Thomson was prepared in the same way to treat liver disorders.

### **Habitats and availability of medicinal plants**

Most medicinal plants used by Tai Lao traditional healers were gathered from their home gardens including such species as *Allium ascalonicum* L. (Amaryllidaceae), *Allium sativum* L., *Alpinia galanga* (L.) Willd. (Zingiberaceae), *Ananas comosus* (L.) Merr. (Bromeliaceae), *Carica papaya* L. (Caricaceae), *Citrus hystrix* DC. (Rutaceae), *Allium cepa* L., *Boesenbergia rotunda* (L.) Mansf. (Zingiberaceae), and *Cymbopogon citratus* Stapf (Poaceae). The same species were also used for food by the villagers. For convenience, these medicinal plants were moved and planted in home gardens and used whenever required [2]. This was also the case among the Naxi healers in southern China [35] where home gardens are ecologically and culturally important systems in which healers cultivate medicinal plants for the wellbeing of farmers. In Naxi only the healers cultivated medicinal plants in their home gardens and they rarely sold them. Plant resources are important to communities where the majority of households rely on integration of traditional knowledge and western medicine for their wellbeing. Medicinal plants maintained in ethnic home gardens are valuable not only for food but also for their economic and ornamental properties [35]. In our study, the majority of medicinal plants were native to Thailand, while, a few exotic plants were used medicinally such as *Cymbopogon citratus* Stapf (Poaceae), the shrub *Pandanus amaryllifolius* Roxb. (Pandanaceae), and *Plumbago indica* L. (Plumbaginaceae) (Additional data 1). In contrast to the dominance of homegarden plants in this study, most medicinal plants used by the Phu Tai ethnic group [12] and in Phatthalung province, Thailand [2], were gathered from community forests.

## **Conclusion**

Northeastern Thailand is rich in traditional knowledge of herbal medicine with diverse ethnobotanical values. Traditional knowledge of Tai Lao healers revealed here includes large amounts of novel information for northeastern Thailand including 146 spp., 127 genera, and 60 families relating to the treatment of various diseases disorder and relief of 26 ailments. Even though conventional medicine is available, many people in rural communities continue to depend on traditional knowledge. Primary

healthcare with highly experienced of traditional healers is still important in their communities, at least for the treatment of simple ailments such as, pain, inflammation, digestive system disorders, wound or skin diseases and pregnancy/birth/puerperium disorders in postpartum women. Conservation efforts and evidence-based policies are needed to preserve the ecological and cultural base on the maintenance of medicinal plant that are use for rural community wellbeing. In the future the traditional knowledge on medicinal plants of Tai Lao healers could boost new innovations in the pharmaceutical industry such as plant used for treatments of cancer; *Cyperus rotundus* L., *Cyathula prostrata* (L.) Blume, *Entada rheedii* Spreng., *Lawsonia inermis* L. should be subjected to pharmacological study to validate their use and to isolate their bioactive compounds. Plant used for injuries or wound such as *Pogonatherum paniceum* (Lam.) Hack., *Clausena wallichii* Oliv. *Clinacanthus nutans* (Burm. F.) Lindau should be examined for antibacterial activities. Plants used for tonic or nutritional disorders such as *Cissampelos pareira* L., *Imperata cylindrica* (L.) P.Beauv. or *Sida acuta* Burm. f. etc. should be determined the antioxidant activity for health promotion for Thailand healthcare sector.

## Abbreviations

IAR: Informant Agreement Ratio; UV: Use values;  $\sum U_i$ : sum of uses; N: number of informants; G:Grass; ExG: Exotic Grass; H:Herb; S:Shrub; ExS: Exotic Shrub; T:Tree; CT: Climbing Tree; PT:Palm Tree; V:Vine

## Declarations

### Acknowledgements

We are really thankful to the 14 Tai Lao traditional healers for their cooperation. Thanks to Assoc. Boonsatien Boonsoong for mapping study areas.

### Author's Contributions

Conceptualization, A.J., validation and formal analysis, A.J. O.N., P.C., writing original draft, A.J., review and editing, supervision, H.B., plant identification, W.T.

### Funding

This study was supported by the Thai Government for Science and Technology scholarship 2016. Henrik Balslev thanks the Carlsberg foundation for support to study the Thai flora (grant #CF14-0245).

### Availability of data and materials

All the data are in manuscript and supporting documents.

### Ethnics approval and consent to participate

This study was authorized by the Science and Technology Department and The Research and Development Institute, Roi Et Rajabhat University (ORIC-RERU), Roi Et, Thailand.

### **Consent for publication**

All authors read and approved the final manuscript for publication.

### **Competing Interest**

The authors declare that they no competing interest.

### **Author's details**

<sup>1</sup> Department of Science and Technology, Faculty of Liberal Arts and Science, Roi Et Rajabhat University, Selaphum, Roi Et 45120, Thailand. <sup>2</sup> Queen Sirikit Botanical Garden, Mae Rim, Chiang Mai 50180, Thailand

<sup>3</sup> Ecoinformatics and Biodiversity, Department of Biology, Aarhus University Build 1540, Ny Munkegade 114, 8000 Aarhus C, Denmark.

## **References**

1. He K. Traditional Chinese and Thai medicine in a comparative perspective. *Complement Ther Med.* 2015;23(6):821–826.
2. Maneenoon K, Khuniad C, Teanuan Y, Saedan N, Prom-in S, Rukleng N, Kongpool W, Pinsook P, Wongwiwat W. Ethnomedicinal plants used by traditional healers in Phatthalung Province, Peninsular Thailand. *J Ethnobiol Ethnomed.* 2015;11:43.
3. Suwankhong D, Liamputtong P, Rumbold B. Existing roles of traditional healers (mor baan) in southern Thailand. *J Commun Health.* 2011;36:438–45.
4. Chokevivat V, Chuthaputti A, Chuthaputti P. The Use of Traditional Medicine in the Thai Health Care System. Regional Consultation on Development of Traditional Medicine in the South East Asia Region, Pyongyang, DPR Korea, 22-24 June 2005.
5. Jesho K, Lerkiatbundit S, Wiroonpanich W. Integration of Thai traditional medicine into physicians' practice part 1: Conditions facilitating the integration. *TJPS.* 2015;39(2): 35-63.
6. Onchomchan D. Promoting the development of folk massage in health care and enhancing Nonthaburi community income: Thai Folk Medicine Group, Department of Development Medical Services, Thai Traditional and Alternative Medicine, Ministry of Public Health; 2005.
7. Amiri MS, Joharchi MR. Ethnobotanical investigation of traditional medicinal plants commercialized in the markets of Mashhad, Iran. *Avicenna J Phytomed.* 2013;3:254–271.
8. Al-Douri NA, Al-Essa LY. A survey of plants used in Iraqi traditional medicine. *Jordan J Pharm Sci.* 2010;3(2):100–108.

9. Pandikumar P, Chellappandian M, Mutheeswaran S, Ignacimuthu S. Consensus of local knowledge on medicinal plants among traditional healers in Mayiladumparai block of Theni District, Tamil Nadu, India. *J Ethnopharmacol.* 2011;134:851–864.
10. Shah A, Marwat SK, Gohar F, Khan A, Bhatti KH, Amin M, Ud ND, Ahmad M, Zafar M. Ethnobotanical study of medicinal plants of semi-tribal area of Makerwal & Gulla Khel (lying between Khyber Pakhtunkhwa and Punjab Provinces), Pakistan. *Am J Plant Sci.* 2013;4:98–116.
11. Ghasemi PA, Momeni M, Bahmani M. Ethnobotanical study of medicinal plants used by Kurd tribe in Dehloran and Abdanan districts, Ilam province, Iran. *Afr J Tradit Complement Altern Med.* 2012; 10(2): 368–385.
12. Junsongduang A, Kasemwan W, Lumjoomjung S, Sabprachai W, Tanming W, Balslev H. Ethnomedicinal Knowledge of Traditional Healers in Roi Et, Thailand. *Plants.* 2020;9(9):1177.
13. Neamsuvan O, Madeebing N, Mah L, Lateh W. A survey of medicinal plants for diabetes treating from Chana and Nathawee district, Songkla province, Thailand. *J Ethnopharmacol.* 2015;174:82-90.
14. Neamsuvan O, Ruangrit T. A survey of herbal weeds that are used to treat gastrointestinal disorders from southern Thailand: Krabi and Songkhla provinces. *J. Ethnopharmacol.* 2017;196:84–93
15. Inta A, Shengji P, Balslev H, Wangpakapattanawong P, Trisonthi C. A comparative study on medicinal plants used in Akha's traditional medicine in China and Thailand: cultural coherence or ecological divergence? *J. Ethnopharmacol.* 2008;116:508–517.
16. Thomas E, Vandebroek I, Sanca S, Damme PV. Cultural significance of medicinal plant families and species among Quechua farmers in Apillapampa, Bolivia. *J. Ethnopharmacol.* 2009;122:60–67.
17. Vandebroek I. The dual intracultural and intercultural relationship between medicinal plant knowledge and consensus. *Economic Botany.* 2010;64:303–317.
18. Canales M, Hernandez T, Caballero J, Romo de Vivar A, Avila G, Duran A, Lira R. Informant consensus factor and antibacterial activity of the medicinal plants used by the people of San Rafael Cuscatlán, Puebla, Mexico. *J. Ethnopharmacol.* 2005;97:429–439.
19. Case RJ, Franzblau SG, Wang Y, Cho SH, Soejarto DD, Pauli GF. Ethnopharmacological evaluation of the informant consensus model on antituberculosis claims among Manus. *J. Ethnopharmacol.* 2006;106: 82–89.
20. Etkin NL, Elisabetsky E. Seeking a trans disciplinary and culturally germane science: the future of ethnopharmacology. *J. Ethnopharmacol.* 2005;100:23–36.
21. Keyes CF. *Isan: Regionalism in Northeastern Thailand.* Ithaca, N.Y. Department of Asian Studies, Cornell University; 1967.
22. Lawler J. Diversity issues in South-East Asia: the case of Thailand. *International Journal of Manpower.* 1996;17:4/5:152-167.
23. Hattaway P. *Isan.* In: *Peoples of the Buddhist world – A Christian prayer diary*, ed. P. Hattaway, Pasadena, CA: William Carey Library; 2004.

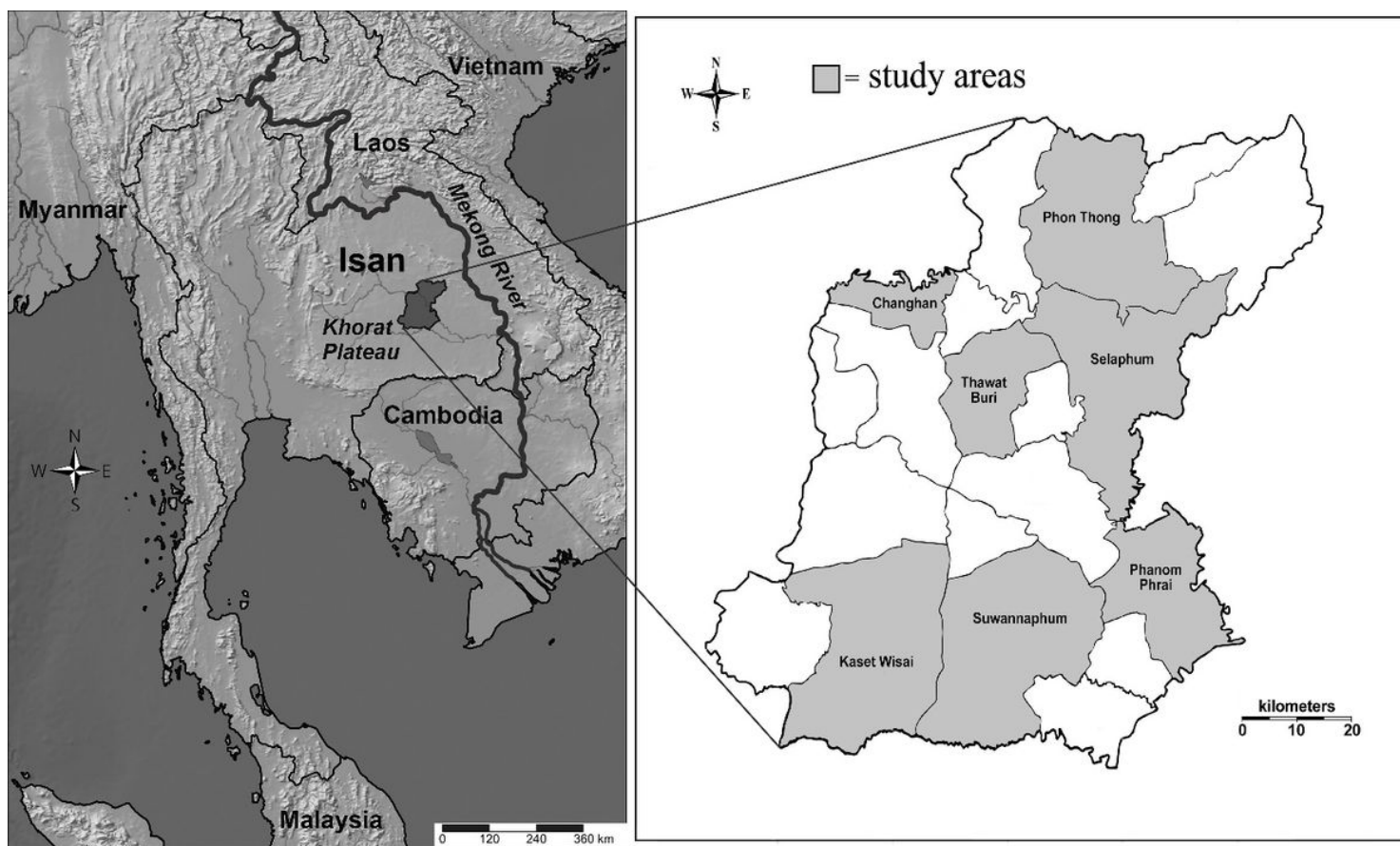


24. Grabowsky V. The Isan up to its integration into the Siamese state. In *Regions and National Integration in Thailand 1982 - 1992*; Harrossowitz W.; Ed; Wiesbaden: Harrassowitz Verlag; Germany; 1995.
25. Sulaiman, Shah S, Khan S, Bussmann RW, Ali M, Hussain D, Hussain W. Quantitative Ethnobotanical study of indigenous knowledge on medicinal plants used by the tribal communities of Gokand valley, district Buner, Khyber Pakhtunkhwa, Pakistan. *Plants*. 2020;9(8):1001
26. Bernard HR. *Social Research Methods: Qualitative and Quantitative Approaches*, 2nd ed.; SAGE Publications: Thousand Oaks, CA, USA; 2013.
27. Biernacki P, Waldorf D. Snowball sampling: Problems and techniques of chain referral sampling. *Sociological Methods & Research*. 1981;10(2):141–163.
28. Pooma R, Suddee S. *Tem Smitinand's Thai Plant Names*; Department of National Parks, Wildlife and Plant Conservation, The Office of the Forest Herbarium: Bangkok, Thailand; 2014.
29. Cook FEM. *Economic Botany Data Collection Standard*; Royal Botanic Gardens (Kew): Richmond, UK; 1995.
30. Trotter RT, Logan MH. Informant census: A new approach for identifying potentially effective medicinal plants. In *Plants in Indigenous Medicine and Diet*; Etkin LN, ed.; Bedford Hill: New York, USA; 1986.
31. Phillips OL, Gentry A, Reynel C, Wilkin P, Gálvez-Durand BC. Quantitative Ethnobotany and Amazonian Conservation. *Conserv. Biol*. 1994;8:225–248.
32. Truter I. African traditional healers: cultural and religious beliefs intertwined in a holistic way. *SA Pharmaceutical Journal*. 2007;56-60.
33. O'Brien KS, Soliman AS, Annan K, Lartey RN, Awuah B, Merajver SD. Traditional herbalists and cancer management in Kumasi, Ghana. *J Canc Educ*. 2012;27:573–579.
34. Boudjelal A, Henchiri C, Sari M, Sarri D, Hendel N, Benkhaled A, Ruberto G. Herbalists and wild medicinal plants in M'Sila (North Algeria): An ethnopharmacology survey. *J. Ethnopharmacol*. 2013;148: 395–402.
35. Yang L, Ahmed S, Stepp JR, Mi K, Zhao Y, Ma J, Liang C, Pei S, Huai H, Xu G, Hamilton AC, Yang Z, Xue D. Comparative home garden medical ethnobotany of Naxi healers and farmers in Northwestern Yunnan, China. *J Ethnobiol Ethnomed*. 2014;10:6
36. Mehta R. Medicinal Plants used by traditional healers in Jashpur District of Chhattisgarh, India. *Life Sciences Leaflets*. 2013;1:31-41.
37. Joshi AR, Joshi K. Indigenous knowledge and uses of medicinal plants by local communities of the Kali Gandaki Watershed Area, Nepal. *J Ethnopharmacol*. 2000;73(1-2):175-183.
38. Jearanai C, Natprapai N, Suwannobon N, Juraree S. A study of traditional Thai complementary therapies, traditional Thai midwifery, and herbal utilization of traditional healers: A case study of traditional healers living in Num Pung Dam, Sakon Nakhon province. Research report, Ruranaree University, Thailand; 2019.

39. Cook GC, Zumla A. Manson's tropical diseases; 22<sup>nd</sup> ed. The Publisher, China; 2009.
40. Sumungkaset A, Nantasri C. Knowledge and wisdom of folk healers in Namon district, Kalasin Province (in Thai). *TLC Research J.* 2016;9(2):87–105.
41. Beltrán-Rodríguez L, Ortiz-Sánchez A, Mariano NA, Maldonado-Almanza B, Reyes-García V. Factors affecting ethnobotanical knowledge in a mestizo community of the Sierra de Huautla Biosphere Reserve, Mexico. *J Ethnobiol Ethnomed.* 2014;10(1):14.
42. Burn V. Traditional Thai medicine. In *Medicine across Cultures: History and Practice of Medicine in NonWestern Cultures*; Selin, H., ed.; Kluwer Academic Publishers: London, UK, 2003.
43. Payyappallimana U. Role of traditional medicine in primary health care: An overview of perspectives and challenges. *Yokohama Journal of Social Sciences.* 2010;14(6):723-743.
44. Pholhiamhan R, Saeunsouk S, Saeunsouk P. Ethnobotany of Phu Thai ethnic group in Nakhon Phanom province, Thailand. *Walailak J. Sci. Tech.* 2018;15:679–699.
45. Junsongduang A, Balslev H, Inta A, Jampeetong A, Wangpakapattanawong P. Karen and Lawa medicinal plant use: Uniformity or ethnic divergence? *J. Ethnopharmacol.* 2014;151:517–527.
46. Gruca M, Andel TR, Balslev H. Ritual uses of palms in traditional medicine in sub-Saharan Africa: A review. *J Ethnobiol Ethnomed.* 2014;10: 60.
47. Phumthume M, Balslev H. Use of medicinal plants among Thai ethnic groups: A comparison. *Economic Botany.* 2019;73:64–75.
48. Tangjitman K, Wongsawad C, Kamwong K, Sukkho T, Trisonthi C. Ethnomedicinal plants used for digestive system disorders by the Karen of northern Thailand. *J. Ethnopharmacol.* 2015;11(1):12-17
49. Srithi K, Balslev H, Wangpakapattanawong P, Srisanga P, Trisonthi C. Medicinal plant knowledge and its erosion among the Mien (Yao) in northern Thailand. *J. Ethnopharmacol.* 2009;123:335–342.
50. Cheikhyoussef A, Shapi M, Matengu K, Ashekele HM. Ethnobotanical study of indigenous knowledge on medicinal plant use by traditional healers in Oshikoto region, Namibia. *J Ethnobiol Ethnomed.* 2011;7(10): 1–11.
51. Siew YY, Zareisedehizadeh S, Seetoh WG, Neo SY, Tan CH, Koh HL. Ethnobotanical survey of usage of fresh medicinal plants in Singapore. *J. Ethnopharmacol.* 2015;155:1450–1466.
52. Ashraf MU, Muhammad G, Hussain MA, Bukhari SNA. *Cydonia oblonga* M. A medicinal plant rich in phytonutrients for pharmaceuticals. *Front. Pharmacol.* 2016;7:163.
53. Phumthum M, Srithi K, Inta A, Junsongduang A, Tangjitman K, Pongamornkul W, Trisonthi C, Balslev H. Ethnomedicinal plant diversity in Thailand. *J. Ethnopharmacol.* 2018;214:90–98,
54. Neumsuvan O, Komonhiran P, Boonming K. Medicinal plants used for hypertension treatment by folk healers in Songkhla province, Thailand. *J. Ethnopharmacol.* 2018;214:58–70.
55. Yabesh JEM, Prabhu S, Vijayakumar S. An ethnobotanical study of medicinal plants used by traditional healers in silent valley of Kerala, India. *J. Ethnopharmacol.* 2014;154:744–789.
56. Güler B, Manav E, Uğurlu E. Medicinal plants used by traditional healers in Bozüyük (Bilecik–Turkey). *J. Ethnopharmacol.* 2015;173:39–47.

57. Yineger H, Yewhalaw D. Traditional medicinal plant knowledge and use by local healers in Sekoru District, Jimma Zone, Southwestern Ethiopia. *J Ethnobiol Ethnomed.* 2007;3:24.
58. Benarba B, Belabid L, Righi K, Bekkar A, Elouissi M, Khaldi A, Hamimed A. Ethnobotanical study of medicinal plants used by traditional healers in Mascara (North West of Algeria). *J. Ethnopharmacol.* 2015;175:626–637.
59. Mutheeswaran S, Pandikumar P, Chellappandian M, Ignacimuthu S. Documentation and quantitative analysis of the local knowledge on medicinal plants among traditional Siddha healers in Virudhunagar district of Tamil Nadu, India. *J. Ethnopharmacol.* 2011;137:523–533.
60. Lamxay V, Boer HJ, Björk L. Traditions and plant use during pregnancy, childbirth and postpartum recovery by the Kry ethnic group in Lao PDR. *J. Ethnobiol. Ethnomed.* 2011;10(7): 14.

## Figures



**Figure 1**

Location of Roi Et province in Thailand where ethnobotanical data concerning medicinal plants were collected in seven districts.

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Additionaldata1Plantlisteditedsubmitver..docx](#)
- [Additionaldata23IARfinal.docx](#)