



Ethnobotanical surveys reveal the crucial role of medicinal plants in the primary healthcare system of the Shan people in Myanmar

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ABSTRACT

Ethnopharmacological relevance: The Shan people of Myanmar live under conditions of longtime social instability and public medical resources inadequate, which tend to strengthen the reliance on local traditional primary healthcare system. The documentation of this kind of resource, however, was rarely and inadequate to support any kind of dynamic trend evaluation. Being an ethnobotanical study, we conducted field survey in the Southern Shan State of Myanmar and aimed to 1) document the local plant species that adopted for primary healthcare purpose, 2) clarify how these species collectively address the broad range of primary medication needs for local people, and 3) lay foundation for dynamic trend evaluation of the role of local medicinal plants under this kind of social and cultural context.

Material and methods: Field surveys were conducted with 124 informants in eight villages. We collected 1259 use reports and documented all the plant species used for treating all the mentioned ailment types. The ailments were translated into their emic meaning and then classified into common disease categories. The top ranked and newly recorded plants or ailment types were analyzed based on historical records from the region.

Results: Totally 156 plant species were used for treating 91 ailments belonging to 16 disease categories, with skin problems and digestive tract were the top cited diseases, and with Fabaceae and Lamiaceae were the top cited plant families. A total of 19 newly recorded plant species were suggested as new member of Myanmar medicinal plant list. Besides, we filled the gaps (for 24 species) and enriched the types (for 83 species) of applicable ailments for known Myanmar medicinal plants.

Conclusion: Our study revealed that the Shan people in Southern Shan State used rich plant species for various therapeutic purposes. Our findings indicate the crucial role of local plant resources for local people's primary healthcare needs and support further study about cultural or regional comparison or historical dynamic trend of the medicinal plants uses in areas facing longtime official or public medical resource inadequate.

1. Introduction

Myanmar's healthcare system faces significant challenges, trailing behind in all aspects of the World Health Organization's (WHO) health

system building blocks, and the country is categorized as a Grade 3 emergency by the WHO, signifying the highest level of concern. Several factors contribute to this situation, including weak governance structures, endemic institutional disparities, widespread poverty, ongoing conflicts, inadequate infrastructure, and seasonal natural disasters

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Abbreviations

APG IV	Angiosperm Phylogeny IV
ICPC	the International Classification of Primary Care System
URs	Use Reports
WHO	World Health Organization

(Brennan, 2017). Myanmar falls among the 57 critical human resource shortage countries, with only 6.7 doctors and 10 nurses and midwives per 10,000 population in 2018, well below the WHO standard of 23 physicians, nurses, and midwives per 10,000 population (WHO, 2020). As a result of these disparities, official government health facilities are long time inaccessible to the majority of the population especially in conflict-affected and hard-to-reach areas. For instance, Shan state, as an ethnic minority region in the Northeastern part of Myanmar, has only 0.35 doctor and 1.53 health workforce per 1000 population (Saw et al., 2019). Treating of the major health problems such as malaria, injuries and non-communicable diseases were challenging and the local people tend to depend on traditional medicinal practices like local healers, unlicensed practitioners, and self-care methods for their primary healthcare needs.

In Myanmar, traditional medicine rooted in the use of medicinal plants has served as the primary healthcare dating back to at least the Tagaung, Srikittra, and Bagan eras around 600 BCE (Ministry of Health and Sports, 2013). The World Health Organization's (WHO) South-East Asia regional meeting revealed that over 85% of Myanmar's population depends on traditional medicine (WHO, 2009). This reliance on plant-based traditional medicine is particularly pronounced in rural areas where access to western medical practices is limited. Consequently, Myanmar's Ministry of Health has initiated the Myanmar Traditional Medicinal Development Programme with the aim of promoting the preservation of scarce medicinal plants and the production of high-quality raw materials for traditional medicine, especially in rural locales (Ministry of Health and Sports, 2014). In support of this endeavor, the documentation of Myanmar's medicinal plants has been a crucial undertaking. To date, information regarding Myanmar's medicinal plants has been cataloged in the publications, encompassing lists and ethnobotanical studies conducted in various regions of Myanmar, published in English and accessible to the public (Ahn et al., 2020; Ali et al., 2010; Aryal et al., 2020; Aung et al., 2016; Aung et al., 2020; Aye and Win, 2019; DeFilipps and Krupnick, 2018; Hein et al., 2023; Kyaw et al., 2020; Lwin, 2019; Lwin and Lwin, 2015; Ministry of Health and Sports, 2004, 2013; Mon et al., 2020; Naw and Htun, 2019; Ong et al., 2018a, b; Sesoltani, 2011; Shin et al., 2018; Soe and Ngwe, 2004; Thu et al., 2018; Tun et al., 2019; Win et al., 2019; Wood et al., 2022; Zhang et al., 2020). Notably, "The Medicinal Plants of Myanmar," authored by DeFilipps and Krupnick in 2018, stands out as a comprehensive compilation of medicinal plants and their utilization.

Shan ethnic group makes up half of the population of Shan State, and represents about 9% of the Myanmar population (Central Intelligence Agency, 2022). The Shan is thought to have lived in the Southwestern part of China, where they were known as Dai, and to have migrated to the eastern part of Myanmar approximately 2000 years ago (Kyar, 1937). In the past, the Shan settled in the valley on both sides of the Salween River and established several tribes with varying sizes and political influences. They speak the Shan language, which shares the same root with the Dai language in China and Tai language in Thailand. Shan people are Buddhist and their traditional medical system follows the teachings of Buddhism, which states that only a balance between actions, mind, weather and food can ensure good health and longevity. Thus, the Shan people believe that the surrounding natural environment, social and supernatural forces, and diet all have crucial influence on a person's state of health. Therefore, traditional Shan medicine is

characterized by its integrative approach, in which physical and spiritual elements, food and medicine, herbal remedies and ritualized curing systems are intertwined for the treatment of disorders with presumed natural or supernatural causes. This form of knowledge and practice are very close to Myanmar's current formal traditional medical system, which is regulated by the Myanmar Ministry of Health.

The Shan people's knowledge of medicinal plants has been documented in the Northern Shan State, revealing that local health care largely depends on the traditional medical system (Aung, 2012; Aye and Win, 2019). However, the situation in the Southern Shan State is to date unknown. This study explores the Shan people's uses of medicinal plants in the Southern Shan State through ethnobotanical surveys and has the following aims: 1) to document the diversity of medicinal plants used by the Shan people of the Southern Shan State as well as knowledge related to these plants and their uses, and 2) to evaluate how the medicinal plants meet the therapeutic needs of the Shan people in this area.

2. Materials and methods

2.1. Study area

Shan State covers 155,801 km², representing almost a quarter of the total area of Myanmar, and has a population of 5.8 million. The state borders China in the north, Laos in the east, and Thailand in the south. It lies on the hilly Shan plateau in eastern Myanmar, which has an average elevation of 1000 m. A total of 2187 plant species have been recorded from the Shan State, accounting for 19% of the total plant species found in Myanmar (Kress et al., 2003). Shan State has 33 ethnic groups and the Shan are the major ethnic group.

Shan State is divided into Northern Shan State, Eastern Shan State, and Southern Shan State. Study of this area was only possible in Southern Shan State because of security issues and travel restriction in most parts of the state, and the area lies out of the political control of the central government. Southern Shan State is one of the Myanmar's most dynamic ethno-agro-ecological zones. We conducted ethnobotanical studies in eight villages in two townships, namely Hsihseng and Loilen (Fig. 1). To ensure that we acquired traditional Shan knowledge in our research, we ensured that six of the eight selected villages had a pure Shan demographic (Table 1). The remaining two villages comprised a mixture of Shan and Pa-O ethnicities. Of the eight sample villages, only three had clinics, each with a single member of government health staff to provide "Western" medicine. On top of this, the relatively high cost of Western medicinal services and the poor road accessibility to health centers decreases the willingness of local people to use these clinics unless emergency operations are required. Local people predominantly depend on herbs and local healers, especially for the treatment of general and chronic illnesses.

2.2. Collection of ethnobotanical data

We conducted ethnobotanical field surveys for four months from September to December 2018, with the assistance of officers from the Myanmar Forest Department, Ministry of Natural Resources and Environmental Conservation. A semi-structured interview questionnaire was prepared to obtain detailed information regarding: 1) medicinal plant species used, including the name of the plant, the disease treated, the mode of preparation, the part used, and the origin of the resource (wild or cultivated), and 2) the demographic profile of the informants, including gender, age, occupation, and level of education. We obtained informed consent from the local administrative offices or village heads prior to each interview, and also gained permission to conduct our field surveys and to use the information for publication. Key informants, such as local healers and Buddhist monks who were knowledgeable on medicinal plants, were selected using the snowball sampling method. The other informants were chosen considering gender, age, occupation, and educational background. Interviews were carried out individually or in

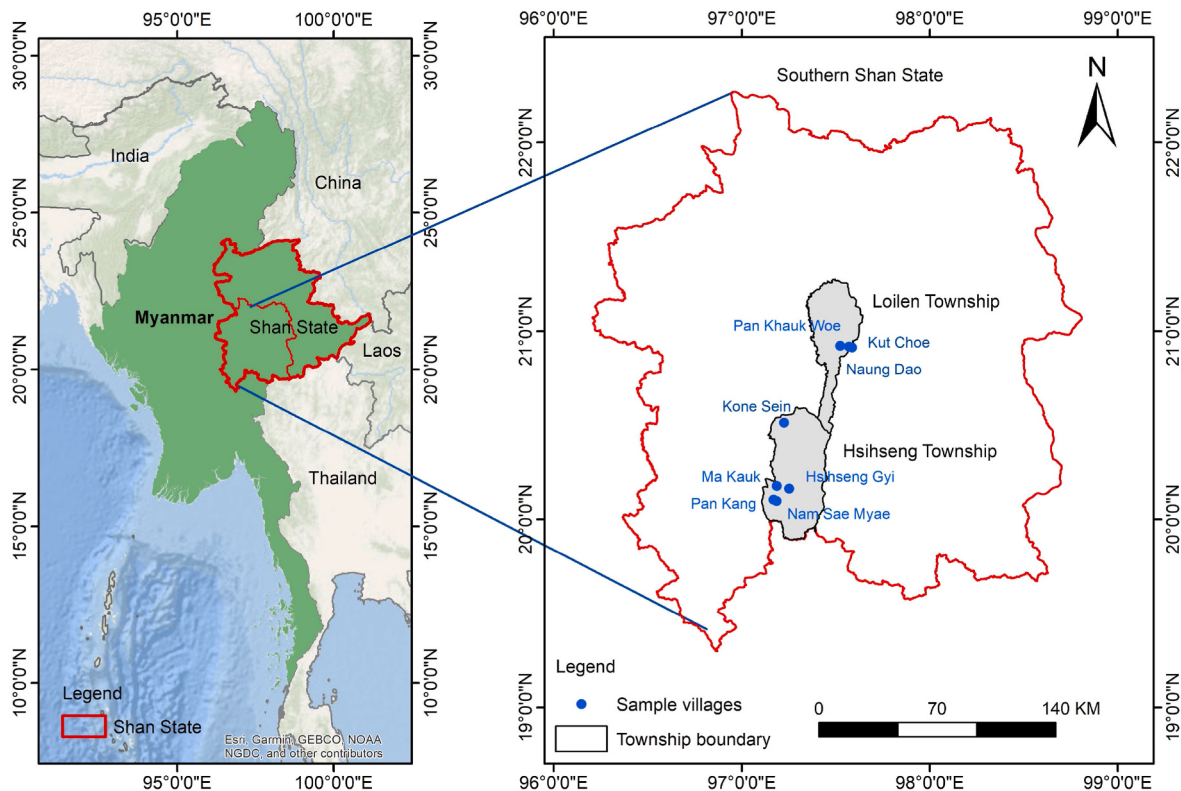


Fig. 1. Location of the study area and the eight sample villages surveyed in Southern Shan State, Myanmar.

Table 1
Information on the study area in Southern Shan State, Myanmar^a.

Township information						Sample village information		
Name	Vegetation type	Annual mean temperature (°C)	Annual mean precipitation (mm)	Total population	Percentage of Shan people (%)	Name	Elevation (m)	Population
Hsihseng	Mixed deciduous forest, bamboo forest and plantations	23.18	2841.12	154,615	17.60	Ma Kauk	827	135
						Pan Kang	813	555
						Nam Sae Myae	816	478
						Hsihsengyi	942	344
						Kone Sein	1023	612
Loilen	Mixed deciduous, upland and lowland evergreen forest	22.70	2782.04	127,787	36.00	Pan Khauk	1323	3018
						Woe		
						Kut Choe	1339	2592
						Naung Dao	1435	4781

^a The annual mean temperature and average precipitation data are taken from the [Weather and Climate \(2022\)](#) of Myanmar. The population data is from the [Township General Administration Department \(2020a, b\)](#) of Myanmar.

small groups based on the time availability of informants, and were conducted at different places, including collection locations of plants, homes of the informants, monasteries, local clinics, and markets (Fig. 2). The Burmese and Shan names of the medicinal plants were recorded using voice recorders to ascertain the correct pronunciation. The Burmese language was used for communication and a local translator was requested when necessary. All the ailments described using the Shan local language were translated into Burmese and English.

2.3. Demographic information regarding the informants

A total of 124 Shan informants contributed their medicinal plant knowledge to our surveys. The ages of informants ranged from 16 to 76 years. Over half of the informants (61%) relied on agriculture, such as the cultivation of rice, corn, and other seasonal crops for their

livelihoods. The rest were Buddhist monks, healers, herbal medicine sellers, forest governmental staff, and dependents. The demographic information of the informants was listed in [Appendix 1](#).

2.4. Collection of voucher specimens and identification of plant species

Voucher specimens were collected as part of the interviews to verify the plant species involved. Three or more sets of voucher specimens were collected for each plant species from nearby forests or, with their permission, from the informants' home compounds (Fig. 2). Photos were taken of both fresh and dry specimens. The specimens were identified with the help of plant taxonomists from the Kunming Institute of Survey and Design, and the Kunming Institute of Botany, Chinese Academy of Sciences in China, and the Forest Research Institute in Myanmar. The species were also cross-checked with the help of taxonomists from the



Fig. 2. Field survey activities conducted from September to December 2018 in Southern Shan State, Myanmar. Following an informant to collect voucher specimens (a); Semi-structured interviews with a Buddhist monk (b), a group of Shan indigenous people in an interview (c), and a local healer in an interview (d).

Botany Department of Queen Sirikit Botanic Garden in Thailand and from Xishuangbanna Tropical Botanical Garden of the Chinese Academy of Sciences, China. Classification followed the APG IV system (Chase et al., 2016). The accepted names were rectified using World Flora Online (<http://www.worldfloraonline.org>) and the origins of the plant species were noted according to Plants of the World Online (www.plantsoftheworldonline.org). Voucher specimens were deposited at KUN (Herbarium, Kunming Institute of Botany, Chinese Academy of Sciences) and RFA (Herbarium, Forest Research Institute, Myanmar).

2.5. Disease type and categories

The reported single ailments were laterally translated from the local description to show the emic meaning. And then, we also categorized the ailments according to the International Classification of Primary Care System (ICPC-2, <http://www.who.int/classification/icd/adaptations/icpc2/en/>) to see the comparative knowledge with the previous ethnobotanical reports from Myanmar. This categorization was achieved during a meeting of the research group members, to avoid personal bias. The translation of disease names and their categories from Burmese and Shan into English was given in Appendix 2.

2.6. Data analysis

Use reports (URs) were taken as the basic method of characterizing informants' knowledge of medicinal plants. A UR was recorded when an informant mentioned certain species for a specific usage (Kufer et al., 2005). In this study, the number of URs was summed up for a given species, or a given disease category to determine their rank. The ethnobotanyR package (Whitney, 2022) was used for data processing. The URs for every ailment of each medicinal plant species were listed in

Table 2.

2.7. Comparative literature reports

We compared the results of our study to the publications, encompassing lists and ethnobotanical studies conducted in various regions of Myanmar, published in English and accessible to the public (Ahn et al., 2020; Ali et al., 2010; Aryal et al., 2020; Aung et al., 2016; Aung et al., 2020; Aye and Win, 2019; DeFilipps and Krupnick, 2018; Hein et al., 2023; Kyaw et al., 2020; Lwin, 2019; Lwin and Lwin, 2015; Ministry of Health and Sports, 2004, 2013; Mon et al., 2020; Naw and Htun, 2019; Ong et al., 2018a, b; Sesoltani, 2011; Shin et al., 2018; Soe and Ngwe, 2004; Thu et al., 2018; Tun et al., 2019; Win et al., 2019; Wood et al., 2022; Zhang et al., 2020) to identify new medicinal plant records and ethnomedicinal uses of the plants currently being reported in Myanmar.

3. Results

3.1. Diversity of medicinal plants mentioned in surveys

A total of 156 medicinal plant species belonging to 131 genera in 71 families were mentioned in the surveys with Shan informants, and were subsequently identified and documented. About half of these species were native to Myanmar (78 species, 51%), while 27 species were introduced. For a further 51 species, it was unclear whether they were native or introduced plants in Myanmar. The two families with the most species mentioned in our surveys were the Fabaceae and the Lamiaceae. The taxonomic information, vernacular and Myanmar names of the plant species, was listed in Appendix 3. A total of 1259 URs were recorded for 91 ailments of the 156 medicinal species. The top five cited medicinal species were *Zingiber barbatum* Wall. (URs = 69), *Ageratina*

Table 2Use report and the therapeutic information of the plants for medicinal uses recorded in Southern Shan State, Myanmar^a.

Scientific name (URs per species)	Ailments	URs per ailments	Plant parts used	Preparation method	Administration method
<i>Abelmoschus esculentus</i> (L.) Moench (1)	Bone fracture	1	Fruit, Whole plant	Cooking, Pounding	Oral, Topical
<i>Abutilon</i> sp. (1)	Injury	1	Whole plant	Pounding	Topical
<i>Achyranthes aspera</i> L. (1)	Kidney stone	1	Whole plant	Decoction	Oral
<i>Acorus calamus</i> L. (17)	Aches and pain	3	Rhizome	Pounding	Topical
	Cough	3	Rhizome	Decoction	Oral
	Edema	2	Rhizome	Decoction	Oral
	Fever	1	Rhizome	Decoction	Oral
	Flatulence	4	Rhizome	Decoction	Oral
	Flu	1	Rhizome	Decoction	Oral
	Indigestion	1	Rhizome	Pounding, Oil processing	Oral, Topical
	Joint pain	1	Rhizome	Pounding	Topical
	Sprain	1	Rhizome	Pounding	Topical
<i>Ageratina adenophora</i> (Spreng.) R.M. King&H. Rob. (63)	Abdominal pain	1	Leaves	Decoction	Oral
	Boils	1	Leaves	Pounding	Topical
	Diabetes	1	Leaves	Decoction	Oral
	Fever	2	Leaves	Decoction	Oral
	Injury	31	Leaves	Pounding	Topical
	Stomachache	1	Leaves	Decoction	Oral
	Wounds	26	Leaves	Pounding	Topical
<i>Ageratum conyzoides</i> (L.) L. (19)	Cough	9	Leaves	Decoction	Oral
	Edema	1	Leaves	Decoction	Oral
	Flatulence	1	Leaves	Decoction	Oral
	Sore throat	8	Leaves	Decoction	Oral
<i>Aloe vera</i> (L.) Burm.f. (37)	Acne	2	Gum	Raw	Topical
	Burns	12	Gum	Raw	Topical
	Diabetes	1	Gum	Raw	Oral
	Dysuria	10	Gum	Raw	Oral
	Indigestion	1	Gum	Raw	Oral
	Jaundice	6	Gum	Raw	Oral
	Kidney stone	1	Gum	Raw	Oral
	Mastitis	1	Gum	Raw	Oral
	Melena	1	Gum	Raw	Oral
	Piles	1	Root	Pounding	Oral
	Scabies	1	Gum	Raw	Topical
<i>Alpinia galanga</i> (L.) Willd. (5)	Flu	1	Tuber	Raw	Nasal
	Joint pain	1	Rhizome	Pounding	Topical
	Muscle ache and pain	1	Rhizome	Pounding	Topical
	Postpartum care	2	Rhizome	Decoction	Bathing
<i>Alysicarpus vaginalis</i> (L.) DC. (12)	Dysuria	5	Whole plant	Decoction	Oral
	Kidney stone	5	Whole plant	Decoction	Oral
	Toothache	1	Whole plant	Decoction	Oral
	Urinary incontinence (Loss of bladder control)	1	Whole plant	Decoction	Oral
<i>Andrographis paniculata</i> (Burm.f.) Nees (54)	Abdominal pain	1	Whole plant	Decoction	Oral
	Child fever	2	Whole plant	Decoction	Oral
	Cough	15	Whole plant	Decoction	Oral
	Dizziness	2	Whole plant	Decoction	Oral
	Hypertension	4	Whole plant	Decoction	Oral
	Malaria	30	Whole plant	Cooking, Honey processing	Oral
<i>Annona squamosa</i> Delile (1)	Hypertension	1	Leaves	Decoction	Oral
<i>Antidesma acidum</i> Retz. (2)	<u>Dysuria</u>	<u>1</u>	<u>Fruit</u>	<u>Raw</u>	<u>Oral</u>
	<u>Kidney stone</u>	<u>1</u>	<u>Fruit</u>	<u>Raw</u>	<u>Oral</u>
<i>Aristolochia indica</i> L. (2)	Abdominal pain	1	Leaves, Fruit	Pounding	Topical
	Back pain	1	Leaves, Fruit	Pounding	Topical
<i>Artemisia vulgaris</i> L. (59)	Diarrhea	1	Leaves	Decoction	Oral
	Fever	1	Leaves	Pounding	Topical
	Hypertension	1	Leaves	Decoction	Oral
	Injury	5	Leaves	Pounding	Topical
	Nose bleeding	28	Leaves	Pounding	Nasal
	Paralysis	1	Leaves	Decoction	Oral
	Ringworm	17	Leaves	Pounding	Topical
	Scabies	2	Leaves	Pounding	Topical
	Stomachache	1	Leaves	Decoction	Oral
	Wounds	2	Leaves	Pounding	Topical
<i>Asparagus filicinus</i> Buch.-Ham. ex D. Don (33)	Diarrhea	3	Tuber	Infusion	Oral
	Flu	1	Tuber	Infusion	Oral
	Indigestion	3	Tuber	Decoction	Oral
	Longevity	1	Tuber	Decoction	Oral
	Numbness	1	Tuber	Decoction	Oral
	Tonic	24	Tuber	Raw, Honey processing	Oral

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Table 2 (continued)

Scientific name (URs per species)	Ailments	URs per ailments	Plant parts used	Preparation method	Administration method
<i>Asystasia gangetica</i> (L.) T.Anderson (7)	Dysuria	2	Leaves	Decoction	Oral
	Kidney disease	3	Leaves	Decoction	Oral
	Kidney stone	2	Leaves	Decoction	Oral
<i>Azadirachta indica</i> A. Juss. (1)	Scabies	1	Leaves	Decoction	Bathing
<i>Benincasa hispida</i> (Thunb.) Cogn. (2)	Kidney stone	1	Fruit	Cooking	Oral
	Vomiting	1	Fruit	Sugar processing	Oral
<i>Biancaea sappan</i> (L.) Tod. (2)	Diabetes	1	Stem	Decoction	Oral
	Hypertension	1	Stem	Decoction	Oral
<i>Bidens pilosa</i> L. (7)	Back pain	7	Whole plant	Pounding	Topical
<i>Blumea balsamifera</i> (L.) DC. (7)	Edema	1	Whole plant	Decoction	Oral
	Fever	2	Whole plant	Decoction	Oral
	Flatulence	1	Whole plant	Decoction	Oral
	Joint pain	3	Whole plant	Decoction	Oral
<i>Boehmeria nivea</i> Gaudich. (1)	Easy child delivery	1	Bark	Decoction	Oral
<i>Boesenbergia rotunda</i> (L.) Mansf. (2)	Indigestion	2	Rhizome	Pounding	Topical
<i>Breynia androgyna</i> (L.) Chakrab. & N.P. Balakr. (1)	Tinea versicolor	1	Leaves	Pounding	Topical
<i>Buddleja asiatica</i> L. (10)	Postpartum care	10	Root	Decoction	Oral
<i>Calotropis gigantea</i> (L.) W.T.Aiton (1)	Scabies	1	Latex	Raw	Topical
<i>Camellia sinensis</i> (L.) Kuntze (2)	Asthma	1	Leaves	Infusion	Oral
	Cough	1	Leaves	Infusion	Oral
<i>Carallia brachiata</i> Merr. (1)	Dysentery	1	Bark	Pounding	Oral
<i>Carica papaya</i> L. (20)	Cancer	1	Leaves	Cooking	Oral
	Constipation	5	Fruit	Raw	Oral
	Cough	3	Leaves	Cooking	Oral
	Flatulence	6	Leaves	Raw	Oral
	Mastitis	1	Leaves	Pounding	Topical
	Melena	1	Leaves	Raw	Oral
	Nerve pain	1	Leaves	Raw	Oral
	Stomach cancer	1	Leaves	Raw	Oral
	Stomachache	1	Leaves	Raw	Oral
<i>Cascabela thevetia</i> (L.) Lippold (3)	Boils	1	Fruit	Pounding	Topical
	Cancerous tumor	1	Leaves	Pounding	Topical
	Catarrh	1	Leaves	Burning	Nasal
<i>Cassia fistula</i> L. (2)	Constipation	1	Leaves	Pounding	Oral
	Edema	1	Bark, Root	Decoction, Pounding	Oral
<i>Celastrus paniculatus</i> Willd. (2)	Scabies	1	Leaves	Pounding	Topical
	Snake bite	1	Leaves	Pounding	Topical
<i>Centella asiatica</i> (L.) Urb (45)	Abdominal pain	2	Whole plant	Decoction	Oral
	Allergic	1	Leaves	Pounding	Topical
	Edema	1	Whole plant	Decoction	Oral
	Fever	1	Whole plant	Decoction	Oral
	Hypertension	4	Whole plant	Pounding	Oral
	Kidney stone	4	Whole plant	Decoction	Oral
	Scar	1	Whole plant	Pounding	Topical
	Tonic	8	Whole plant	Pounding	Oral
	Weak eyesight	22	Whole plant	Pounding	Oral
	Wounds	1	Whole plant	Pounding	Topical
<i>Chromolaena odorata</i> (L.) R.M.King & H. Rob. (48)	Cancer	3	Leaves	Decoction	Oral
	Cough	1	Leaves	Decoction	Oral
	Injury	40	Leaves	Pounding	Topical
	Wounds	4	Leaves	Pounding, Decoction	Topical, Oral
<i>Circaea alpina</i> L. (3)	Boils	3	Leaves	Pounding	Topical
<i>Cissampelos pareira</i> L. (2)	Typhoid	2	Whole plant	Decoction	Oral
<i>Cissus discolor</i> Blume (61)	Aches and pain	1	Tuber	Decoction	Oral
	Acne	2	Tuber	Pounding	Topical
	Boils	2	Tuber	Pounding	Topical
	Burns	1	Tuber	Pounding	Topical
	Cancer	10	Tuber	Decoction	Oral
	Cancerous tumor	23	Tuber	Pounding	Topical
	Child fever	1	Tuber	Decoction	Oral
	Edema	8	Tuber	Decoction	Oral
	Inflammation in injury	1	Tuber	Decoction	Oral
	Jaundice	1	Tuber	Decoction	Oral
	Leukemia	1	Tuber	Decoction	Oral
	Non-cancerous tumor	3	Tuber	Pounding	Topical
	Postpartum care	1	Tuber	Decoction	Bathing
	Stomachache	3	Tuber	Decoction	Oral
	Stomach cancer	1	Tuber	Decoction	Oral
	Wounds	2	Tuber	Decoction	Oral
<i>Citrus aurantiifolia</i> (Christm.) Swingle (15)	Analgesic	1	Fruit	Raw	Topical
	Allergic	2	Fruit	Raw	Topical
	Cough	1	Fruit	Infusion	Oral
	Diabetes	1	Fruit	Infusion	Oral

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Table 2 (continued)

Scientific name (URs per species)	Ailments	URs per ailments	Plant parts used	Preparation method	Administration method
<i>Citrus limon</i> (L.) Brum.f. (4)	Headache	5	Fruit	Raw	Nasal
	Hypertension	2	Fruit	Infusion	Oral
	Insomnia	1	Fruit	Infusion	Oral
	Joint pain	1	Fruit	Roast	Topical
	Paralysis	1	Fruit	Roast	Topical
	Cough	1	Leaves	Decoction	Oral
	Flatulence	1	Fruit	Raw	Oral
	Paralysis	2	Root	Decoction	Oral
	Scabies	2	Leaves	Pounding	Topical
	Diarrhea	2	Leaves, Whole plant	Cooking, Decoction	Oral
<i>Clerodendrum burchanani</i> (Roxb.) Walp. (5)	Dysentery	2	Leaves, Whole plant	Cooking, Decoction	Oral
<i>Clerodendrum</i> sp. (11)	Piles	1	Whole plant	Decoction	Oral
	Gum inflammation	2	Latex	Pounding	Oral
	Joint pain	2	Root	Pounding	Topical
	Postpartum care	5	Root	Decoction	Bathing
	Sprain	2	Root	Pounding	Topical
<i>Coffea arabica</i> L. (1)	Cold tolerance	1	Leaves	Decoction	Oral
<i>Colocasia esculenta</i> (L.) Schott (1)	Boils	1	Leaves	Roast	Topical
<i>Colubrina asiatica</i> Brongn. (1)	Insomnia	1	Leaves	Decoction	Oral
<i>Combretum indicum</i> (L.) DeFilipps (1)	Piles	1	Leaves	Decoction	Oral
<i>Crateva religiosa</i> G.Forst. (1)	Diabetes	1	Root	Decoction	Oral
<i>Crotalaria incana</i> L. (5)	Scabies	5	Whole plant	Decoction	Bathing
<i>Croton persimilis</i> Müll.Arg. (12)	Ascites	2	Root	Pounding	Topical
	Back pain	2	Leaves	Decoction	Bathing
	Edema	2	Root, Wood	Pounding	Topical
	Insomnia	2	Leaves	Raw	Oral
	Joint pain	1	Root	Pounding	Topical
	Numbness	1	Root	Pounding	Topical
	Postpartum care	2	Leaves	Decoction	Bathing
	Flatulence	1	Rhizome	Decoction	Oral
	Abdominal pain	5	Rhizome	Pounding	Oral
	Constipation	1	Rhizome	Pounding	Oral
<i>Curcuma caesia</i> Roxb. (1)	Cough	1	Rhizome	Pounding	Oral
<i>Curcuma longa</i> L. (31)	Diabetes	2	Rhizome	Pounding	Oral
	Diarrhea	5	Rhizome	Pounding	Oral
	Flatulence	4	Rhizome	Pounding	Oral
	Hypertension	3	Rhizome	Honey processing	Oral
	Indigestion	1	Rhizome	Pounding	Oral
	Inflammation in injury	1	Rhizome	Pounding	Topical
	Injury	1	Rhizome	Pounding	Topical
	Menstrual disorder	3	Rhizome	Pounding	Oral
	Postpartum care	4	Rhizome	Pounding	Topical
	Earache	1	Rhizome	Pounding	Ear drop
<i>Curcuma</i> sp. (2)	Sore throat	1	Rhizome	Pounding	Oral
<i>Cymbopogon citratus</i> Stapf (24)	Menstrual disorder	2	Whole plant	Decoction	Oral
	Postpartum care	22	Whole plant	Decoction	Bathing
<i>Cyperus rotundus</i> L. (1)	Atherosclerosis	1	Whole plant	Decoction	Oral
<i>Cyperus scariosus</i> R.Br. (3)	Atherosclerosis	1	Whole plant	Decoction	Oral
	Flatulence	1	Whole plant	Decoction	Oral
	Typhoid	1	Whole plant	Decoction	Oral
<i>Datura metel</i> L. (3)	Ringworm	1	Leaves	Pounding	Topical
	Scabies	2	Whole plant	Decoction	Bathing
<i>Dioscorea wallichii</i> Hook.f. (1)	Insect bite	1	Tuber	Pounding	Topical
<i>Dracaena angustifolia</i> (Medik) Roxb. (2)	Jaundice	1	Wood	Pounding	Oral
	Tonic	1	Wood	Pounding	Oral
<i>Drymaria cordata</i> (L.) Willd. exSchult. (2)	Child fever	2	Whole plant	Pounding	Topical
<i>Eclipta prostrata</i> (L.) L. (26)	Burns	1	Leaves	Pounding	Topical
	Fever	1	Leaves	Decoction	Oral
	Injury	1	Leaves	Pounding	Topical
	Menstrual disorder	5	Leaves	Decoction	Oral
	Paralysis	14	Leaves	Decoction	Oral
	Scar	3	Leaves	Pounding	Topical
	Wounds	1	Leaves	Pounding	Topical
	Heart disease	1	Leaves	Decoction	Oral
	Joint pain	2	Leaves	Cooking	Oral
	Tinea versicolor	1	Whole plant	Decoction	Bathing
<i>Eryngium foetidum</i> Walter (2)	Back pain	1	Leaves	Cooking	Oral
	Epilepsy	1	Leaves	Cooking	Oral
<i>Euphorbia heterophylla</i> L. (12)	Constipation	12	Leaves	Decoction	Oral
<i>Euphorbia hirta</i> L. (3)	Diarrhea	1	Whole plant	Decoction	Oral
	Dysentery	1	Whole plant	Decoction	Oral
	Ulcer	1	Latex	Raw	Topical

(continued on next page)

Table 2 (continued)

Scientific name (URs per species)	Ailments	URs per ailments	Plant parts used	Preparation method	Administration method
<i>Fagopyrum cymosum</i> (Trevir.) Meisn. (4)	Waist pain	4	Leaves	Raw	Oral
<i>Ficus racemosa</i> L. (2)	Flatulence	1	Leaves	Cooking	Oral
	Snake bite	1	Latex	Pounding	Topical
<i>Flemingia javanica</i> C.Y.Wu (3)	<u>Edema</u>	<u>2</u>	<u>Whole plant</u>	<u>Decoction</u>	<u>Oral</u>
	<u>Ulcer</u>	<u>1</u>	<u>Leaves</u>	<u>Roast</u>	<u>Topical</u>
<i>Foeniculum vulgare</i> Mill. (4)	Gastroenteritis (Diarrhea and vomiting)	1	Seed	Pounding	Oral
	Indigestion	2	Whole plant	Decoction, Pounding	Oral
	Tonic	1	Seed	Pounding	Oral
<i>Galinsoga parviflora</i> Cav (1)	<u>Snake bite</u>	<u>1</u>	<u>Leaves</u>	<u>Pounding</u>	<u>Topical</u>
<i>Garcinia pedunculata</i> Roxb. ex Buch.-Ham. (1)	Jaundice	1	Fruit	Decoction	Oral
<i>Glycine max</i> (L.) Merr. (1)	Cough	1	Seed	Cooking	Oral
<i>Harrisonia perforata</i> (Blanco) Merr. (1)	<u>Tooth decay</u>	<u>1</u>	<u>Stem</u>	<u>Pounding</u>	<u>Oral</u>
<i>Helicteres isora</i> L. (1)	Flatulence	1	Whole plant	Decoction, Infusion	Oral
<i>Hellenia speciosa</i> (J.Koenig) Govaerts (5)	Otorrhea	4	Leaves	Decoction	Oral
	Sore eyes	1	Stem	Pounding	Eye drop
<i>Indigofera articulata</i> Gouan (3)	<u>Hypertension</u>	<u>1</u>	<u>Root</u>	<u>Decoction</u>	<u>Oral</u>
	<u>Peptic ulcer</u>	<u>1</u>	<u>Root</u>	<u>Decoction</u>	<u>Oral</u>
	<u>Stomachache</u>	<u>1</u>	<u>Root</u>	<u>Decoction</u>	<u>Oral</u>
<i>Ipomoea aquatica</i> Forssk. (2)	Food poison	2	Leaves	Pounding	Oral
<i>Jasminum sambac</i> (L.) Aiton (1)	Hypertension	1	Root	Decoction	Oral
<i>Jatropha multifida</i> L. (2)	<u>Bone fracture</u>	<u>1</u>	<u>Leaves</u>	<u>Pounding</u>	<u>Topical</u>
	<u>Sprain</u>	<u>1</u>	<u>Leaves</u>	<u>Pounding</u>	<u>Topical</u>
<i>Justicia adhatoda</i> L. (1)	Blood up coughing	1	Leaves	Decoction	Oral
<i>Lagerstroemia speciosa</i> Pers. (5)	Cancer	2	Root	Pounding	Topical
	Piles	1	Root	Pounding	Topical
	Scabies	1	Root	Pounding	Topical
	Sore eyes	1	Root	Pounding	Topical
<i>Leea rubra</i> Blume ex Spreng. (1)	<u>Joint pain</u>	<u>1</u>	<u>Root</u>	<u>Pounding</u>	<u>Topical</u>
<i>Leucas cephalotes</i> (Roth) Spreng. (2)	Jaundice	2	Whole plant	Decoction	Oral
<i>Mangifera indica</i> L. (3)	Diabetes	1	Leaves	Pounding	Oral
	Hypertension	1	Leaves	Pounding	Oral
	Sore throat	1	Bark	Decoction	Oral
<i>Melastoma malabathricum</i> L. (5)	Child fever	1	Whole plant	Decoction	Oral
	Dysuria	1	Whole plant	Decoction	Oral
	Throat cancer	3	Whole plant	Decoction	Oral
<i>Mimosa pudica</i> L. (46)	Dysuria	19	Whole plant	Decoction	Oral
	Hepatitis	1	Whole plant	Decoction	Oral
	Kidney stone	23	Whole plant	Decoction	Oral
	Postpartum care	1	Whole plant	Decoction	Bathing
	Sprain	1	Whole plant	Pounding	Topical
	Typhoid	1	Whole plant	Decoction	Oral
<i>Mitragyna parvifolia</i> Korth. (6)	Cancer	1	Bark	Decoction	Oral
	Child fever	4	Bark	Decoction	Oral
	Menstrual disorder	1	Flower	Pounding	Oral
<i>Momordica charantia</i> L. (2)	Ringworm	1	Leaves	Pounding	Topical
	Scabies	1	Leaves	Pounding	Topical
<i>Momordica dioica</i> Roxb. ex Willd (19)	<u>Cancer</u>	<u>1</u>	<u>Leaves</u>	<u>Pounding</u>	<u>Oral</u>
	<u>Child fever</u>	<u>1</u>	<u>Leaves</u>	<u>Pounding</u>	<u>Topical</u>
	<u>Diabetes</u>	<u>1</u>	<u>Fruit</u>	<u>Cooking</u>	<u>Oral</u>
	<u>Ringworm</u>	<u>8</u>	<u>Leaves</u>	<u>Pounding</u>	<u>Topical</u>
	<u>Scabies</u>	<u>8</u>	<u>Leaves</u>	<u>Pounding</u>	<u>Topical</u>
<i>Moringa oleifera</i> Lam. (29)	Headache	1	Leaves	Pounding	Oral
	Hypertension	25	Leaves	Cooking	Oral
	Throat cancer	3	Fruit	Cooking	Oral
<i>Morus indica</i> L. (1)	<u>Dysentery</u>	<u>1</u>	<u>Leaves, Fruit</u>	<u>Raw</u>	<u>Oral</u>
<i>Moullava digyna</i> (Rottler) Gagnon & G.P. Lewis (3)	<u>Dysentery</u>	<u>1</u>	<u>Stem</u>	<u>Decoction</u>	<u>Oral</u>
	<u>Insect bite</u>	<u>1</u>	<u>Seed</u>	<u>Pounding</u>	<u>Topical</u>
	<u>Toothache</u>	<u>1</u>	<u>Seed</u>	<u>Pounding</u>	<u>Topical</u>
<i>Nervilia fordii</i> Schltr. (3)	Bone fracture	1	Whole plant	Pounding	Topical
	Child fever	1	Whole plant	Decoction	Oral
	Sprain	1	Whole plant	Pounding	Topical
<i>Nicotiana tabacum</i> L. (1)	<u>Injury</u>	<u>1</u>	<u>Leaves</u>	<u>Pounding</u>	<u>Topical</u>
<i>Ocimum basilicum</i> L. (6)	Cough	3	Leaves	Pounding	Oral
	Hypertension	2	Leaves	Pounding	Oral
	Tuberculosis	1	Leaves	Pounding	Oral
<i>Ocimum tenuiflorum</i> L. (11)	Cough	8	Leaves	Pounding	Oral
	Earache	1	Leaves	Raw	Ear drop
	Headache	1	Leaves	Pounding	Topical
	Indigestion	1	Leaves	Pounding, Oil processing	Oral
<i>Oroxylum indicum</i> (L.) Benth. ex Kurz (13)	Flatulence	1	Bark	Decoction	Oral
	Hypertension	2	Bark	Decoction	Oral
	Mastitis	5	Fruit	Raw	Oral

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Table 2 (continued)

Scientific name (URs per species)	Ailments	URs per ailments	Plant parts used	Preparation method	Administration method
<i>Orthosiphon aristatus</i> (Blume) Miq. (2)	Melena	5	Bark	Decoction	Oral
	Diabetes	1	Whole plant	Decoction	Oral
	Tonic	1	Root	Pounding	Oral
<i>Oxalis corniculata</i> L. (2)	Weak eyesight	2	Whole plant	Decoction	Oral
<i>Paris polyphylla</i> Sm. (6)	Kidney stone	1	Tuber	Decoction	Oral
	Longevity	2	Tuber	Honey processing	Oral
	Tonic	3	Tuber	Honey processing	Oral
<i>Pauldopia ghorta</i> (Buch.-Ham. ex G. Don)	Hypertension	1	Leaves	Decoction	Oral
<i>Steenis</i> (1)					
<i>Persicaria chinensis</i> (L.) H.Gross (2)	Hypertension	1	Whole plant	Decoction	Oral
	Kidney stone	1	Whole plant	Decoction	Oral
<i>Phyllanthus emblica</i> L. (14)	Diarrhea	1	Fruit	Raw	Oral
	Dizziness	9	Fruit	Raw	Oral
	Hypertension	1	Fruit	Raw	Oral
	Menstrual disorder	1	Fruit	Raw	Oral
	Scabies	1	Leaves	Pounding	Topical
	Ulcer	1	Leaves	Pounding	Topical
<i>Phyllanthus niruri</i> L. (12)	Atherosclerosis	1	Whole plant	Decoction	Oral
	Diabetes	3	Whole plant	Decoction	Oral
	Dysuria	2	Whole plant	Decoction, Sugar processing	Oral
	Hypertension	2	Whole plant	Decoction	Oral
	Kidney stone	3	Whole plant	Decoction	Oral
	Urinary incontinence (Loss of bladder control)	1	Whole plant	Decoction	Oral
<i>Pinus kesiya</i> var. <i>langbianensis</i> (A.Chev.) Gaussen ex Bui (2)	Flu	1	Stem	Decoction	Oral
<i>Piper betle</i> L. (30)	Nerve pain	1	Bark, Wood	Oil processing	Topical
	Cough	19	Leaves	Decoction, Sugar processing	Oral
	Excessive sweating	1	Leaves	Decoction	Oral
	Headache	6	Leaves	Pounding	Topical
	Nose bleeding	1	Leaves	Pounding	Nasal
	Scorpion bite	1	Leaves	Decoction, Sugar processing	Oral
	Sore throat	2	Leaves	Decoction	Oral
	Nose bleeding	1	Leaves	Pounding	Nasal
<i>Piper longum</i> L. (1)	Edema	4	Leaves	Decoction	Oral
<i>Plantago depressa</i> Willd (7)	Hypertension	1	Whole plant	Decoction	Oral
	Nerve pain	2	Leaves, Whole plant	Decoction	Oral
			plant		
<i>Plectranthus amboinicus</i> (Lour.) Spreng. (4)	Cough	4	Leaves	Pounding	Oral
<i>Plukenetia volubilis</i> L. (1)	Hypertension	1	Leaves, Fruit	Decoction	Oral
<i>Plumbago zeylanica</i> L. (3)	Tinea versicolor	1	Root	Pounding	Topical
	Menstrual disorder	1	Root	Pounding	Oral
	Tonic	1	Root	Pounding	Oral
<i>Prunus amygdalus</i> Batsch (1)	Fever	1	Leaves	Decoction	Oral
<i>Psidium guajava</i> L. (2)	Diarrhea	1	Leaves	Decoction, Raw	Oral
	Dysentery	1	Leaves	Decoction, Raw	Oral
<i>Punica granatum</i> L. (3)	Diarrhea	2	Leaves	Decoction	Oral
	Scar	1	Leaves	Pounding	Topical
<i>Rauvolfia serpentina</i> (L.) Benth. ex Kurz (2)	Hypertension	2	Root	Decoction	Oral
<i>Rehmannia glutinosa</i> (Gaertn.) DC. (7)	Diabetes	1	Whole plant	Decoction	Oral
	Dysuria	2	Root	Decoction	Oral
	Kidney stone	3	Root	Decoction	Oral
	Scabies	1	Leaves	Pounding	Topical
	Child fever	8	Fruit	Raw	Oral
<i>Rhus coriaria</i> L. (17)	Dysuria	3	Fruit	Raw	Oral
	Toothache	3	Fruit	Honey processing	Oral
	Waist pain	3	Root	Decoction	Oral
<i>Ricinus communis</i> L. (2)	Injury	1	Leaves	Pounding	Topical
	Sprain	1	Leaves	Roast	Topical
<i>Rubia cordifolia</i> L. (1)	Dysuria	1	Whole plant	Decoction	Oral
<i>Saccharum officinarum</i> L. (1)	Cough	1	Stem	Raw	Oral
<i>Saccharum sinense</i> Roxb. (1)	Heart disease	1	Stem	Raw	Oral
<i>Schleichera oleosa</i> (Lour.) Oken (1)	Hypertension	1	Fruit	Raw	Oral
<i>Scoparia dulcis</i> L. (2)	Boils	1	Whole plant	Pounding	Topical
	Inflammation in injury	1	Whole plant	Pounding	Topical
<i>Selinum carvifolia</i> (L.) L. (1)	Indigestion	1	Seed	Pounding	Oral
<i>Senegalia rugata</i> (Lam.) Britton & Rose (7)	Dysuria	5	Leaves	Decoction	Oral
	Menstrual disorder	2	Leaves	Cooking	Oral
<i>Senna alata</i> (L.) Roxb. (1)	Ringworm	1	Leaves	Pounding	Topical
<i>Senna sulfurea</i> (Collad.) H.S.Irwin & Barneby (6)	Diabetes	3	Leaves	Cooking	Oral
<i>Sesbania grandiflora</i> (L.) Poir (1)	Gonorrhea	3	Leaves	Cooking	Oral
	Hypertension	1	Leaves	Cooking	Oral
<i>Seseli yunnanense</i> Franch. (7)	Diarrhea	7	Whole plant	Decoction	Bathing
<i>Sida rhombifolia</i> L. (3)	Injury	1	Whole plant	Pounding	Topical

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Table 2 (continued)

Scientific name (URs per species)	Ailments	URs per ailments	Plant parts used	Preparation method	Administration method
<i>Smallanthus sonchifolius</i> (Poepp.) H. Rob. (1)	Postpartum care	1	Whole plant	Decoction	Bathing
	Scabies	1	Whole plant	Decoction	Bathing
	Dysuria	1	Leaves	Infusion	Oral
	Burns	2	Fruit	Pounding	Topical
	Cough	10	Leaves	Cooking	Oral
<i>Solanum lycopersicum</i> L. (2)	Flatulence	12	Leaves	Cooking	Oral
<i>Solanum nigrum</i> L. (35)	Ringworm	1	Leaves	Pounding	Topical
	Stomachache	12	Leaves	Cooking	Oral
	Asthma	3	Fruit	Cooking	Oral
	Cough	3	Fruit	Cooking	Oral
	Dysuria	2	Root	Decoction	Oral
<i>Solanum torvum</i> Sw. (6)	Hypertension	1	Fruit	Raw	Oral
<i>Solanum violaceum</i> Ortega (6)	Scabies	1	Fruit	Pounding	Topical
	Waist pain	2	Root	Decoction	Oral
	Toothache	1	Fruit	Pounding	Oral
	Acne	1	Tuber	Pounding	Topical
	Toothache	1	Resin	Pounding	Oral
<i>Stephania japonica</i> var. <i>discolor</i> (Blume) Forman (2)	Tonic	1	Tuber	Honey processing	Oral
<i>Strychnos nux-vomica</i> L. (1)	Toothache	1	Tuber	Pounding	Oral
	Flatulence	1	Root	Decoction	Oral
	Anemia	1	Leaves	Decoction	Oral
	Asthma	1	Leaves	Decoction	Oral
	Cancer	1	Leaves	Decoction	Oral
<i>Tadehagi triquetrum</i> (L.) H. Ohashi (16)	Hepatitis	4	Leaves	Decoction	Oral
	Pneumonia	1	Leaves	Decoction	Oral
	Tuberculosis	8	Leaves	Decoction	Oral
	Constipation	1	Fruit	Sugar processing	Oral
	Dysuria	1	Leaves	Decoction	Oral
<i>Tamarindus indica</i> L. (3)	Weak eyesight	1	Bark	Pounding	Topical
<i>Terminalia chebula</i> Retz. (3)	Dysentery	2	Fruit	Raw	Oral
	Pneumonia	1	Fruit	Raw	Oral
	Diarrhea	1	Fruit	Raw	Oral
	Heart disease	1	Bark	Decoction	Oral
	Dysuria	1	Leaves	Decoction	Oral
<i>Terminalia citrina</i> Roxb. ex Fleming (1)	Joint pain	1	Leaves	Pounding	Topical
<i>Terminalia elliptica</i> Willd. (1)	Edema	8	Stem	Infusion, Decoction, Sugar processing	Oral
<i>Tetragastria</i> sp. (2)	Flatulence	1	Stem	Infusion, Decoction, Sugar processing	Oral
<i>Tinospora sinensis</i> (Lour.) Merr. (28)	Hypertension	8	Stem	Infusion, Decoction, Sugar processing	Oral
	Paralysis	8	Stem	Infusion, Decoction, Sugar processing	Oral
	Stomachache	2	Stem	Infusion, Decoction	Oral
	Tonic	1	Stem	Infusion, Decoction, Honey processing	Oral
	Kidney disease	3	Whole plant	Decoction	Oral
<i>Tradescantia zebrina</i> var. <i>zebrina</i> Hort. Ex Bosse (3)	Epilepsy	1	Whole plant	Decoction	Oral
<i>Trichosanthes cucumerina</i> L. (1)	Allergic	1	Leaves	Pounding	Topical
<i>Vitex pinnata</i> L. (1)	Dysuria	1	Leaves	Decoction	Oral
<i>Vitex quinata</i> (Lour.) F.N. Williams (1)	Fever	1	Leaves	Decoction	Oral
<i>Vitex trifolia</i> L. (1)	Menstrual disorder	1	Leaves	Decoction	Oral
<i>Vitex vestita</i> Wall. ex Walp. (1)	Back pain	3	Rhizome	Pounding	Topical
<i>Zingiber barbatum</i> Wall. (69)	Bone fracture	2	Rhizome	Pounding	Topical
	Diarrhea	1	Rhizome	Decoction	Oral
	Edema	4	Rhizome	Decoction	Oral
	Flatulence	1	Rhizome	Decoction	Oral
	Flu	1	Rhizome	Decoction	Oral
<i>Zingiber officinale</i> Roscoe (13)	Hypertension	3	Rhizome	Decoction	Oral
	Indigestion	1	Rhizome	Decoction	Oral
	Inflammation in injury	4	Rhizome	Pounding	Topical
	Joint pain	11	Rhizome	Pounding	Topical
	Menstrual disorder	7	Rhizome	Decoction	Oral
<i>Zingiber officinale</i> Roscoe (13)	Postpartum care	24	Rhizome	Decoction	Bathing
	Ringworm	1	Rhizome	Pounding	Topical
	Scabies	2	Rhizome	Pounding	Topical
	Sprain	3	Rhizome	Pounding	Topical
	Tonic	1	Rhizome	Decoction	Oral
<i>Zingiber officinale</i> Roscoe (13)	Aches and pain	2	Rhizome	Pounding	Topical
	Cough	3	Rhizome	Decoction	Oral
	Fever	4	Rhizome	Decoction, Sugar processing	Oral
	Flu	1	Rhizome	Decoction, Sugar processing	Oral
	Indigestion	1	Rhizome	Decoction, Sugar processing	Oral

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Table 2 (continued)

Scientific name (URs per species)	Ailments	URs per ailments	Plant parts used	Preparation method	Administration method
Zingiber sp. (2)	Joint pain	2	Rhizome	Pounding	Topical
	Sore throat	1	Rhizome	Decoction, Sugar processing	Oral
	Indigestion	2	Rhizome	Decoction	Oral

^a 1. The species in bold and underline are the 19 newly recorded plant species for medicinal uses in Myanmar in this study.
2. The species with underline are the 24 known Myanmar medicinal plant species without any information on treatment use, which were first documented in this study.
3. The “ailments treated” in bold are the newly recorded applicable ailments for 83 known medicinal plant species in Myanmar.

adenophora (Spreng.) R.M.King & H. Rob. (URs = 63), *Cissus discolor* Blume (URs = 61), *Artemisia vulgaris* L. (URs = 59), and *Andrographis paniculata* (Burm.f.) Nees (URs = 54). In terms of life form, we recorded 60 herbs, 47 shrubs, 33 trees, 15 climbers and one woody climber.

3.2. Part used, methods of preparation, and administration of the medicinal plants

Leaves were the most common plant part used (72 species), followed by whole plant, fruit, root, rhizome, bark, stem, tuber, latex, seed, wood, flower, gum, and resin. Methods of administration included oral intake (124 species), topical application, bathing, nasal inhalation, ear drops, and eye drops. A total of 10 methods were recorded for the preparation of medicines, and 91 ailments were treated by these plants. Decoction (91 species) followed by pounding were the most common methods of preparation.

3.3. Therapeutic usage of the medicinal plants

The 156 medicinal plants documented in this study were used to treat 16 ICPC-2 disease categories which were comprised from 91 single ailments. The two most cited disease categories were skin and digestive disorders (Fig. 3, a), together comprising 34% URs. Skin diseases included 15 ailments, and were treated using 47 plant species. Injuries, wounds, and scabies were the top cited skin ailments. A total of 68 plant species were used to treat 19 ailments of the digestive system, with flatulence, diarrhea, and constipation being the top cited ailments.

In the case of single ailment, the maximum use reports were reported for cough (87 use reports and 18 species), followed by injury (82 use reports and 9 species), post-partum care (72 use reports and 10 species), hypertension (71 use reports and 25 species) and the rest 87 ailments (Fig. 3, b).

3.4. New findings pertaining to the Myanmar medicinal plants

Our study found 19 of the 156 plant species as new records for medicinal uses in Myanmar when compared with the historical publications in English and accessible to the public (Fig. 4). Furthermore, the study filled the gaps (for 24 species) and enriched the types (for 83 species) of applicable ailments for known medicinal plant species in Myanmar (Table 2).

4. Discussion

4.1. Cross-comparison of represented species from the Fabaceae and Lamiaceae families

The Fabaceae and Lamiaceae were the top two families in terms of number of species used medicinally by the Shan people in the Southern Shan State. These are the third and fourth largest plant families in Myanmar (Kress et al., 2003). Our results were in this respect consistent with those in studies from Kachin (Hein et al., 2023), Chin (Ong et al., 2018a, 2018b), and Mon (Kyaw et al., 2020) states. Species in the families of Fabaceae and Lamiaceae were also commonly used for

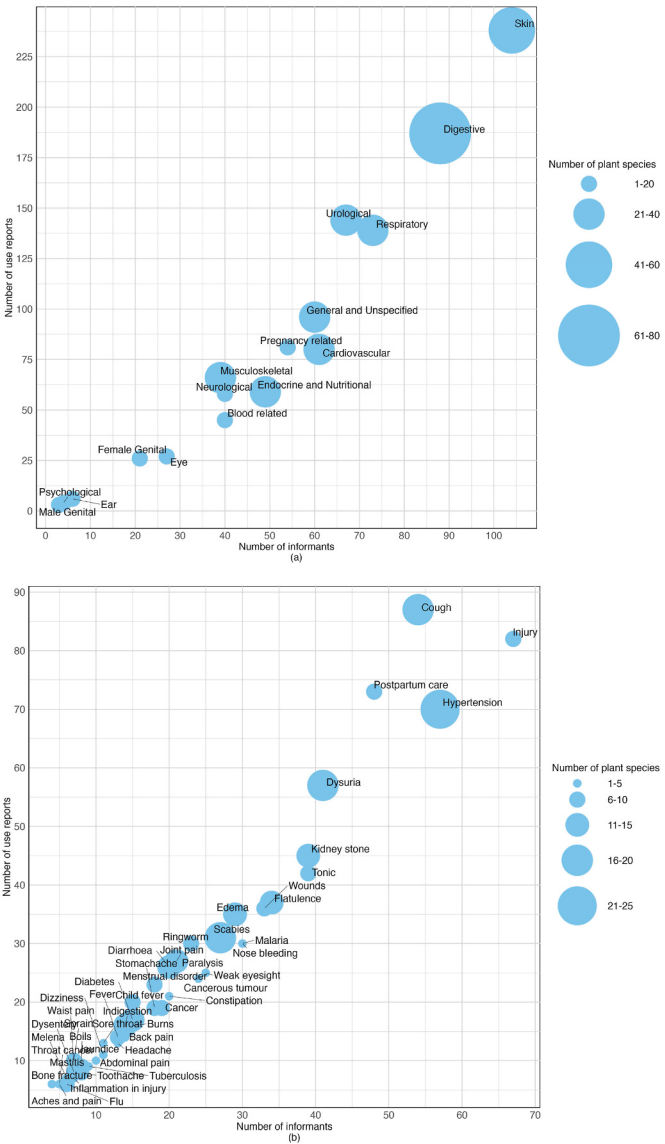


Fig. 3. Disease categories (a) and highly cited ailments (b) treated with medicinal plants as reported by the Shan people of the Southern Shan State, Myanmar. Only the ailments with more than 5 use reports are shown in the figure (b); Disease categories follow the International Classification of Primary Care system (ICPC-2, <https://www.who.int/standards/classifications/otherclassifications/international-classification-of-primary-care>); Ailments were translated from emic meaning.

traditional medicinal purposes in the countries surrounding Myanmar, including China (Sun et al., 2020), Thailand (Maneeoon et al., 2015), Laos (Dubost et al., 2019; Libman et al., 2006) and Bangladesh (Islam et al., 2022).

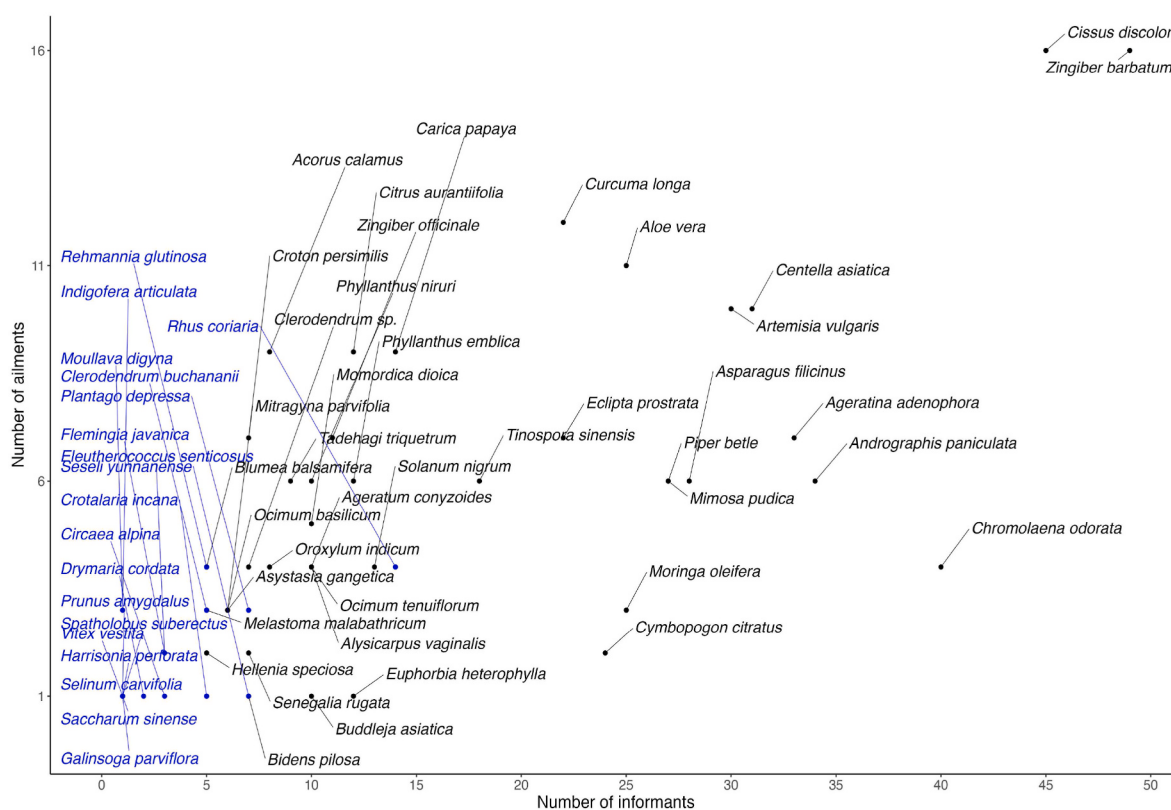


Fig. 4. The citation frequencies of all the 19 new recorded plant species (blue color) for medicinal uses comparing with the known species we recorded in this study (black color, only the species reported by more than 5 informants are shown in the figure).

Eight plant species belonging to the Fabaceae family, including *Alysicarpus vaginalis* (L.) DC., *Biancaea sappan* (L.) Tod., *Cassia fistula* L., *Tadehagi triquetrum* (L.) H., *Tamarindus indica* L., *Mimosa pudica* L., *Senna alata* (L.) Roxb., and *Senegalia rugata* (Lam.) Britton & Rose, were documented as being utilized by inhabitants in Kachin (Hein et al., 2023), Mon (Kyaw et al., 2020), and Chin (Ong et al., 2018b) states. Additionally, DeFilipps and Krupnick (2018) identified the traditional uses of three of these species including *C. fistula*, *M. pudica*, and *S. alata* in their research on Myanmar's medicinal plants. *A. vaginalis* was reported to be commonly used to treat urinary and kidney problems by the Shan, Kachin, Mon, and Chin peoples. *T. triquetrum* was used to treat asthma and hepatitis by both the Shan and Mon peoples, and to treat tuberculosis by the Shan, Kachin, and Mon. *M. pudica* was commonly used for treating dysuria and edema by the Shan and Mon peoples. It was also reported to be used in the treatment of diuretic disorders and to promote urinary function (DeFilipps and Krupnick, 2018). *C. fistula* was reported to treat constipation by Mon people (Kyaw et al., 2020) and by some people in Myanmar (DeFilipps and Krupnick, 2018). *S. alata* was commonly used to treat ringworm and skin disease by the Shan, Mon, and Kachin peoples, while it has also been reported to have a use in the treatment of skin problems, such as scabies, ringworm, and eczema (DeFilipps and Krupnick, 2018).

Of the plant species in the Lamiaceae documented in our study, six species, *Coleus amboinicus* Lour., *Leucas cephalotes* (Roth), *Orthosiphon aristatus* (Blume) Miq., *Ocimum basilicum* L., *Ocimum tenuiflorum* L., and *Vitex trifolia* L., have also been reported to have medicinal uses in Kachin (Hein et al., 2023), Mon (Kyaw et al., 2020), and Chin (Ong et al., 2018b) states. *C. amboinicus* and *O. basilicum* were used to treat cough by both the Shan and Kachin peoples. *O. aristatus* and *V. trifolia* were used in the treatment of diabetes and fever, as well as a tonic, by the Shan and Mon peoples. DeFilipps and Krupnick (2018) also documented a traditional use of *O. aristatus* against diabetes. *O. tenuiflorum* was used to treat headaches by the Shan and Chin peoples.

This sharing of ethnobotanical knowledge across diverse cultural groups underscores the profound significance of traditional knowledge. It provides a solid foundation for conducting comparative studies and further emphasizes the need to explore the potential effectiveness of plant-based medicines. Since identifying plant-based medicinal approaches necessitate investigations that range over broad geographic regions and across multiple cultures (Trotter and Logan, 1986).

4.2. Top five cited medicinal plants

Out of the 156 medicinal plant species, *Z. barbatum*, *A. adenophora*, *C. discolor*, *A. vulgaris*, and *A. paniculata* were the five species most reported.

Z. barbatum belongs to the Zingiberaceae family and is locally known as *Meik-tha-lin* or *Pwe-U* in Myanmar and *Mi-salan* in the Shan language. The species is endemic to Myanmar and Thailand (<http://plantsoftheworldonline.org>). So far, it has only been reported as medicinal plant in Myanmar, and the rhizome is used to treat abdominal pain, allergic reactions, cuts and wounds, flatulence, Cervical spondylosis (Hein et al., 2023), sprains, inflammation in injuries, pain in the joints and back (Kyaw et al., 2020), and gout (Wicaksana et al., 2011). In our study area, the plant was transplanted and/or domesticated from the wild and grown in backyards as a medicinal plant. This point out the enduring relevance of this plant in the lives of the communities where it is found. The rhizomes and leaves of *Z. barbatum* were used in **postpartum care**, as well as to treat various ailments, including joint pain, **menstrual disorders**, **edema**, inflammation in injuries, back pain, **hypertension**, sprains, bone fractures, **scabies**, **diarrhea**, flatulence, **flu**, **indigestion** and **ringworm** and also as a **tonic**, which appearing here in the order of their reported frequency in the URs (The ailments in bold letters are first reported in this study). Shan women bathe in a boiled mixture of *Z. barbatum* rhizomes and leaves together with *Cymbopogon citratus* (DC.) Stapf, *Croton persimilis* Müll. Arg. and other plants after giving

birth as postpartum care. The rhizome of *Z. barbatum* contains volatile oil compounds, made up of 21% monoterpenes and 30% sesquiterpenes (Shukurova et al., 2020). Our findings highlight the diverse application of *Z. barbatum* as a valuable resource in traditional medicine and its potential for future pharmacological research.

A. adenophora, a member of the Asteraceae family, is known as *Kyar-ma-naing-bizat* or *Bizat-mae* in Myanmar. It is a widely distributed invasive weed originating from Mexico, and is believed to have various medicinal values (Debnath and Debnath, 2017). In our study, the Shan people use the leaves to treat seven different ailments, including injuries, wounds, fever, abdominal pain, boils, diabetes, and stomachache. Similar uses, including treating injuries, abscesses, skin itching, cuts and wounds, as well as for hepatitis, malaria, abdominal pain and dysentery, have been reported from Myanmar and from neighboring countries (Anderson, 1896; Bantawa and Rai, 2009; Ong et al., 2018b; Hein et al., 2023). In considering the traditional wounds healing practice of *A. adenophora*, Kumar et al. (2017) conducted a study of using a 10% w/w gel of ethanol extract on rats with excision and incision wounds, employing *in vivo* models for 13 days. The results of the study demonstrated that *A. adenophora* exhibited a remarkable potential for wound healing ($p < 0.01$). However, some phytochemicals in this plant also exhibit toxicity and the major toxic compounds were 9-Oxo-10, 11-dehydro-agerophorone (euptox A), 2-deoxo-2-(acetyloxy)-9-oxo-agerophorone (DAOA) and 9-oxo-agerophorone (OA) (Ren et al., 2021). Euptox A exhibit toxicity with a median lethal dose (LD50) of 1470 mg/kg body weight of mice, DAOA and OA also showed hepatotoxicity in mice with respective LD50 of 926 mg/kg BW and 1470 mg/kg BW (Ouyang et al., 2015). While in a study of Giri et al. (2022), (+)-7,7'-bis (5R,7R,9R,10S)-2-oxocadinan-3,6(11)-dien-12,7-olide was proposed to have potential activity against coronavirus. The potential anti-coronavirus activity of *A. adenophora* is a compelling prospect for further investigation, particularly in the context of the global interest in antiviral treatments. However, in light of the findings on toxicity, future research can prioritize the thorough characterization of safety profiles and the determination of optimal dosages to fully exploit the therapeutic potential of *A. adenophora*, while mitigating any potential harm and side effects.

C. discolor from the Vitaceae family is known as *Tabindaing-mya-nan* in Myanmar and *Man-ho-yoe* in the Shan language. We found that the Shan people mostly collected this species from the wild, and sometimes transplanted to their gardens for self-use or as source of cash income. According to the local sellers, one kg of the fresh tuber was 2000 to 30,000 Myanmar Kyats, approximately 1.27–19 US Dollars, in 2018. The rootstock was used by the Shan in the treatment of 16 diseases, including cancerous tumors, cancer, edema, non-cancerous tumors, stomach cancer, acne, boils, wounds, aches and pain, burns, childhood fevers, inflammation in injuries, jaundice, leukemia, postpartum care and stomachache, which appearing here in the order of their reported frequency in the URs. A few previous studies have reported the uses of this species in India for treating healing wounds, ringworm, itching sores, and stomach problems (Bhat et al., 2014; Shantabi et al., 2014), and for stomach problems, cancer and various types of tumors, especially of the female genital tract, in other parts of Myanmar (Lwin et al., 2021; Ong et al., 2018b). Lwin et al. (2021) found glycosides, sterol, triterpene, and phenolic (particularly flavonoids) in an extract of the rootstock, and this extract had *in vitro* anti-tumor activities against cervical cancer, breast cancer, endometrial cancer, and ovarian cancer cell lines. This pharmacological efficacy agrees with our ethnomedicinal findings on the treatment of cancer and tumor. A toxicity test conducted by Garcia et al. (2000) suggested the oral consumption of *C. discolor* was safe at doses ranging between 2500 and 3500 mg dry extract/kg. This finding lays a good foundation for future clinical investigations. This translational research has the potential to bridge the gap between traditional knowledge and evidence-based medical practices, offering benefits to the communities relying on this valuable plant while potentially contributing to broader healthcare solutions.

A. vulgaris, from the Asteraceae family, is known as *Me-di-dok* in Myanmar and as *Ya-khit-tut* in the Shan language. Shan people use it to treat nose bleeding, ringworm, injuries, scabies, wounds, diarrhea, fever, hypertension, paralysis, and stomachache. Its use to treat hypertension was consistent with reports from the Philippines (Nigam et al., 2019) and Vietnam (Nguyen et al., 2016). Moreover, several gynecological uses, including as an emmenagogue, a uterine sedative, or a postpartum tonic, or to treat amenorrhea, dysmenorrhea, oligomenorrhea, pregnancy disorders, leucorrhea, and severe pain during delivery, have been reported from Southeast Asia (Boer and Cotingting, 2014). According to Tigno et al. (2000), the 10% solution of the aqueous extract of the aerial parts of *A. vulgaris* into the isolated perfused mesentery of male Sprague-Dawley rats effectively reversed the hypertensive effect. Afsar et al. (2013) found the anti-inflammatory activity of methanolic leaf extract of *A. vulgaris* using the cotton pellet granuloma method, and the more significant result shows at 400 mg/kg compared with the control. The study of Kodippili et al. (2011) *in vivo* in the *Plasmodium yoelii* rodent malaria model showed the oral administration of the extract at 500 and 1000 mg/kg significantly inhibited parasitemia, while the study of Bamunuarachchi et al. (2013), in *Plasmodium berghei* ANKA murine malaria model showed ethanolic leaf extract at doses of 500, 750, and 1000 mg/kg significantly inhibited parasitemia. In addition, chronic administration of the extract at high dose ruled out the overt signs of toxicity and stress as well as hepatotoxicity, renotoxicity, and hematotoxicity. Therefore, the oral administration of *A. vulgaris* is reported as nontoxic and induces antimalarial (antiparasitic) effects. These pharmacological activities validate the scientific basis for the traditional use of this plant as a remedy for treating hypertension, inflammation, and malaria.

A. paniculata, from the Acanthaceae family, is known as *Shan Say-khar-kyi* or *Say-khar gyi* (meaning “Shan bitter medicine”) in Myanmar and *Ma-pyit-khon* in the Shan language. It is commonly known as the “king of bitters”, and is a well-known plant in oriental and Aryurvedic medicine (Okhwarobo et al., 2014). In our study, the plant was used to treat malaria, coughs, hypertension, child fever, dizziness, and abdominal pain. Similar uses in the treatment of fevers, coughs, hypertension, and malaria have been reported from Indonesia, India and Bangladesh (Nagendrappa et al., 2013; Islam et al., 2014; Sujarwo et al., 2015; Tiwary et al., 2015; Aminah et al., 2021). Due to its high performance in treating malaria, Mishra et al. (2011) conducted tests combining Andrographolide from aerial and whole parts with curcumin, which demonstrated impressive anti-malarial effects against *Plasmodium falciparum* and *Plasmodium berghei* *in vitro* and *in vivo*, with IC_{50} values of 9.1 and 17.4 μ M, respectively. The methanol extract of leaves in a randomized, double-blind placebo-controlled clinical study with 223 patients were found to be effective in reducing symptoms of upper respiratory tract infection, significantly reducing sore throat symptoms when containing compounds Andrographolide, 3-Oxo-14-deoxy-11, 12-didehydroandrographolide, Neoandrographolide, Andrograpanin, Isoandrographolide from the aerial parts and skullcap-flavone I from the whole plant (Saxena et al., 2010). *A. paniculata* was also used as a supportive agent to cope with the coronavirus in some countries, due to its ability to reduce inflammation, improve virus clearance (Zhang et al., 2021), give relief from mild symptoms and prevent their progression to severe symptoms (National Drug Selection Committees, 2021) and boost immunity (Ghosh et al., 2020). The clinical trials revealed that the presence of Andrographolide is the main role of showing antiviral activity in a different extract of plant parts as it has been confirmed for its antiviral activities against the influenza A virus, hepatitis B virus, hepatitis C virus, herpes simplex virus-1 (HSV-1), human immunodeficiency virus (HIV), Chikungunya virus (CHIKV), Epstein-Barr virus (EBV) and human papillomavirus (HPV) in the studies of Edwin et al. (2016) and Gupta et al. (2017). The findings highlighted the important of traditional knowledge in the transition to evident-based medicine, even in the context of the global interest in antiviral treatments. Based on the cross-validation of traditional knowledge to the clinical evident,

A. paniculata is suggested as a potential candidate for drug discovery in malaria and virus-related diseases.

4.3. Top two prevalent diseases

The first most prevalent disease category was skin disease (237 URs, 102 informants) with 15 recorded ailments. Forty-six species (30% of the total reported species) were used to treat ailments in this category. *A. adenophora* was the top cited species, and *Chromolaena odorata* (L.) R. M.King & H. Rob., *Momordica dioica* Roxb. ex Willd, *Aloe vera* (L.) Burm. f., *C. discolor*, and *Z. barbatum* were also commonly used in the treatment of skin diseases. The high prevalence of skin ailments such as injuries, wounds, ulcers, boils, skin burns and insect bites were mostly a result of the environment to which the informants were exposed and the type of work they were engaged in. For instance, injuries (85 URs) were the most common ailments because most of the informants (78%) practiced outdoor farming related livelihoods without primary protection measures, which incur a high risk of being injured. Plants were the regular choice of medicinal treatment for the Shan people, especially in the treatment of acute injuries, chronic wounds and ulcers, due to the lack of medical facilities in remote villages, finding immediate self-treatment involving only simple preparation and application methods is essential.

Digestive system disorders were the second most prevalent disease category (187 URs, 86 informants) with 19 ailments reported and with 62 medicinal plants used in their treatment. Flatulence (37 URs) and diarrhea (26 URs) were found to be the most common ailments. These two ailments were most likely linked to the use of contaminated water and unhygienic living conditions. In the study area, drinking water is sourced from the open wells situated in the home compounds, where domestic animals are raised in the ground levels of the traditional stilt houses. Additionally, no paved roads or drainage systems were available in most of the sample villages. Consequently, during the rainy season, the animal waste and contaminated mud may have found its way into the wells and are likely to be the source of contamination of the drinking water. The World Health Organization recommends that improved environmental management, including promoting safe household water, implementing better hygiene measures, and addressing sanitation issues, can significantly reduce up to 94% of deaths from diarrhea (Tulchinsky and Varavikova, 2014).

Our findings on most prevalent diseases aligned with ethnobotanical studies in Kachin (Hein et al., 2023) and Mon (Kyaw et al., 2020), where digestive issues were most prevalent for Kachin and Mon peoples. Similarly, in the study conducted in Chin (Ong et al., 2018a, 2018b), digestive problems, and skin, particularly injuries, were the most prevalent health issues among Chin people. The comparative finding suggests that inadequate sanitation facilities among the rural communities and a high risk of accidents and occupational hazards in the locals' work environment and livelihood as farmers (e.g. in slash and burn agriculture) among the reported ethnic groups were main causes of the most prevalence diseases. Improving the living conditions could be the primary focus in order to address and reduce that kind of prevalence health problem, especially in the remote and hard to reach areas of Myanmar.

4.4. New findings pertaining to the Myanmar traditional medicinal system

Our research uncovered 19 out of the 156 plant species that are newly recognized as medicinal uses in Myanmar when compared to previously published English-language materials accessible to the public. Notably, *Rhus coriaria* was mentioned by 14 informants for its efficacy in treating a range of conditions, including child fever, dysuria, toothache, and waist pain. The species *Crotalaria incana*, *Clerodendrum buchananii*, *Rehmannia glutinosa*, *Seseli yunnanense* and *Plantago depressa* were being reported by more than five informants in treating between one to four ailments. In contrast, seven species including *Galinsoga parviflora*, *Harrisonia perforata*, *Prunus amygdalus*, *Saccharum sinense*, *Selinum carvifolia*, *Spatholobus suberectus*, and *Vitex vestita* with only one

use report in our study and never been mentioned in the previous studies in Myanmar listed above. Those species, however, have been listed as medicinal plants in other studies out of Myanmar. The study contributed to the updating of the Myanmar medicinal plant list and have enriched the ethnobotanical knowledge of known medicinal plants, which opens gaps for further research, and support the objective of sustainable development goal 3, which aims to ensure healthy lives and promote well-being for all at all ages (UN General Assembly, 2015).

5. Conclusion

Our study revealed that *Z. barbatum*, *A. adenophora*, *C. discolor*, *A. vulgaris*, and *A. paniculata* were the most important medicinal plants for the Shan people of the Southern Shan State, and that a total of 156 plant species were used for medicinal purposes in this area. The prevalent skin and digestive diseases were treated with 46 and 62 plants, respectively, which deserved further phytochemical and pharmacological exploration for their potential in treating skin and digestive problems. The study documented 19 new plant species for medicinal uses in Myanmar and contributed to the update of the Myanmar medicinal plant list. The results demonstrated that medicinal plants and their traditional practices are crucial for the Shan people's primary healthcare needs.

CRediT authorship contribution statement

Aye Mya Mon: Writing – original draft, Data curation, Formal analysis. **Pyae Phyoe Hein:** Formal analysis, Investigation. **Moe Zaw:** Investigation, Resources. **Myo Thiha Kyaw:** Investigation. **Yongping Yang:** Conceptualization, Visualization. **Xuefei Yang:** Conceptualization, Supervision, Visualization. **Yinxian Shi:** Supervision, Writing – review & editing.

Declaration of competing interest

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

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jep.2024.117875>.

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