Quantitative ethnopharmacological documentation and molecular confirmation of medicinal plants used by the Manobo tribe of Agusan del Sur, Philippines

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Abstract
Background Philippines is renowned as one of the species-rich countries and culturally megadiverse in ethnicity worldwide. Ethnomedicinal knowledge of Indigenous Cultural Communities/Indigenous Peoples (ICCs/IPs) is vital for biodiversity conservation and healthcare improvement. This study aims to document the traditional practices, medicinal plant use, and knowledge; to determine the relative importance, consensus, and the extent of all medicinal plants used; and to integrate molecular confirmation to some medicinal plants used by the Agusan Manobo. Methods Quantitative ethnopharmacological data were obtained using semi-structured interviews, group discussions, field observations, and guided field walks with a total of 335 key informants comprising of tribal chieftains, traditional healers, community elders and residents of the community with their traditional medical knowledge. The use categories (UC), use report (UR), fidelity level (FL), and informant consensus factors (ICF) were quantified. The informants’ medicinal plant use knowledge and practices were statistically analyzed using the descriptive and inferential statistics Mann-Whitney U and Kruskal-Wallis tests. Results A total of 122 medicinal plant species belonging to 108 genera and 51 families, used in 16 use categories, were collected and identified. Integrative molecular approach confirmed 24 species with uncertain identity using multiple universal markers. The highest ICF (0.96) was cited for the category of abnormal signs and symptoms (ASS). The maximum FL values of 100% were found for Carica papaya L., Premna odorata Blanco, Cinnamomum mercadoi S.Vidal, Tinospora crispa (L.) Hook.f. & Thomson, and Ficus concinna (Miq.) Miq. used for the treatment of dengue fever, cough with phlegm, stomach trouble, joint pain, and fracture and dislocation, respectively. The highest UR (1134) and UC (12) was reported for Anodendron borneense (King & Gamble) D.J.Middleton. Statistically, the medicinal plant knowledge among respondents was significantly different ( p <0.001) when grouped according to education, gender, position, occupation, civil status, and age but not significantly different ( p =0.379) when grouped according to location. Conclusion Documenting such traditional knowledge of medicinal plants and practices is highly important for future management and conservation strategies of these plant genetic resources. This quantitative ethnopharmacological study will serve as a future reference not only for more ethnopharmacological documentation but also
Introduction

The application of traditional medicine has gained renewed attention for the use of Traditional, Complementary, and Alternative Medicine (TCAM) in the developing and industrialized countries [1,2]. Conventional drugs these days may serve as effective medicines and therapeutics, but some rural communities still prefer natural remedies to treat selected health-related problems and conditions. Medicinal plants have long been used since the prehistoric period [3], but the exact time when the use of plant-based drugs has begun is still uncertain [4]. The WHO has accounted for about 60% of the world’s population relying on traditional medicine, and 80% of the population in developing countries almost depend on traditional herbal remedies for their primary health care [5]. Estimates for the numbers of plant species used medicinally worldwide include 35,000–70,000 [6], with 7,000 in South Asia [7] comprising ca. 6,500 in Southeast Asia [8,9]. In the Philippines, more than 1,500 medicinal plants used by traditional healers have been documented [10], and 120 plants have been scientifically validated for safety and efficacy [11]. Of all documented Philippine medicinal plants, Tan and Sia [12] determined a top list of plants used for TCAM. Most of these Philippine medicinal plants have been further studied to validate their biological and biochemical potential [13-17] scientifically.

Because of the increasing demand for drug discovery and the development of medicinal plants, the application of the quantitative approach in ethnobotany [18] and ethnopharmacology [19] has been rising continuously in the last few decades including multivariate analysis [20]. However, few studies of quantitative ethnobotanical research were conducted despite the rich plant biodiversity and cultural diversity in the Philippines. In particular, the Ivatan community in Batan Island of Luzon [21] and the Ati Negrito community in Guimaras Island of Visayas [18] have been documented, while Mindanao has remained less studied. Even though Philippines is rich in indigenous knowledge, few ethnobotanical studies have been conducted and published [22].

The Philippines is culturally megadiverse in diversity and ethnicity among Indigenous Peoples (IPs) embracing more than a hundred divergent ethnolinguistic groups [23,24] with known specific identity, language, socio-political systems, and practices [25]. Of these IPs, 61% are mainly inhabiting
Mindanao, followed by Luzon with 33% and some groups in Visayas (6%) [26]. One of these local people and minorities are the indigenous group of Manobo, inhabiting several areas only in Mindanao. They are acknowledged to be the largest Philippine ethnic group occupying a wide area of distribution than other indigenous communities like the Bagobo, Higaonon, and Atta [27]. The Manobo ("river people") was the term named after the “Mansuba” which means river people, coined from the “man” (people), and the “suba” (river) [28]. Among the provinces dwelled by the Manobo, the province of Agusan del Sur is dominated by this ethnic group known as the Agusan Manobo. The origin of Agusan Manobo is still uncertain and immemorial. However, they are known to be one of the settlers from South China as the proto-Philippine or proto-Austronesian people earlier than the Ifugao and tribes in northern Luzon [29].

Manobo indigenous people are clustered accordingly, occupying areas with varying dialects and some aspects of culture due to geographical separation. Their historic lifestyle and common livelihood are rural agriculture and primarily depend on their rice harvest, root crops, and vegetables for consumption [30]. Some members of Agusan Manobo are widely dispersed in highland communities above mountain drainage systems, indicating a suitable area for their indigenous medicinal plants in the province. Every city or municipality is governed with a tribal chieftain known as the “datu” (male) or “bae” (female) with his or her respective tribal healer “babaylan” and the tribal leaders “datu” of each barangay leading their community. Their tribe has passed several challenges over the years but has still maintained to conserve and protect their ancestral domain to continually sustain their cultural traditions, practices, and values up to this present generation. This indicates that there is rich medicinal plant knowledge in the traditional practices of Agusan Manobo, but their indigenous knowledge has not been systematically documented. Furthermore, there is no comprehensive ethnobotanical studies of medicinal plants used among the Manobo tribe in the Philippines. Documenting the ethnomedicinal plant use and knowledge, and molecular confirmation of species using integrative approach will help in understanding the nature of medicinal plants in the treatment of health-related problems of the people of Agusan del Sur. This will also help the entire Agusan Manobo community to implement conservation priorities of their indigenous plant species.
Furthermore, the provincial government of Agusan del Sur may enforce the proper utilization of their natural resources from IPs. Ideas and knowledge about ethnomedicinal use and practices of medicinal plants give credence to the traditional methods and preparation of herbal medicine by ethnic groups. Despite the limited funds and qualified personnel in the region, it is highly relevant to recognize the role of ethnopharmacology and species identification in the conservation of these plant genetic resources with medicinal properties. With the introduction of the molecular barcodes for species identification by Hebert et al. [31] the problem of unauthenticated medicinal species can now be resolved [32-39]. Significantly, researchers have recently developed the application of ethnopharmacological study into a quantitative approach with measuring indices to quantify the relationship between plant species and humans [40-42]. This study, therefore, aims to (1) conduct a quantitative ethnopharmacological documentation of traditional therapy (2) evaluate the medicinal plant use and knowledge, and (3) utilize integrative molecular approach for species confirmation of medicinal plants used by the Manobo tribe in Agusan del Sur, Philippines.

Materials And Methods

Study Area

Fieldwork was conducted in the province of Agusan del Sur, Philippines (8°30′N 125°50′E), bordered from the north by Agusan del Norte, to the south by Davao del Norte, and from the west by Misamis Oriental and Bukidnon, to the east by Surigao del Sur. Agusan del Sur is bounded with mountain ranges from the eastern and western sides, forming an elongated basin or valley in the central longitudinal section of the land. The province is subdivided into 13 municipalities (from the largest to smallest land area): La Paz, Esperanza, Loreto, San Luis, Talacogon, Sibagat, Prosperidad, Bunawan, Trento, Veruela, Rosario, San Francisco, and Sta. Josefa; and the only component city, the City of Bayugan. Forestland comprises almost two-thirds (74%) of the province of Agusan del Sur, while alienable and disposable (A&D) areas constitute around one-third (26%) of the total land area [43]. Every city or municipality has a respective community hospital and health center with limited doctors and rural health workers. Typically, local people only visit hospitals or health centers for surgical and
obstetric emergencies. Most residents rely on their medicinal plants for disease treatment and medication due to cost and poor access to healthcare services. This study purposively covered areas of selected city and municipalities (Bayugan, Esperanza, and Sibagat) for accessibility, availability and security reasons to barangays with Certification of Ancestral Domain Title (CADT) as endorsed by the National Commission on Indigenous Peoples - CARAGA Administrative Region (NCIP-CARAGA) (Fig. 1).

**Sampling and interview**

Fieldwork was undertaken from March 2018 to May 2019. It consisted of obtaining prior informed consent, observing rituals, acquiring resolutions, certifications, and permits, conducting semi-structured interviews, focus group discussions, plant observations, and medicinal plant collections in selected barangays of Bayugan, Sibagat and Esperanza. This study was initiated in coordination with the Local Government Unit (LGU), NCIP-LGU, and Provincial Environment and Natural Resources Office (PENRO) of Agusan del Sur. Consultation meetings and discussions were carried out together with the concerned parties (tribal leaders, tribal healers, and NCIP officers) to discuss research intent as purely academic, and to acquire mutual agreement and respect to conduct this study. As approved, the research intent was certified through resolution and certification duly signed by the tribal council of elders following the by-laws of NCIP for the welfare and protection of indigenous peoples, and finally certified by NCIP-CARAGA.

A total of 335 *Agusan Manobo* (more than 10% of the total *Manobo* population of selected barangays; see Additional file 1: Table S1) were selected through purposive and snowball sampling with 106 female and 229 male individuals in an age range from 18–87 years old (median age 42 years) (see Additional file 2: Table S2). Ethnopharmacological data were collected through semi-structured interviews with *Manobo* residents. The respective barangay tribal leaders assisted interviews among respondents with no appointments made prior to the visits. The semi-structured questionnaire used was modified and adapted from the Traditional Knowledge Digital Library (TKDL) template, as suggested by the Department of Health – Philippine Institute of Traditional and Alternative Health Care (DOH-PITAHC) (Additional file 3: Table S3). The ethics review committee of the Graduate School,
University of Santo Tomas (USTGS-ERC) approved this questionnaire and secured a valid translation to Manobo dialect (Minanubu) with the help of a community member and NCIP officer. It has series of questions about the common health problems encountered by the respondents, the actions undertaken to address such problems, the medicinal plants they used (vernacular name), the plant’s part(s) used, the forms, modes, quantity or dosage and frequency of administration, the source or transfer of knowledge and the experienced adverse or side effects. Interviews were accompanied by nurses and allied workers as coordinated by the rural health center to verify reported diseases accurately by the informants.

Meetings and focus group discussions were also performed to review the accuracy of acquired data among the respondents with the help of guided questions among the tribal council of elders comprising the NCIP-recognized indigenous peoples mandatory representatives (IPMRs), the tribal chieftains, the tribal healers and the respective tribal leaders of every barangay tribal communities together with the NCIP officer.

**Plant collection and identification**

Collection of plant specimens was conducted through guided field walks with the aid of the traditional healers, expert plant gatherers and members within the tribal community. The plant habit, habitat, morphological characteristics, vernacular names, and some indigenous terms of their uses were documented. Leaf samples were placed in zip-locked bags containing silica gel for molecular analysis in preparation for further molecular confirmation. Voucher specimens were deposited in the University of Santo Tomas Herbarium (USTH). Putative plant identification using vernacular names was compared to the reference of local names, *Dictionary of Philippines Plant Names* by Madulid [45]. Plant identification was assisted by Mr. Danilo Tandang, a botanist and researcher at the National Museum of the Philippines. Specimens unidentifiable by morphology were selected for molecular confirmation. All scientific names were verified, checked for spelling and synonyms, and family classification using *The Plant List* [46], *World Flora Online* [47], *The International Plant Names Index* [48], and *Tropicos* [49]. The occurrence, distribution, and species identification were further verified
using the updated Co’s Digital Flora of the Philippines [50].

**DNA extraction, amplification, and sequencing**

Collected plant specimens with insufficient material for identification due to lack of reproductive parts and unfamiliarity were subjected to molecular confirmation. The total genomic DNA was extracted from the silica gel-dried leaf tissues of samples following the protocols of DNeasy Plant Minikit (Qiagen, Germany). The ITS (nrDNA), *matK*, *trnH-psbA*, and *trnL-F* (cpDNA) markers were used for this study. Primer information and PCR conditions used for amplification using Biometra T-personal cycler (Germany) can be found in (Additional file 4: Table S4) for future parameter reference. PCR amplicons were checked on a 1% TBE agarose to inspect for the presence and integrity of DNA. Amplified products were sent to Eurofins Genomics for DNA sequencing reactions. Sequences were then assembled and edited using Codon Code Aligner v4.1.1. All sequences were then evaluated and compared using BLASTn search query available in the GenBank (www.ncbi.nlm.nih.gov). The BLASTn method estimates the reliability of species identification as a sequence similarity search program to determine the sequence of interest [51] regardless of the age, plant part, or environmental factors of the sample [52].

**Quantitative Ethnopharmacological Analysis**

The Use Report (UR) is counted as the number of times a medicinal plant is being used in a particular purpose in each of the categories [18,21]. Only one use-report was counted for every time a plant cited as being used in a particular disease or purpose and even multiple disease or purpose under the same category [53]. Multiple use-report was counted when at least two interviewees cited the same plant for the same disease or purpose. Fidelity Level (FL) developed by Friedman et al. [54] is calculated using the formula: $FL(\%) = \left(\frac{Ip}{Iu}\right) \times 100$, where $Ip$ is the number of informants who independently suggested a given species for particular disease, and $Iu$ is the total number of informants who mentioned the plant for any use or purpose regardless of category [18]. High FL values (near 100%) implies the most preferred medicinal plant species for a particular ailment.
category, while low FLs are those with many different purposes [21]. The ICF introduced by Trotter and Logan [55] was used to analyze the degree of informants’ agreement based on their medicinal plant knowledge in each of the categories [18,21]. This is computed using the formula: ICF = (Nur - Nt) / (Nur - 1), where Nur is the number of UR in each category, and Nt is the number of species used for a particular category by all informants. The maximum value (1.00), means a high degree of informant agreement that the particular medicinal plant species cited could cure a particular disease. However, a minimum value (0.00) means no information exchange among the informants [56]. High ICF values (approach to 1.00) are anticipated to be effective in treating a particular disease [57], which can be an indicator for interesting medicinal plant species for biochemical studies [58].

**Statistical tools**

The plant URs were computed and analyzed using IBM SPSS Statistics software v.23 (SPSS Inc. Released, 2015). Descriptive and nonparametric inferential statistics Mann-Whitney U and Kruskal-Wallis tests were employed to test for significant differences at 0.01 level of significance. These two statistical analyses measure and compare the medicinal plant use and knowledge of informants when grouped according to location, education, gender, position, occupation, civil status, and age.

**Integrative molecular identification**

Selected plant samples unidentifiable by morphology were subjected to an integrative molecular identification approach as previously recommended by Ghorbani et al. [38] for accurate species identification of plant samples. Most of all extracted samples for molecular analyses were successfully amplified and sequenced (91%) using multiple universal markers. Some medicinal plants could not be successfully amplified using the given primer due to low levels of DNA present in the samples [59] or plant secondary metabolites present as inhibitory factors [60]. Selected plant samples were compared with the available morphological characteristics, interview data on vernacular names, and traditional knowledge, determining scientific names based on the reference of local names using the *Dictionary of Philippines Plant Names* [45]. and utilizing multiple molecular markers, ITS (nrDNA), matK, trnH-
psbA, and \textit{trnL-F} (cpDNA) for sequencing and BLAST matching. Two sequence similarity-based methods using BLAST \[61\] were applied for molecular confirmation. BLAST similarity-based identification was adapted from the study of Ghorbani et al. \[38\] with slight modification. This involves using the simple method taking the top hits, and optimized method. All successfully sequenced samples were sequentially queried using megablast \[61\] online at NCBI nucleotide BLAST against the nucleotide database.

For the simple method, all top hits within 5 points deviation down of the max score were considered. If the max score (-5 points) showed only a single species, then a species-level identification was assigned. On the other hand, if the max score (-5 points) showed several species but similar genus, then a genus-level identification was assigned. However, if the max score (-5 points) showed multiple species in several genera of the same family, then a family-level identification was assigned. Besides, within 5 points deviation down of the max score, the highest max score and the highest percent identity were also determined. From the top 5 hits down of the max score, an optimized method using the formula, \([\text{max score (query cover/identity)}]\), was calculated.

The integrative approach combined the simple and optimized BLAST-based sequence matching results with reference of local names, and expert determination based on comparative morphology. As a result, all species identity, generic, and familial affinity were further confirmed from the recorded occurrence and distribution of putative species in the study area based on the updated \textit{Co's Digital Flora of the Philippines} \[50\].

Results

**Medicinal plant knowledge of Agusan Manobo**

The majority of the respondents (90.45\%) cited their acquisition of medicinal plant knowledge from their parents. They also have mentioned other sources of knowledge like fellow tribe band (67.76\%), relatives (64.48\%), community (61.49\%), and by means of self-discovery (47.76\%). However, the descriptive and inferential statistics revealed varying factors affecting the medicinal plant knowledge among the sampled key informants.

When grouped according to location, there was no significant difference on their medicinal plant
knowledge as revealed in Kruskal-Wallis test \((p=0.379)\) where the City of Bayugan has the highest number of UR \((Md=112, n=150)\), followed by the two municipalities, Esperanza \((Md=111, n=95)\), and Sibagat \((Md=108, n=90)\). This result showed an exchange of information on these adjacent localities among the *Manobo* community may it be the council of elders and members who are medicinal plant gatherers, peddlers, and traders. However, when grouped according to education, respondents who have secondary level as their highest educational attainment \((Md=116, n=167)\) showed highest medicinal plant knowledge when compared to primary \((Md=105, n=57)\), and tertiary \((Md=92, n=111)\) as revealed by the highly significant difference presented in Kruskal-Wallis test \((p<0.001)\). This result implied that respondents who finished tertiary are more educated with modern medicine and highly acquainted with commercial drugs available over-the-counter for immediate treatment and therapy. On the other hand, members with lower educational level have more medicinal plant knowledge, and most traditional healers, gatherers and peddlers have finished at most on the secondary level.

When grouped according to gender, non-parametric tests revealed that men \((Md=116, n=229)\) have more medicinal plant knowledge than women \((Md=104, n=106)\), as demonstrated by the significant difference in both Mann-Whitney \(U\) test \((p<0.001)\) and Kruskal-Wallis test \(p<0.001\). It can be observed that men have more medicinal plant knowledge in Agusan *Manobo* culture, an observation supported by the fact that in two of the three selected localities, the tribal healers are male and most of the tribal officials are also males. This result is contrary to the previous statistical findings of Ong and Kim (2014) in Ati culture where women are more knowledgeable than men because they are more involved in medicinal plant gathering and peddling and women also play a big role in caring for their sick children.

Also, knowledge among the respondents when grouped according to position varies significantly, as revealed by the Kruskal-Wallis test \((p<0.001)\). This result means that the *Manobo* tribal officials have more medicinal plant knowledge when compared to their members \((Md=104, n=239)\), with the exception of their knowledgeable tribal healers \((Md=189, n=3)\). This is evident with the results among tribal officials, namely tribal leaders \((Md=178, n=31)\), tribal IPMRs \((Md=177, n=6)\), tribal chieftains \((Md=172, n=45)\), *Manobo* tribal council of elders \((Md=164, n=7)\), *Manobo* NCIP focal persons
When grouped according to the occupation, non-parametric Kruskal-Wallis test also significantly revealed \( p<0.001 \) that informants with occupation in farming \( (Md=118, n=205) \), and animal husbandry \( (Md=116, n=47) \) have more medicinal plant knowledge compared to employed \( (Md=98, n=49) \), and unemployed \( (Md=96, n=16) \) informants. This result suggested that Manobo people who are working in line with agriculture are more exposed to medicinal plant knowledge as they are farming crops and raising animals in hinterlands, and mountainous areas where most medicinal plants are located. Also, when grouped according to civil status, married informants \( (Md=136, n=147) \) showed higher medicinal plant knowledge than single ones \( (Md=92, n=188) \) as revealed by the very high significant difference in both Mann-Whitney U test \( p<0.001 \) and Kruskal-Wallis test \( p<0.001 \). This result implied that married respondents were more exposed during community gatherings, which involve a discussion about medicinal plants with regards to their uses and applications. Exchange of information could be observed when couples were present during the scheduled tribal meetings. Finally, when grouped according to age, descriptive and inferential statistics revealed that respondents from the age group of more than 65 years old have the highest medicinal plant knowledge \( (Md=173, n=37) \), followed by 50–65 years old \( (Md=155, n=53) \), 35–49 years old \( (Md=102, n=103) \), and 18–24 years old \( (Md=96, n=142) \), respectively, as revealed by the highly significant difference manifested in Kruskal-Wallis test \( p<0.001 \). This result corresponds to our expectation because older informants most likely have more knowledge of medicinal plant uses and practices based on their long term of experience. This result may also imply that younger generations are becoming more acquainted and educated with modern medicinal treatment making them more reluctant in their traditional medicinal plant gathering and peddling. This transforming awareness, social, and cultural experiences may have influenced their medicinal plant interest, traditional knowledge, and attitudes among the Agusan Manobo. Younger generation is becoming more privileged to be educated as part of the government scholarship and program for indigenous communities resulting in migration to urban communities.
**Medicinal plants used**

A total of 122 reported medicinal plant species belonging to 108 genera and 51 families were categorized in 16 uses or diseases, as shown in Tables 1 and 2. All informants interviewed agreed about the healing power of medicinal plants, but only 58.5% of the informants use medicinal plants to treat their health conditions. While some residents (30.75%) directly rely on seeking for tribal healers in their community, all these Babaylans utilized their known medicinal plants for immediate treatment and therapy. However, the minority (10.75%) of the respondents depended on seeing a medical practitioner and allied health workers in the treatment of their health conditions at a nearby hospital or health center.

**Species molecular confirmation**

Due to inconclusive morphological identification, unfamiliarity, and confusing species identity because of local name similarity, a total of 24 medicinal plant species were confirmed by DNA sequencing and by comparing the sequences with those present in GenBank. This method supported ethnopharmacological data to be deposited in a repository [18], which is essential and helpful for future researchers and investigators for use by data mining approaches [62]. The molecular data can also be helpful in the growing barcoding studies of medicinal plants. Putative identification based on literature, expert determination using morphology, and molecular sequences using BLAST search query were tabulated (Additional file 5: Table S5). The integrative approach coalesced with *a priori* data from putative identifications based on the interview data on vernacular names, local plant name dictionary, and assessment of available morphological characteristics along with *a posteriori* data from multiple molecular markers, occurrence, and distribution of putative species in the Philippines. This paper applied a more detailed taxonomic identification since all reported medicinal plant taxa were identified (nearly all to species level) as shown in Table 2. While all generic and familial affinities of medicinal plants were confirmed, five medicinal plants were not identified up to species level due to lack of morphological characteristics, concerning especially the reproductive parts of *Piper* species; several cultivars and hybrids of *Rosa* species; and several species and varieties of *Bauhinia* species.
Nevertheless, all generic and familial affinities of the medicinal plants documented here were verified combining similarity matching and a priori and a posteriori data as recommended by Ghorbani et al. [38] to reduce ambiguity and make it possible to assign a single species identification of their unfamiliar species. All determined plant samples with confusing identity having local name similarity and local species pairing, including plant samples with inconclusive morphological identification, were accurately verified using an integrative molecular approach.

**Plant local names**

Most notable medicinal plants of Agusan Manobo have confusing species identity bearing similar local names, gender identity and local species pairing. It is popular to use medicinal plants known as “Lunas” (meaning “cure”) with several plants associated under its name. For instance, the top four medicinal plants in terms of use-report and use value have local name similarity, namely Lunas tag-uli (Anodendron borneense), Lunas bagon tapol (Piper decumanum L.), Lunas kahoy (Micromelum minutum (G.Forst.) Wight & Arn.), and Lunas bagon puti (Piper nigrum L.), respectively. These four medicinal plants named “lunas” have almost similar use-reports in nine disease categories which only differ in their use value, informant consensus factor, fidelity level, and efficacy accordingly. Other “lunas”-named specimens such as Lunas pilipo (Acmella grandiflora (Turcz.) R.K.Jansen), Lunas buyo (Piper aduncum L.), and Lunas gabi (Alocasia zebrina Schott ex Van Houtte) also share similarities from the four mentioned samples in terms of ethnomedicinal properties as treatment for cuts and wounds. Also, another three medicinal plants were locally classified with the name “Talimughat” (meaning “recover”), namely “Talimughat lignin” (Grewia laevigata Vahl), “Talimughat taas” (Friesodielsia lanceolate (Merr.) Steen.) and “Talimughat pikas” (Bauhinia sp.). These three medicinal plants were noted with high fidelity for postpartum care and recovery. Plant samples with high fidelity for anemia also have similar local names which are found to be similar species, namely “Mayana kanapkap” (Coleus scutellarioides (L.) Benth.), and “Mayana pula” (Coleus scutellarioides (L.) Benth.). Some medicinal plants also have attached “genders” (male or female) in their local names which specify the more effective plant “gender” for a specific medicinal use or purpose. Examples are
“kapayas laki” (*Carica papaya* L., male), “dupang bae” (*Urena lobata* L., female), and “Gapas-gapas bae” (*Erechites valerianifolius* Link ex Spreng.) DC., female) as effective treatment for dengue virus, postpartum care and recovery, and gas pain and flatulence, respectively. In addition, most species with high use values have local species pairing as classified by the tribe according to distinct white and red coloration, namely “puti” and “tapol,” respectively, with the latter as more effective than the former in treatment for various health conditions. The following recognized local species pairs as white and red plant samples, respectively, are “Alibangbang puti” (*Phanera semibifida* (Roxb.) Benth.) and “Alibangbang tapol” (*Phanera semibifida* (Roxb.) Benth.); “Banti puti” (*Omalanthus macradenius* Pax & Hoffm.) and “Banti tapol” (*Omalanthus macradenius* Pax & Hoffm.); “Lunas-bagon puti” (*Piper nigrum*) and “Lunas-bagon tapol” (*Piper decumanum*); “Tobog puti” (*Ficus fistulosa* Reinw. ex Blume) and “Tobog tapol” (*Ficus cassidyana* Elmer); and “Tuba-tuba puti” (*Jatropha curcas* L. and “Tuba-tuba tapol” (*Jatropha gossypifolia* L.). Local species pairing of “Alibangbang puti” and “Alibangbang tapol” was found to be similar species (*Phanera semibifida* (Roxb.) Benth.). Another species pair, “Banti puti” and “Banti tapol” was also found to be similar species (*Omalanthus macradenius* Pax & Hoffm.). However, molecular confirmation of all species pairs by the locals do not necessarily point to the same species but are mostly referring to another species. Thus, it is always important in any ethnomedicinal, ethnobotanical, and ethnopharmacological study to obtain the correct identification of medicinal plants using an integrative molecular approach for accuracy, consistency, and dependable species identity for future natural product investigations.

**Collection sites**

The majority (57%) of the medicinal plants were collected in the wild, woods or forest while some were collected within the community village (7.2%) and within the houses (4.8%). Some local people are cultivating some of these medicinal plants near homes for their convenience, but collecting medicinal plants in the wild is highly encouraged for efficacy as the locals believe that the plants should grow in their natural setting rather than cultivation. Scientific studies tend to support the idea of medicinal plant collection in the wild because plant secondary metabolites will be mostly expressed
in the natural setting under environmental stress and conditions while they could not be comparably expressed under monoculture conditions [63]. Uniyal et al. [64] reported higher levels of secondary metabolites in wild populations where plants grow slowly, unlike in much faster-growing monocultures.

**Plant parts used**

All plant parts are used from various plant species against a variety of diseases. The most frequently used plant parts are the leaves (41.6%), followed by roots (16.1%), barks (12.0%), stems (8.5%), sap or latex (6.7%), and flowers (4.1%) (Fig. 2). Sometimes, more than one plant part of the same species is used in combination, like leaves and barks for preparation and administration which the locals believed to have synergistic effect.

**Preparation and administration**

The primary preparation method was decoction (34.0%), followed by pounding, crushing, rubbing, grinding, and powderizing (13.7%), poultice (12.3%), extracting (9.0%), directly applying or eating (8.5%), infusion (7.1%), or as wash, bath, hot compress (5.5%), heating or warming (3.6%), tincture (2.7%), brewing (1.6%), burning (1.4%) and steaming (0.5%) as depicted in Fig. 3. The more common route of administration is internal (60%) rather than external (40%). This result is similar to previous ethnobotanical reports conducted in Mindanao [65-66] but contrary to other ethnobotanical studies among ethnobotanical survey held in Luzon [21] and Visayas [18] where external application is more common. While external administration could be safer, according to Agusan Manobo, the internal application is more common since most of their health conditions are associated internally with decoction as their most common preparation. In cases of external diseases and illnesses, preparation of more prolonged coconut oil infusions of medicinal plant stems and barks are often applied.

**Use report (UR)**

The Use Report (UR) represents the relative importance of medicinal plants for certain categorized
uses or diseases. High URs are considered the most important species among Agusan Manobo. Five medicinal plants with the highest URs (more than 900) were Anodendron borneense (1,134) in 12 categories, Piper decumanum L. (1,018) in 9 categories, Micromelum minutum (955) in 9 categories, Arcangelisia flava (L.) Merr. (922) in 10 categories, and Cinnamomum mercadoi (908) in 9 categories. These high use-reported plants were the most frequently used plant species for pregnancy, skin rashes and itchiness, hemorrhage, tumor, and stomach trouble, respectively. The respondents consistently reported these in all study sites, but only harvested in the wild. Some other plants can be cultivated with high URs, as shown in the number of use-reports in Table 2. While high UR species can often be harvested for medicinal use and purpose, these important species call for conservation priority [67]. The four medicinal plants included among the top 10 recommended medicinal plants by the Department of Health (DOH) of the Philippines, were cultivated by the Agusan Manobo residents within their community. These scientifically validated medicinal plants were also reported with high URs, namely “Bayabas” Psidium guajava L. (275) “Lagundi” Vitex negundo L. (475), “Gabon” Blumea balsamifera (L.) DC. (412), and “Tsaang gubat” Ehretia microphylla Lam. (336).

**Use categories (UC)**

Reported medicinal uses of plants in this study were grouped into 16 category names based on the citations of informants and the likeness to the use category. Reported uses and diseases in medical terms were verified by the assigned local physicians and allied workers nearby hospitals and health centers to confirm disease occurrence and epidemiology in the area. A total of 120 reported uses or diseases treated by 122 plant species were documented in the study area (Table 1).

**Fidelity level (FL)**

FLs imply the most preferred medicinal plant for a particular disease or purpose. FL value ranges from 1% to 100% depending on the URs cited by the informants for a given species for a particular ailment. A total of 38 species were found with the maximum FL of 100%, including the identified species with the highest number of use-mentions, Carica papaya, Premna odorata, Cinnamomum mercadoi,
Tinospora crispa, and Ficus concinna, which are used to treat constipation, dengue fever, cough with phlegm, stomach trouble, joint pain, and fracture and dislocation, respectively (Table 1). Other species with low FL values indicate less preferred species to treat a particular ailment, however, this suggests the extent of medicinal plant use as treatment a for various diseases.

**Informant consensus factor (ICF)**

ICFs measure the agreement among informants on the use of plant species for a particular use or disease category. While the agreement among the selected informants varies in different categories, the ICF values are all greater than or equal to 0.90 (Table 1). Among the 16 use categories, the category of abnormal signs and symptoms (ASS) was the highest showing an ICF value of 0.96. This result means that informants agreed to use a single species for this category. Under this category, Sida rhombifolia L. was recorded as the most frequently used species, particularly used as a treatment for cramp and spasm locally termed as “pasmo” among the Agusan Manobo. This means that most of the informants totally agree on the use of a specific plant for a particular ailment or purpose.

Of all categories, the category of other problems of external causes (OEC) showed the second to the highest number of URs with the highest number of taxa used. This result was similar to the previous findings of Ong and Kim [18] among the Ati Negrito indigenous group. This category is known to cover a wide range of disease signs and symptoms from mild to severe conditions and unexplained causes. The recorded most common health problems of Agusan Manobo within their household also belong in this category. The percentages of informants who cited their common illnesses under this category were 88.06% fever, 58.21% headache, and 58.51% body ache. Other reported common health conditions were 77.01% cough, 69.55% colds, 37.31% stomach troubles, and 15.52% other illnesses.

**Dosage, frequency and experienced adverse or side effects of using medicinal plants**

For a detailed ethnopharmacological study, it is essential to consider the therapeutic use, medication action, and possible effects. This study involved documenting the quantity or dosage, administration
frequency, and experienced adverse or side effects, as shown in Table 2. A particular number of plant parts were followed in their mode of preparation. Having leaves as their most used medicinal plant part, 3–5 leaves (or at least an odd number) of decocted, heated, and pounded leaves should be used. Most of the medicinal plants (82%) were reported by the respondents with no experiences of adverse or side effects, while 18% of medicinal plants were experienced with adverse or side effects. There were seven medicinal plants reported to cause abortion to pregnant women once taken or applied. Other listed medicinal plants when taken in excess, can cause other adverse or side effects. Five of these medicinal plants can cause anemia, dizziness, and weakening, and also five medicinal plants can cause acid reflux and hypocupremia. Some of the medicinal plants can cause burn, allergy and can be poisonous when eaten or applied while the rest of the reported cases concern excessive intake, which can cause blood viscosity, intestinal weakening, thrombocytopenia, and abnormalities to lactating mothers. These reported adverse or side effects were determined by attending local medical practitioners during their hospital visits and in times of emergency.

Discussion
This ethnopharmacological documentation recorded a total of 122 medicinal plant species belonging to 108 genera and 51 families across 16 use or disease categories. The majority of medicinal plants are trees (36%) and herbs (33%), which are mostly found in the wild while some are cultivated. These are followed by 17% shrubs, 11% climbers, 2% grasses, and 1% ferns. The highest percentage of medicinal trees documented in this study is parallel with the earlier ethnobotanical studies [18, 68]. The highest frequency of using leaves and aerial plant organs was also reported in several ethnobotanical studies in the Philippines [18, 21, 22, 65, 66, 68-70] and other countries [71-73]. The highest frequency of decoction for preparation and administration is similar to previous ethnobotanical investigations [18, 65, 66, 68-70].

Lamiaceae was the most represented family with 12 species, followed by Asteraceae with 11, Moraceae with 8 species, and Fabaceae with 6 species. This result is contrary to previous ethnobotanical studies in which Asteraceae were the most represented family [21, 65, 66, 69]. The Lamiaceae (mint family) possess a wide variety of ornamental, medicinal, and aromatic plants
producing essential oils that are used in traditional and modern medicine, food, cosmetics, and pharmaceutical industry [74]. This family is known for effective pain modulation with potential analgesic or antinociceptive effects, which includes several aromatic medicinal spices like mint, oregano, basil, and rosemary [75]. Asteraceae (the aster, daisy, composite, or sunflower family) are the largest family of flowering plants which were reported to have pharmacological activities such as antitumor, antibacterial, antifungal, and anti-inflammatory [76] containing phytochemical compounds such as polyphenols, flavonoids, and diterpenoids [77, 78]. The Moraceae (fig family) was reported to have wide a variety of chemical constituents with potential biological activities as previously investigated in *Ficus racemosa* L. [79], *Ficus carica* L. [80], and *Ficus benjamina* L. [81]. Fabaceae (pea family), which is the third largest family also contain various bioactive constituents with potential pharmacological and toxicological effects [82]. A member of this family which has long been cultivated and introduced in the Philippines, *Gliricidia sepium* (Jacq.) Kunth ex Steud., was investigated to have antimicrobial and antioxidant activities, as well as several phytochemicals present [13].

The Department of Health (DOH) of the Philippines has continually endorsed 10 medicinal plant species in its traditional health maintenance program: (1) *Cassia alata* L., (2) *Momordica charantia* L., (3) *Allium sativum* L., (4) *Psidium guajava* L., (5) *Vitex negundo* L., (6) *Quisqualis indica* L., (7) *Blumea balsamifera* (L.) DC., (8) *Ehretia microphylla* Lam., (9) *Peperomia pellucida* (L.) Kunth and (10) *Clinopodium douglasii* (Benth.) Kuntze. Of all these 10 recommended and clinically tested medicinal plants, 4 species were included in this survey.

The societal gaps which differentiate educational level, gender, position, occupation, and age among the *Manobo* indigenous community may result in the disappearance of their medicinal plant knowledge and traditional practices. While there was no significant difference in their medicinal plant knowledge in different locations, it is still highly important to document their medicinal plant knowledge to perpetuate their cultural tradition and medicinal practices, as well as protect and conserve these important plant genetic resources.

Many ethnobotanical studies include vernacular names as part of the putative identification. While
vernacular names are useful in ethnopharmacology, pharmacognosy, and pharmacovigilance [83, 84], reliance on these vernacular names for species identification and classification can cause ambiguity and incorrect identification resulting to research invalidation [85]. DNA-based identification is a useful tool for accurate species identification. Correct identification of a medicinal plant should be examined using a molecular approach [86] for consistency of species and pharmacological investigations of natural products [87]. Although plant-based drug discovery in the ethnobotanical approach provides future drug leads, authentication of the plant material is a great challenge and opportunity [88].

Comparison with previous ethnobotanical studies

A number of ethnobotanical and ethnomedicinal documentation were conducted in the Philippines, but few involve quantitative analyses in their studies. Most of the ethnobotanical researches conducted in the Philippines purposively selected key informants who are knowledgeable of their medicinal plants like residents, traditional healers, herbalists, gardeners, traders and elders, but a limited count of studies focused on specific IPs or tribal communities in the country. Among the three major islands in the Philippines (Luzon, Visayas, and Mindanao), the island of Mindanao is still underdocumented despite its largest population of ICCs/IPs in the country. In Luzon, four indigenous groups were documented, namely the Kalanguya tribe in Tinoc, Ifugao [89], the Ivatan in Batan Island Batanes [21], the Ayta in Dinalupihan, Bataan [70], and the Ilongot-Ègongot in Maria Aurora, Aurora [90] communities. Balangcod and Balangcod [22] also documented plant utilization among local communities in Kabayan, Benguet Province, namely Ibaloi, Kankanaey and Kalanguya in addition to the earlier documented tribes such as the Negritos [91], the Tasadays [92, 93], the Ifugao [94, 95] and the Bontoc [96]. Other studies of cultural communities involve indigenous knowledge and practices for sustainable management like the Ifugao forests in Cordillera, Philippines [97].

In Visayas, only the Ati Negrito of Guimaras island (Ong and Kim, 2014), while in Mindanao, three tribes were studied, namely the Higaonon tribe of Iligan City [65], Subanen tribe of Dumingag, Zamboanga del Sur [69], Muslim Maranaos of Iligan City [66], Subanen tribe of Lapuyan, Zamboanga
del Sur [68], and Tagabawa tribe of Davao del Sur [98]. Of all reported ethnobotanical studies in Mindanao, this is the first study utilizing detailed quantitative analysis of relative importance, effectivity consensus, and the extent of the potential use of each medicinal plant species among the IPs. Moreover, this study also integrated molecular confirmation for the first time applying multiple universal markers and coalescing a priori and a posteriori data for accurate species identification to resolve complex plant vernacular names.

In comparison with existing ethnobotanical studies in the Philippines, two novel plant medicinal uses were documented, namely *Anodendron borneense* and *Piper decumanum* with no existing records of ethnobotanical and pharmacological investigations to date, and even to other countries. The ethnopharmacological profiles of these medicinal plants are novel findings in this study, which are only known among the *Agusan Manobo* and solely reported in the province of Agusan del Sur, Philippines. Additional information on this study incorporating experienced adverse or side effects is newly introduced and recommended for a more detailed ethnopharmacological documentation in the Philippines. This comprehensive ethnopharmacological documentation could be a reference material for future ethnomedicinal and pharmacological studies.

**Conclusion**

This study presents the culturally rich ethnomedicinal knowledge and practices of the *Manobo* tribe in Agusan del Sur, Philippines. The results of the study revealed a high diversity of medicinal plants used by the *Agusan Manobo* with 122 species used in 16 use categories. Like any other ethnolinguistic indigenous group in the country, traditional knowledge may be lost or forgotten due to possible migration, acculturation, and declining interest of the younger generation due to the increasing availability of commercial over-the-counter medicine. Their medicinal plants are known by a limited number of individuals, mostly by their healers, elders, and tribal officials. This quantitative ethnopharmacological documentation is the first to show the high consensus and relative importance of medicinal plants used by the *Agusan Manobo* and provides molecular confirmation to some of their medicinal plant species. The combined quantitative ethnopharmacological documentation and species confirmation by an integrative molecular approach of medicinal plants used in traditional medicine is
a breakthrough for obtaining more detailed and comprehensive findings that will be a valuable contribution to the repository of knowledge. The findings of this study will serve as reference material for future systematic and pharmacological studies. While the findings of this study are promising, regarding new potential therapeutic agents for healthcare improvement, it is of utmost importance to reconsider important medicinal plant species for conservation priorities as part of the government programs and initiatives to perpetuate the world heritage of traditional knowledge on medicinal plants of our diverse cultural communities.

Declarations

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Ethics approval and consent participate

All necessary approval, prior informed consent, permit and certification were secured from the local government units (LGUs), provincial government administration, PENRO-LGU and NCIP-LGU of Agusan del Sur, DENR-CARAGA gratuitous permit (no. R13-2019-12), NCIP-CARAGA (no. R13-2019-01), and the USTGS-ERC permit (protocol no. GS-2019-PN007). The purpose of the study was discussed to the tribal communities headed by the respective tribal chieftains, and they agreed to provide information after ritual observation.

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**Availability of data and materials**

The authors declare that all other data supporting the findings of this study are available within the article and its supplementary information files.

**Authors’ contributions**

MLD proposed the research study, carried out the fieldwork, molecular work, and wrote the manuscript as the major contributor of the study. DT assisted with species identification and authentication at the Philippine National Herbarium. GJA evaluated the data of fieldwork and molecular work for inclusion in the manuscript. UM and SCS reviewed, analyzed and gave critical comments. All authors have read and approved of the final manuscript.

**Consent for publication**

Not applicable

**Competing Interest**

The authors declare that there is no competing interests.

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Tables

Table 1. Categories of diseases, Informant Consensus Factor (ICF) and Fidelity Level (FL) of notable plants.
| Category No. | Category names and abbreviations | Reported diseases or uses under each category name | No. of use-report | % of all use-reports |
|-------------|----------------------------------|----------------------------------------------------|------------------|---------------------|
| 1           | Diseases caused by bacterial, viral and parasitic infections (BVP) | Ascariasis, chicken pox, herpes simplex, scabies, jaundice (hepatitis), mumps (parotitis), athlete's foot, warts, amoebiasis, white spot (tinea flava), impetigo, measles, colds (influenza), dengue fever, malaria, typhoid fever, ringworm | 1020 | 9.68 |
| 2           | Tissue growth problems (TGP) | Cancer, cyst, tumor (myoma) | 318 | 3.02 |
| 3           | Endocrine, nutritional and metabolic (ENM) | Diabetes, tonic, beriberi, hormonal imbalance, goiter | 345 | 3.28 |
| 4           | Diseases of the nervous system (DNS) | Migraine, Parkinson's disease, nervous breakdown (depression, anxiety, mental stress, nervousness) | 63 | 0.60 |
| 5           | Diseases of the eye (EYE) | Sore eyes, cataract, eye problem (blurred vision, conjunctivitis, eye infection) | 85 | 0.81 |
| 6           | Diseases of the ear (EAR) | Ear congestion, ear infection, discharging ear (otorrhea) | 120 | 1.14 |
| 7           | Diseases of the circulatory system (DCS) | Anemia, hypertension, varicose veins, heart problem (enlargement), internal bleeding, hemorrhage | 307 | 2.91 |
| 8           | Diseases of the respiratory system (DRS) | Asthma, pneumonia, emphysema, pulmonary tuberculosis, nasal congestion, lung nodule, cough, cough with phlegm, Respiratory disease complex (rhinitis, tracheitis, bronchitis), sore throat (tonsilitis) | 891 | 8.46 |
| 9           | Diseases of the digestive system (DDS) | Constipation, diarrhea, stomach trouble (dysentery, stomachache, bloating), vomiting (nausea), peptic ulcer, toothache, gum swelling, indigestion (dyspepsia), mouth sore (canker sore), stomach acidity (gastritis), swollen/bleeding gums (gingivitis), pancreatitis, liver problem (fatty liver), hemorrhoids, appetite enhancer | 1556 | 14.77 |
| 10          | Diseases of the skin (DOS) | Boils (furuncle/carbuncle), skin eruptions, skin rashes and itchiness (eczema, dermatitis), psoriasis, pimple and acne, hair loss, dandruff | 704 | 6.68 |
| 11          | Musculoskeletal system and connective tissue problems (MCP) | Joint pain (arthritis, gout), rheumatism, sprain, tendon mass nodule, swollen muscles/swellings, muscle pain | 748 | 7.10 |
| 12          | Genito-urinary problems (GUP) | Urination difficulty, kidney stones, kidney problem (high uric acid and creatinine), urinary bladder swelling, dysmenorrhea, delayed or irregular menstruation, urinary tract infection | 577 | 5.48 |
| 13          | Uses in pregnancy to delivery, maternal and infant care (MIC) | Pregnancy (impotence and sterility), abortifacient, labor and delivery enhancer, childbirth tool, miscarriage, maternal care, postpartum care and recovery, new-born baby care, milk production enhancer | 420 | 3.99 |
| 14          | Abnormal signs and symptoms (ASS) | Abdominal pain, backache, body ache, headache, fever, weakness and fatigue (asthenia), baby teething, child sleeplessness, malaise and fatigue, “pasmo” (cramp and spasm), “bughat” (relapse), skin numbness (paresthesia), dizziness and fainting, body chills, gas pain and flatulence, hangover | 1958 | 18.59 |
| 15          | Other problems of external causes (OEC) | Allergy, burns, cuts and wounds, fracture and dislocation, bruises and contusions, animal bites (snake, dog), insect bites (mosquito, wasp, scorpion), poisoning, contacts with plant or animal parts | 1332 | 12.65 |
| 16          | Other uses (OS) | Circumcision antiseptic and anesthetic | 89 | 0.84 |
Table 2.
Medicinal plants used by the Agusan Manobo in the Philippines.

| Plant No. | Scientific Name          | Family         | Local Name  | Voucher No. | No. of use-reports | No. of categories | Disease or purpose                                                                 |
|-----------|--------------------------|----------------|-------------|-------------|--------------------|--------------------|-----------------------------------------------------------------------------------|
| 1         | *Andrographis paniculata* Nees<sup>3</sup> | Acanthaceae    | White flower | UTH 015616  | 480                | 9                  | Jaundice, malaria, colds; cancer; diabetes; hypertension, heart enlargement, atherosclerosis; cough, respiratory disease complex, sore throat; diarrhea, dyspepsia, ulcer, liver problem; abortifacient fever, gas pain and flatulence  Boils, skin rashes and itchiness, dermatitis |
| 2         | *Rhinacanthus nasutus* (L.) Kurz | Acanthaceae    | Marvelosa or Serpentina | UTH 015622  | 583                | 6                  | Colds; diabetes, beriberi; nervous breakdown; hypertension; diarrhea, stomachache; weakness and fatigue, cramp and spasm  |
| 3         | *Amaranthus spinosus* L. | Amaranthaceae  | Kudyapa      | UTH 015589  | 211                | 9                  | Diabetes; anemia; cough, bronchitis; dysentery, constipation; urinary tract infection; fever  Labor and delivery enhancer  Boils, psoriasis, skin rashes eczema, pimple, acne; snake and scorpion bite |
| 4         | *Mangifera indica* L.<sup>3</sup> | Anacardiacea   | Mangga       | UTH 015591  | 222                | 5                  | Constipation  Cough, cough with phlegm, sore throat  |

Diarrhea, stomach trouble; headache  Scabies; cuts and wounds
|   | Species                          | Family    | Common Name | USTH Code | Quantity | Uses                                      |
|---|----------------------------------|-----------|-------------|-----------|----------|-------------------------------------------|
|5  | *Spondias pinnata* (L.f.) Kurz   | Anacardiaceae | Abhid       | USTH 01559 9 | 372      | Colds; diabetes; cough; fever              |
|6  | *Annona muricata* L.            | Annonaceae | Guyabano    | USTH 01559 3 | 209      | Cancer; diabetes; hypertension; dysentery |
|7  | *Cananga odorata* (Lam.) Hook.f. & Thomson | Annonaceae | Anangilan or llang-ilang | USTH 01557 7 | 358      | Colds; cough; stomach trouble; ulcer; fever, body chills; Scabies, athlete's foot; pimple; rheumatism; swollen muscles or swellings, muscle pain; insect bites |
|8  | *Friesodielsia lanceolata* (Merr.) Steen. | Annonaceae | Taimughat taas | USTH 01555 8 | 198      | Muscle pain; labor and delivery enhancer, postpartum care and recovery; backache, body ache, cramp and spasm, weakness and fatigue, relapse |
|9  | *Uvaria zschokkei* Elmer        | Annonaceae | Bigo        | USTH 01566 2 | 195      | Amoebiasis; hypertension; fever, weakness and fatigue; Hair loss; insect bites |
|10 | *Alstonia*                       | Apocynaceae | Dita        | USTH 386   | 9        | Tonic; ear congestion;                   |
| 11 | Anodendron borneense (King & Gamble) | Apocynaceae | Lunas tagulii | USTH 015639 | 1134 | 12 |
|----|-------------------------------------|-------------|--------------|--------------|------|-----|

Cancer; diabetes; ear infections; diarrhea, stomach trouble, ulcer, toothache; arthritis, rheumatism; pregnancy; body ache, weakness and fatigue, cramp and spasm, relapse; poisoning Colon and prostate cancer, cyst, tumor; diabetes; hypertension; pulmonary tuberculosis; diarrhea, stomach trouble, ulcer, toothache, swollen gums; arthritis, rheumatism; impotence and sterility, postpartum care and recovery; body ache, weakness and fatigue, cramp and spasm, relapse, gas pain and flatulence; sprain; poisoning Scabies, warts, impetigo, typhoid fever; boils, skin eruptions, skin rashes and itchiness; arthritis, rheumatism, swellings, muscle pain; backache, body ache, weakness and fatigue, cramp and spasm, relapse gas pain and flatulence; allergy, burns, cuts and wounds, sprain, animal and insect bites, contacts with plants and animal parts
| No. | Species                                                                 | Family       | Common Name       | Code    | Quantity | Uses                                      |
|-----|------------------------------------------------------------------------|--------------|-------------------|---------|----------|------------------------------------------|
| 12  | *Hoya imbricata* Decne.                                                | Apocynaceae  | Pikot-pikot       | USTH 01561 8 | 57       | Boils; cuts and wounds                    |
| 13  | *Alocasia zebrina* Schott ex Van Houtte                               | Araceae      | Lunas gabi        | USTH 01561 4 | 44       | Allergy, cuts and wounds, snake and insect bite, poisoning |
| 14  | *Homalomena philippinensis* Engl. ex Engl. & K.Krause                  | Araceae      | Payaw             | USTH 01559 7 | 466      | Colds; body ache, headache, fever         |
|     |                                                                        |              |                   |          |          | Tonsillitis; pregnancy, impotence and sterility, labor and delivery enhance |
|     |                                                                        |              |                   |          |          | Rheumatism; cuts and wounds               |
|     |                                                                        |              |                   |          |          | Hemorrhoids                               |
| 15  | *Hydrocotyle vulgaris* L.                                              | Araliaceae   | Goto Kola         | USTH 01556 3 | 263      | Diabetes; hypertension; fever             |
|     |                                                                        |              |                   |          |          | Cuts and wounds                           |
| 16  | *Areca catechu* L.                                                     | Areaceae     | Huling-huling     | USTH 01561 | 42       | Breast cancer                            |
| No. | Scientific Name                           | Family     | Common Name | Code  | Quantity | Uses                                                              |
|-----|------------------------------------------|------------|-------------|-------|----------|-------------------------------------------------------------------|
| 17  | Calamus megaphyllus Becc.                | Arecaeae   | Kapi        | USTH 01560 8 | 168      | Hypertension; asthma; diarrhea, dyspepsia; gastritis, indigestion; arthritis, rheumatism |
| 18  | Thottea affinis (Planch. ex Rolfe) ined. | Aristolochiaceae | Salimbagat  | USTH 01564 3 | 278      | Amoebiasis; cancer; toothache                                      |
| 19  | Dracaena roxburghiana (Schult.f.) Byng & Christenh. | Asparagaceae | Espada-espada | USTH 01564 7 | 78       | Boils; snake bite                                                  |
| 20  | Acmella grandiflora (Turcz.) R.K.JansenC | Asteraceae  | Lunas pilipo | USTH 01554 8 | 396      | Toothache; anesthetic                                             |
|     |                                          |            |             |       |          |                                                                   |
|     |                                          |            |             |       |          |                                                                   |
| 21  | Ageratum conyzoides L.                   | Asteraceae  | Albahaca    | USTH 01560 2 | 77       | Abortifacient; weakness an fatigue                                |
|     |                                          |            |             |       |          |                                                                   |
|     |                                          |            |             |       |          |                                                                   |
| 22  | Artemisia vulgaris L.                    | Asteraceae  | Helbas      | USTH 01561 9 | 365      | Asthma, cough, cough with phlegm; diarrhea, dyspepsia; delayed menstruation; relapse |
|     |                                          |            |             |       |          |                                                                   |
|     |                                          |            |             |       |          |                                                                   |
| 23  | Bidens pilosa L.                         | Asteraceae  | Tuway-tuway | USTH 01558 2 | 218      | Colds; diarrhea; muscle pain; backache, body ache, fever, weakness and fatigue, cramp and spasm, |
|     |                                          |            |             |       |          |                                                                   |
| No. | Species                          | Family     | Origin          | Code     | Quantity | Uses                                                   |
|-----|---------------------------------|------------|-----------------|----------|----------|--------------------------------------------------------|
| 24  | *Blumea balsamifera* (L.) DC. | Asteraceae | Gabon           | USTH 01557 3 | 412      | Hypertension; cough, cough with phlegm; urination difficulty; postpartum care and recovery; body ache, headache, fever, weakness and fatigue, gas pain and flatulence. Headache |
| 25  | *Chromolaena odorata* (L.)     | Asteraceae | Hagonoy         | USTH 01563 2 | 448      | Tumor; hemorrhage; fever. Boils; burns, cuts and wounds |
| 26  | *Cyanthillium cinereum* (L.)   | Asteraceae | Kanding-kanding | USTH 01558 7 | 476      | Colds, malaria; pulmonary tuberculosis; dog bite. Chicken pox, herpes simplex, measles; boils, skin eruptions, skin rashes and itchiness; weakness and fatigue, cramp and spasm |
| 27  | *Erechtites valerianifolius* (Link ex Spreng.) DC. | Asteraceae | Gapas-bae       | USTH 01566 6 | 208      | Stomachache, dyspepsia; body ache, headache, gas pain and flatulence. Cuts and wounds |
| No. | Scientific Name                        | Family       | Common Name  | Catalog No. | Quantity | Uses                                                                 |
|-----|--------------------------------------|--------------|--------------|-------------|----------|----------------------------------------------------------------------|
| 28  | *Gynura procumbens* (Lour. ) Merr. C | Asteraceae   | Ashitaba     | USTH 01564 5 | 215      | Emphysema, cough; diarrhea, stomach trouble; kidney stones; abdominal pain |
| 29  | *Mikania cordata* (Burm.f.) B.L.Rob. C | Asteraceae   | Moti-moti    | USTH 01554 3 | 397      | Cough; ulcer, Sore eyes, Skin rashes and itchiness; cuts and wounds, snake and scorpion bites; circumcision antiseptic |
| 30  | *Pseudelephantopus spicatus* (Juss.) Rohr C | Asteraceae   | Kukog banog | USTH 01556 4 | 500      | Urination difficulty, kidney problem, urinary bladder swelling, delayed menstruation, urinary tract infection; fever, weakness and fatigue, cramp and spasm |
| 31  | *Diplazium esculentum* (Retz.) Sw.   | Athyriaceae  | Pako-pako    | USTH 01554 5 | 212      | Sore eyes; eczema, skin rashes and itchiness; cuts and wounds, sprain, snake bite, Cold; cough; diabetes, dysentery; labor and delivery enhancer, postpartum care and recovery; body ache, headache, fever |
| 32  | *Begonia contracta* Warb.            | Begoniaceae  | Budag-budag  | USTH 01565 4 | 85       | Pimple, dandruff; burns, Ascariasis, amoebiasis; cancer; diabetes; hypertension; stomach acidity, constipation |
| No. | Species                        | Family         | Common Names                | Code   | Quantity | Medical Uses                                                                 |
|-----|-------------------------------|----------------|----------------------------|--------|----------|------------------------------------------------------------------------------|
| 36  | *Abroma augusta* (L.) L.f.    | Byttneriaceae  | Samboligaw            | USTH 01563 | 329      | Headache, fever, weakness and fatigue                                       |
|     |                               |                |                           | 7      | 8        | Cancer; swellings                                                            |
| 37  | *Kleinhovia hospita* L.       | Byttneriaceae  | Bitan-ag               | USTH 01563 | 146      | Diabetes, tonic; bronchitis; stomachache; dysmenorrhea, irregular menstruation; sterility Scabies; boils, skin eruptions, dermatitis; cuts and wounds |
|     |                               |                |                           | 1      | 6        | Tumor; asthma, cough, pneumonia; dyspepsia, liver problem; headache; baby teething Scabies; psoriasis |
| 38  | *Melochia umbellata* (Houtt.)| Byttneriaceae  | Banitlong               | USTH 01564 | 265      | Rheumatism; backache, body ache, headache                                   |
|     | Stapf                         |                |                           | 9      | 4        | Canker sore; burns                                                           |
| 39  | *Hippobroma longiflora* (L.) | Campanulaceae  | Elepanteng puti         | USTH 01558 | 213      | Toothache                                                                    |
|     | G.Don                         |                |                           | 3      | 5        | Nervous breakdown; asthma, bronchitis; fever                                |
| 40  | *Carica papaya* L. C.         | Caricaceae     | Kapayas laki            | USTH 01566 | 659      | Cuts and wounds                                                              |
|     |                               |                |                           | 8      | 6        | Constipation, dyspepsia; milk production enhancer                            |
|     |                               |                |                           |        |          | Tonic; asthma; stomach problem                                              |
|     |                               |                |                           |        |          | Dengue fever                                                                 |
|     |                               |                |                           |        |          | Body ache, fever, cramp                                                       |
| No. | Species                                      | Family       | Location      | Code  | Count | Common Uses                                                                 |
|-----|---------------------------------------------|--------------|---------------|-------|-------|-----------------------------------------------------------------------------|
| 41  | *Hellenia speciosa* (J.Koenig) Govaerts     | Costaceae    | Tambabasi or Tawasi | USTH 01557 8 | 744 8 | Diabetes, goiter; migraine; ear congestion; cough, lung nodule; urination difficulty, kidney problem; headache, fever Diarrhea, stomachache, dysentery | Sore eyes |
| 42  | *Kalanchoe pinnata* (Lam.) Pers. C          | Crassulaceae | Hanlilika     | USTH 01558 4 | 486 12 | Diabetes; anemia, hypertension; asthma; cough; constipation, diarrhea, stomach trouble, hemorrhoids; kidney stone; labor and delivery enhance fever Herpes simplex; hemorrhoids; boils, eczema swellings; burns, cuts and wounds, bruises and contusions, insect bites Abdominal pain, body ache headache, fever |
| 43  | *Rhynchospora colorata* (L.) H.Pfeiff.      | Cyperaceae   | Busikad       | USTH 01557 1 | 254 6 | Chicken pox, measles; cancer; cough; stomach acidity; fever, relapse, gas pain and flatulence; sprain Baby teething |
| 44  | *Stenomeris borneensis* Oliv.               | Dioscoreaceae| Banag         | USTH 01553 7 | 540 6 | Myoma; migraine; arthritis, rheumatism; postpartum care and recovery; urinatio difficulty, urinary bladder swelling; headache, cramp and spasm, relapse Colds, dengue fever; asthma; diarrhea, vomiting fever |
| 45  | *Euphorbia hirta* L. C                      | Euphorbiaceae| Tawa-tawa     | USTH 01566 5 | 305 7  | Ringworm; sore eyes; boils, skin rashes and itchiness;                     |

*Note: USTH codes correspond to the National University of Science and Technology, Lae, Papua New Guinea.*
| 46 | *Jatropha curcas* L.<sup>c</sup> | Euphorbiacea | Tuba-tuba puti | USTH 01559 5 | 495 | 7 |
| 47 | *Jatropha gossypifolia* L. | Euphorbiacea | Tuba-tuba tapol | USTH 01558 6 | 810 | 9 |
| 48 | *Melanolepis multiglandulosa* (Reinw. ex Blume) Rchb. & Zoll. | Euphorbiacea | Awom | USTH 01562 1 | 485 | 5 |
| 49.1 | *Omalanthus macradenius* Pax & Hoffm. | Euphorbiacea | Banti puti | USTH 01563 3 | 202 | 3 |

Colds; pulmonary tuberculosis; diarrhea; arthritis, rheumatism; backache, body ache, fever, weakness and fatigue, cramp and spasm, relapse, gas pain and flatulence
Scabies, ringworm; ear infection, discharging ear; toothache; swollen muscles and swellings; cuts and wounds, fracture and dislocation, animal and insect bites

Colds, malaria, typhoid fever; pulmonary tuberculosis; diarrhea; arthritis, rheumatism; dysmenorrhea, irregular menstruation; backache, body ache, fever, weakness and fatigue, cramp and spasm, relapse, gas pain and flatulence
Ringworm; boils, carbuncle dermatitis; swollen muscle and swellings, muscle pain; backache, body ache, fever, cuts and wounds
Scabies, ringworm; ear infection, discharging ear; toothache, mouth sore; cut and wounds, fracture and dislocation, animal and insect bites

Beriberi; emphysema, cough; diarrhea, stomach trouble
Fibroma; body ache, weakness and fatigue
| No. | Common Name                        | Family       | Local Name          | Code   | Parts | Description                                                                                                                                                      |
|-----|-----------------------------------|--------------|---------------------|--------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 49.2| *Omalanthus macradenius* Pax & Hoffm. | Euphorbiaceae | Banti tapol         | USTH 01555 4 | 3     | Impetigo; diarrhea, stomach trouble; cuts and wounds                                                                                                           |
| 50  | *Bauhinia* sp.                     | Fabaceae     | Talimughat pikas    | USTH 01557 5 | 4     | Rheumatism, muscle pain; delayed menstruation; labor and delivery enhancer, postpartum care and recovery; backache, body ache, weakness and fatigue cramp and spasm, relapse |
| 51  | *Crotalaria incana* L.             | Fabaceae     | Sagay-sagay         | USTH 01559 8 | 2     | Diabetes; joint pain, swollen muscles and swellings, muscle pain                                                                                                    |
| 52  | *Gliricidia sepium* (Jacq.) Kunth ex Steud. | Fabaceae     | Madre de Cacao      | USTH 01562 0 | 6     | Scabies; boils, skin eruption pain; skin rashes and itchiness; cuts and wounds                                                                                   |
|     |                                   |              |                     |         |       | Eczema, dermatitis; arthritis and rheumatism; burns, cuts and wounds, bruises and contusions                                                                      |
|     |                                   |              |                     |         |       | Abortifacient, postpartum care and recovery                                                                                                                      |
| 53  | *Mimosa pudica* L. C              | Fabaceae     | Hibi-hibi or makahiya| USTH 01557 0 | 8     | Body ache, headache, fever fracture and dislocation, sprain                                                                                                      |
|     |                                   |              |                     |         |       | Diabetes; hypertension; dysentery, asthma; fever; urination difficulty Baby teething                                                                           |
|     |                                   |              |                     |         |       | Mumps; boils; child sleeplessness, malaise and fatigue                                                                                                           |
| 54  | *Ormosia macrodisca* Baker C      | Fabaceae     | Bahay               | USTH 01562 5 | 6     | Atherosclerosis (high cholesterol)                                                                                                                                    |
Typhoid fever; nervous breakdown; high cholesterol; kidney problem fever

Nervousness; skin numbness

| No. | Species                                      | Family     | Common Names                  | Code    | Quantity |
|-----|---------------------------------------------|------------|-------------------------------|---------|----------|
| 55.1| *Phanera semibifida* (Roxb.) Benth.         | Fabaceae   | Alibangbang puti              | USTH 01564 6 | 66       |
|     |                                             |            |                               |         | 1        |
|     |                                             |            | Internal bleeding, hemorrhage  |         |          |
| 55.2| *Phanera semibifida* (Roxb.) Benth.         | Fabaceae   | Alibangbang tapol             | USTH 01563 4 | 53       |
|     |                                             |            |                               |         | 1        |
|     |                                             |            | Internal bleeding, hemorrhage  |         |          |
| 56  | *Cratoxylum sumatranum* (Jack) Blume        | Hypericaceae| Bansilay                      | USTH 01554 1 | 96       |
|     |                                             |            |                               |         | 4        |
|     |                                             |            | Colds; cough; dysentery        |         |          |
|     |                                             |            | Toothache                      |         |          |
|     |                                             |            | Impetigo; cuts and wounds      |         |          |
| 57  | *Callicarpa pedunculata* R.Br.              | Lamiaceae  | Awoy                         | USTH 01566 1 | 378      |
|     |                                             |            |                               |         | 4        |
|     |                                             |            | Ulcer, pancreatitis, fatty liver; weakness and fatigue cramp and spasm | | |
|     |                                             |            | Asthma                         |         |          |
|     |                                             |            | Swollen muscles, muscle pain; backache, body ache | | |
| 58  | *Coleus amboinicus* Lour. c                 | Lamiaceae  | Kalabo                        | USTH 01561 7 | 380      |
|     |                                             |            |                               |         | 4        |
|     |                                             |            | Asthma, cough, cough with phlegm; dyspepsia; abdominal pain, gas pain and flatulence | | |
59.1  *Coleus scutellarioides* (L.) Benth.

Lamiaceae  |  Mayana kanapkap  |  USTH 01556  |  260  |  5  

Burns, bruises and contusions, insect bites

59.2  *Coleus scutellarioides* (L.) Benth. C

Lamiaceae  |  Mayana pula  |  USTH 01564  |  414  |  6  

Anemia; asthma, pneumonia, emphysema, cough, pulmonary tuberculosis; dyspepsia, ulcer; gas pain and flatulence

Conjunctivitis

60  *Gmelina arborea* Roxb. ex Sm.

Lamiaceae  |  Gmelina  |  USTH 01563  |  335  |  5  

Toothache, gum swelling

Discharging ear

61  *Hyptis capitata* Jacq. C

Lamiaceae  |  Sawan-sawan  |  USTH 01557  |  498  |  7  

Colds, malaria; cough; diarrhea, stomachache; new-born baby care; fever, gas pain and flatulence

Delayed menstruation

Toothache; cuts and wounds
| No. | Species                  | Family | Common Name | Code   | Quantity | Use(s)                                                                 |
|-----|--------------------------|--------|--------------|--------|----------|------------------------------------------------------------------------|
| 62  | *Mentha arvensis* L.     | Lamiaceae | Herba buena  | USTH 01566 9 | 174 7 | Measles; cough; diarrhea, dysentery; dysmenorrhea; headache, fever, cramp and spasm, gas pain and flatulence; Asthma; dizziness and fainting |
| 63  | *Mentha canadensis* L.   | Lamiaceae | Sencia       | USTH 01567 0 | 432 9 | Sinusitis, cough; stomachache, vomiting; delayed menstruation; backache, body ache, headache, fever, gas pain and flatulence; Ringworm; ear infection and congestion; toothache; Abdominal pain; muscle pain; cuts and wounds, dislocation, snake bite |
| 64  | *Ocimum basilicum* L.    | Lamiaceae | Sangig       | USTH 01563 0 | 385 9 | Cough, cough with phlegm; diarrhea, vomiting, constipation, hemorrhoids; delayed menstruation; postpartum care and recovery; headache, fever, gas pain and flatulence; Ear infection, congestion and discharge; Arthritis, rhematism; boils skin rashes and itchiness; cuts and wounds, bruises and contusions; Toothache; cuts and wounds, snake bites |
| No. | Species                                | Family      | Town       | District  | Plate No. | Page | Notes                                                                 |
|-----|----------------------------------------|-------------|------------|-----------|-----------|------|----------------------------------------------------------------------|
| 65  | Orthosiphon aristatus (Blume) Miq.  | Lamiaceae   | Wachichao  | USTH 01555| 513       | 6    | Diabetes; hypertension; diarrhea, stomachache; joint pain, gout, rheumatism; urination difficulty, kidney stones, kidney problem, urinary bladder swelling, prostate problem; labor and delivery enhancer |
| 66  | Premna odorata Blanco                  | Lamiaceae   | Abgaw      | USTH 01555| 668       | 7    | Colds; nasal congestion, sinusitis, cough, cough with phlegm; diarrhea, ulcer; rheumatism; postpartum care and recovery; weakness and fatigue, gas pain and flatulence Cuts and wounds |
| 67  | Teijsmanniodendron ahermanianum (Merr.) Bakh. | Lamiaceae   | Kulipapa   | USTH 01560| 128       | 3    | Beriberi; muscle pain; labor and delivery; backache, body ache, cramp and spasm |
| 68  | Vitex negundo L.                       | Lamiaceae   | Lagundi    | USTH 01556| 475       | 5    | Cough, cough with phlegm; ulcer; rheumatism; postpartum care and recovery; headache, gas pain and flatulence Amoebiasis; cancer; hypertension; cough; diarrhea, stomach trouble, ulcer, stomach acidity; kidney problem, urinary tract infection; weakness and fatigue, cramp and spasm |
| 69  | Cinnamomum mercadoi S.Vidal            | Lauraceae   | Kaningag   | USTH 01558| 908       | 8    | Cuts and wounds                                                                 |
| 70  | Litsea cordata (Jack) Hook.f.          | Lauraceae   | Loktob     | USTH 01558| 307       | 7    | Mumps; cyst, tumor, myoma; goiter; asthma, pneumonia, emphysema, cough; ulcer; arthritis; kidney problem, dysmenorrhea       |
| No. | Species Name                                      | Family           | Common Name   | Code          | QTY | Notes                                                                 |
|-----|--------------------------------------------------|------------------|---------------|---------------|-----|----------------------------------------------------------------------|
| 71  | *Machilus philippinensis* Merr.                  | Lauraceae        | Efficascent   | USTH 01557    | 82  | Cough; weakness and fatigue                                         |
| 72  | *Lagerstroemia speciosa* (L.) Pers. C            | Lythraceae       | Banaba        | USTH 01559    | 384 | Ulcer; urination difficulty, kidney stones, high uric acid and creatinine; maternal care; backache, body ache, fever |
| 73  | *Gossypium hirsutum* L.                         | Malvaceae        | Gapas         | USTH 01555    | 283 | Hemorrhage; postpartum care and recovery; body ache, fever, body chills |
| 74  | *Sida rhombifolia* L.                           | Malvaceae        | Eskuba laki   | USTH 01560    | 768 | Cough; stomach trouble; kidney stone, kidney problem, prostate problem, irregular menstruation Chicken pox, herpes simplex, scabies; boils; swellings; backache, body ache, headache; cuts and wounds |
| 75  | *Urena lobata* L. C                             | Malvaceae        | Dupang bae    | USTH 01566    | 482 | Fever                                                                |
| 76  | *Angiopteris evecta* Sw.                        | Marattiaceae     | Amampang      | USTH 01565    | 126 | Stomach trouble; arthritis, rheumatism; labor and delivery, postpartum care and recovery; fever; cuts and wounds, fracture and dislocation, bruises and contusion, sprain, animal bites Diabetes; sore throat; toothache; abdominal pain |
| 77  | *Medinilla teysmannii* Miq.                     | Melastomataceae  | Tampion       | USTH 01558    | 282 | Muscle pain; postpartum care and recovery; backache, body ache, weakness and fatigue, cramp and spasm Swollen muscles and swellings, muscle pain; gas pain and flatulence; sprain |
| No. | Scientific Name                                      | Family     | Common Name | Code   | Quantity | Uses                                                                                           |
|-----|-----------------------------------------------------|------------|-------------|--------|----------|------------------------------------------------------------------------------------------------|
| 78  | *Melastoma malabathricum* L.                        | Melastomataceae | Hantutuknaw puti | USTH 01558 8 | 274      | 3                                                                                                     |
|     |                                                     |            |             |        |          | Diarrhea, dysentry, stomachache, hemorrhoids headache, fever Toothache; cuts and wounds            |
| 79  | *Lansium domesticum* Correa                        | Meliaceae  | Lansones    | USTH 01556 5 | 103      | 4                                                                                                     |
|     |                                                     |            |             |        |          | Malaria; diarrhea, dysentery, dyspepsia; fever gas pain and flatulence Insect bites                 |
| 80  | *Sandoricum koetjape* (Burm.f.) Merr.               | Meliaceae  | Santol      | USTH 01562 4 | 464      | 7                                                                                                     |
|     |                                                     |            |             |        |          | Tonic; hypertension; diarrhea, dysentery; postpartum care and recovery; abdominal pain, fever       |
|     |                                                     |            |             |        |          | Toothache                                                                                           |
|     |                                                     |            |             |        |          | Boils, skin rashes and itchiness, dermatitis                                                     |
|     |                                                     |            |             |        |          | Ringworm                                                                                           |
| 81  | *Swietenia mahagoni* (L.) Jacq.                     | Meliaceae  | Mahogany    | USTH 01567 1 | 334      | 8                                                                                                     |
|     |                                                     |            |             |        |          | Dysmenorrhea, delayed menstruation; abortifacient abdominal pain                                  |
|     |                                                     |            |             |        |          | Amoebiasis, malaria; cancer, tonic; hypertension cough; diarrhea; miscarriage; fever Jaundice; tumor, myoma; diabetes, tonic; respiratory disease complex; diarrhea, dysentery, dyspepsia, ulcer appetite enhancer; dysmenorrhea, delayed menstruation; abortifacient fever Scabies; boils, skin rashes |
| No. | Species                          | Family     | Habit   | Code    | Code    | Quantity | Number of Uses | Uses                                                                 |
|-----|---------------------------------|------------|---------|---------|---------|-----------|----------------|----------------------------------------------------------------------|
| 83  | *Tinospora crispa* (L.) Hook. f. & Thomson | Menispermacaeae | Panyawan | USTH 01556 6 | 782     | 9         | Malaria; tonic; diarrhea, stomach trouble, vomiting, ulcer, toothache; arthritis, rheumatism; dysmenorrhea; abortifacient; abdominal pain, backache, body ache, fever Scabies; sore eyes; cuts and wounds Arthritis, rheumatism; abortifacient; abdominal pain, body ache; gas pain and flatulence |
| 84  | *Ficus botryocarpa* Miq.         | Moraceae   | Kabiya  | USTH 01567 2 | 53      | 1         | Headache, fever |
| 85  | *Ficus cassidyana* Elmer         | Moraceae   | Tobog tapol | USTH 01555 1 | 492     | 8         | Colds; diabetes; hypertension; asthma, cough, respiratory disease complex; diarrhea, stomachache; urinary tract infection; postpartum recovery, maternal care, milk production enhancer; weakness and fatigue, relapse Diabetes; hypertension Body ache, headache, fever |
| 86  | *Ficus concinna* (Miq.) Miq.     | Moraceae   | Balete  | USTH 01555 2 | 608     | 4         | Prostate cancer, cyst, tumor; arthritis, rheumatism; kidney problem, prostate problem |

Cuts and wounds
| No. | Species                          | Family   | Common Name  | Code    | Quantity | Uses                                                                 |
|-----|---------------------------------|----------|--------------|---------|----------|----------------------------------------------------------------------|
| 87  | *Ficus fistulosa* Reinw. ex Blume | Moraceae | Tobog puti   | USTH 01556 | 480      | Fracture and dislocation, sprain                                     |
|     |                                 |          |              | 1       |           | Colds; diabetes; hypertension; asthma, cough, respiratory disease complex; diarrhea, stomachache; urinary tract infection; postpartum recovery, maternal care, milk production enhancer; weakness and fatigue, relapse Diabetes; hypertension |
| 88  | *Ficus pseudopalma* Blanco       | Moraceae | Lobi-lobi    | USTH 01563 | 331      | Body ache, headache, fever                                             |
|     |                                 |          |              | 6       |           | Diabetes; hypertension, atherosclerosis, hemorrhage; diarrhea, stomach trouble, dyspepsia; kidney stones; muscle pain postpartum care and recovery; cramp and spasm Stomach trouble; asthma, sinusitis; muscle pain; backache, body ache, headache, fever, weakness and fatigue |
| 89  | *Ficus septica* Burm.f.          | Moraceae | Lagnob       | USTH 01562 | 576      | Warts; cataract, eye problem                                          |
|     |                                 |          |              | 3       |           | Herpes simplex; boils                                                  |
| 90  | *Ficus sp.*                      | Moraceae | Tuwa-tuwa    | USTH 01564 | 71       | Pregnancy, impotence and sterility, postpartum care and recovery Colds; asthma, cough, pneumonia, lung nodule; muscle pain; cramp and spasm, relapse |
| 91  | *Morus alba* L.                 | Moraceae | Tahibo       | USTH 01554 | 277      |                                                                      |
| No. | Species                        | Family      | Common Name | Code | Unit | Uses                                                                 |
|-----|--------------------------------|-------------|-------------|------|------|----------------------------------------------------------------------|
| 92  | *Muntingia calabura* L.        | Muntingiaceae | Mansanitas  | USTH 01562 | 169 | Colds; diarrhea, stomachache, vomiting, ulcer; prostate problem; abdominal pain, headache |
| 93  | *Myristica agusanensis* Elmer | Myristicaceae | Duguang kahoy | USTH 01561 | 194 | Measles; respiratory disease complex                                   |
| 94  | *Psidium guajava* L. c         | Myrtaceae    | Bayabas      | USTH 01566 | 275 | Diarrhea, ulcer                                                        |
|     |                                |             |             |      |      | Constipation                                                           |
| 95  | *Pandanus amaryllifolius* Roxb. c | Pandanaceae | Pandantsina  | USTH 01555 | 197 | Heart enlargement, high cholesterol; urination difficulty, kidney stone, kidney problem, urinary bladder swelling, prostate problem |
| 96  | *Phyllanthus amarus* Schumach. & Thonn. | Phyllantaceae | Talikod or Likod-likod | USTH 01559 | 459 | Jaundice, colds; tonic; coughs; stomach problem; kidney stone, kidney problem, urinary bladder swelling; new-born baby care; fever |
| 97  | *Piper aduncum* L.             | Piperaceae   | Lunas buyo   | USTH 01556 | 193 | Scabies, jaundice, ringworm; skin rashness an itchiness, dermatitis, eczema; cuts and wounds |
| 98  | *Piper decumanum* L.           | Piperaceae   | Lunas bagon tapol | USTH 01554 | 1018 | Typhoid fever; cancer, cyst tumor; pulmonary tuberculosis; diarrhea, stomach trouble, ulcer; gas |
| No. | Plant Name          | Family       | Common Name       | Code          | ID   | Quantity |
|-----|--------------------|--------------|-------------------|---------------|------|----------|
| 99  | *Piper nigrum* L. ³ | Piperaceae    | Lunas bagon puti  | USTH 01556    | 824  | 9        |
| 100 | *Piper sp.*        | Piperaceae    | Buyo Pilipog      | USTH 01559    | 296  | 3        |
| 101 | *Eleusine indica* (L.) Gaertn. ³ | Poaceae | Bilabila          | USTH 01556    | 481  | 11       |
| 102 | *Imperata cylindrica* (L.) | Poaceae | Kogon             | USTH 01560    | 107  | 4        |

Piperaceae

- *Piper nigrum* L. ³
  - Pain and flatulence; poisoning
  - Tonsillitis; toothache, gum swelling, canker sore

- Scabies, warts, impetigo; boils, skin eruptions, skin rashes and itchiness, pimple, acne; arthritis, rheumatism, swellings, muscle pain; backache, body ache, gas pain and flatulence; allergy, burns, cuts and wounds, sprain, snake, dog and insect bites contacts with plants and animal parts; anesthetic Cancer, cyst, tumor; tonsillitis; diarrhea, stomac trouble, ulcer, toothache, gum swelling, mouth sore; gas pain and flatulence; poisoning

Poaceae

- *Piper sp.*
  - Asthma, cough; rheumatism; fracture and dislocation

- *Eleusine indica* (L.) Gaertn. ³
  - Measles; diabetes; internal bleeding; cough; diarrhea; arthritis; kidney problem; postpartum care and recovery; fever, cramp and spasm; fracture and dislocation

- *Imperata cylindrica* (L.)
  - Urination difficulty

- Ringworm; hair loss; cuts and wounds
| No. | Common Name                      | Family      | Scientific Name                  | Genus    | Species     | Number | City | Description                                                                 |
|-----|---------------------------------|-------------|----------------------------------|----------|-------------|--------|------|----------------------------------------------------------------------------|
| 103 | Paspalum conjugatum P.J.Bergius | Poeaceae    | Miligoy                          |          |             | 124    | USTH 01562 7 | Chicken pox, measles; diarrhea, toothache; fever, baby teething            |
|     |                                 |             |                                  |          |             |        |      | Diarrhea, dysentery                                                          |
|     |                                 |             |                                  |          |             |        |      | Hair loss; cuts and wounds                                                   |
| 104 | Rosa sp.                        | Rosaceae    | Rose                             |          |             | 83     | USTH 01562 8 | Colds; nasal congestion, sinusitis                                          |
|     |                                 |             |                                  |          |             |        |      | Cuts and wounds                                                              |
| 105 | Mussaenda philippica A.Rich.    | Rubiaceae   | Buyon                            |          |             | 123    | USTH 01555 6 | Jaundice, colds; stomachache, dysentery; fever; snake bite                 |
|     |                                 |             |                                  |          |             |        |      | Cough, asthma                                                                |
| 106 | Uncaria lanosa Wall.            | Rubiaceae   | Kawilan                          |          |             | 94     | USTH 01555 7 | Stomach trouble                                                             |
|     |                                 |             |                                  |          |             |        |      | Diarrhea                                                                    |
| 107 | Melicope latifolia (DC.) T.G.Hartley | Rutaceae | Bagaynga                         |          |             | 43     | USTH 01554 0 | Cough                                                                        |
| 108 | Melicope triphylla (Lam.) Merr. | Rutaceae    | Dahile                           |          |             | 86     | USTH 01566 0 | Pulmonary tuberculosis, cough                                               |
|     |                                 |             |                                  |          |             |        |      | Snake bite                                                                  |
| 109 | Micromelum minutum (G.Forst.) Wight & Arn. | Rutaceae | Lunas kahoy                       |          |             | 955    | USTH 01553 8 | Cancer, cyst; diarrhea, stomach trouble, ulcer; poisoning                |

58
| No. | Plant Name                  | Family      | Common Name   | Code      | Quantity | Description                                                                 |
|-----|----------------------------|-------------|---------------|-----------|----------|-----------------------------------------------------------------------------|
| 110 | Capsicum annuum L.          | Solanaceae  | Sili na bisaya| USTH 01562| 151 6   | Tonsillitis; toothache, gum swelling, canker sore                           |
|     |                            |             |               |           |          | Scabies, warts, impetigo; boils, skin eruptions, skin rashes and itchiness,|
|     |                            |             |               |           |          | pimple, acne; joint pain, rheumatism, swellings, muscle pain; backache,    |
|     |                            |             |               |           |          | body ache, gas pain and flatulence; allergy, burns, cuts and wounds; snake,|
|     |                            |             |               |           |          | dog and insect bites; contacts with plants and animal parts; anesthetic     |
| 111 | Grewia laevigata Vahl       | Sparmanniac| Talimughat lingin | USTH 01554| 474 5   | White spot, athlete's foot; appetite enhancer; boils, skin rashes and itchiness,|
|     |                            | eae         |               |           |          | psoriasis, dandruff; insect bites                                            |
|     |                            |             |               |           |          | Diabetes; hypertension, heart enlargement; rheumatism; labor and delivery enhancer,|
|     |                            |             |               |           |          | postpartum care and recovery; backache, body ache, fever, weakness and fatigue,|
|     |                            |             |               |           |          | relapse                                                                     |
|     |                            |             |               |           |          | Muscle pain; labor and delivery enhancer, postpartum care and recovery; backache, body ache, fever, cramp and spasm; relapse |
| 112 | Crotalaria incana L.        | Fabaceae    | Alingatong    | USTH 01557| 84 5     | Myoma; hormonal imbalance; cough; constipation; fever, weakness and fatigue,|
|     |                            |             |               |           |          | relapse                                                                     |
| 113 | Leucosyke capitellata Wedd. | Urticaceae  | Anagasi       | USTH 01554| 28 1     | Stomach trouble and vomiting                                                |
| 114 | Oreocnide                  | Urticaceae  | Kubi or       | USTH 151  | 151 3    | Cough; diarrhea, stomach                                                    |
| No. | Scientific Name                          | Family       | Common Name | Code | Quantity | Description                                                                 |
|-----|-----------------------------------------|--------------|-------------|------|----------|----------------------------------------------------------------------------|
| 115 | *rubescens* (Blume) Miq.                | Urticaceae   | Salin-ubod  | 01567| 6        | Depression; anxiety; nervousness; stomach acidity; backache, body ache, headache, fever, weakness and fatigue |
|     | *Pipturus arborescens* (Link) C.B.Rob.  |              | Handamay    | USTH | 540      | Boils; bruise; sprain; Herpes simplex, scabies; skin rashes and infection; cuts and wounds |
|     |                                         |              | USTH        | 01567| 3        |                                                                 |
| 116 | *Poikilospermum acuminatum* (Trec ul.) Merr. | Urticaceae   | Hanupi      | USTH | 243      | Sore eyes; ulcer; postpartum care and recovery; fever |
|     |                                         |              | USTH        | 01565| 6        |                                                                 |
|     |                                         |              |             | 01565| 5        | Sore eyes; ulcer; postpartum care and recovery; fever |
| 117 | *Stachytarpheta jamaicensis* (L.) Vahl  | Verbenaceae  | Elepanteng lingganag | USTH | 396      | Ascariasis; abortifacient; fever |
|     |                                         |              | USTH        | 01559| 5        |                                                                 |
|     |                                         |              |             | 01559| 4        | Ascariasis; abortifacient; fever |
| 118 | *Dianella ensifolia* (L.) DC.           | Xanthorrhoeaceae | Ikug-ikug | USTH | 164      | Maternal care; postpartum care and recovery, milk production enhancer |
|     |                                         |              |             | 01565| 4        | Cuts and wounds; Herpes simplex |
|     |                                         |              |             | 01565| 6        | Maternal care; postpartum care and recovery, milk production enhancer |
| 119 | *Curcuma longa* L. C.                   | Zingerberaceae | Duwaw yellow | USTH | 248      | Diabetes; cough; arthritis, rheumatism; delayed |
|     |                                         |              |             | 01567| 6        |                                                                 |


| No. | Species                                      | Family          | Local Name  | Code     | Use                          |
|-----|---------------------------------------------|-----------------|-------------|----------|------------------------------|
| 120 | Curcuma zedoaria (Christm.) Rosc.           | Zingerberaceae  | Duwaw violet| USTH 01564 | Cough; fever                 |
| 121 | Alpinia haenkei C.Presl                    | Zingiberaceae   | Yanguas     | USTH 01564 | Cough; stomachache; urination difficulty, urinary tract infection |
| 122 | Kaempferia galanga L.                       | Zingiberaceae   | Kisol       | USTH 01557 | Colds; tonic; cough, sore throat; dyspepsia, toothache; postpartum care and recovery; headache, fever |

- Bk, barks; Br, branch; Fl, flowers; Fr, fruits; Lf, leaves; Rt, roots; Rz, rhizomes; Sd, seeds; Sh, shoots; St, stems; Wh, whole plant.
- I, internal; E, external.
- FL=100%

**Figures**
Study sites (pinned in yellow) in the province of Agusan del Sur: the only city (Bayugan City), and the two selected municipalities (Esperanza and Sibagat).
Figure 2

Plant parts used by the Agusan Manobo for medicinal application. Bk, barks; Br, branches; Fl, flowers; Fr, fruits; Lf, leaves; Rt, roots; Rz, rhizomes; Sd, seeds; Sh, shoots; Sp, sap or latex; St, stems; Wh, whole plant.
Figure 3

Mode of preparation of medicinal plants used by the Agusan Manobo. Bn, burning; Br, brewing; Dc, decoction; Di, directly applying or eating; Ex, extracting; Ht, heating or warming; In, infusion; Pd, pounding, crushing, rubbing, grinding, powderizing; Po, poultice; Sm, steaming; Ti, tincture; Ws, as wash, bath, hot compress.

Supplementary Files

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8 Additional File 5 - Integrative molecular identification.docx
7 Additional File 4 - Parameters.docx
4 Additional File 1 - Census of Agusan Manobo population.docx
6 Additional file 3 - Table S3. Questionnaire .docx
