

Ethnobotanical survey of medicinal plants used by the Mamanwa tribe of Surigao del Norte and Agusan del Norte, Mindanao, Philippines

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²Premier Research Institute of Science and Mathematics, Mindanao State University, Tibanga, Iligan City, Lanao del Norte, Mindanao, Philippines. ✉✉email: biverly.rodriguez@g.msuiit.edu.ph, ✉✉✉ julietgrace.nasiad.@g.msuiit.edu.ph

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Abstract. Nuneza OM, Rodriguez BC, Nasiad JGM. 2021. Ethnobotanical survey of medicinal plants used by the Mamanwa tribe of Surigao del Norte and Agusan del Norte, Mindanao, Philippines. *Biodiversitas* 22: 3284-3296. Traditional knowledge on medicinal plants plays an important role in public healthcare and development of drugs. In the Philippines, studies on ethnomedicinal plants have increased throughout the years. However, documentation on the ethnobotanical knowledge in Mindanao is few and mostly focused on other well-known tribes. This ethnobotanical study was carried out to document medicinal plants used by the Mamanwas tribe in ten Indigenous Cultural Communities (ICCs) of Surigao del Norte and Agusan del Norte, Philippines. Ethnomedicinal information on the plant parts used, different modes of preparation, and mode of utilization was gathered from 143 local informants through informal interviews and semi-structured questionnaires. Seventy-eight plant species under 70 genera and 42 families were documented to treat various ailments in their communities. Family Asteraceae held the dominance with ten species that were reported to have medicinal uses. Out of the 78 species, trees constituted the largest proportion with 32 plant species that cover 41%. In terms of plant parts used, leaves are frequently used constituting 46%. As to mode of preparation, decoction (40%) ranked the highest followed by poultice (18%) and heating over fire (14%). Documentation of the valuable ethnomedicinal knowledge will help preserve the vanishing tradition of cultural communities in terms of medicinal plant utilization.

Keywords: Ethnomedicinal, healthcare, herbal, traditional knowledge

INTRODUCTION

Ethnobotany includes the study of how indigenous communities of a specific location uses plants for food, clothing, housing, and medicine (Aiyeloja and Belo 2006). As old as human civilization, people use plants as source of drugs for treatment, prevention of diseases, and for the promotion of good health (Alpuerto et al. 2010) through trial-and-error method (Patil 2012). This indigenous knowledge on traditional medicinal plants is passed on from generation to generation by oral tradition especially to the cultural group. Much of this traditional knowledge has been kept secret from the outsider's world (Majumdar and Datta 2007). This indicates that the great wealth of knowledge on economically useful plants and traditional techniques used to manage, harvest, and conserve these species rely on cultural groups (Soejarto et al. 2009).

According to the World Health Organization (2005), about 80% of the population of the world depends on traditional medicine, mostly herbal remedies, for their primary health care need. Ethnobotanical surveys conducted in different parts across Asia contribute to the existing repository of traditional ethnobotanical knowledge. For example, Keo et al. (2018) documented 50 species of medicinal plants in Cambodia that have been customarily used to treat common ailments while the survey of Sharmila et al. (2018) on some plant species in Nainamalai Foothill in the Eastern Ghats recorded a total of 124 plants

used in a variety of medicinal applications. Meanwhile, the study of Taek et al. (2018) reported several ethnomedicinal plants as treatment for malaria in Malaka, West Timor. On the other hand, the findings of Zain-ul-Abidin et al. (2018) revealed that 40 highly anti-diabetic plant species used in South Pakistan for the treatment and control of diabetes mellitus type II are reported for the first time.

The Philippines is recognized as one of the earth's most important biodiversity hotspots (Gaither and Rocha 2013) with approximately 13000 plant species of which 39% of them are considered as endemics (Banag-Moran et al. 2020). Many of these plants are widely used as traditional alternative medicine (Quisumbing 1978). The practice of using plants as medicine in the Philippines dates back to Spanish pre-colonial era that continued for the next three hundred years during the Spanish occupation in the Philippines. Documentation on herbal medicines such as manuscripts and books were mostly done by Spanish missionaries and after which, American colonization took over which have led to the scientific approach on studying medicinal plants (Joven 2012). According to Quisumbing (1978), poor medicinal supplies during World War II resulted to the demand for extensive research on medicinal plants as an answer to the need for ethnopharmacological and other related studies to be carried out to solve the problem on the scarcity of imported drugs and medicines. Nonetheless, despite the long history of plants used traditionally for medicinal purposes in the Philippines, as

of the present there are only ten plant species approved by the Philippine Department of Health as scientifically proven alternative medicines for certain conditions (Galvez-Tan and Sia et al. 2014; Heinrich and Jager 2015).

Several studies conducted in all parts of the country documented various plant species used by the local people. The study of Maghanoy et al. (2013) recorded 46 medicinal plant species in Bukidnon that are used by three tribes in treating various illnesses. Gurrea (1993) presented 20 species of common medicinal plants with information gained through interviews with local healers from several municipalities in Bukidnon from 1986 to 1987. Cuyacot et al. (2014) collected five species of medicinal plants based on ethnopharmacological uses of the inhabitants of Mt. Nebu, Bukidnon. In Agusan Del Sur, Arquion et al. (2015) found that the plant species, *Ficus nota* knew as "tibig" is traditionally used by the Manobo tribe in Talacogon as alternative medicine. Trono et al. (2016) reported that the Manobo tribe in Bukidnon traditionally uses the bark decoction of *Trema orientalis* as treatment for diabetes.

Considering the wealth of indigenous knowledge on medicinal plants in the country, it is necessary to conduct studies on medicinal plants utilized by lesser-known tribes like the Mamanwas in Surigao and Agusan provinces in Mindanao. Thus, this study aims to document the local names of the medicinal plants used by the Mamanwas and identify the plants according to common name and scientific name, record the habit of growth and plant parts utilized for medicine, and document the ailments treated, mode of application and the different mode of preparation of the medicinal plants used by the Mamanwa tribe in Surigao del Norte and Agusan del Norte, Philippines.

MATERIALS AND METHODS

Study area and period

The study was conducted in the province of Surigao del Norte (9° 30' to 9° 35' N 125° 34' to 125° 52' E) and Agusan del Norte (9° 26' to 9° 27' N 125° 34' to 125° 36' E) which are two of the five provinces belonging to CARAGA region in Mindanao, Philippines (Figure 1). The whole duration of survey and plant sample collection was conducted from July 11, 2019, to November 15, 2019. Surigao del Norte mainly consists of three major islands such as Siargao Island, Dinagat Island, and Bucas Grande Island. The province is divided into 20 municipalities and 335 barangays. In terms of topography, the mainland portion of Surigao del Norte is composed of varied terrain ranging from flat to rugged mountains. On the other hand, Agusan del Norte consists of mountains in its northeastern and western parts and in between is mostly flat and rolling lands. It is composed of 10 municipalities and 165

barangays and is the second smallest province in the region.

Typically, the Mamanwa tribe of the area still relies on medicinal plants which are found within their ancestral land to treat various kind of ailments and diseases. This study covered four municipalities of Surigao Del Norte (i.e., Bacuag, Claver, Gigaquit and Tubod) and one municipality of Agusan Del Norte (i.e., Kitcharao) which is within the ancestral land CADT-048. Ten Indigenous Cultural Communities (ICC) that are occupied by the Mamanwa tribe were selected as sampling sites, namely: Sitio Puyawon (9° 32' 50.2'' N 125° 40' 56.6'' E), ICC of Sitio Palalihan (9° 30' 20'' N 125° 40' 24.4'' E) and ICC of Sitio Tiltilan (9° 32' 28.2'' N 125° 40' 3.5'' E) of the Municipality of Gigaquit; ICC of Sitio Baliw (9° 32' 17.4'' N 125° 36' 53.2'' E) of the Municipality of Bacuag); ICC of Barangay Cawilan (9° 32' 58.4'' N 125° 34' 53.6'' E) and ICC of Barangay Timamana (9° 35' 38.6'' N 125° 34' 25.2'' E) of the Municipality of Tubod); ICC of Sitio Bliss (9° 27' 20.9'' N 125° 34' 51.5'' E) and ICC of Barangay Mahayahay (9° 26' 48.3'' N 125° 35' 15.2'' E) of the Municipality of Kitcharao; ICC of Barangay Urbizondo (9° 30' 52'' N 125° 52' 28.5'' E) and ICC of Barangay Taganito (9° 30' 48'' N 125° 52' 31.1'' E) of the Municipality of Claver.

Free-Prior and Informed Consent (FPIC)

Prior informed consent was secured following the guidelines on Free and Prior Informed Consent (FPIC) and related process stipulated in the National Commission on Indigenous Peoples (NCIP) Administrative Order No. 3 Series of 2012 in compliance with the implementing rules and regulations of Republic Act No. 8371 or otherwise known as The IPRA Law (Indigenous Peoples' Rights Act). First, an application for the issuance of certification of precondition was submitted together with the project proposal at the NCIP Regional Office that has jurisdiction over the proposed study area. Once the application was submitted, the NCIP Regional director forwarded the request to the responsible NCIP Provincial Office and identified the Field-Based Investigation (FBI) Team which is composed of the Provincial Officer as the team leader and the corresponding members. Then, a Pre-FPIC Conference organized by the FPIC Team was attended by the research team together with the Mamanwa tribal leaders. During the Pre-FPIC Conference, the proposed study was presented to the tribal leaders and as an output, work and financial plan were formulated and agreed upon. A series of meetings such as the first and the second community assemblies were conducted. After the Mamanwa tribal leaders had given their consent to the project to conduct research in their area, the MOA (Memorandum of Agreement) presentation/ finalization and signing as well as the ritual were conducted.

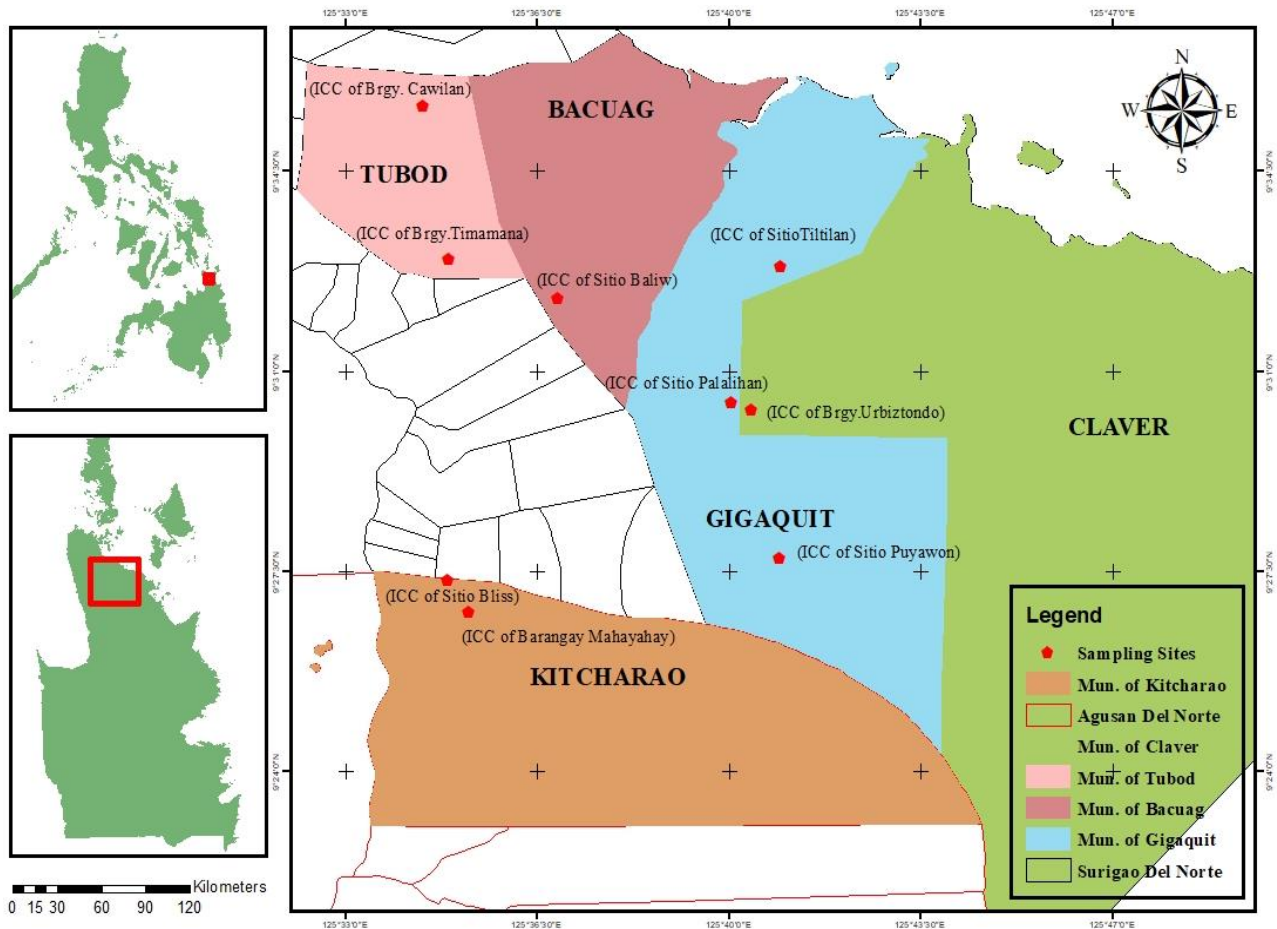


Figure 1. Location of the Mamanwa communities in Surigao del Norte and Agusan del Norte, Philippines indicating the sampling sites: ICC of Sitio Puyawon ($9^{\circ} 32' 50.2''$ N $125^{\circ} 40' 56.6''$ E), ICC of Sitio Palalihan ($9^{\circ} 30' 20''$ N $125^{\circ} 40' 24.4''$ E), ICC of Sitio Tiltilan ($9^{\circ} 32' 28.2''$ N $125^{\circ} 40' 3.5''$ E), ICC of Sitio Baliw ($9^{\circ} 32' 17.4''$ N $125^{\circ} 36' 53.2''$ E), ICC of Barangay Timamana ($9^{\circ} 35' 38.6''$ N $125^{\circ} 34' 25.2''$ E), ICC of Barangay Cawilan ($9^{\circ} 32' 58.4''$ N $125^{\circ} 34' 53.6''$ E), ICC of Barangay Urbiztondo ($9^{\circ} 30' 52''$ N $125^{\circ} 52' 28.5''$ E), ICC of Sitio Bliss ($9^{\circ} 27' 20.9''$ N $125^{\circ} 34' 51.5''$ E), ICC of Barangay Mahayahay ($9^{\circ} 26' 48.3''$ N $125^{\circ} 35' 15.2''$ E)

Gratuitous permit

Local permits secured from barangay chairpersons and municipal mayors were first secured as necessary requirements for the granting of a gratuitous permit. A gratuitous permit (WILDLIFE GP No. R13-2019-34) was obtained from the Department of Environment and Natural Resources (DENR) CARAGA Regional Office. The GP granted permission to the research team to conduct the survey and collect samples (medicinal plants) from the areas belonging to Certificate of Ancestral Domain Title (CADT) No. 048, subject to the terms, conditions and restrictions specified in the said GP pursuant to the provisions of Wildlife Resources Conservation and Protection Act of 2001 (Republic Act 9147).

Interview and field sampling

Data were obtained using informal interviews, semi-structured questionnaires, and group conversations in the dialect (Cebuano, Bisaya) with the key informants, tribal members/local residents, male and female respondents, and traditional healers. Any form of videography was done in accordance with the FPIC and in the context of cultural

sensitivity and vulnerability. Field excursion/walk with the traditional healers and herbal medicine collectors was carried out to observe the plants. Plant samples were collected together with the IP's to assure the identity of the plant. The collected plants were tagged and the details of the plants were recorded.

Demographic information such as age, gender, source of livelihood, educational status, dialect of respondents, and ethnobotanical knowledge (medicinal plants and its uses) were gathered. The interviews were developed as informal conversations in order to let the respondents speak spontaneously and to minimize, if not eliminate, the element of pressure. Elderly, "dakula" or "datus" (recognized head or community leader of the tribe), and "tambajon" or "babaylans" (local healers), identified by the "dakulas" or "datus" and other local people who have knowledge on medicinal plants were interviewed. In order to get a gender perspective, women especially mothers or wives were also interviewed. Data such as the medicinal plants used, the part/s of the plant used, the mode of local preparation, the mode of treatment, expected effects, and ailments treated were gathered. Moreover, traditional knowledge and

practices in agriculture and spiritual aspect were also documented (if mentioned). Informal conversations were held to gather data on the status of medicinal plants and traditional medicinal knowledge of the community and their transferability from generation to generation (Martin 1995). This method assumes that there are variations in informants' opinions, experiences, and knowledge related to medicinal plants (Tumoro and Maryo 2016).

Identification and preservation of plant specimens

For the identification of medicinal plants, the books entitled *A Dictionary of Philippine Plant Names Volume I* (2001) and *A Pictorial Cyclopedia of Philippine Ornamental Plants Second Edition* (2000) written by Dr. Domingo Madulid, internet sources (taxonomic and pictorial keys) from legitimate sites such as www.philippineplants.org / *Co's Digital Flora* (Pelser et al. 2011 onwards), www.phytoimages.siu.edu (Nickrent et al. 2006 onwards), and www.stuartxchange.com (Stuart 2003 onwards) were used. Moreover, the method of Umair et al. (2017) on authenticating plant species was followed using the international plant name index (<http://www.ipni.org>) and GRIN taxonomy site ([http://www.ars-grin.gov/cgi-bin.npgs/html/queries.pl](http://www.ars-grin.gov/cgi-bin/npgs/html/queries.pl)), whereas names of plant families follow A.P.G. system (Stevens 2001). A botany professor and an expert on plant taxonomy at the Mindanao State University-Iligan Institute of Technology and a consultant from the University of the Philippines Los Baños identified the species and confirmed the identification. The species entries were complemented along with data on taxonomic position (family), vernacular name, common name, life form (plant habit), and folk medicinal uses. The life forms were categorized as herbs, shrubs, grasses, and trees, according to the system proposed by Raunkiaer (1934, 1937) and modified by Brown (1977).

Collected specimens were pressed using a wooden plant press, treated with denatured alcohol to avoid the growth of molds and fungi, dried, and prepared to be submitted as herbarium specimens. Three copies of plant samples were collected where 2 copies are deposited at the herbarium in the Mindanao State University-Iligan Institute of Technology and one copy will be deposited at the Philippine National Museum.

RESULTS AND DISCUSSION

Demographic characteristics

Demographic characteristics of the key informants from the 10 ICCs belonging to four municipalities of Surigao del Norte (Gigaquit, Claver, Bacuag, and Tubod) and one municipality of Agusan del Norte (Kitcharao) were gathered through informal interviews. A total of 142 respondents were interviewed wherein 30 or 21% are male and 112 or 79% are female. Mainly, there were more female informants than male informants in this study. This can be due to the fact that females are more available than males because females are usually left in the household

while males are working in the farm or away from home. In terms of age, among the respondents, the age range of 31-40 years old (32%) has the highest frequency interviewed, followed by 21-30 years old (24%), 41-50 years old (19%), and 51-60 years old (14%). As to marital status, 95% of the respondents are married while only 5% are single. From the ten ICCs, only 12 respondents have experienced being a traditional health practitioner. Of the 12 traditional health practitioners, four or 44% are male and eight or 67% are females. Similar finding was reported in the study of Tantengco et al. (2018) among the Ayta in Dinalupihan, Bataan wherein the report stated higher number of female informants than male because females were more available than males (Table 1).

Plant species recorded

In this ethnomedicinal survey, a total of 78 plants species (including two fern species) were documented as medicinal plants in the different Mamanwa communities visited by the research team in Sitio Puyawon, Sitio Tiltilan and Sitio Palalihan in Gigaquit, Surigao del Norte; Sitio Cawilan and Sitio Timamana in Tubod, Surigao del Norte; Sitio Urbiztondo and Sitio Taganito in Claver, Surigao Del Norte; Sitio Baliw in Bacuag, Surigao Del Norte; and Sitio Mahayahay and Sitio Bliss in Kitcharao, Agusan Del Norte. The plant families, scientific names, along with the plant habit of growth, common names/ English names and local/ Mamanwa names, plant part(s) used, modes of preparation and utilization, and medicinal plants are presented in Table S1.

Previous studies on medicinal plants used by the Mamanwa tribe conducted across different Mamanwa-inhabited areas in Mindanao are few and limited. The most recent study documenting the ethnomedicinal knowledge of Mamanwas was conducted by Demetillo et al. (2019) in selected mining area in Claver, Surigao del Norte, wherein it has documented a total of 51 plant species which was gathered from 29 respondents. Meanwhile, the study of Gruyal et al. (2014) documented 65 medicinal plants gathered from 50 informants in Northern, Surigao del Sur. To compare, the results in this ethnobotanical study have documented greater number of medicinal plant species. The greater number of medicinal plants documented can be attributed to greater number of respondents interviewed as well as wider coverage of the study. However, this can also indicate that the Mamanwa tribe in the selected study sites have managed to retain their traditional medicinal practices.

According to Yaseen et al. (2019), plant biodiversity is a potentially valuable source of novel drugs. The number of species distributed to different plant families presented in Table 2 shows a considerable diversity of medicinal plants. Among the plant families, Family Asteraceae (Compositae) held dominance among others having the highest number of species with 10 reported medicinal plants followed by Families Poaceae (Graminae), Lamiaceae, Annonaceae, and, Moraceae (with 4 species each), Families Amaryllidaceae, Fabaceae, Lauraceae, Rutaceae, and Zingiberaceae (with 3 species each) while the rest are represented by two or one species only.

Table 1. Demographic profile of the respondents from Surigao del Norte and Agusan del Norte, Philippines

Demographic characteristics	Municipality					Total	Percentage (%)
	Gigaquit	Bacuag	Tubod	Claver	Kitcharao		
Sex	Number of male and female informants						
Male	12	3	5	5	5	30	21%
Female	38	18	21	10	25	112	79%
Total	50	21	26	15	30	142	100%
Age range	Number of respondents by age group						
≤ 20	3	0	2	0	3	8	6%
21-30 years	17	0	4	4	10	35	24%
31-40 years	12	9	8	7	9	45	32%
41-50 years	4	12	5	3	3	27	19%
51-60 years	7	0	7	1	5	20	14%
≥61 years	7	0	0	0	0	7	5%
Total	50	21	26	15	30	142	100%
Marital status	Number of respondents by marital status						
Single	2	1	2	0	2	7	5%
Married	48	20	24	15	28	135	95%
Total	50	21	26	15	30	142	100%
Sex	Number of male and female herbalist						
Male	4	0	0	0	0	4	33%
Female	7	0	1	0	0	8	67%
Total	11	0	1	0	0	12	100%

Table 2. Over-all distribution of species across different families of medicinal plants used by the Mamanwa Tribe of Surigao del Norte and Agusan del Norte, the Philippines

Families	No. of species
Acanthaceae	2
Amaryllidaceae	3
Anacardiaceae	1
Annonaceae	4
Apiaceae	1
Apocynaceae	2
Arecaceae	1
Asparagaceae	1
Asteraceae	10
Athyriaceae	2
Balsaminaceae	1
Bixaceae	1
Caricaceae	1
Commelinaceae	1
Crassulaceae	1
Cucurbitaceae	1
Cyperaceae	1
Dilleniaceae	1
Euphorbiaceae	2
Fabaceae	3
Lamiaceae	4
Lauraceae	3
Lecythidaceae	1
Lyrathaceae	1
Meliaceae	1
Menispermaceae	1
Moraceae	4
Moringaceae	1
Myrtaceae	2
Muntingaceae	1
Musaceae	1
Piperaceae	1
Poaceae	4
Rubiaceae	2
Rutaceae	3
Solanaceae	1
Urticaceae	2
Verbenaceae	1
Vitaceae	1
Zingiberaceae	3
Total	78

Corresponding to this result, the study of Malawani et al. (2017) also documented the highest number of representatives from Family Asteraceae with seven recorded species. Asteraceae/Compositae having the most representative species can be attributed to the fact that it is one of the largest and most diverse of all plant families where it includes over 1,620 genera and 23,600 individual species (Tamokou et al. 2017). The case study on the usage of Family Asteraceae conducted in Saddah Lower Kurram Agency by Muhammad et al. (2016) affirms that this family is used by local communities to treat various human ailments. However, when compared to studies conducted by Fiscal (2017), Rubio and Naïve (2018), and Tantengco et al. (2018), plant families such as Euphorbiaceae, Fabaceae, Lamiaceae and Liliaceae have dominated in terms of species representation.

Habit of growth

On the data of the habit of growth, out of the 78 species, trees constituted the largest proportion with 32 plant species that cover 41%, followed by herbs with 26 species (33%), shrubs with 8 species (10%), vines with 4 species (5%), ferns with 2 species (3%), and palm with 1 species (1%) (Table 3).

Table 3. The habit of growth of medicinal plant species used by the Mamanwa Tribe Surigao del Norte and Agusan del Norte, the Philippines

Habit of growth	Surigao Del Sur and Agusan del Norte	
	Number of plant species	Percentage (%)
Tree	32	41%
Herb	26	33%
Shrub	8	10%
Grass	5	6%
Vine	4	5%
Fern	2	3%
Palm	1	1%
Total	78	100%

Mamanwas are located in areas where trees are abundant. In fact, the term Mamanwa is etymologized from the word ‘man’ which means first and ‘banwa’ as forest thus, widely known as the first forest dwellers (Balacuit et al. 2018). Therefore, they mostly rely on trees in treating various diseases. Waay-Juico et al. (2017) on the Tagabawa tribe in Sta. Cruz, Davao del Sur, also reported the high usage of trees as medicinal plants which could be an indication that trees are abundant in the area as compared to other habit forms.

Plant parts utilized as medicine

Different plant parts were utilized for the preparation of herbal medicines, however, leaves were the most frequently used plant parts, constituting 46%, followed by roots (17%), fruit (8%) whole plant (7%), stem (7%), bark (6%), shoot (4%), rhizome (2%), bulb (1%), sap (1%), and hair (1%) (Figure 2).

The high usage of leaves in making herbal medicines as compared to other plant parts is due to the reason that it is easier to collect and it poses lesser threat to the local flora. It indicated that the survival and continuity of useful medicinal plants of Surigao Del Norte are greatly maintained and protected by the Mamanwas in their use most of the leaves, thus, it ensures sustainable utilization of their medicinal plants. Several ethnobotanical surveys conducted in the Philippines reported similar results with leaves as the most frequently used plant parts. The use of leaves is common in ethnobotanical studies (Mahmood et al. 2011). Leaves have high storage of chemical compounds through photosynthesis which are active components of most herbal preparation in high concentrations (Guevara and Garcia 2018). According to Hamel et al. (2018), leaves are the site for the synthesis of secondary metabolites and the frequent usage of leaves can be justified by the abundant chemical groups they contain. In addition, the study of Khan et al. (2014) stated that the use of leaves is not detrimental to the plant life cycle as compared with using other plant parts such as the roots,

flowers, etc., and reported that high utilization of leaves is due to its easy availability. Meanwhile, Baddu et al. (2018) also reported that leaves are the most utilized plant parts for medicinal purposes with 30 identified uses in curing illnesses among the Y’ Apayaos of Sta. Praxedes, Cagayan Province. Olowa et al. (2012) also reported that the frequent use of leaves as compared to other plant parts in medicinal preparations indicated that the survival and continuity of useful medicinal plants in Rogongon is greatly maintained and protected by the Higaonons.

The roots were the second frequently used plant part used by the Mamanwas as body energizers or otherwise known as “talimughat”. According to some informants, Mamanwas are known for the use of “talimughat” as body energizers. Before they were categorized as semi-settlers, they were usually seen on the streets selling “talimughat”. However, the use of roots as herbal remedy is detrimental for the plants and the environment as well.

Methods of preparation and mode of application

The preparation and administration of the medicinal plants vary based on the type of disease treated. In this study, there were six types of methods of preparation recorded (Table 4). The most frequently employed preparation method was decoction (40%), because it is the easiest way to prepare medicinal plants. Other methods of preparation were poultice (18%), heating over fire (14%), extract (11%), raw (10%), and infusion (7%). Plant parts that were frequently prepared as decoction were leaves and roots and were mostly used to cure stomach pain, diarrhea, flatulence, cough, fever, and as body energizers. It was also recorded that the use of either bark or roots prepared as decoction was observed to be related to reproductive healthcare in women. For immediate treatments of cuts and wounds, leaves or the whole plant were pounded to create a poultice and applied directly to affected area. The result of the study is similar to the findings of Mapatac (2019) wherein decoction was the most employed method of preparation.

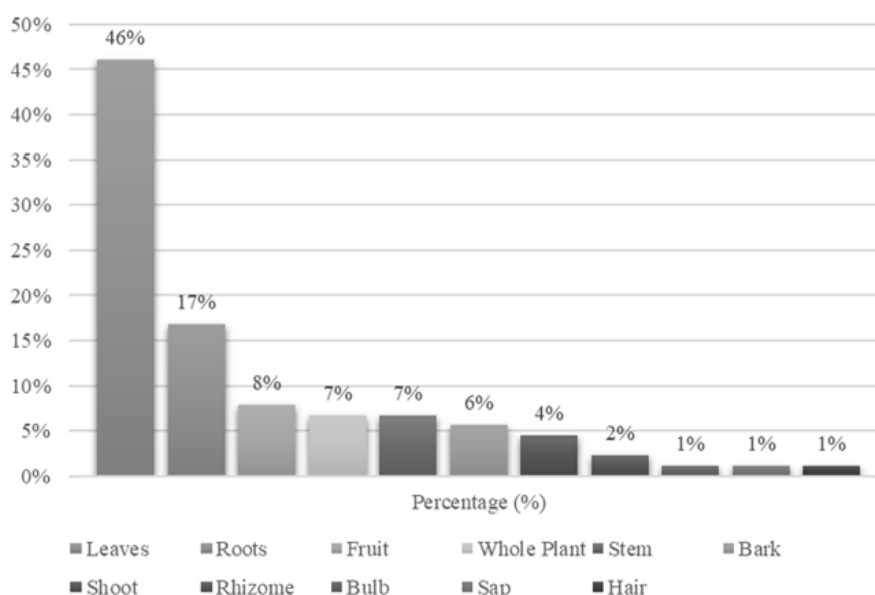


Figure 2. Plant parts used in herbal preparations by the Mamanwas of Surigao del Norte and Agusan del Norte, Philippines

Table 4. Method of preparation of medicinal plants used by the Mamanwas of Surigao del Norte and Agusan del Norte, Philippines

Method of preparation	Surigao del Norte and Agusan del Norte	
	Percentage (%)	
Decoction	35	40%
Poultice	16	18%
Heated	12	14%
Extract	10	11%
Raw	9	10%
Infusion	6	7%
Total	88	100%

Table 5. Mode of application of medicinal plants used by the Mamanwas of Surigao del Norte and Agusan del Norte, Philippines

Mode of application	Number of applications	Percentage
		(%)
Taken orally	45	52%
Directly applied to affected area	41	47%
Wrapped on affected area	1	2%
Total	87	100%

As to mode of application, around 52% of the medicinal plants were taken orally. Forty-two percent of medicinal plants were directly applied to affected area and wrapped on affected area was only 1%. (Table 5). The result is similar to the findings of other ethnobotanical surveys conducted in Dinalupihan Bataan (Tantengco et al 2018) and Subanens in Dumingag, Zamboanga Del Sur (Morilla et al 2014). Both previous studies documented that oral intake of decoction is the most common route of administration of medicinal plants.

To conclude, this study showed that the Mamanwa communities situated in selected ICC's of Surigao del Norte and Agusan del Norte in Mindanao, Philippines used a total of 78 plant species belonging to 70 genera and 42 families for medicinal purposes. This indicates that a diverse set of medicinal plants is utilized by the Mamanwas as herbal medicines. The Mamanwas have also managed to retain their traditional medicinal practices even nowadays due to their practical benefits, availability, and reliability in terms of providing primary aid and immediate remedy to address various common ailments and diseases. On the data on habit of growth, trees constituted the largest proportion comprising 41% of the plant species documented. In terms of plant parts used, leaves are the most frequently used. This indicates that the survival and continuity of useful medicinal plants of Surigao del Norte and Agusan del Norte are greatly maintained and protected by the Mamanwas in their use mostly of the leaves, thus, it ensures sustainability in the utilization of their medicinal plants. As to mode of utilization, the most frequently employed is decoction (40%) because it is the easiest way to prepare the medicinal plants. Plant parts that are frequently prepared as decoction are leaves and roots and

mostly used to cure stomach pain, diarrhea, flatulence, cough, fever and as body energizers.

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Table S1. Medicinal plants used by the Mamanwa Tribe of Surigao del Norte and Agusan del Norte, Philippines

Family/scientific name	Common name	Mamanwa name	Habit of growth	Plant parts used	Preparation and mode of utilization	Medicinal application
SPERMATOPHYTA						
Acanthaceae						
<i>Justicia gendarussa</i> Burm.f.	Willow-leaved Justicia	Bangon-bangon	Herb	Leaves	Boil in water and drink the decoction; pound leaves and applies topically on affected area to serve as poultice	Heals sprain and dislocated bones
<i>Hemigraphis alternata</i> (Burm.f.) T. Anderson.	Purple waffle plant	Baylas	Herb	Fruit	Pound fruit and directly apply to affected area to serve as poultice	Relieves pain during childbirth
				Leaves	Pound until thoroughly soft, squeeze to obtain extract and drop some onto the affected area	Wound healing
Amaryllidaceae						
<i>Allium ascalonicum</i> L.	Shallots	Sibujin	Herb	Leaves	Heat over fire and apply directly on affected area	Inflammation
					Squeeze the leaves very well, add some salt and massage onto the body	Cure for convulsions or “apresiya” among children
<i>Allium sativum</i> L.	Garlic	Ahos	Herb	Bulb	Pound until thoroughly soft and massage onto the body or stomach	Relieves stomachache
					Pound and apply directly on affected area	Inflammation; cures venom obtained from snake bites, dog bites and “uhipan” (centipede)
<i>Allium tuberosum</i> Rottler ex. Spreng	Chives	Ganda	Herb	Leaves	Heat over fire and apply directly on affected area	Relieves stomachache
					Pound until thoroughly soft and massage onto the body or stomach	Inflammation; cures venom obtained from snake bites, dog bites and “uhipan” (centipede)
<i>Allium tuberosum</i> Rottler ex. Spreng	Chives	Ganda	Herb	Leaves	Heat over fire and apply directly on affected area	Heals fractures and dislocation; treats rheumatism, arthritis; aids to provide comfort when an individual is having difficulty when breathing; treats convulsion
					Pound until thoroughly soft and massage onto the body or stomach	Inflammation; cures venom obtained from snake bites, dog bites and “uhipan” (centipede)
Anacardiaceae						
<i>Mangifera indica</i> L.	Mango	Mangga	Tree	Fruit	Cut fruit and eat the fleshy part	Treats diarrhea
Annonaceae						
<i>Annona muricata</i> L.	Soursop	Rabana	Tree	Leaves	Boil in water and drink decoction three times a day	Relieves cough
					Heat over fire and place it on the affected area	Heals wound
					Young shoot	Massage on the back
<i>Annona squamosa</i> L.	Sugar apple	Atis	Tree	Leaves	Prepare a decoction by boiling and then consume orally as a drink	Treats UTI
					Put on aching body parts	Relief from muscle strain and “pi-ang” or dislocation
<i>Orophea sericea</i> Keb.	N/A	Panwahut	Tree	Roots	Boil in water and drink decoction	Relieves fatigue
<i>Polyalthia dolichophylla</i> Merr.	N/A	Hamutan	Tree	Roots	Boil in water and drink decoction	Relieves fatigue and headache
Apiaceae						
<i>Centella asiatica</i> (L.) Urb.	Gotu kola	Jahong-jahong or Yahong-yahong	Herb	Leaves and stem	Put in a glass of water and drink infused water three times a day	Stomachache, Amoeba, measles
					Put in a glass of water together with “busikad” plant and drink	Helps in treating measles by making them appear or according to the term locals used “para mulutaw ang tipdas”

Apocynaceae						
<i>Alstonia scholaris</i> (L.) R.Br.	White cheese wood	Dita or Lita	Tree	Bark	Pound the bark to obtain extract and apply directly on the affect area Prepare a decoction by boiling and then consume orally as a drink	Hernia or “danlak” Treats vomiting and loose bowel movement
<i>Plumeria acuminata</i> Air.	Temple flower	Kalachuchi	Tree	Leaves	Pound the leaves and apply topically on affected area to serve as poultice	Herpes simplex
Areaceae						
<i>Calamus</i> sp.	Rattan (uway)	Kayapi	Palm	Fruit	Pound fruit and directly apply to affected area to serve as poultice	Acts as “talimughat” by relieving pain during childbirth
				Roots	Prepare a decoction by boiling the roots and then consume orally as a drink	According to locals, this is taken in order to avoid or prevent getting pregnant
Asparagaceae						
<i>Sansevieria roxburghiana</i> Schult.f	Bow string	Espada or Tigre-tigre	Herb	Whole plant	Pound and apply directly on affected area to serve as poultice	Eliminate venom due to snake bite
Asteraceae (Compositae)						
<i>Ageratum conyzoides</i> L.	Billygoat Weed	Albahaka	Herb	Leaves	Pound to obtain extract and apply directly to affected area Pound leaves into smaller pieces and rub or massage on the chest or back	Relieves headache and migraine
<i>Artemisia capillaris</i> Thnb.	Oriental wormwood	Bino-bino or Pikasin	Shrub	Roots	Pound roots, squeeze extract and rub or massage on to the different parts of the body	Insect repellent
<i>Artemisia vulgaris</i> L.	Mugwort	Hilbas	Herb	Leaves and stem	Rub or massage on the chest and back the pounded leaves and stem	Fever; relieves cough and discomfort caused by sticky phlegm cough
<i>Ayapana triplinervis</i> (Vahl) R.M. King & H. Rob	Triplinerved Eupatorium	Magjupana	Herb	Leaves	Pound the leaves and apply topically on the affected area to serve as poultice	Fever
<i>Blumea balsamifera</i> (L.) DC.	Ngai camphor	Sagbong	Shrub	Leaves	Boil in water and drink decoction four times to induce urination	Kidney infection
				Roots	Boil in water and drink decoction before eating meal	“punit”; To avoid getting pregnant
<i>Cosmos sulpheris</i> Cav.	Cosmos	Cosmos	Herb	Leaves	Heat over fire and directly apply on affected area	Relieves abdominal pain
<i>Chromolaena odorata</i> (L.) R.M. King & H. Rob.	Devil weed	Hagonoy	Herb	Leaves	Heat over fire and directly apply on affected area	Relief from stomachache and flatulence
<i>Crassocephalum crepidiodes</i> (Benth.) S. Moore.	Red flower Ragleaf	Taba-taba	Herb	Shoot	Boil in water and drink decoction	Relieves fatigue, stomachache, ulcer
<i>Elephantopus scaber</i> L.	Elephant’s foot	Kukug banog	Herb	Roots	Put roots in a glass of water and drink the infused water	Treats measles
<i>Tagetes erecta</i> L.	Marigold	Alahito	Herb	Leaves	Rub or massage on the chest and back the pounded leaves to relieve discomfort	Relieves fatigue
Balsaminaceae						
<i>Impatiens balsamina</i> L.	Garden balsam or Kamantigue	Sarungga	Herb	Leaves	Boil in water and drink decoction four times a day to induce urination	Kidney infection
Bixaceae						
<i>Bixa orellana</i> L.	Annato	Syotis or Switis	Tree	Leaves	Heat over fire and directly apply on affected area	Heals sprain
				Roots	Boil in water and drink decoction thrice a day to soften cough	Cures cough
Caricaceae						
<i>Carica papaya</i> L.	Papaya	Kapayas	Shrub	Leaves	Boil in water and drink decoction	Dengue

Commelinaceae						
<i>Amiscolotype hispida</i> (Less. & A. Rich.) D.Y. Hong	-No common name found-	Lupo-lupo	Herb	Leaves, stem	Heat over fire and directly place on affected area	Heals fracture and dislocation
Crassulaceae						
<i>Kalanchoe pinnata</i> (Lam.) Pers.	Miracle leaf	Hanlilika	Herb	Leaves	Put leaves on the affected area Pound leaves into pieces and apply on affected area	Treats mumps Relieves pain during toothache
Cucurbitaceae						
<i>Momordica charantia</i> L.	Bitter gourd	Ampalaya	Vine	Leaves	Boil in water and drink decoction squeeze leaves and obtain extract to drink	Cleanse the stomach and treats diarrhea helps expel worms in babies
Cyperaceae						
<i>Cyperus kyllingia</i> Endl.	Whitehead Spikehedge	Busikad	Grass	Whole plant	Boil in water and drink decoction	Diarrhea, measles
Dilleniaceae						
<i>Dillenia philippinensis</i> Rolfe	Katmon	Maragnaw	Tree	Bark	Boil in water and drink decoction	Heals wound, cures diarrhea
Euphorbiaceae						
<i>Euphorbia hirta</i> L.	Asthma weed	Tawa-tawa	Herb	Whole plant Stem	Boil in water and drink decoction three times a day Squeeze to obtain sap and use as eye drops	Dengue fever Soothes sore eyes
<i>Jatropha curcas</i> L.	Physic nut	Tuba-tuba	Shrub	Leaves and Stem	Heat over fire and directly apply on affected area	Relieves muscle pain
Fabaceae						
<i>Caesalpinia sappan</i> L.	Sappan wood	Sibukaw	Tree	Roots	Boil in water and drink decoction	Urinary Tract Infection (UTI), coughing with blood "sugpa"
<i>Gliricidium sepium</i> (Jacq.) Walp.	Madre de cacao	Kakwate or Madre de kakaw	Tree	Leaves	Pound leaves and apply directly to affected area	Relieves skin itchiness
<i>Phanera integrifolia</i> (Roxb.) Benth.	-No common	Buka-buka/alibangbang	Vine	Leaves, roots	Boil in water and drink decoction	Coughing with blood "sugpa"
Lamiaceae						
<i>Gmelina arborea</i> Roxb.	Yemane	Gemelina	Tree	Leaves	Obtain some fresh leaves and massage or place onto the body	Treats flatulence or "panuhot"; heals rheumatism and dislocation
<i>Mentha arvensis</i> L.	Peppermint or wild mint	Herba buena	Herb	Leaves	Boil in water and drink decoction thrice a day	Stomachache
<i>Plectranthus amboinicus</i> (Lour.) Spreng.	Oregano	Kalabo or Karabo	Herb	Leaves	Pound, squeeze to obtain extract, mix with "agridulsi" (lemon) and take one tablespoon three times a day	Cough relief
<i>Vitex negundo</i> L.	Five-leaved Chaste tree	Lagundi	Tree	Leaves	Put in a glass of water and drink	Relief from cough
Lauraceae						
<i>Cinnamomum mindanaense</i> Elmer.	Kalingag tree	Kaningag	Tree	Leaves	Boil in water and drink decoction	Treats stomachache, ulcer, high blood pressure
<i>Litsea ampla</i> Merr.	No common name found	Panamog	Tree	Leaves Roots	Boil in water and drink decoction Boil in water, set to cool and use as antiseptic wash	Coughing with blood "sugpa" Disinfects wound
<i>Persea Americana</i> Mill.	Avocado	Abukado	Tree	Leaves	Boil in water and drink decoction three times a day	Relieves fever, diarrhea, stomachache, ulcer
Lecythidaceae						
<i>Petersianthus quadrialatus</i> (Merr.) Merr	Philippine Rosewood	Marakamang	Tree	Leaves	Heat over fire and place directly on affected area	Relief for abdominal pain due to dysmenorrhea, treats hernia "danlak" in men
Lyrathaceae						
<i>Lagerstroemia speciosa</i> Pers.	Queen's flower	Banaba	Tree	Leaves Bark	Boil in water and drink decoction	Treats kidney infection Cures diarrhea and abate coughing with blood "sugpa"

Meliaceae						
<i>Sandoricum koetjape</i> Merr.	Wild mangosteen	Santol	Tree	Fruit	Open and eat fleshy part	Treats diarrhea
Menispermaceae						
<i>Tinospora crispa</i> (L.) Hook.f. & Thomson	Heavenly elixir	Panjawan or panyawan	Vine	Stem	Scrape the stem and eat	Eliminate ingested poison or toxic chemical(s)
Moraceae						
<i>Ficus heteropluera</i> var. <i>mindanaensis</i> (Warb.) Corner	Balite	Dalakit or Dayakit	Tree	Bark	Heat over fire and wrap around the affected area	Heals fractures and dislocation
<i>Ficus septica</i> Burm.f.	Septic fig (hauili)	Labnog	Tree	Leaves	Heat over fire and apply directly on affected area	Relief from headache
				Young shoot	Boil in water and drink decoction	Relieves stomachache
				Fruit	Squeeze minimal amount of juice over the affected area	Cures skin disease such as warts
Moraceae						
<i>Ficus variegata</i> Blume	Red-stem fig (tangisang-bayawak)	Agahon	Tree	Sap	Cut a portion of the stem to extract sap and put some drops on the affected area	Relieves pain during toothache
<i>Trophis philippinensis</i> (Bur.) Corner	N/A	Panhabagat	Tree	Leaves	Boil in water and drink decoction	Relieves fatigue
Moringaceae						
<i>Moringa oleifera</i> Lam.	Drumstick tree	Kalamunggay or kamunggay	Tree	Roots	Boil in water and drink decoction	Relieves fatigue
Myrtaceae						
<i>Psidium guajava</i> L.	Guava	Bayabas	Tree	Young leaves	Boil in water, use as an antiseptic wash or disinfectant	Heals wound
<i>Syzygium aqueum</i> (Burm.f.) Alston	Water apple	Tambis	Tree	Roots	Boil in water, use as an antiseptic wash or disinfectant	Heals wound
Muntingiaceae						
<i>Muntingia calabura</i> L.	Jamaica cherry	Mansanitas	Tree	Young shoot	Boil leaves in water and drink decoction	Dengue
Musaceae						
<i>Musa x paradisiaca</i> L.	Banana	Saging (tundan)	Herb	Young leaves	Put leaves directly on the lower portion of the abdomen	Help induce normal urination during “bus-aw” (difficulty or urinating in discontinuous manner), gives relief by giving a ‘cooling effect’
Piperaceae						
<i>Peperomia pellucida</i> (L.) Kunth.	Shiny bush	Sinaw-sinaw	Herb	Leaves and stem	Put the leaves and stem in a glass of water and drink the infused water four times a day to relieve pain or induce urination	Cures arthritis, Kidney infection
Poaceae (Graminae)						
<i>Cymbopogon citratus</i> DC. Stapf	Lemon grass	Tanglad	Grass	Whole plant	Boil in water and drink decoction three times a day	Lowers hypertension
<i>Cymbopogon nardus</i> (L.) Rendle.	Citronella grass	Siniswil	Grass	Whole Plant	Pound until soft and apply directly to affected area	Anti-rabies; Insect repellent
<i>Eleusine indica</i> (L.) Gaernt.	Water apple	Paragis o bila-bila	Grass	Whole plant	Boil in water and drink decoction	Relieves over fatigue and flatulence
<i>Zea mays</i> L.	Corn	Mais	Grass	Young hair	Put in a glass of water and drink three times a day	Stimulate urination and treats kidney trouble
Rubiaceae						
<i>Neonauclea formicaria</i> (Elmer) Merr.	Bangkal	Ambabayud or Ambabalod	Tree	Young shoot	Boil in water and drink decoction thrice a day	Amoeba
<i>Uncaria lanosa</i> Wall. Subsp. <i>philippinensis</i> (Elmer) Gruezo	N/A	Kawilan	Tree	Roots	Boil in water and drink decoction	Relieves fatigue

Rutaceae							
<i>Citrus maxima</i> (Burm.f.) Merr.	Grapefruit (pomelo)	Buongon	Tree	Leaves	Pound until soft and apply directly to infected area	Relieves headache	
Rutaceae							
<i>Citrus x microcarpa</i> Bunge	Kalamansi	Lemonsito	Tree	Fruit	Squeeze the juice into a glass, add water and drink	Cures cough	
<i>Glycosmis elmeri</i> Merr.	Gin berry	Tambagisa	Tree	Fruit	Eat freshly picked fruit	Expels poison ingested	
Solanaceae							
<i>Capsicum frutescens</i> L.	Chili	Sili	Herb	Leaves	Crush the leaves, mix with coconut oil and rub or massage on the chest	Relieves discomfort from asthma	
Urticaceae							
<i>Leucosyke</i> <i>capitellata</i> (Poir.) Wedd.	Tooth scrubber	Alagasi or Anagasi	Shrub	Bark	Scrape the mature skin of the stem to obtain the bark and chew	Heals mouth ulcer "luas"	
<i>Pipturus</i> <i>arborescens</i> (Link.) C. Rob.	Dalunot	Handayamay	Shrub	Roots	Boil in water and drink decoction	Relief from headache	
					Scrape the leaves and then place them on the affected area	Treat swelling to help subside inflammations	
Verbenaceae							
<i>Stachytarpheta</i> <i>jamaicensis</i> (L.) Vahl.	Bastard vervain	Kanding-kanding	Shrub	Roots	Boil in water and drink decoction	Abates coughing with blood "sugpa"	
Vitaceae							
<i>Leea guineensis</i> G. Don	Leea	Manipis	Shrub	Bark	Put bark in a glass of water and drink the infused water	Relieves fatigue, stomachaches, diarrhea (children), ulcer, toothache; heals wound, skin diseases, eliminates poison and an anti-rabies	
Zingiberaceae							
<i>Curcuma longa</i> L..	Turmeric	Duyaw	Herb	Rhizome	Preheat rhizome, squeeze to Obtain extract, mix with coconut oil and apply on the affected area	Cures bruise and boils	
<i>Kaempferia</i> <i>galangal</i> Linn.	Resurrection lily	Kisol	Herb	Leaves	Boil in water and drink decoction	Relieves cough	
					Place leaves in a glass of water and drink the infusion	Relieves fatigue	
<i>Zingiber officinale</i> Roscoe	Ginger	Luy-a	Herb	Rhizome	Pound until soft then mix with "sagbong" and add a small amount of kerosene	Flatulence	
PTERIDOPHYTES (fern and fern-allies)							
Athyriaceae							
<i>Diplazium</i> <i>esculentum</i> (Retz.) Sw.	Vegetable fern	Pako	Fern or fern allies	Leaves	Pick fresh leaves and put directly on affected area	Anti-rabies	
Marratiaceae							
<i>Angiopteris</i> <i>palmiformis</i> (Cav.) C. Chr.	Giant fern	Makaraghu (pakong kalabaw)	Fern or fern allies	Roots	Pound thoroughly to extract the juice and apply directly to affected area	Heals swelling and inflammation	