Forest and Society. Vol. 3(2): 171-192, November 2019
Received: 2019-01-22; Accepted: 2019-04-30
ISSN: 2549-4724, E-ISSN: 2549-4333

Regular Research Article

Ethnobotanical study on medicinal plants in traditional markets of Son La province, Vietnam

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Abstract: Traditional markets in Vietnam are considered as important places for trading medicinal plants and also play a social role of exchanging traditional use of herbal medicine among different cultural and social groups at the local level. This study aims to identify and document medicinal plants used in 32 traditional markets of Son La province. Data were obtained through interviews and field observation method. A total of 167 informants include 13 herbalists, 49 herbal sellers, and 105 local people were interviewed. The study collected a total of 99 plant species belonging to 88 genera and 57 families. Identified plant species are used by local people for the treatment of 61 different diseases. Leaves, stems and roots are most commonly used either fresh, dried or by decocting the dried parts in water. In the study, the Relative Frequency of Citation (RFC) ranged from 0.02 to 0.44; the Use Value (UV) ranged from 0 to 0.84; the Informant Consensus Factor (ICF) ranged from 0.84 to 1; the Fidelity Level (FL) ranged from 44.44% to 100%. Villagers view and our observations confirmed that knowledge about the number of medicinal plants available in the study area and used by interviewees positively correlated with the threats on medicinal plants in the wild habitats. Illegal and unsustainable exploitation by the local people is a major cause of their depletion from nature.

Keywords: Ethnic people; Ethnobotany; medicinal plants; Son La province; traditional markets

1. Introduction

The traditional use of medicinal plants has been an ancient practice for a long time, with traditional knowledge being transferred from generation to generation and among communities (Samy and Ignacimuthu, 2000; Pieroni and Quave, 2005; Verpoorte et al., 2005; Vitalini et al., 2013). About 80% of the world's population relies on traditional medicine, especially in remote areas in developing countries where medicinal plants may form the only available source of health care (Hoang et al., 2008a; Hoang et al., 2019; van Andel, 2000; van Andel et al., 2015).

Medicinal plants can be of a great importance in daily lives of those who live near places where they grow not only for their healing abilities, but also as a commodity to be sold in urban areas (Ticktin, 2004). The world market for herbal remedies in 1999 was calculated to be worth US$ 19.4 billion (Hamilton, 2004), and for herbal medicines based on traditional knowledge the estimate was US$ 60 billion in 2000 (UNCTAD, 2000).

Herbal markets are cultural places for human societies where a variety of herbal medicines are traded and represent the biological diversity of an area (de Albuquerque et al., 2007). Herbalists purchase and sell medicinal plant species and offer their traditional knowledge about the use of plants, which parts to use, modes of utilization, dosages and herbal recipes and other information (Da Rocha Silva and Andrade, 2005; Leitão et al., 2009; Santos et al., 2009). The trade of medicinal plants in herbal markets represents a traditional healthcare system where precious traditional knowledge translates into the transmission of valuable traditional and biological knowledge from indigenous communities (Baldé et al., 2006). This fact is particularly evident in the practices of local communities living in rural areas.

 http://dx.doi.org/10.24259/fs.v3i2.6005

In Vietnam, there are various herbal markets located in Hanoi and Ho Chi Minh Cities, Quang Ninh, Lao Cai and Quang Nam provinces. Medicinal plant-use in Vietnam spans all socioeconomic levels and the trade of herbal remedies in markets depends on herbalists, herbal industries, and patients who use herbal medicines to cure various diseases. The domestic market of medicinal plants of Vietnam is not well documented, and the market for medicinal plants and derivatives only represents a small fraction compared to all internal and external trade of the country fueled by growing demand, that is why ethnobotanical studies of traditional markets and their history are needed.

Many ethnobotanical studies on traded herbal medicines have been conducted across continents in Asia, Africa, Oceania, and Latin America, and their findings contribute to the understanding of plant diversity through the trade of medicinal plant species and their cultural values. Our study focused on Son La province of Vietnam, the region with great potential in exploitation and consumption of medicinal plants. The present study aimed to elicit data on the traditional uses of medicinal plants marketed in Son La province. Using ethnobotanical indices such as Relative Frequency of Citation (RFC), Use Value (UV), Fidelity Level (FL), Informant Consensus Factor (ICF) to provide information on how much in demand of the medicinal plants and their availability status. In addition, the present paper provides baseline data for the preservation of traditional knowledge and its potential in clinical practice.

2. Methods

2.1 Study area

Son La is a province in the Northwest region of Vietnam. The total area of Son La is 14,055 km2, and is one of the five largest provinces in Vietnam. Its approximate geographic location is 20039' – 22002' North and 103011' – 105002' East. It borders Lao Cai province and Yen Bai province in the North; Phu Tho province and Hoa Binh province in the East, Laos in the south and Dien Bien province and Lai Chau province in the West (Figure 1). The physical features of this region exhibit the diversity of plateaus, valleys, ravines streams, and plains with altitudes ranging between 100 and 2879 m above sea level. The mountainous forest environment habitats have very large number of plant species, with 1.187 species of 645 genera and 161 families were reported.

Population of the province is 1.195.107 people belonging to 12 ethnic groups: Thai, Kinh, Hmong, Muong, Dao, Khomu, Xinhmun, Khang, Laha, Lao, Tay and Hoa, with Thai being the major group. Each ethnic group has its own language and eight of them (the Kinh, Thai, Mong, Dao, Tay, Dao, Lao, and Hoa) have their own scripts and written language. All ethnic groups have their own history and long periods of interaction with each other.

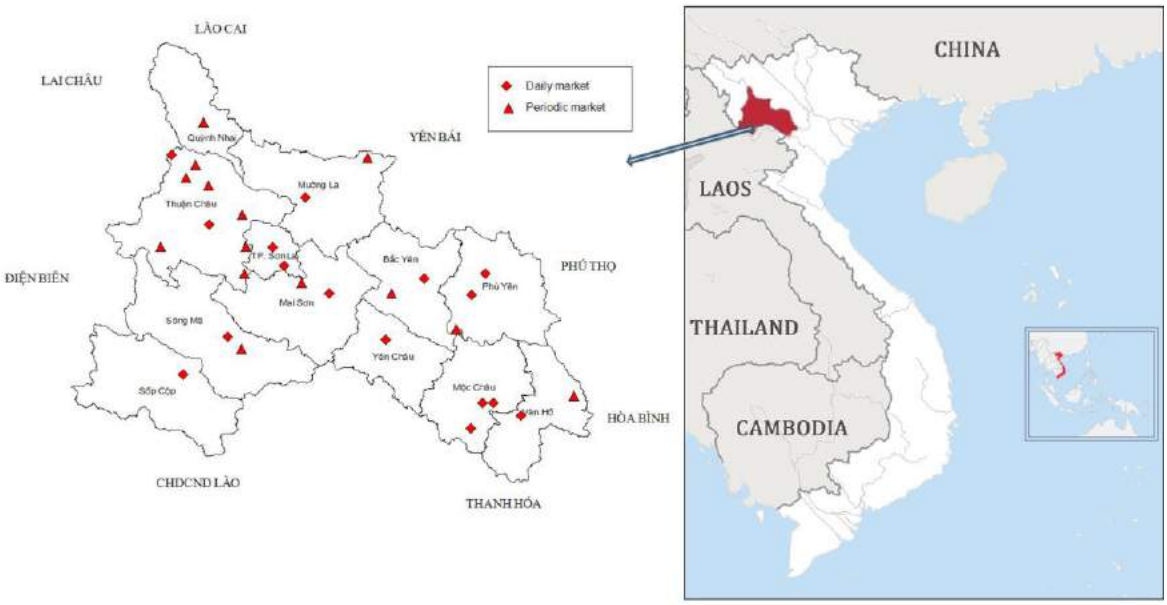

Figure 1. Geographical location of study area, Son La province, Vietnam

2.2 Ethnobotanical data collection

From January 2016 to June 2018, 64 visits were carried out in each of the 17 daily markets and 15 periodic markets located in 12 districts of Son La province. Goods found at the daily markets most frequently include personal use items, electronic equipment, groceries, cooked foods, meat products, vegetables, fruits, and fresh or dry raw medicinal plants. Besides the main daily markets, periodic markets occur weekly. Vendors at periodic markets are rural harvesters and/or small retailers who sell medicinal plants, meat products (pork and beef), fruits, and vegetables.

Ethnobotanical interviews were used as the basis for data gathering by using semi-structured questionnaires and open-ended interviews, adopting the standard methodology followed by Martin (2004). The questionnaire used in the study was developed following the works of Martin (1995), and Pardo-de-Santayana et al. (2007). In total 167 informants (vendors and healers, middlemen, long-distance traders and consumers) in the age from the age of 17 to 70 were interviewed. Ethnobotanical information, including the various data such as name, gender, age, education, experience, vernacular names of the plants and their uses, methods of preparation, places of supply, medical indications and diseases were defined locally by healers (Cunningham, 2001; Given and Harris, 1994; Martin, 1995). After collecting the specimens, we represented these specimens to different people to confirm the accuracy of the results. Medicinal plants were also checked and compared with the 'Vietnam medicinal plants' (Loi, 1995), 'Dictionary of medicinal plants of Vietnam' (Chi, 1996), 'Plants of Vietnam' (Ho, 2000), confirmed from online databases namely: The Plant List and the Kew Botanic Garden medicinal Plant Names services.

2.3 Statistical analysis

The database resulting from the ethnobotanical inventory used quantitative ethnobotanical indices consisting of RFC, UV, FL and ICF.

2.3.1 Relative frequency of citation (RFC)

This index shows the local importance of plant species based on a number of informants for each species and total informants interviewed in the study. Relative frequency of citation (RFC) in this study is used as followed by Tardío and Pardo-de-Santayana (2008) and recently used by Vitalini et al. (2013), Yaseen et al. (2015) and Bano et al. (2014)

$$FRC = \frac{FC}{N} \quad (0 < \mathrm{FRC} < 1)$$

Where FC is the number of informants who mention the use of the species;
N is the number of informants participating in the survey.

2.3.2 Use value (UV)

The use value (UV) is an ethnobotanical index that shows the relative importance of plant species known locally based on the number of recorded uses for each species. It was calculated by following the formula given by Phillips and Gentry (1993) who modified the index of Prance et al. (1987) by including the number of informants citing a given plant-use. Their UV) index for species "s" is defined by the following formula simplified by Rossato et al. (1999), de Albuquerque et al. (2007) and Hoang et al. (2008b):

$$\mathrm{UV} = \sum \mathrm{Ui}/\mathrm{N}$$

Where U i is the number of different uses mentioned by each informant i and N is the total number of informants interviewed in the survey.

2.3.3 Fidelity level (FL)

Fidelity level determines the specific uses of each plant species and preference over other species. It expresses the specificity of disease treated by a reported plant species. It is calculated by using a formula adopted by Khan et al. (2015).

$$\mathrm{FL} = (I_p/I_u) \times 100$$

Where "Ip" is the number of informants who share their knowledge about a given species for the treatment of a specific disease and "Iu" is the total number of all informants who reported all uses about a given plant species (Al-Qura'n, 2009)

2.3.4 Informant consensus factor (ICF)

The level of homogeneity among information provided by different informants was calculated by the Informants' Consensus Factor Trotter and Logan (1986) and Heinrich M et al. (1998) using the following formula:

$$IFC = \frac{Nur - Nt}{Nur - 1}$$

Where, Nur = number of use reports from informants for a particular plant-use category; Nt = number of taxa or species that are used for that plant use category for all informants. IFC Values range between 0 and 1, where '1' indicates the highest level of informant consent.

3. Results and discussion

3.1 Informants' sociodemographic profile

Two hundred thirty-five individuals were approached in total, but 68 participants refused to

join in the study claiming not to know about medicinal plants and their uses, thus they were not interviewed (47 men and 21 women). In total 167 people including 13 herbalists, 49 herbal sellers, and 105 local people (Table 1) were interviewed using ethnobotanical questionnaires, open-ended interviews. In ethnobotanical studies, the gender, education level, and age are factors that influence the transmission of traditional knowledge on therapeutic uses of medicinal plants in any ethnic community (Bano et al., 2014).

Table 1. Demographic profile of Informants

Variable	Category	No. of Informant	Percentage
Gender			
	Female	102	61.08
	Male	65	38.92
Age			
	17-20	6	3.59
	21–30	13	7.78
	31-40	50	29.94
	41-50	57	34.13
	51-60	32	19.16
	61-70	9	5.39
Education			
	Illiterate	9	5.39
	Primary Education	64	38.32
	Secondary Education	62	37.13
	Higher Education	32	19.16
Informants			
	Local People	105	62.87
	Herbalist	13	7.78
	Herb seller	49	29.34
Experience of Herbal sellers			
	Less than 2 years	7	14.29
	2–5 years	12	24.49
	5–10 years	19	38.78
	10–20 years	8	16.33
	More than 20 year	3	6.12
Experience of Herbalists			
	Less than 2 years		0.00
	2–5 years	6	46.15
	5–10 years	4	30.77
	10–20 years	2	15.38
	More than 20 year	1	7.69
Ethnic groups			
	Muong	26	15.57
	Hmong	35	20.96
	Kinh	46	27.54
	Thai	52	31.14
	Other	8	4.79

Among the informants, females account for 61.08% (102 individuals), while males account for 32.08% (65 individuals). This is an indication that women are more familiar with medicinal plants knowledge and use. This can be explained by the fact that, women are usually responsible for health care in their household, while having better knowledge of medicinal plants than men and are also predominantly engaged in collecting and trading in medicinal plants. All 68 people who claimed not to know about medicinal plants were younger than 30 years old. These proportions are indicative of generational differences in knowledge about medicinal plants, older people have more knowledge due to their experience accumulated with age. The informants below the age of 30 have less knowledge on the medicinal plants and used smaller number of medicinal plants remedies. A number of studies have documented that the lack of traditional knowledge among younger people, and this has been attributed to the expansion of modern education, cultural

change, and the influences of modernization (Srithi et al., 2009). As a result of changing realities, traditional knowledge of medicinal plants that were once embedded in numerous indigenous cultures is rapidly disappearing. It has been suggested that to avoid the loss of this intellectual heritage, it is necessary to either keep it alive or at least to document and describe the traditional use of plants (Bussmann and Sharon, 2006).

In education, 38.32% (64 individuals) had passed only the primary level, 37.13% (62 individuals) had passed secondary school level, 19.16% (32 individuals) had higher education, while only 5.39% (nine individuals) were illiterate. In the study area, traditional knowledge of medicinal plants is commonly found among people with a low level of education. Among all informants 31.14% were Thai ethnic group, 27.54% Kinh ethnic group, 20.96% Hmong ethnic group, 15.57% Muong ethnic groups and 4.79% of other ethnicity. In the present study, the Thai and Muong ethnic groups informants showed a greater diversity of traditional knowledge of using medicinal plants compared to other ethnic groups interviewed.

3.2 Ethnobotanical data on medicinal plant diversity

3.2.1 Diversity of medicinal plants

The study recorded 99 medicinal plants species traded in 32 traditional markets within the Son La province, belonging to 88 genera in 57 families (Table2). These species are the major ingredients and hold properties for 142 different treatments and recipes. For most species only one recipe was mentioned; some have multiple medicinal applications (Figure 2). The number of medicinal plant species sold in markets within the Son La province is 3.2% of the total medicinal plant species in Vietnam (Chi 1996). The plant families with the highest number of recorded species were, in order, Zingiberaceae with eight species (7.6%), Cucurbitaceae with five species (4.8%), Fabaceae with five species (4.8%), Euphorbiaceae with four species (3.8%), Amaranthaceae with three species (2.9%), Asteraceae with three species (2.9%), Lamiaceae with three species (2.9%), Rubiaceae with three species (2.9%), Amaryllidaceae with three species (2.9%), and Poaceae with three species (2.9%). According to interviews with long-distance traders, Mahonia bealei, Codonopsis javanica, Fibraurea tinctoria, Polygonum multiflorum, Morinda officinalis, and Curculigo orchioides are popular items in herbal markets in other provinces. Given the vegetation of the areas, it is quite likely that these species were collected from the nearby Natural Reserve Areas of Xuan Nha, Ta Xua, Sop Cop, Copia, and MuongL which are extremely rich in plant diversity but vulnerable to incursions by people.

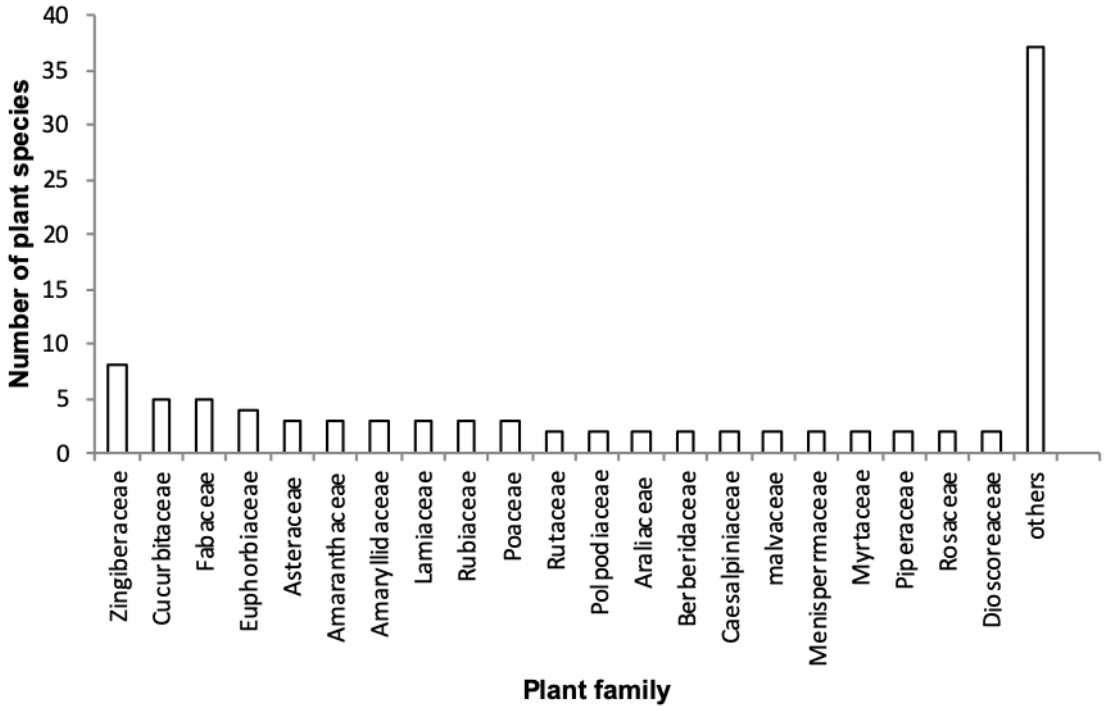

Figure 2. Dominant medicinal plant families in 32 traditional markets in Son La province

3.2.2 Diversity of plant parts used

In traditional medicine, different plant parts are used to treat different diseases: different components of one medicinal plant may have different effects. Some medicinal plant species have only one component that can be used, while for other species several components or the whole plant can be used (Hoang et al., 2008a). Among the medicinal species available at the major markets of the Son La province, we encountered 10 different usable plant parts: leaves 46 reports, root, rhizome 33 reports, fruits 25 reports, whole plant 19 reports, stems 19 reports, seeds (nine), tubers (eight), flowers (five), barks (four) and Bulb (one) (Figure 3). Leaves were by far the most common plant material used, followed by root and rhizome. Leaves, roots and rhizome were also often well represented in other studies (Hoang et al., 2008a; Xi-long and Fu-wu, 2009). In addition, leaves are easily traded in the herbal market, so preference is given to leaves in various ethnic communities. Among indigenous communities, people always use leaves because of their availability and ease in the preparation of recipes.

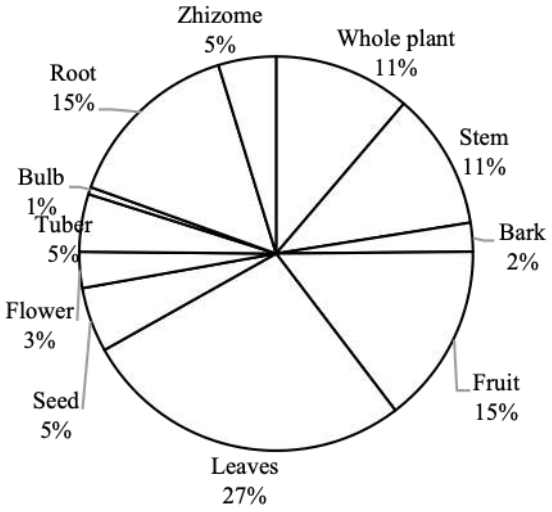

Figure 3. Percentage of plant parts utilized for medicinal purpose

3.2.3 Knowledge of plants and preparation

Majority of the interviewed people were familiar with the preparation of plants for medical uses including decoction, paste, juice, chewing, cooking or boiling, powdering and pickling (Figure 4). The most common methods of the collection and preparation of medicinal plants are cutting leaves, roots, stem or bark into small pieces and boiling them in water. Some decoctions are also used as steam baths. For pastes, plant parts are finely crushed or chewed, and then the resulting paste is applied to the affected part. For a juice, the plant part is extracted and used orally. For some remedies plant parts are chewed raw, then swallowed. For some remedies plant parts are pickled in honey or wine. Some plant materials can also be dried and stored for later use.

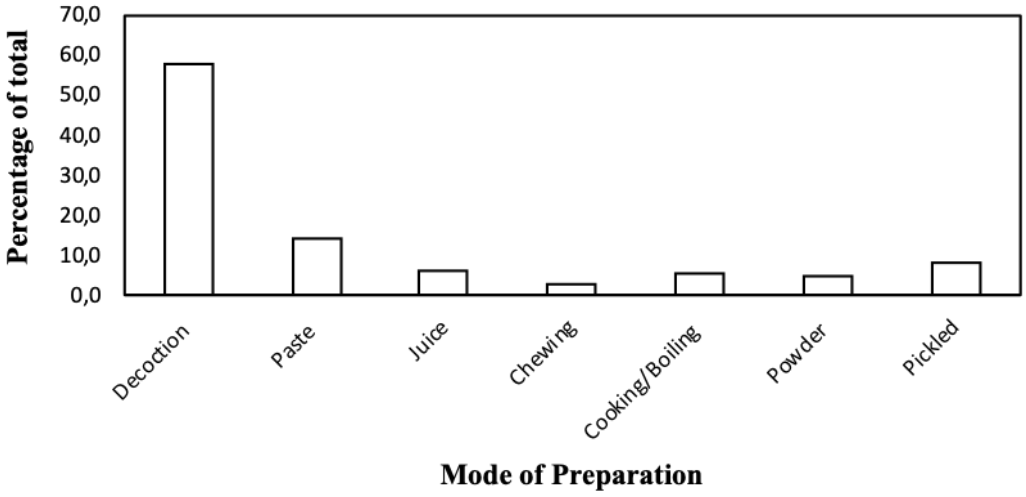

Figure 4. Percentage of preparation modes

3.2.4 Administration of medicines

In regard to the mode of administration, the form used most frequently was oral intake (81.69%) followed by external application (12.28%), rubbing/massage (3.52%), while only 2.11% are delivered by inhalation (Figure 5). The fact that oral route of administration of the herbals is the most common in the study area. This also has been previously studies (Gurib-Fakim, 2006; Hoang et al., 2008a).

Figure 5. Mode of administration of medical remedies

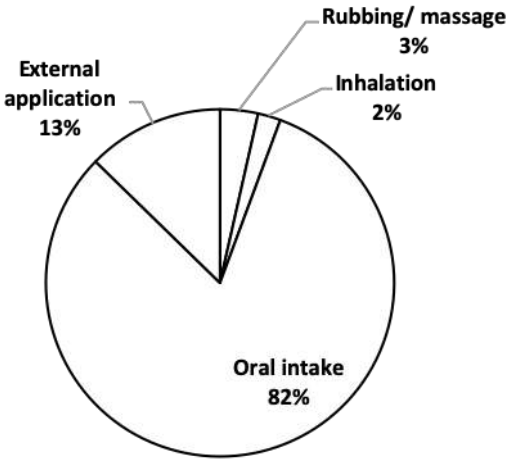

Table 2. Medicinal plants in traditional markets of Son La province

Family and scientific name	Vernacular name	Habit at	Part used	Method of preparation		Medicinal application	FC	FRC	UV	FL (%)
Adiantacecae										
Adiantum flabellulatum L.	Dớn	W	Whole plant	Decoction	Oral intake	Diabetes, Coughs	16	0.10	0.56	81.25
Asplenuaceae										
Asplenium nidus L.	Tổ điểu	W	Leaves, Tuber	Paste	External application	Rheumatism, Arthritis, Strained muscles	17	0.10	0.12	94.12
Dicksoniaceae										
Cibotium barometz (L.) J.Sm.	Lông cu li	W	Root	Paste	External application	Haemostatic	26	0.16	0.65	92.31
Marsileaceae										
Marsilea quadrifolia L.	Rau bợ	W	Whole plant	Cooking/Boiling	Oral intake	Insomnia	14	0.08	0.36	78.57
Polpodiaceae										
Drynaria bonii Christ	Tắc kè đá	W	Root	Decoction	Oral intake	Kidney failure, Arthritis,	18	0.11	0.28	83.33
Drynaria fortunei (Kunze ex Mett.) J.Sm.	Cốt toái bổ	W	Root	Decoction	Oral intake	Rheumatism, Arthritis	21	0.13	0.33	80.95
Gnetaceae										
Gnetum montanum Markgr.	Gắm	W	Seed	Powder	Oral intake	Malaria	6	0.04	0.00	66.67
		W	Root, Leaves	Paste	External application	Snakebite				

Family and scientific name	Vernacular name	Habit at	Part used	Method of preparation		Medicinal application	FC	FRC	UV	FL (%)
Acanthaceae										
Rhinacanthus na sutus (L.) Kurz	Bạch hạc	W	Leaves, Stem	Paste	External application	Herpes, Itches, Wounds	18	0.11	0.17	7.78
Amaranthaceae										
Achyranthes bidentata Blume	Ngưu tất	W	Root	Decoction	Oral intake	Nephropathy, Urinating problems, Liver	11	0.07	0.45	81.82
Alternanthera sessilis (L.) R.Br. ex DC.	Rau dệu	W	Whole plant	Decoction	Oral intake	Colitis	21	0.13	0.43	80.95
Amaranthus viridis L.	Đơn đỏ	W	Leaves, Root	Paste	External application	Snakebite	6	0.04	0.00	83.33
Apiaceae										
Centella asiatica (L.) Urb.	Rau má	W	Whole plant	Decoction	Oral intake	Fever, Dysentery, Herpes, Liver	38	0.23	0.84	100.00
Apocynaceae										
Catharanthus roseus (L.) G.Don	Dừa cạn	W	Root, Stem	Decoction	Oral intake	High blood pressure	11	0.07	0.27	72.73
Aquifoliaceae										
Ilex kaushue S.Y. Hu	Chè đắng	C	Leaves	Decoction	Oral intake	Liver, Stomach ache, Diabetes	21	0.13	0.62	71.43
Araliaceae										
Panax pseudoginseng Wall.	Tam thất	C	Tuber	Powder	Oral intake	Liver, Tonic, Stomach ache, Weakness after childbirth	37	0.22	0.57	86.49
Polyscias fruticosa (L.) Harms	Đinh lăng	C	Root	Decoction	Oral intake	Diabetes, Weakness	43	0.26	0.67	83.72
			Leaves	Chewing	Oral intake	Diarrhoea				
Aslepiadaceae										
Streptocaulon juventas (Lour.) Merr.	Hà thủ ô trắng	W	Root	Decoction	Oral intake	Stomach ache	10	0.06	0.20	70.00
Asteraceae										
Artemisia vulgaris L.	Ngải cứu	W/C	Leaves	Juice	Oral intake	Headache	39	0.23	0.54	79.49
			Stem, Leaves	Juice	Oral intake	Risk of miscarriage				
			Leaves	Paste	Rubbing/massage	Rheumatism, Back ache				
Blumea balsamifera (L.) DC.	Đai bi	W/C	Leaves	Decoction	Oral intake	Colds, Flu, Coughs	13	0.08	0.54	84.62
			Stem	Decoction	Oral intake	Stomach ache				
Cynara scolymus L.	Actiso	C	Whole plant	Decoction	Oral intake	Liver, Cancer	15	0.09	0.20	73.33
Baseliaceae										
Basella rubra L.	Mồng tơi	C	Leaves	Cooking/Boiling	Oral intake	Sores, Colitis	18	0.11	0.61	77.78
			Leaves	Paste	External application	Insect bite				
Berberidaceae										
Mahonia bealei (Fortune) Pynaert	Hoàng liên ô rô	W	Stem	Decoction	Oral intake	Stomach ache, Colitis, Liver	36	0.22	0.39	69.44
Epimedium macranthum	Dâm dương hoắc	W	Leaves	Decoction	Oral intake	Kidney failure,	12	0.07	0.25	91.67

Family and scientific name	Vernacular name	Habit at	Part used	Method of preparation		Medicinal application	FC	FRC	UV	FL (%)
C.Morren & Decne.						Aphrodisiac				
Bignoliaceae										
Oroxylum indicum (L.) Kurz	Núc nác	W	Bark	Paste	Rubbing/massage	Fever	19	0.11	0.58	73.68
			Bark	Decoction	Oral intake	Dysentery				
Celastraceae										
Celastrus hindsii Benth.	Xạ đen	W/C	Leaves	Decoction	Oral intake	Liver, High blood pressure, Cancer, Diabetes	45	0.27	0.42	93.33
Caesalpiniaceae										
Gleditsia australis F.B.Forbes & Hemsl.	Bồ kết	W/C	Fruit, Seed	Powder	Inhalation	Flu, Cold	15	0.09	0.33	93.33
			Fruit	Juice	External application	Toothache				
Tamarindus indica L.	Me	C	Fruit	Decoction	Oral intake	Fever, Indigestion	17	0.10	0.71	88.24
Campanulaceae										
Codonopsis javanica (Blume) Hook.f. & Thomson	Đẳng sâm	W	Root	Drinking	Oral intake	Liver, Dysentery, Low blood pressure, Kidney failure, Bronchitis	47	0.28	0.49	74.47
Caprifoliaceae										
Lonicera japonica Thunb.	kim ngân	W/C	Leaves	Decoction	Oral intake	Allergies	14	0.08	0.36	85.71
			Flower	Decoction	Oral intake	Dysentery				
Cucurbitaceae										
Coccinia grandis (L.) Voigt	Mắc hói	C	Fruit	Decoction	Oral intake	Diabetes	12	0.07	0.33	75.00
			Fruit	Cooking/Boiling	Oral intake	Indigestion				
Gynostemma pentaphyllum (Thunb.) Makino	Giảo cổ lam	W	Leaves	Decoction	Oral intake	Liver, High blood pressure	37	0.22	0.59	94.59
Momordica charantia L.	Mướp đắng	C	Whole plant	Decoction	Oral intake	Diabetes, Liver, Hypertension	25	0.15	0.52	96.00
			Fruit	Juice	Oral intake	Dysentery				
			Root	Decoction	Oral intake	To vomit				
Momordica cochinchinensis (Lour.) Spreng.	Gấc	C	Seed	Paste	External application	Mumps	11	0.07	0.27	72.73
Siraitia grosvenorii (Swingle) C.Jeffrey ex A.M.Lu & Zhi Y.Zhang	Quả la hán	C	Fruit	Decoction	Oral intake	Liver, High blood pressure	26	0.16	0.69	80.77
Ebenaceae										
Diospyros decandra Lour.	Thị	C	Fruit, Leaves	Decoction	Oral intake	High blood pressure	6	0.04	0.33	50.00
Euphorbiaceae										
Baccaurea ramiflora Lour.	Dâu gia đất	W	Leaves	Paste	External application	Itches	5	0.03	0.20	60.00
Jatropha curcas L.	Dầu mè	C	Leaves	Decoction	Oral intake	Kidney failure	9	0.05	0.33	44.44
Phyllanthus emblica L.	Me tròn	W	Bark, Root	Decoction	Oral intake	Hypertension, Fever, Urinating problems	38	0.23	0.47	73.68
			Fruit	Chewing	Oral intake	Diabetes				
			Fruit	Pickled	Oral intake	Aphrodisiac				
Phyllanthus	Diệp hạ	W	Whole	Decoction	Oral intake	Liver, Tonic,	32	0.19	0.69	90.63

Family and scientific name	Vernacular name	Habit at	Part used	Method of preparation		Medicinal application	FC	FRC	UV	FL (%)
urinaria L.	châu		plant Leaves	Paste	External application	Sores, Itches Snakebite				
Fabaceae										
Abrus precatorius L.	Cam thảo	W	Whole plant	Decoction	Oral intake	Coughs, Cold, Herpes	15	0.09	0.47	73.33
Desmodium styr acifolium (Osbeck) Merr.	Kim tiền thảo	W	Leaves, Stem	Decoction	Oral intake	Liver, Kidney failure	17	0.10	0.29	76.47
Lablab purpureus (L.) Sweet	đậu ván trắng	C	Seed	Powder	Oral intake	Diarrhoea, Food poisoning	8	0.05	0.63	87.50
			Fruit, Seed	Decoction	Oral intake	Fever, To vomit, Diarrhoea				
Pueraria phaseoloides (Roxb.) Benth.	Sắn dây	C	Tuber	Powder	Oral intake	Weakness	17	0.10	0.76	94.12
Styphnolobium japonicum (L.) Schott	Hoa hòe	W/C	Flower, Seed	Decoction	Oral intake	Low blood pressure	19	0.11	0.79	100.00
Illiciaceae										
Illicium verum Hook.f.	Hồi	C	Fruit	Decoction	Oral intake	Stomach ache, Diarrhoea, Flu, Rheumatism	5	0.03	0.20	80.00
			Fruit	Pickled	Rubbing/massage	Back ache				
Lamiaceae										
Elsholtzia cristata Willd.	Kinh giới	C	Whole plant	Decoction	Oral intake	Cold, Hemostatics, Head ache	7	0.04	0.43	85.71
Leonurus sibiricus L.	Ích mẫu	C	Leaves, Stem	Decoction	Oral intake	Weakness	11	0.07	0.55	63.64
			Leaves	Decoction	Oral intake	haemorrhage				
Perilla frutescens (L.) Britton	Tía tô	C	Leaves, Stem	Decoction	Oral intake	Cold, Flu, Food poisoning, Rheumatism	12	0.07	0.33	75.00
Lauraceae										
Cinnamomum cassia (L.) J.Presl	Quế	C	Bark	Decoction	Oral intake	Cold, Stomach ache, Indigestion	19	0.11	0.16	68.42
Loranthaceae										
Helixanthera parasitica Lour.	Tầm gửi	W	Leaves, Stem	Decoction	Oral intake	Stomach ache	3	0.02	0.67	66.67
malvaceae										
Abutilon indicum (L.) Sweet	Cối xay	W	Leaves, Fruit	Decoction	Oral intake	Fever, Flu	13	0.08	0.38	76.92
Hibiscus sabdariffa L.	Actiso đỏ	C	Flower	Pickled	Oral intake	Liver, high blood pressure	35	0.21	0.54	82.86
Menisperrmaceae										
Fibraurea tinctoria Lour.	Hoàng đằng	W	Stem, Root	Decoction	Oral intake	Diarrhea, Stomach ache, Sores	18	0.11	0.28	72.22
			Stem	Paste	External application	Wounds				
Stephania glabra (Roxb.) Miers	Bình vôi	W	Tuber	Decoction	Oral intake	Stomach ache , Liver, Coughs, Cold	19	0.11	0.32	89.47
Moraceae										
Artocarpus	Chay	W	Bark	Chewing	Oral intake	Toothache	21	0.13	0.67	71.43

Family and scientific name	Vernacular name	Habit at	Part used	Method of preparation		Medicinal application	FC	FRC	UV	FL (%)
tonkinensis A.Chev. ex Gagnep.										
Myrsinaceae										
Ardisia silvestris Pit.	Lá khôi	W	Leaves, Root	Decoction	Oral intake	Stomach ache, Colitis, Dysentery	26	0.16	0.42	80.77
Myrtaceae										
Baeckea frutescens L.	Thanh hao	C	Leaves	Paste	External application	Infection	3	0.02	0.33	66.67
			Leaves, Stem	Decoction	Oral intake	Irregular menses				
Cleistocalyx operculatus (Roxb.) Merr. & L.M.Perry	Vối	W/C	Leaves, Flower	Decoction	Oral intake	Liver	39	0.23	0.64	100.00
Olacaceae										
Erythropalum scandens Blume	Bò khai	W	Leaves,	Cooking/Boiling	Oral intake	Liver, Kidney failure	16	0.10	0.50	87.50
Oleaceae										
Jasminum nervosum Lour.	Chè vằng	W	Whole plant	Decoction	Oral intake	Weakness after childbirth	38	0.23	0.55	100.00
			Leaves, Root	Paste	External application	Itches				
Passifloraceae										
Passiflora foetida L.	Lạc tiên	W	Whole plant	Decoction	Oral intake	Weakness, Insomnia	28	0.17	0.43	82.14
Plantaginaceae										
Adenosma caeruleum R.Br.	Nhân trần	W	Whole plant	Decoction	Oral intake	Liver, depression	25	0.15	0.68	80.00
Plantago asiatica L.	Mã đề	W	Leaves, Stem	Decoction	Oral intake	Kidney failure, Flu	9	0.05	0.44	77.78
Piperaceae										
Piper betle L.	Trầu không	C	Leaves	Paste	External application	Wounds, itches	11	0.07	0.55	90.91
			Leaves	Decoction	Inhalation	Sore eyes				
Piper sarmentosum Roxb.	Lá lốt	C	Whole plant	Decoction	Oral intake	Rheumatism, Cold, Constipation, Back ache,	5	0.03	0.20	60.00
			Leaves	Juice	Oral intake	Toothache				
Polygonaceae										
Polygonum multiflorum Thunb.	Hà thủ ô	W	Root	Decoction	Oral intake	Tonic, High blood pressure, Liver, Weakness after childbirth	23	0.14	0.39	91.30
Portulacaceae										
Portulaca oleracea L.	Rau sam	W	Stem, Leaves	Cooking/Boiling	Oral intake	Indigestion, Dysentery	15	0.09	0.53	86.67
Rosaceae										
Docynia indica (Wall.) Decne.	Sơn tra	W/C	Fruit	Decoction	Oral intake	Liver, Stomach ache	51	0.31	0.80	84.31
			Fruit	Pickled	Oral intake	Liver				
Prunus mume (Siebold) Siebold & Zucc.	Mơ	C	Fruit	Pickled	Oral intake	Liver, Cough	31	0.19	0.65	70.97
Rubiaceae										
Morinda officinalis F.C.How	Ba kích	W	Tuber	Decoction	Oral intake	Kidney failure, Impotence	42	0.25	0.40	88.10
			Tuber	Pickled	Oral intake	Aphrodisiac				
Paederia foetida L.	Lá mơ	W/C	Leaves	Cooking/Boiling	Oral intake	Dysentery, Diarrhoea	31	0.19	0.81	100.00
Uncaria	Câu đằng	W	Stem	Decoction	Oral intake	High blood	7	0.04	0.14	0.00

Family and scientific name	Vernacular name	Habit at	Part used	Method of preparation		Medicinal application	FC	FRC	UV	FL (%)
rhynchophylla (Miq.) Miq. ex Havil.						pressure				
Rutaceae										
Citrus aurantiifolia (Christm.) Swingle	Chanh	C	Fruit	Pickled	Oral intake	Cough	68	0.41	0.68	94.12
			Root	Decoction	Oral intake	Cough, Flu				
Citrus japonica Thunb.	Quất	C	Fruit	Pickled	Oral intake	Cough	37	0.22	0.57	75.68
Saururacea										
Gymnotheca chinensis Decne.	Giấp cá	W	Whole plant	Juice	Oral intake	Sores, Liver, Haemorrhoids	26	0.16	0.62	88.46
			Leaves	Paste	External application	Fever, Herpes				
Solanaceae										
Solanum procumbens Lour.	Cà gai leo	W	Whole plant	Decoction	Oral intake	Liver	28	0.17	0.57	100.00
Vitaceae										
Ampelopsis cantoniensis (Hook. & Arn.) Planch.	Chè dây	W/C	Whole plant	Decoction	Oral intake	Stomach ache	12	0.07	0.25	75.00
Amaryllidaceae										
Allium ramosum L.	Hẹ	C	Leaves	Cooking/Boiling	Oral intake	Cold, Cough	19	0.11	0.26	68.42
			Leaves, Seed	Juice, Pickled	Oral intake	Aphrodisiac				
Allium sativum L.	Tỏi	C	Bulb	Chewing	Oral intake	Dysentery, Cough, Flu	38	0.23	0.61	81.58
Crinum latifolium L.	Trinh nữ hoàng cung	C	Leaves	Decoction	Oral intake	Cancer, Granulomatosis	7	0.04	0.00	71.43
Asparagaceae										
Disporopsis longifolia Craib	Hoàng tinh hoa trắng	W	Whole plant	Decoction	Oral intake	Tonic, Back pain, Rheumatism	5	0.03	0.00	80.00
Dioscoreaceae										
Dioscorea cirrhosa Lour.	Củ nâu	W	Tuber	Decoction	Oral intake	Hemostasis, Indigestion	9	0.05	0.11	77.78
Dioscorea hamiltonii Hook.f.	Củ mài	W	Tuber	Decoction	Oral intake	Colitis , Fever	21	0.13	0.67	71.43
Hypoxidaceae										
Curculigo orchioides Gaertn.	Sâm cau	W	Leaves, Stem, Root	Decoction	Oral intake	Kidney failure, Weakness ,Rheumatism	26	0.16	0.65	88.46
			Root	Pickled	Oral intake	Impotence, Aphrodisiac				
Iridaceae										
Iris domestica (L.) Goldblatt & Mabb.	Rẻ quạt	W	Zhizome	Decoction	Oral intake	Cough	6	0.04	0.17	100.00
Musaceae										
Musa balbisiana Colla	Chuối hột	W	Fruit	Decoction	Oral intake	Kidney failure, Calculus of kidney and ureter, Diabetes	18	0.11	0.61	88.89
			Fruit	Paste	External application	Eczema				
			Fruit	Pickled	Oral intake	Stomach ache, Kidney failure				

Family and scientific name	Vernacular name	Habit at	Part used	Method of preparation		Medicinal application	FC	FRC	UV	FL (%)
Pandanaceae										
Pandanus tonkinensis Martelli ex B.C.Stone	Dứa dại	W	Fruit	Decoction	Oral intake	Liver	21	0.13	0.33	100.00
			Root	Decoction	Oral intake	Oedema				
Poaceae										
Cymbopogon citratus (DC.) Stapf	Sả	C	Whole plant	Paste	External application	Bone fractures	19	0.11	0.79	89.47
			Whole plant	Decoction	Inhalation	Flu, Cold				
Coix lacryma-jobi L.	Ý dĩ	C	Seed	Cooking/Boiling	Oral intake	Pneumonia, Cancer, Constipation	8	0.05		
Imperata cylindrica (L.) Raeusch.	Cỏ tranh	W	Root	Decoction	Oral intake	Kidney failure, Liver	17	0.10	0.53	76.47
Smilacaceae										
Smilax glabra Roxb.	Khúc khắc	W	Stem, Root	Decoction	Oral intake	Skin diseases , Arthritis	9	0.05	0.44	88.89
Zingiberaceae										
Alpinia globosa (Lour.) Horan.	Sẹ	W	Fruit	Decoction	Oral intake	Stomach ache, Cold, Dysentery	3	0.02	0.00	66.67
Alpinia officinarum Hance	Riềng	C	Stem, Rhizome	Decoction	Oral intake	Coughs, Flu,	15	0.09	0.20	73.33
			Leaves	Juice	Oral intake	Food poisoning				
Amomum aromaticum Roxb.	Thảo quả	C	Fruit	Decoction	Oral intake	Dysentery, cold	4	0.02	0.00	75.00
Amomum villosum Lour.	Sa nhân đỏ	W/C	Seed	Decoction	Oral intake	Stomach ache, Malaria	5	0.03	0.00	80.00
Curcuma longa L.	Nghệ	C	Zhizome	Powder	Oral intake	Stomach ache, Colitis, Liver	71	0.43	0.61	81.69
			Zhizome	Paste	External application	Skin diseases				
Curcuma zedoaria (Christm.) Roscoe	Nghệ đen	C	Zhizome	Powder	Oral intake	Stomach ache, Colitis	37	0.22	0.65	100.00
Kaempferia galanga L.	Địa liền	C	Zhizome	Decoction	Oral intake	fever, indigestion, pertussis	5	0.03	0.20	80.00
			Zhizome	Pickled	Rubbing/massage	Back ache, Rheumatism				
Zingiber officinale Roscoe	Gừng	C	Zhizome	Juice	Oral intake	Indigestion, Flu	74	0.44	0.78	77.03
			Zhizome	Paste	Rubbing/massage	Cold				

W: Wild, C: Cultivated, FC: Frequency of Citation (Number of informants), FRC: Relative Frequency of Citation, UV: Use Value, FL: Fidelity level percentage

3.2.4 Habitat and sources of medicinal plants

Among all the medicinal plants recorded at traditional markets in the province, 51 of them (55.72%) were collected from the wild, 37 (21.37%) from cultivated land, 11 (15.26%) from both wild and cultivated land. Medicinal plants obtained from the wild (such as forests, grassland,

wetlands and so on) were open to any local people who need to use them. However, medicinal plants obtained from home gardens were primarily grown for the purpose of food preparation such as spices, and for marketing such as fences, stimulants, and ornaments.

3.2.5 Diseases treated with medicinal plants

This research registered 99 medicinal plant species traded in 32 traditional markets within the Son La province, which are used for the treatment of 61 different diseases. For 22 of these diseases, local people use only one medicinal plant for each disease. For seven of the 61 diseases, local people use two plant species for the treatment of each disease. The highest number of species was used to treat fairly common diseases, such as liver disease, stomachache, colds, kidney failure, coughs, dysentery, rheumatism, and fever.

All the local therapeutic uses of medicinal plants were grouped in 18 medical categories (Table 3), which were adapted from the catalogue of International Classification of Diseases made by the WHO. WHO recognizes in each medical category the health practice systems of traditional populations. In this study, 'illness' refers to being ill from a sociocultural personal perception, while 'disease' is considered from the biomedical perspective (Alexiades, 1996).

Table 3. Therapeutic uses of medicinal plants to treat local ailments at Son La province

Medical category	Local illnesses and diseases recognized
Certain infectious or parasitic diseases	Malaria, mumps
Neoplasms	Cancer, Granulomatosis
Diseases of the blood or blood-forming organs	Hemorrhage, Hematonisis
Diseases of the immune system	Allergies
Endocrine, nutritional or metabolic diseases	absent scanty and rare menstruation, Diabetes, Irregular menses, Oedema
Mental, behavioural or neurodevelopmental disorders	Depression
Sleep-wake disorders	Insomnia
Diseases of the visual system	Sore eyes
Diseases of the circulatory system	High blood pressure, Hypertension, Low blood pressure
Diseases of the respiratory system	Bronchitis, Colds, Coughs, Flu, Pertussis, Pneumonia
Diseases of the digestive system	Colitis, Constipation, Diarrhea, Dysentery, Haemorrhoids, Indigestion, Liver, Stomach ache, Toothache
Diseases of the skin	Eczema, Herpes, Itches, Skin diseases, Sores
Diseases of the musculoskeletal system or connective tissue	Angina pectoris, Arthritis, Back pain, Rheumatism, Strained muscles
Diseases of the genitourinary system	Calculus of kidney and ureter, Kidney failure, Urinating problems, Nephropathy
Conditions related to sexual health	Aphrodisiac, Impotence
Pregnancy, childbirth or the puerperium	Risk of miscarriage, Weakness after childbirth
Symptoms, signs or clinical findings, not elsewhere classified	Fever, headache, Weakness
Injury, poisoning or certain other consequences of external causes	Bone fractures, Food poisoning, Infection, Insect bite, Snakebite, to vomit, Wounds

3.3 Quantitative analyses of ethnomedicinal data

3.3.1 Relative Frequency of Citation

In this study, the RFC range was from 0.02 to 0.44 (Table 2). The plant species with the highest RFC were *Zingiber officinale*, *Curcuma longa, Citrus aurantifolia, Docynia indica, Codonopsis javanica, Celastrus hindsii,* and *Polyscias fruticose*. The reason behind their maximum RFC values may be due their use in traditional herbal recipes and them being commonly known by

3.3.2 Use Value

The UV represents the relative importance of plant species based on the number of uses reported for each species. In this study, the UV range was from 0 to 0.84 (Table 2). The highest UV was found for *Centella asiathica*, while the lowest value was found for *Gnetum montanum, Amaranthus viridis, Atractyloides macrocephala, Crinum latifolium, Disporopsis longifolia, Alpinia globose, Amomum aromaticum,* and *amomum vilosum*. Other important species having high UV were *Paederia foetida, Docynia indica, Styphnolobium japonicum, Cymbopogo citratus* and *Zingiber officinale*. In our present study, authors also observed the highest UV were commonly known to local people and also commonly available in the study area. The UV was lower because informants had less knowledge about the plant species, which might be of exotic origin or uncommon availability in the study area.

3.3.3 Fidelity Level (FL)

Percentage of informants claiming the use of a certain plant for the same major ailment was calculated for the most frequently reported ailments to evaluate species consensus (Tumoro and Maryo, 2016). FL highlights confirmed high usage of the plant species for a particular ailment, whereas low FL confirms a wide range of medicinal uses but with a low frequency for each ailment. FL may suggest that a specific plant species is used to treat a particular disease (Bano et al., 2014). In the present study, FL ranged from 44.44% to 100% (Table 2). Out of all documented plant species, nine were found to have the highest FL of 100% such as Centella asiathica, Styphnolobium japonicum, Cleistocalyx operculatus, Paederia foetida, Solanum procumbens, Pandanus tonkinensis, Styphnolobium japonicum, Jasminum nervosum, and Belamcanda chinensis. Plants with the highest FL value (100%) are used to treat digestive system problems, childbirth or the puerperium, while the low FL value was found in plants used for treatment of parasitic diseases and poisonings or other external causes.

3.3.4 Factor of Informant Consensus (FIC)

In studies related to medicinal plants, the FIC index provides a measure of reliability for the specified state of evidence regarding the agreement amongst a specific human group. The 99 medicinal plants in 32 traditional markets to treat different human ailments were classified into 18 medical categories, with a FIC value assigned to each plant (Table 4). In the results, ICF ranged from 0.78 to 0.97 which demonstrates strong levels of consensus amongst all 167 informants in the multiple uses of the 105 medicinal plant species. Two medical categories shared the highest value of FIC=0.97, which shows a high level of agreement among the 167 informants for 57 medicinal plant species to treat the digestive system, and pregnancy childbirth or the puerperium.

The digestive system illnesses have the highest value of used citations by 1.528 market vendors, who report 53 medicinal plant species, because informants interviewed used specific plant species commonly for digestive diseases which is related to a high incidence of gastrointestinal ailments in Vietnam. We also observed that other studies conducted in the public herbal markets (Bano et al., 2014; Lulekal et al., 2013; Macía, 2004; Macía et al., 2005; Malla et al., 2015; Quave and Pieroni, 2015; Tariq et al., 2015) have reported the highest ICF for digestive diseases. The results reveal the importance of medicinal plant species in treating ailments of the digestive system.

Table 4. Informant Consensus Factor (ICF) for the categorized ailments mentioned by the informants

Medical category	No. of Species	% of all species	No. of use reports	% of use reports	ICF*
Certain infectious or parasitic diseases	4	3.81	17	0.44	0.81
Neoplasms	6	5.71	51	1.32	0.90
Diseases of the blood or blood-forming organs	5	4.76	60	1.55	0.93
Diseases of the immune system	3	2.86	10	0.26	0.78
Endocrine, nutritional or metabolic diseases	10	9.52	153	3.95	0.94
Mental, behavioral or neurodevelopmental disorders	2	1.90	18	0.46	0.94
Sleep-wake disorders	4	3.81	39	1.01	0.92
Diseases of the visual system	3	2.86	12	0.31	0.82
Diseases of the circulatory system	12	11.43	258	6.65	0.96
Diseases of the respiratory system	26	24.76	549	14.16	0.95
Diseases of the digestive system	53	50.48	1528	39.40	0.97
Diseases of the skin	13	12.38	195	5.03	0.94
Diseases of the musculoskeletal system or connective tissue	12	11.43	191	4.93	0.94
Diseases of the genitourinary system	13	12.38	200	5.16	0.94
Conditions related to sexual health	7	6.67	158	4.07	0.96
Pregnancy, childbirth or the puerperium	4	3.81	109	2.81	0.97
Symptoms, signs or clinical findings, not elsewhere classified	14	13.33	238	6.14	0.95
Injury, poisoning or certain other consequences of external causes	15	14.29	87	2.24	0.84

ICF*=Informant Consensus Factor.

Meanwhile, the lowest ICF values registered in this study included immune system problems (0.78), certain infectious or parasitic diseases (0.81), and poisoning or other external causes (0.84) showing less or no consensus on using plants against to treat these diseases and illnesses. The lowest ICF does not mean that plants are not important for those categories. The low ICF may be due to unavailability of information among study participants (Bano et al., 2014).

4. Conclusion

The present ethnobotanical study of traded medicinal plant species reveals a rich diversity of traditional medicine among herbal sellers, herbalists and local people in the herbal markets of Vietnam's Son La province. As the first ethnobotanical study of herbal markets of Son La province, this description of economically important medicinal plant species provides a source for all contributors such as collectors, herbalists or herbal sellers.

The ethnobotanical findings of this study demonstrate that the traditional knowledge of medicinal plant species in the Son La province is mainly retained by elders, and most of them gained their knowledge from their parents and grandparents. Younger informants had less knowledge about the medicinal plants and used a smaller number of medicinal plants, which can be attributed to the expansion of modern education, cultural changes, and the influences of modernization.

The study recorded 99 medicinal plant species belonging to 88 genera in 57 families traded in 32 traditional markets in the Son La province. These plants are used for the treatment of 61 different diseases in 18 medical categories. During data analysis, it was observed that applied ethnobotanical indices such as Relative Frequency of Citation (RFC), Use Value (UV), Relative Importance (RI), Fidelity Level (FL) and Informant Consensus Factor (ICF) validate the effectiveness of the ethnobotanical practices of local people. The plant species having the highest values of ethnobotanical indices may be subjected to bioassay investigation, whereas those with low use value scores require analysis of their bioactivity to vindicate their use for treating a given ailment. The plant species offering new treatment options may be conserved for future reference studies.

Acknowledgments

The authors are grateful to the Vietnamese government and the Chinese Government for financial support Nguyen Thanh Son to study at the University of Chinese Academy of Sciences. We also would like to thank Vietnam National Foundation for Science and Technology Development (NAFOSTED) under grant number 106.06-2018.23 and project number KHCN. 22C/13-18 for funding this study. We would like to thank Nguyen Sinh Khang (Institute of Ecology and Biological Resources, Vietnam Academy of Science and Technology), Nguyen Thi Lien, Dinh Thi Hoa (Tay Bac University), Ye Xing Er, Tong Yi Hua (South China Botanical Garden) kindly helped fus to identify many species which is gratefully acknowledged. We also would like to thank Tran Anh Tuan, Dao Thanh Hai, Nguyen Thi Minh Chau, Nguyen Thuy Trang (Tay Bac University) for their assistance in the field.

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