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Ethnopharmacological documentation and molecular authentication of medicinal plants used by the Manobo and Mamanwa tribes of Surigao del Sur, Philippines

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Abstract. *Ilagan VAD, Alejandro GJD, Paraguison DJB, Perolina SMW, Mendoza GR, Bolina AB, Raterta R, Vales MB, Suarez GJD, Blasco FA. 2022. Ethnopharmacological documentation and molecular authentication of medicinal plants used by the Manobo and Mamanwa tribes of Surigao del Sur, Philippines. Biodiversitas 23: 3185-3202.* Mindanao Island is renowned for its rich biodiversity and various ethnolinguistic groups with diverse histories and cultures. The Mamanwa and Manobo live in close proximity, resulting in merging beliefs and cultural practices. This study aims to assess the various medicinal plants using ethnopharmacological indices, determine their relationship to their users, and molecularly confirm unidentifiable plants used by the tribes. Ethnomedicinal data were gathered from 127 key informants representing both tribes through semi-structured interviews. Family Importance Value (FIV) and Use Value (UV) were quantified and revealed a total of 48 species utilized by both tribes belonging to 26 families and 42 genera. These plants are used in 32 diseases within 10 categories, and the most utilized family belongs to *Apocynaceae* (FIV= 20% for both tribes). Respiratory illness has the greatest contribution to the utilization of medicinal plants (ICF= 0.92, 42%). The most utilized plant part is the leaves and mainly prepared by decoction and administered orally. Integrative molecular confirmation led to the identification of the 5 morphologically unidentifiable plants to be *Elaeocarpus serratus* Benth., *Uncaria lanosa* Wall., *Aglaonema crispum* (J.R. Pitcher & Manda) Nicolson, *Canthium tetraphyllum* Baill., and *Timonous timon* (Spreng.) Merr..

Keywords: Ethnopharmacology, Manobo, Mamanwa, medicinal plants, molecular confirmation

INTRODUCTION

The use of medicinal plants for health and medicine has existed throughout human history, wherein it has been used by various cultures and ethnicities throughout the world (Petrovska 2012). In the Philippines, ethnomedicinal plant use has been well-established throughout its history. It has been advocated for healthcare and treatment of various ailments (Principe and Jose 2002; Mendoza 2009; Joven 2012). The Philippines has more than 14,000 species of plants, of which 1,500 medicinal plant species are utilized by traditional herbalists (Dela Cruz and Ramos 2006). Significant attention has been directed specifically at the Caraga region, wherein notable communities practice traditional medicine in the treatment of various diseases. Numerous residents and indigenous tribes in parts of Agusan del Norte and Surigao del Norte (Nuneza et al. 2021), Agusan del Sur (Dapar et al. 2020c; Paraguison et al. 2020) and Surigao del Sur (Blasco et al. 2014; Montero et al. 2021) possess traditional knowledge on plant-based remedies and ethnomedicinal practices. The ethnomedicinal practices of these tribes offer insight into potential sources of medicinal plant species and novel phytopharmacological compounds.

In the context of ethnopharmacology, medicinal plants are an indispensable source for the development of new potential drugs. Approximately 25% of modern pharmaceutical drugs globally are derived from natural products (Newman and Cragg 2012). They contain secondary metabolites for pathogen defense (Chalo et al. 2017). In the Philippines, 200 medicinal plant species have been evaluated for their phytochemical potential as a source of pharmaceutical drug products (Eusebio and Umali 2004). The presence of natural products from plant extracts or isolated pure compounds would also provide extensive opportunities for new drug discoveries due to the unmatched availability of chemical diversity (Sasidharan et al. 2011). However, it has been estimated that of the 300,000 plant species that exist in the world, only a small fraction (15%) takes into account the identification and evaluation of pharmacological properties present in these plants (Palhares et al. 2015). For this reason, further research

on the evaluation and characterization of phytochemical compounds has been encouraged (De Luca et al. 2012).

Studies in the Philippines have incorporated both plant assessment and ethnobotanical investigation to document indigenous medicinal plant knowledge against various categories of diseases (Cordero et al. 2020). The studies focused on indigenous groups present in Luzon (Balangcod and Balangcod 2011) and Visayas (Ong and Kim 2014; Cordero et al. 2020), yet Mindanao remained relatively lacking (Dapar et al. 2020c). Mindanao is the largest region of cultural diversity as it accounts for more than half (61%) of the Philippines' total indigenous population (NCIP 2013). Moreover, the documentation concerning these plants is limited, particularly in the province of Surigao del Sur. Corroboration about the use, medicinal knowledge, effectiveness, disease classification, and diversity of the medicinal plants used by these indigenous groups requires further elucidation. Ethnomedicinal research that utilizes comparative molecular approaches and plant species verification is also limited. The use of an integrative molecular approach provides a wider range of possibilities in medicinal plant species identification and differentiation (Dapar et al. 2020c). The epidemiological data of these regions have shown a wide range of diseases that are suited for the utilization of the different plants within the communities. In the Philippines, acute respiratory tract infection was the leading cause of morbidity across all regions and ischaemic heart disease is the leading cause of mortality (DOH 2018). In CARAGA region, these are the top two leading causes of morbidity and mortality. It was followed by urinary tract infections, dengue, influenza and diarrhea (DOH 2018).

Two notable indigenous groups that inhabit the Mindanao region are the Manobo and Mamanwa. The Manobo is considered the largest group of IPs in Mindanao as the tribe consists of about 750,000 individuals living in all ethnographical areas in the region (Reyes et al. 2017). The word Manobo is derived from the Malay word "mansuba" which means river people, pertaining to their inclination to settle near small bodies of water (Gosadan and Rayan 2018). Manobos are clustered according to certain dialects and cultures. Their livelihood depends on the cultivation of rice, corn, root crops, and is supplemented by hunting and food gathering (NCCA, 2015b). Over generations, the Manobo tribe has surpassed challenges, managed to retain their ancestral territory, and upheld their tradition, culture, and values (Petrola 2015). This culture suggests that traditional practices of medicine have been passed down for generations (Dapar et al. 2020a; Jamera et al. 2020).

The other indigenous group, the Mamanwa is considered to be one of the oldest and smallest surviving groups of IPs in the Philippines, with around 2,000 members (NCCA 2015a; Omoto 2016). The word Mamanwa is derived from "man" (first) and "banwa" (forest) which directly translates to first forest dwellers, referring to their nomadic nature (Balacuit et al. 2018). They are a mobile group that continuously relocates themselves in search of resources and livelihood. They rely on slash and burn cultivation on small patches, with heavy dependence on food gathering. Settlements of the tribe are small-scale with only 3-20 households on ridges and valleys (NCCA, 2015a). Their continuous relocation has led this tribe to have a difficult way of living, and they are considered the second poorest IPs in the Philippines (Burton 2003). Financial problems have led the tribe to use herbal medicine for their medicinal and health needs (Matapac 2019). Despite the upheavals, the fundamental beliefs, culture, and practices have survived and passed on to generations (Balacuit et al. 2018).

The Manobo and Mamanwa both exhibit a distinct identity in terms of their origin, lifestyle, culture, and ethnomedicinal plant use. Although the differences between these two indigenous groups, territorial and physical proximity has allowed them to co-exist. The frequent interactions between these two indigenous groups have resulted in intermarriages and bloodlines that further integrated their socio-political system, religious practices, and cultural beliefs (ICCA 2015). Their shared cultural heritage implies a rich repository of knowledge on ethnomedicinal plant use and folkloric medicinal practices in the treatment of various diseases (Dapar et al. 2020c; Nuneza et al. 2021).

Multiple ethnomedicinal studies have been inferring the most utilized medicinal plants of their studied sites via consensus. However, these consensuses are not usually supplemented with the proper statistical analysis and ethnopharmacological indices which makes the formulated inference not statistically reliable to represent the whole population. This study provides a more objective analysis of the tribes' usage of their respective medicinal plants and assesses the preservation of their tradition.

This study uses ethnopharmacological indices to assess the medicinal plant species used by the Mamanwa and Manobo tribes of Tago and Tandag City, Surigao del Sur. This study is a quantitative investigation that appraises the relationship between these medicinal plant species and their users, which were determined through statistical use values and quantification of different use categories of these plants. Furthermore, molecular confirmation was done on the selected plant samples that were not morphologically identified in order to provide proper authentication.

MATERIALS AND METHODS

Study area

The study was done in Tandag City and Tago, Surigao del Sur, Philippines (Figure 1). Tandag City is the capital of Surigao del Sur, with a land area of 291 km^2 encompassing 21 barangays, while Tago has a land area of 343.52 km^2 with 24 barangays. Tandag and Tago are coastal areas located in North Eastern Mindanao, both facing the Pacific Ocean. They are bound by adjacent municipalities of Cortes, Lanuza, San Miguel, Bayabas, Cagwait, and Marihatag. The distance of their location is approximately 450 nautical miles from Manila. To this day, the tribes of Mamanwa and Manobo are still present in this location and have their own medicinal practices to cure diseases (Blasco et al. 2014).

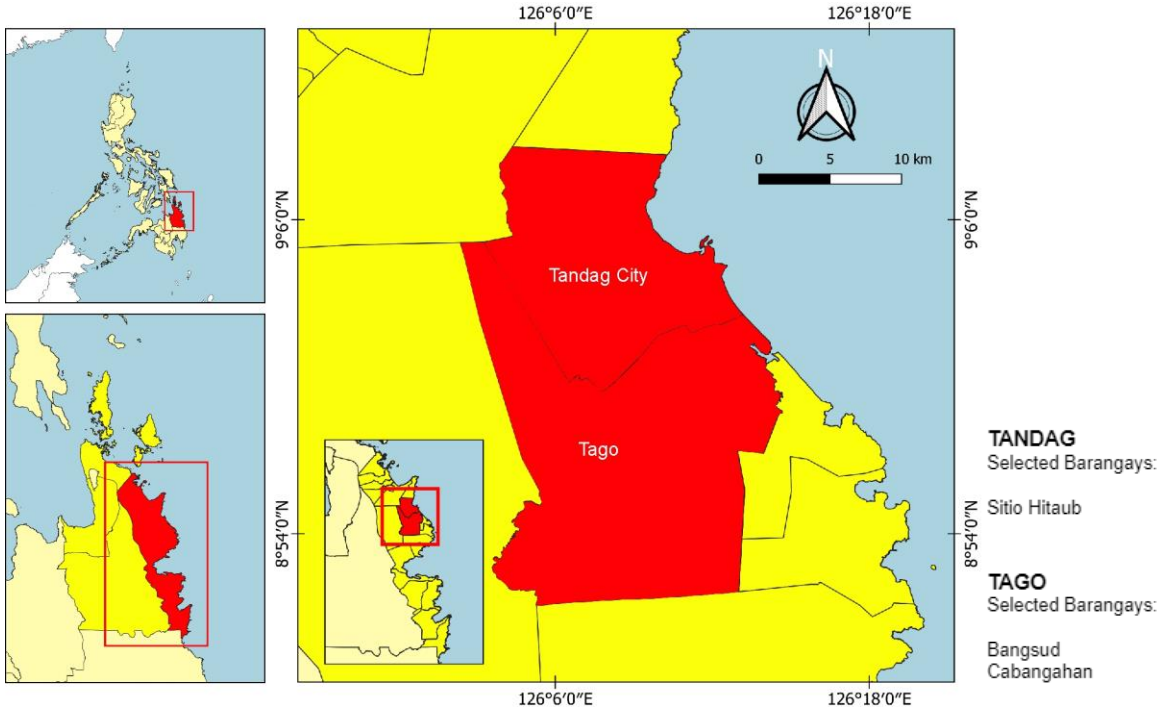


Figure 1. Study sites: Tandag City (09°4 N 126°11 E) and Tago (08°58 N 126°09 E) at Surigao del Sur, Caraga Region, Mindanao, Philippines, and the selected barangays within each municipality

Semi-structured interview

The interview was conducted with the approval and permission of barangay captains of the selected barangays. The study was performed in coordination with the local government unit NCIP-LGU. The necessary permits and documents were acquired for the conduction of the study. The informed consent forms were also signed by the respondents of the three barangays prior to the interview. The researchers clearly established that the intention of the study was purely academic, and the welfare and rights of the tribes were respected. The distributed survey materials underwent ethical review procedures. Ethnopharmacological data were collected from the key informants of the tribes - local healers and tribespeople practicing their traditional medicine. The informants were selected based on their existing medicinal knowledge by pre-interview with the researchers. The semi-structured interview given to the selected participants was translated into Bisaya, a language that both tribes understand. The corresponding plants based on the structured interview were collected through a random sampling technique. The interview process and list of questions can be seen in Figures S1 and S2.

Sampling technique

The Cochran sampling formula was used to calculate the appropriate number of participants needed. A total of 127 (21.2%) participants were selected from the studied tribes (90% confidence level, E=6.5%). This confidence level ensures that the formulated results are dependable (Adam 2020). Population data from PSA - Surigao, showed that the selected barangays of Tago, namely Bangsud and Cabangahan, have a total population of 112 and 146, respectively. In contrast, Sitio Hitaub garnered a total population of 340. The division of the sampling was relative garnering 61 respondents from the Mamanwa and 66 from the Manobo. The respondents for the Manobo were divided equally among the selected barangays.

Plant collection and identification

The procurement of plant specimens was done through guided field walks under the supervision of local herbalists. The morphology, habitat, usage, vernacular terms, and names of these plants were documented. Samples of leaves were stored in zip-locked bags with silica gel (Chase and Hills 1991) prior to molecular analysis. Voucher and herbarium specimens, with flowers and fruits were preserved using 50% ethanol prior to comprehensive morphological analysis. Presumptive identification using vernacular names was made to compare the already documented local names using the reference Dictionary of Philippine Plant Names (Madulid 2001). The identification process was assisted by a representative of the National Museum of the Philippines. Molecular confirmation was done on selected specimens that were morphologically unidentifiable. Several references were used for verification and checking of the family classification, spelling, and synonyms of the scientific names. These included Tropicos (Tropicos 2021), The Plant List (The Plant List 2021), The International Plant Names Index (IPNI 2021), and World Flora Online (WFO 2021). Further verification of species identification, occurrence, and distribution was conducted using Co's Digital Flora of the Philippines (Pelser et al. 2019) and Global Biodiversity Information Facility (GBIF 2021).

Ethnopharmacological indices

Use value

Use Value (Phillips and Gentry 1993) determined the importance of a particular species in a given population. This was calculated using the formula: UV= (ΣUi/N), where Ui is the number of UR or citations of a particular species and N is the total number of informants (Bussman et al. 2016). UV did not indicate the usage of plants for single or multiple purposes; however, it described the plant use reports relative to their importance in a particular community.

Fidelity level

Fidelity level (Friedman et al. 1986) shows the degree of agreement on the effectiveness of a particular plant species in each disease category. This uses the formula: FL(%)= (Ip/Iu) x 100, where Ip is the number of informants who solely suggested that a particular species is used for a specific disease, and Iu is the total number of informants who mentioned the plant. A high FL value (closer to 1) indicates that a plant is used mostly for the same purpose. On the other hand, a low FL value (closer to 0) indicates that a plant has a variety of uses (Ong and Kim 2014).

Informant consensus factor

Informant Consensus Factor (Hassan et al. 2017) determined the general agreement of the informants based on their existing knowledge of plants in each disease category. This was calculated using the formula: ICF = (Nur – Nt)/ (Nur-1), where Nur is the number of UR in each disease category, and Nt is the total number of plant species used for a particular disease category (Abe and Ohtani 2013; Ong and Kim 2014).

Family importance value

A modified Family Importance Value was used to determine the importance of various families of different medicinal plant species (Ali et al. 2018). This was computed using the formula; FIV= (FC/URt) x 100, where FC is the frequency of citation of the plant family, and URt is the number of use reports per tribe. The informants only provided specific plant species, which were classified to their families accordingly based on the existing classification from Genbank. Two rankings - one for each tribe, were generated from this analysis. FIV ranges from 0-100 and families having values closer to 100 were considered more acknowledged.

Jaccard's index

Jaccard's Index (Kurek et al. 2016) evaluated the similarity of the medicinal plant species within the two areas. It was computed using the formula: J = C/(A+B), where A and B are the number of species living in habitats A and B respectively, and C is the number of species found in both areas.

International classification of diseases

International Classification of Diseases (ICD-11) is the eleventh revision and up-to-date version of the International Classification of Diseases. This tool allowed the systematic organization, classification, analysis, and comparison of mortality and morbidity data across different countries around the world at varying times (WHO 2021). This served as the reference guide in categorizing the different diseases within the community.

DNA extraction, amplification, and sequencing

DNA extraction and amplification were done at the Research Center for the Natural and Applied Sciences (RCNAS), University of Santo Tomas, and based on the procedures of Gupta (2020). The silica-gel dried leaf samples were subjected to DNA extraction following the protocols of DNeasy Plant Minikit. Molecular markers *trnL-F* and *trnH-psbA* of the cpDNA were used in this study. Markers were amplified using PCR Master Mix Kit. The corresponding sequence and PCR protocol for each marker are seen in Table 1. The Biometric T-gradient thermal cycler served as the reference for the necessary parameters, including the primer information and PCR conditions needed for DNA amplification. Inspection and confirmation for the presence and integrity of DNA in the amplicons were checked using agarose gel electrophoresis, run for 30-45 minutes, and calibrated at 80 volts. QIA-quick Purification Kit was used for the purification of the products after amplification. Purified samples were forwarded to Macrogen Inc., South Korea for sequencing.

Table 1. Gene regions, primers, and amplification protocols used for PCR

Gene region	Primer gene	Reference	Primer sequence	PCR protocol
psbA-trnH	*psbA-F* *trnH-R*	Rashmi et al. (2016)	5'GTTATGCATGAACGTAATGCTC-3' 5'CGCGCATGGTGGATTCACAATCC-3'	**Denaturation**: initial at 97 °C for 2 min; followed by 35 cycles of 97 °C for 25 s; **Annealing**: 55 °C for 1 min; extension at 72 °C for 2 min; final extension at 72 °C for 7 min.
trnL-F	c f	Kress et al. (2005)	5'CGAAATCGGTAGACGCTACG-3' 5'ATTTGAACTGGTGACACGAG-3'	**Denaturation**: initial at 94 °C for 1 min, followed by 28 cycles of 93 °C for 1 min; **Annealing**: 55 °C for 1 min, extension at 72 °C for 3 min; final extension at 72 °C for 6 min.

RESULTS AND DISCUSSION

Medicinal plant characteristics and use

A total of 48 medicinal plant species were collected within 26 families and 42 genera summarized in Table 2. These plants are used in 32 diseases within 10 categories. Most of the plants are shrubs (35%), followed by trees (33%), herbs (23%), and vines (9%). Families with the highest medicinal plants collected came from Rubiaceae with 7 species, followed by Moraceae (4), then Apocynaceae, Malvaceae, and Zingiberaceae (3). The plants are mainly cultivated around the house (67%), or gathered in the wild near houses (20%), forests (10%), sought in neighboring barangays (2%), or bought in markets (1%). In treating diseases, the Manobo mainly relies upon using medicinal plants (78%), then seeking help from professionals (18%), and *albularyo* (10%). On the other hand, the Mamanwans also mainly rely on medicinal plants (80%), *albularyo* (17%), then doctors (3%).

Use Value (UV)

The highest UV used by both tribes are *Callicarpa longifolia* Lam. (0.57), *Canthium tetraphyllum* Baill. (0.49), and *Tabernaemontana pandacaqui* Lam. (0.41), shown in Table 2. These plants are the most used medicinal plants by both tribes and are generally cultivated around their houses. *C. longifolia* is used for Diseases of the respiratory system, cough and cold. *C. tetraphyllum* is used for general and respiratory symptoms such as fever, cough, and cold. *T. pandacaqui* is used in diseases of the digestive system and general signs and symptoms. The highest UV of plants used only in tribe Manobo is *Mikania cordata* (Burm.fil.) B.L.Rob. (0.21), while *Glochidion rubrum* Blume (0.25) in tribe Mamanwa. *M. cordata* is used by the Manobo in treating 4 disease categories. Its leaves are infused in water, and dropped in the eyes to treat cataracts, gurgled to treat mouth ulcers, drank to treat cough, or directly applied or massaged on the wounded area. *G. rubrum* is used by the Mamanwa to treat sprains and sinusitis by massaging or rubbing a decoction of its bark to inflamed areas.

These mentioned high-ranking plants are common in the study sites and widely used by both tribes. Therefore, they should be conserved by the community for medicinal use for generations to come. Although most of the respondents (97%) reported that there are no side effects or contraindications, they should still be subjected to further studies for their efficacy.

Fidelity Level (FL)

FL shows the degree of agreement on the effectiveness of a medicinal plant species in a particular disease. A high value of FL indicates that the tribes are in agreement to use that specific medicinal plant for a specific disease. The interpretation for this index is based on the number of UR to show the margin of error. The groupings were based on the distribution of the corresponding results (SD = 17).

The first group (UR: 1-17) comprised 32 medicinal plants, 16 of which garnered a value of 100. From this, 14 garnered a UR less than or equal to 8. This indicates that even though these medicinal plants garnered a high magnitude of FL, it has poor reliability due to their low UR. Medicinal plants, namely; *Commersonia bartramia*, (L) Merr. and *Grewia multiflora* Juss., garnered an FL of 100 and were recognized by both tribes. This signifies that both tribes acknowledge the usage of the bark of *C. bartramia* for stomachache, and the soaked bark of *G. multiflora* for teething.

The FL of the second group (UR: 18-34) ranges from 32-100 and is composed of 9 medicinal plants. It was recorded that 3 of these, namely, *Eleocarpus serratus* Benth., *Clerodendrum lanuginosum* Blume, and *Greeniopsis euphlebia* Merr., garnered an FL of 100. This implies, with relatively appropriate dependability, that both tribes acknowledge the use of the saturated fruit of E. serratus and the infused roots of *C. lanuginosum* for cough, and the infused leaves of *G. euphlebia* for stomachache.

Only 7 medicinal plants garnered more than 34 UR, and only *Alpinia elegans* K.Schum., garnered an FL of 100 in this group. This manifests that both tribes agree, with relatively high reliability and accuracy, that decocted leaves of *A. elegans* are predominantly used for fever. For this group, a low FL does not imply a poor usage agreement of the medicinal plants but infers that these plants have versatile uses for medicinal purposes.

Informant Consensus Factor (ICF)

Table 3. shows the breakdown of the ICF values in each disease category. There are 32 diseases within 10 categories. Diseases of the respiratory system (0.92, 46%), General signs and symptoms (0.88, 44%), and Diseases of the skin (.87, 10%), are the top-scoring categories in both tribes.

The decocted leaves of *C. longifolia are* mainly used in treating *respiratory diseases* by oral absorption, as agreed upon by both the Manobos (0.92) and the Mamanwans (0.90). In treating general signs and symptoms, the Manobos (0.88) confirmed the oral absorption or direct compress of raw and *decocted bark and leaves of Tabernaemontana pandacaqui* Lam. for body pain and fever while the Mamanwans (0.86) used decocted leaves of A. elegans to treat fever. Lastly, in treating *diseases of the skin*, both the Mamanwans (0.8) and Manobos (0.89) apply the bark of *Lepionopsis ternatensis* Valeton. ternatensis on affected areas in treating cuts and wounds.

In categories: *Use for Pregnancy and Childbearing*, *Disease of Genitourinary*, and *Other Uses*, only tribe Mamanwa uses medicinal plants to treat these disease categories while there is no recorded value for tribe Mamanwa. Manobos use *Vernonia arborea* Buch.-Ham as a tonic for childbearing and difficulty in urination, *Dendrocnide venosa* (Elmer) Chew for birthing, *Aglaonema crispum* (J.R. Pitcher and Manda) Nicolson for UTI, *Piper celtidiforme* Opiz for dysmenorrhea, *Ryapsora cauliflora* Merr. for snakebites, *Mimosa pudica* L. and *Breynia vitis-idaea* (Burm.f.) C.E.C.Fisch. for inducing sleep. Most of the disease categories have a wide range of ICF values (0.67- 1.0), which means there is a varying level of agreement within the combined communities. Tribes Manobo and Mamanwa have overlapping medicinal plants used in certain categories, while there is exclusivity in some categories.

Table 2. Medicinal plants used; Aqueous steeping - S, Infusion - I, Decoction - D, Raw - R, Pounded - P, Juice - J, Tag. - Tagalog, Bis. - Bisaya, Eng. - English, Buk. - Bukidnon, Ilok. - Ilokano

Scientific name	Local name	Family	Used by tribe	Voucher number	Diseases	Parts used	Administration mode and form	UR	UV	FL
Cyathocalyx apoensis (Elmer) J. Sinclair	Bunganon (Bis.)	Annonaceae	Mamanwa	HNUL 0020874	Thinning	Flower & Roots	S - Applying/ Compress	5	0.08	100
Lepiniopsis ternatensis Valeton	Kuyon-kuyon (Bis.)	Apocynaceae	Both	USTH 016493	Wounds/cuts, itchiness	Bark	S - Applying/ Compress	32	0.25	56.25
Orophea enterocarpa Maingay ex Hook. f.	Lanutan (Tag.)	Annonaceae	Both	USTH 016470	Cough/ fever	Leaves	I, D - Oral absorption	50	0.39	68
Tabernaemontana pandacaqui Lam.	Banilad (Tag.)	Apocynaceae	Both	HNUL 0020875	Diarrhea/ body pain/ fever/ abdominal pain/ flatulence	Bark & leaves	R, D - Applying/ Compress, Poultice, Oral absorption	52	0.41	25
Allamanda cathartica L.	Buttercup (Eng.)	Apocynaceae	Both	USTH 016471	Diarrhea	Bark	D - Oral absorption	13	0.10	46.15
Ilex brunnea Merr.	Butuan-butuan (Bis.)	Acquifoliaceae	Both	HNUL 0020876	Cough/fever	Leaves	D - Oral absorption	20	0.16	60
Aglaonema crispum (J.R. Pitcher & Manda) Nicolson	Payaw-payaw (Bis.)	Araceae	Both	HNUL 0020877	Boils/ fever/ UTI/ cough/ toothache	Whole plant	R - Applying/ Compress	13	0.10	30.77
Vernonia arborea Buch.-Ham	Tagmalinaw (Bis.)	Asteraceae	Manobo	USTH 016496	Tonic for women giving birth, stomach ache, difficulty in urination	Leaves	R - Applying/ Compress, Rubbing/ Massaging	6	0.099	50
Mikania cordata (Burm.f.) B.L.Rob.	Muti-muti (Bis.)	Asteraceae	Manobo	HNUL 0020878	Cataract/ cough/ ulcer/ cuts/ itchiness	Leaves	I, D - Applying/ Compress, Rubbing/ Massaging, Oral absorption	14	0.21	28.57
Radermachera gigantea Miq.	Pedali (Bis.)	Bianoniaceae	Mamanwa	USTH 016491	Constipation	Leaves	D, S - Oral absorption	4	0.07	100
Tacca palmata Blume	Payong-payong (Tag.)	Dioscoreaceae	Both	USTH 016499	Stomachache/ fever/ cold/ cough	Rhizomes	D - Oral absorption	28	0.22	32.14
Dillenia philippinensis	Catmon (Eng.)	Diliniaceae	Both	HNUL 0020879	Cough/ cold	Fruit	D - Oral absorption	51	0.40	66.67
Mimosa pudica L.	Dugi (Bis.)	Fabaceae	Manobo	HNUL 0020880	Induces sleep/ cough/ rheumatism	Whole plant	D - Oral absorption	11	0.17	72.73
Elaeocarpus serratus Benth.	Batwan (Bis.)	Elaeocarpaceae	Both	USTH 016503	Cough	Fruit	S - Oral absorption	22	0.17	100
Glochidion rubrum Blume	Jaket-jaket (Eng.)	Euphorbiaceae	Mamanwa	13-933	Sinusitis/ sprain	Bark	D - Rubbing/ Massaging	15	0.25	66.67
Ryparosa cauliflora Merr.	Ampay (Bis.)	Phyllanthaceae	Manobo	HNUL 0020882	Snake bite	Bark	P - Applying/ Compress	4	0.06	67.12
Callicarpa longifolia Lam.	Awoy (Tag.)	Lamiaceae	Both	USTH 016490	Cough/ Cold	Leaves	D - Oral absorption	73	0.57	67.12
Clerodendrum lanuginosum Blume	Bubulanon (Bis.)	Lamiaceae	Both	HNUL 0020883	Cough	Roots	I - Oral absorption	23	0.18	100
Urena lobata L.	Dawpang (Bis.)	Malvaceae	Both	HNUL 0020884	Boils/ fever/ cuts	Flower	D - Rubbing/ Massaging	19	0.15	47.37
Donax canniformis Rolfe	Ban-ban (Bis.)	Maranthaceae	Manobo	HNUL 0020885	Conjunctivitis/ fever/ cough	Leaves	I - Oral absorption, Rubbing/ Massaging	8	0.12	100
Medinilla surigaoensis Regalado	Pagatpat (Tag.)	Melastomatac eae	Mamanwa	USTH 016473	Cough	Leaves	D - Oral absorption	7	0.11	100

Ficus linerifolia Elmer	Tabog (Bis.)	Moraceae	Manobo	HNUL 0020886	Warts/ headache/ fever	Bark	D, S - Rubbing/Massaging, Oral absorption	8	0.12	50
Ficus minahassae Miq.	Tam-isan (Bis.)	Moraceae	Manobo	HNUL 0020887	Fever/ headache	Roots	D - Oral absorption	5	0.08	60
Ficus septica Burm.	Tobog (Bis.)	Moraceae	Manobo	HNUL 0020888	Fever/ fatigue/ body ache	Roots	S - Rubbing/ Massaging	8	0.12	37.5
Ficus simplicissima Lour.	Bagon (Bis.)	Moraceae	Manobo	HNUL 0020889	Diarrhea	Roots	J, D - Oral absorption	8	0.12	100
Syzygium jambos (L.) Alston	Tambistambis (Tag.)	Myrtaceae	Manobo	HNUL 0020890	Fever/ asthma/ mouth ulcer/ sore throat	Fruit	D - Oral absorption	13	0.20	30.77
Ardisia squamulosa C. Presl	Butao (Ilok.)	Primulaceae	Both	USTH 016474	Diarrhea/ fever	Leaves	D - Oral absorption	5	0.04	60
Ludwigia hyssopifolia (G. Don) Exell.	Malapako (Bik.)	Onagraceae	Manobo	HNUL 0020891	Diarrhea	Whole plant	D - Oral absorption	12	0.18	100
Piper celtidiforme Opiz	Boyo-boyo (Tag.)	Piperraceae	Both	HNUL 0020892	Wounds/ cough/ fever/ abdominal pain/ dysmenorrhea	Leaves	C, G - Applying/ Compress, Oral absorption	19	0.15	31.58
Actephila excelsa (Dalzell) Müll.Arg.	Catmon (Eng.)	Phyllanthaceae	Manobo	HNUL 0020893	Cough/ fever	Fruit	R - Eat	6	0.09	66.67
Breynia vitis-idaea (Burm.f.) C.E.C.Fisch.	Salimpatuyog (Tag.)	Phyllanthaceae	Manobo	USTH 016497	Induce sleep	Leaves	D - Oral absorption	3	0.05	100
Canthium tetraphyllum Baill.	Kandiis (Tag.)	Rubiaceae	Both	USTH 016498	Fever/ cough/ cold	Leaves & bark	D - Oral absorption/ Applying compress	62	0.49	37.10
Greeniopsis euphlebia Merr.	Tabakon uwak (Bis.)	Rubiaceae	Both	USTH 016494	Stomachache	Leaves	I - Oral absorption	18	0.14	100
Ixora macrophylla Bartl. ex DC.	Santan daku (Tag.)	Rubiaceae	Mamanwa	USTH 016484	Cough	Fruit	S - Oral absorption	8	0.13	100
Psychotria diffusa Merr.	Ilab (Tag.)	Rubiaceae	Manobo	HNUL 0020894	Headache	Leaves	I - Applying/ Compress	3	0.05	100
Timonius timon (Spreng.) Merr.	Tawa-tawa (Tag.)	Rubiaceae	Mamanwa	USTH 016501	Cough/ fever	Leaves	D - Oral absorption	6	0.10	66.67
Uncaria cordata (Lour.) Merr.	Litib	Rubiaceae	Manobo	HNUL 0020901	Wounds	Leaves	D - Applying/ Compress	11	0.17	100
Uncaria lanosa Wall.	Kawilan (Buk.)	Rubiaceae	Manobo	HNUL 0020902	Cough/ nausea	Leaves	J, D - Oral absorption	5	0.08	60
Datura metel L.	Tagutong (Bis.)	Solanaceae	Both	USTH 016492	Asthma/ toothache	Flowers & seeds	S - Inhalation, Applying/ Compress	26	0.20	73.08
Commersonia bartramia (L) Merr.	Mamagan (Tag.)	Malvaceae	Both	HNUL 0020895	Stomachache	Bark	R - Oral absorption	6	0.05	100
Grewia multiflora Juss.	Sandong (Tag.)	Malvaceae	Both	HNUL 0020896	Teething	Bark	S - Oral absorption	5	0.04	100
Elatostema sublaxum Elmer	Hagupit (Tag.)	Urticaceae	Manobo	HNUL 0020897	Cough	Leaves	D, S - Oral absorption	4	0.06	100
Dendrocnide venosa (Elmer) Chew	Sagay (Bis.)	Urticaceae	Manobo	HNUL 0020898	Birth	Roots	D - Oral absorption	3	0.05	100
Leea philippinensis Merr.	Amamali (Bis.)	Vitaceae	Manobo	USTH 016479	Teething	Bark	R - Applying/ Compress	3	0.05	100
Leea guineensis G.Don	Amamali (Bis.)	Vitaceae	Manobo	HNUL 0020899	Body pain/ rheumatism	Bark	R, D - Rubbing/Massaging	3	0.05	66.67
Alpinia elegans K.Schum.	Tagbak (Tag.)	Zingiberaceae	Both	USTH 016485	Fever	Leaves	D - Rubbing/ Massaging	44	0.34	100
Alpinia haenkei C.Presl	Panoon (Tag.)	Zingiberaceae	Manobo	HNUL 0020900	Fever	Fruit	D, J - Oral absorption	5	0.08	100
Globba campsophylla K. Schum.	Luy-a luy-a (Tag.)	Zingiberaceae	Both	USTH 016472	Fever/ cough	Leaves	D, R - Oral absorption	38	0.30	63.16

Table 3. ICD Classification and ICF values

Disease category	Reported diseases	Plants used (%)	Informant Consensus Factor		
			Manobo	Mamanwa	Combined
Diseases of the skin	Thinning hair, Boils, Warts, itchiness, Cuts & Wounds	10.42	0.89	0.8	0.87
Diseases of the respiratory system	Cough, sinusitis, Asthma, Cold	45.83	0.92	0.90	0.92
Diseases of the digestive system	Diarrhea, Constipation, Stomachache, Nausea, Flatulence	22.92	0.85	0.83	0.86
General signs and symptoms	Fever, Abdominal pain, Body ache, Fatigue	43.75	0.88	0.86	0.88
Use for pregnancy and childbearing	Tonic for women giving birth, Birthing	4.17	0.86	0	0.86
Diseases of the visual system	Cataract, Conjunctivitis	4.17	0	1.0	0.5
Disease of genitourinary	UTI, Difficulty in urination, dysmenorrhea	6.25	0.67	0	0.67
Diseases or disorders of the orofacial complex	Toothache, Teething, Mouth ulcer	8.33	0.81	0.83	0.87
Musculoskeletal system and connective tissue problems	Sprain, Rheumatism	6.25	0.5	1.0	0.71
Other uses	Induces sleep, Snakebite	6.25	0.75	0	0.75

Plant parts used

Both tribes utilize all plant parts available for medical applications on various diseases (Figure 2). The most frequently used plant parts for both tribes are leaves (44%, Tago; 40%, Tandag), followed by barks (30% for both), roots (9%, Tago; 7% Tandag), then fruits (5%, Tago; 8% Tandag). Preparation and administration

Several preparation and administration techniques were utilized by both tribes (Figures 3-4). Both the Manobo and Mamanwa use decoction (60%, Tago; 61% Tandag) as the main preparation method, followed by aqueous steeping (16%, Tago; 20%, Tandag). The succeeding techniques have observable variations. Infusion is more frequently (10%) used by the Manobo than raw (5%). In contrast, Mamanwa uses raw (8%) preparation more frequently than infusion (5%).

Jaccard's Index

A comparison of obtained plants used for medicinal purposes from two municipalities was shown in Jaccard's Index (JI). Of all the 48 plant species, 6 species were uniquely used by the Mamanwa tribes in Tandag City while; 21 species were uniquely used by Manobo tribe in Tago; and 21 plant species overlapped being utilized by both tribes, obtaining a high Jaccard's Index (JI=0.778).

Family Importance Value (FIV)

FIV determines the most acknowledged families from both tribes. Since this is a modified approach, the importance of each family is relative only to that specific tribe. As seen in Table 4, the Rubiaceae family garnered the highest relative importance for both the Mamanwa and Manobo tribes with 15.55% and 12.53%, respectively. Both tribes manifested *C. remotineerium* as the highest contributor to the tally. Next, the Apocynaceae (14.07%) and Zingiberaceae (11.03%) garnered the 2nd highest FIV for the Mamanwa and Manobo tribes, respectively. *T. pandacaqui* and *A. elegans* showed the highest contribution for the tribes of Mamanwa and Manobo, respectively. The Lamiaceae ranked 3rd as it accumulated 13.33% and 10.53% for the tribes of Mamanwa and Manobo, respectively. Both tribes manifested *C. longifolia* as the highest contributor.

Table 4. Modified Family Importance Value of each family for Manobo and Mamanwa, Philippines

Family	Manobo	Mamanwa	Family	Manobo	Mamanwa
Apocynaceae	10.03	14.07	Marantaceae	2.01	0
Annonaceae	6.77	6.91	Melastomataceae	0	1.73
Aquifoliaceae	1.25	3.70	Moraceae	7.27	0
Araceae	1.25	1.98	Myrtaceae	3.26	0
Asteraceae	5.01	0	Primulaceae	0.25	0.99
Bignoniaceae	0	0.99	Onagraceae	3.01	0
Dioscoreaceae	2.76	4.20	Piperaceae	1.25	3.46
Dilleniaceae	6.77	5.93	Phyllanthaceae	2.26	3.70
Fabaceae	2.76	0	Rubiaceae	12.53	15.56
Elaeocarpaceae	2.01	3.46	Solanaceae	2.01	4.44
Achariaceae	1.00	0	Urticaceae	1.75	0
Lamiaceae	10.53	13.33	Vitaceae	1.50	0
Malvaceae	2.51	4.94	Zingiberaceae	11.03	10.62

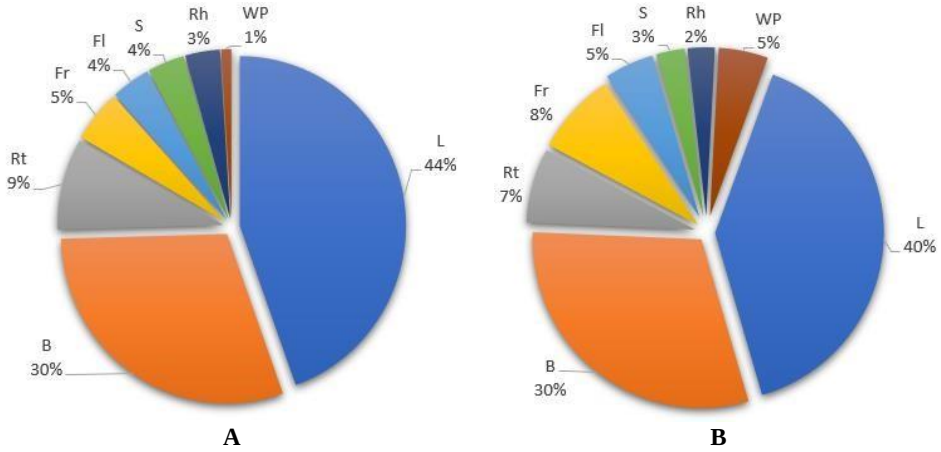


Figure 2. Parts used from medicinal plants from different barangays in Philippines: A. Tago, Surigao Del Sur B. Tandag City, Surigao Del Sur. L, leaves; B, bark; Rt, roots; Rh, rhizomes; Fr, fruit; Fl, flower; S, seed

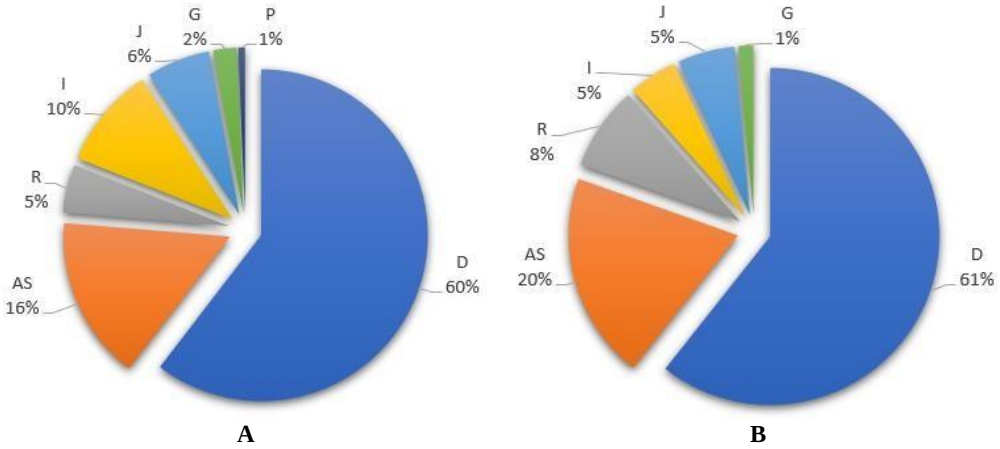


Figure 3. Different preparation techniques for medicinal plant parts from different barangays in Philippines: A. Tago, Surigao Del Sur B. Tandag City, Surigao Del Sur. D, decoction; AS, aqueous steeping; R, raw; J, juiced; P, pounded; C, crushed; I, infusion

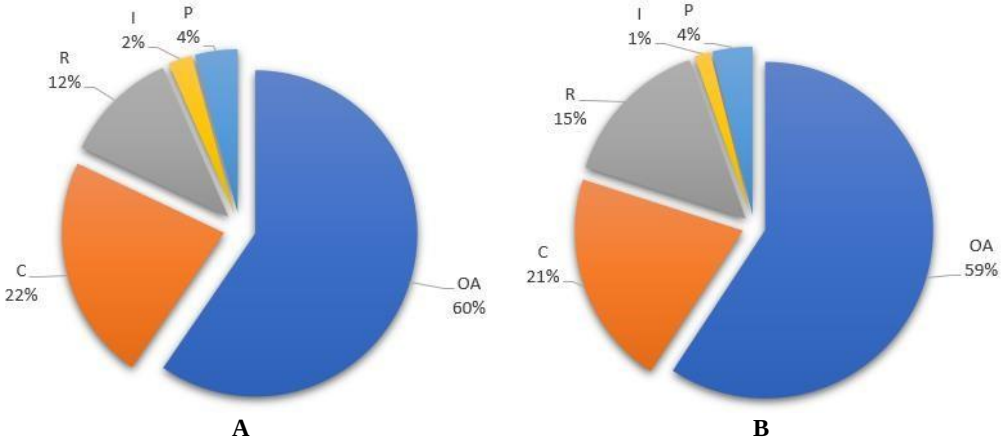
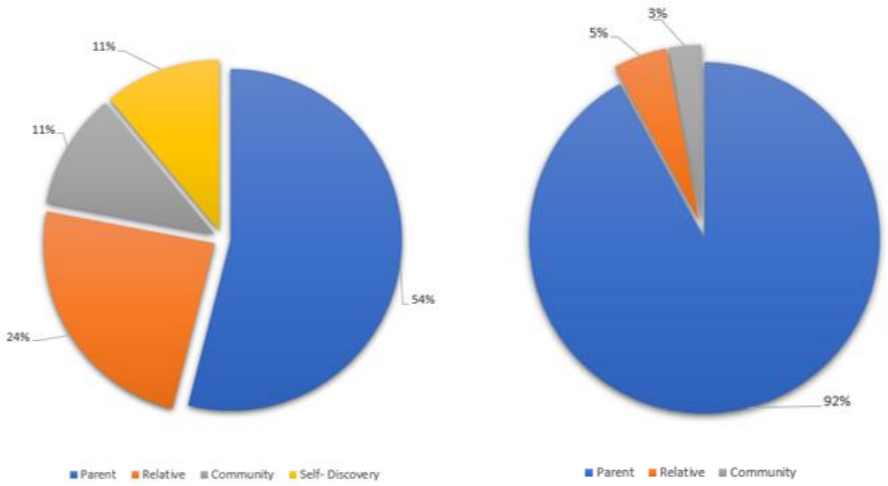


Figure 4. Different administration forms of medicinal plant parts from different barangays in Philippines: A. Tago, Surigao Del Sur B. Tandag City, Surigao Del Sur. OA, oral absorption; C, applying compress; R, rubbing; I, inhalation; P, poultice



A **B**

Figure 5. Source of medical plant knowledge by the A. Mamanwa B. Manobo, Philippines:

Furthermore, the Zingiberaceae (10.62%) and Apocynaceae (10.03%) obtained the 4th highest FIV for the Mamanwa and Manobo tribes, respectively. Among its species, *A. elegans* and *T. pandacaqui* displayed the highest tally for the tribe of Mamanwa and Manobo, respectively. Lastly, Annonaceae (6.91%) and Moraceae (7.27%) garnered the 5th highest FIV for the tribes of Mamanwa and Manobo, respectively. *Orophea enterocarpa* Maingay ex Hook.f. and the genus of Ficus garnered the highest contribution for the tribes of Mamanwa and Manobo, respectively.

Medicinal knowledge of both tribes

In the Mamanwa tribe, the majority of their medicinal plant knowledge came from their parents (54%), followed by relatives (24%), self-discovery (11%), and community (11%). For the Manobo, the majority also relied on the knowledge of their parents (92%), followed by relatives (5%), then self-discovery (3%) (Figure 5).

The modified FIV was utilized as a basis in finding variability between the different demographics. It was found that all the gathered data were statistically different from the normal distribution. Thus, the Kruskal-Wallis test was carried out.

When analyzed according to the different age groups, it was found that there was no significant difference between the median scores for the Mamanwa (*p(same)*=0.677). This means that regardless of age, all of the members have equal knowledge regarding the medicinal plants that they utilize. In contrast, a deviation was found for the Manobo. The age group 46-60 garnered the highest median score with 1.068, followed by the age group 60 and above (0.855), 31-45 (0.534), and 18-30 (0.427). This implies that ages ranging from 46-60 are more knowledgeable about the medicinal plants that the tribe utilizes.

When examined according to gender, it was found that the median scores for both genders were not significantly deviated from each other for Mamanwa (*p(same)*=0.437). This suggests that the general understanding of the males and females of this tribe is invariable. In contrast, a deviation was found in Manobo (*p(same)*=0.031). The females garnered a higher median score (1.816) as compared to the males (1.175)

When grouped according to educational attainment, a significant difference was established for both the Manobo (*p(same)*=0.001) and Mamanwa (*p(same)* = 0.00). For the Mamanwa, it was found that informants who only finished Primary education (2.531) were more familiar with the medicinal plants of the tribe as compared to Secondary and Tertiary finishers (0.633 and 0.001, respectively). On the contrary, Secondary finishers (5.982) are more knowledgeable as compared to the Primary and Tertiary finishers (3.846 and 0.427, respectively) for the Manobo. This infers that the familiarity of the informants is not affected by their academic intuition.

When examined according to different occupations, a variability was established for the Manobo (*p(same)*=0.001). However, no difference was found for the Mamanwa (*p(same)*=0.123). This suggests that the understanding of the medicinal plants of the Manobos is variable relative to their respective occupations. Informants with occupations related to agriculture are more familiar with medicinal plants. Next to this are domestic workers and the unemployed having the same median score of 0.641. Lastly, industrial workers showed the least familiarity with medicinal plants.

Molecular confirmation

Although studies use several universal markers to validate the identity of plants (Kool et al. 2012), successful sequences using the markers in the study are enough to identify plant species since the percent identity of 4 sequences yielded >98%, and only 1 sequence (*C. tetraphyllum*) was garnered 88% identity. Results for the integrated molecular confirmation of uncertain plant species are summarized in Table 5.

Table 5. Integrative molecular confirmation

Local name	Marker	Putative identification	Molecular confirmation by blast			Integrative molecular identification
			Max Score	Percent identity	Optimized BLAST	
Batwan	*trnL-F*	*Eleocarpus castaneus*	*Elaeocarpus glaber*	*Elaeocarpus serratus*	*Elaeocarpus serratus*	*Elaeocarpus serratus*
Kawilan	*trnL-F*	*Uncaria longiflora*	*Uncaria lanosa*	*Uncaria lanosa*	*Uncaria lanosa*	*Uncaria lanosa*
Payaw-payaw	*trnL-F*	*Aglaonema commutatum*	*Aglaonema crispum*	*Aglaonema crispum*	*Aglaonema crispum*	*Aglaonema crispum*
Kandiis	*trnH-psbA*	*Canthium remotinerium*	*Canthium tetraphyllum*	*Canthium tetraphyllum*	*Canthium tetraphyllum*	*Canthium tetraphyllum*
Tawa-tawa	*trnH-psbA*	*Timonius philippinensis*	*Timonius timon*	*Timonius timon*	*Timonius timon*	*Timonius timon*

All plants were amplified using the two markers. However, the most successful sequences per plant were used in the study. The basis of using a specific marker for a plant species is the success of the amplification and sequencing. Although, it is recommended to use as many universal markers to reliably identify uncertain species (Dapar et al. 2020c). The marker with a higher max score and percent identity was used to identify the uncertain plant species. The 5 medicinal plants are confirmed within their generic and familial affinities. The molecular confirmation was verified by botanical experts based on the morphology and species occurrence to establish an identification up to species level.

Discussion

There exist several ethnomedicinal and ethnobotanical studies in the Philippines that look at the medicinal knowledge and preferred plants of the tribal communities of the country. Despite the specificity of chosen IPs for these studies, these independent studies would have varying results in the plants used regardless if they study the same tribe. In a previous study conducted in Agusan del Sur by Dapar et al. (2020c) concerning the Manobo, they found that the most representative family was contrary to those found in more preceding studies.

The most represented (having more than 2 species) families used by the Manobo tribe in Agusan del Sur, in descending order, are Lamiaceae, Asteraceae, Moraceae, and Fabaceae, while the most species dominant families for the Mamanwas in Surigao del Norte and Agusan del Norte are Asteraceae, Poaceae, Lamiaceae, Annonaceae, Moraceae, Amaryllidaceae, Fabaceae, Lauraceae, Rutaceae, and Zingiberaceae (Dapar et al. 2020c; Nuneza et al. 2021). This is contrary to our results since Moraceae was the only family for the Manobo to be among the most represented in the Agusan study, while no families from the Mamanwa were among the families mentioned in the Surigao del Norte and Agusan del Norte study. Similar to the study of Blasco et al. Rubiaceae was also the most species represented family in the studied areas, demonstrating the strong diversity of this family in the region (2014).

The families most frequently used by the two tribes also differ from the families that are most represented for the whole province. In Surigao del Sur, the most frequently used families for the residence are Gramineae, Poaceae, Fabaceae, Labiaceae, and Zingiberaceae, while on the northernmost coasts of the province; Gramineae, Verbenaceae, Labiatae, and Malvaceae were the families with the most utilized species (Gruyal et al. 2014; Montero and Geducos 2021). Among the most represented families for both tribes, only Malvaceae and Zingiberaceae have representation in these regional studies. This conveys the idea that the tribes' choice of medicinal plants is distinctive to the preferred plants of the region's population, as these communities are unique in their culture, customs, knowledge, and identity (NCIP, 2013).

In our findings, the most important families for the tribes also did not fully reflect those found in other studies. In a study conducted in Bayugan City, Agusan del Sur that looked upon the Manobo's ethnomedicinal plants, the families with the highest FIVs, from highest to lowest, were Piperaceae, Lauraceae, Apocynaceae, and Euphorbiaceae. Another similar study done in the municipality of Prosperidad found that the most relevant plants for the Manobo that lived there were Asteraceae, Aristolochiaceae, Apocynaceae, Urticaceae, and Poaceae (Dapar et al. 2020a; Paraguison et al. 2020). Only Apocynaceae was the high FIV family in our study to be among the high FIV families in those Agusan studies. So far, there are no other published studies that look upon the FIV of the families used by the Mamanwa aside from this one.

The variety of preferred plants within the same tribe may be attributed to the difference in plant diversity of a given location. The diversity and availability of plants and other resources in a region can affect the ethnopharmacological knowledge of a tribe since they would depend on what is most exploitable in the area (Alves and Rosa 2007). In studies that assessed ethnobotanical knowledge of the Ati tribe that lived in Malay (Aklan), and Guimaras island, two locations separated by sea, the highest in UV for the former were *M. paradisiaca, B. balsamifera,* and *P. scutellarioides.* Meanwhile, the highest for the latter were *P. guajava, B. balsamifera,* and *C. nucifera* (Ong and Kim 2014; Cordero et al. 2020).

The location of any community can affect their traditional health practices since these areas offer their own environmental conditions and historical context. Their prolonged exposure to the environment shapes the ethnomedical knowledge of these tribes (Kujawska et al. 2017; Zank and Hanazaki 2017). It has also been known that plant species originating from the tropics are more likely to contain biologically active compounds due to the strong pressures of bacterial and fungal pathogens in these diverse ecosystems (Kokoska et al. 2019). The most relevant disease in a community also affects the medicinal

preferences of its members. In a study done in Puebla, México that looked upon the ICF and antimicrobial activity of the medicinal plants used by the locality, the plants with the highest antimicrobial activity also proved to have the highest ICF values. The illnesses that corresponded to these values were odontological diseases, wounds and burns which are commonly affected by bacterial infections (Canales et al. 2005).

Medicinal plants have become an indispensable source of new potential drugs (Newman and Cragg 2012; Souza et al. 2018). The study demonstrates the Manobo and Mamanwa tribes' extensive medicinal plant knowledge, as well as the occurrence and distribution of medicinal plant species in the rural areas of Tago and Tandag. Rubiaceae, Moraceae, Apocynaceae, Malvaceae, and Zingiberaceae were most well-represented with a high species number used by both tribes.

Rubiaceae (coffee family) was reported to have been used in 8 different diseases or purposes across 5 categories. Rubiaceae is the 4th largest family of angiosperms and comprises the largest population of indigenous species among the Philippine eudicot plants with around 550 species, wherein 83% are endemic (Alejandro 2007; Davis et al. 2009). The Rubiaceae family is characterized by producing bioactive metabolites with antimicrobial, antimalarial, antihypertensive, antidiabetic, antioxidant, and anti-inflammatory properties (Kala 2015; Martins and Nunez 2015). Moraceae (fig family) was reported to have been used in 6 different diseases across 4 categories. Plant species collected that comprise the Moraceae family all belong to the genus Ficus. The genus Ficus exhibits various chemical constituents with pharmacological activities such as cytotoxicity, anti-inflammatory, antioxidant, antirheumatic, and antibacterial effects (Apostol et al. 2016; Chen et al. 2020).

Apocynaceae (dogbane family) was reported to have been used in 8 diseases across 3 categories. Apocynaceae is a large angiosperm family comprising shrubs, woody, or herbaceous plants that produce milky latex (Wiart 2006). Plants in this family are often high in alkaloids, which have a variety of biological activities like anti-inflammatory, anti-asthmatic, antimicrobial, antioxidant, antibacterial, anti-ulcer, and wound-healing properties (Bhadane et al. 2018; Islam and Lucky 2019). Malvaceae (mallow family) was reported to have been used in 5 diseases across 4 categories. Malvaceae is distributed within tropical to temperate regions with economically important members used for food, textiles, timber, and ornamentals (Mitchell 1982; Xu and Deng 2017). The Malvaceae family has been previously documented in the treatment of fever, cough, headache, toothache, inflammation, ulcer, and skin diseases (Rahman and Gondha 2014; Abat et al. 2017; Das and Islam 2019). Zingiberaceae (ginger family) was reported to have been used in 2 diseases within 1 category. Zingiberaceae contains various phytochemical compounds with extensive use in traditional medicine (Kumar et al. 2013; Dalisay et al. 2018; Hamzah and Zubair 2019)

In the topmost relevant plant families used, the tribes' shared the same top 5 FIV families, save for Dilleniaceae for the Mamanwa and Moraceae for the Manobo. These shared families are Apocynaceae, Rubiaceae, Zingiberaceae, and Annonaceae, all of which are known for containing species with ethnomedicinal relevance in various parts of the world (Ford and Gaoue 2017; Phumthum et al. 2019). Ethnomedical species classified under Apocynaceae are known for treating ailments such as body aches and joint pains, skin disorders such as eczema, and coughs and sore throats (Hosseini et al. 2021). Certain species of Apocynaceae are also found to have synergistic effects when applied with antibiotic medications (Chusri et al. 2014). Rubiaceae contain species that are known for alleviating blood sugar and rheumatic pain, as well as anti-inflammatory, antimicrobial, antimalarial, antihypertensive, and antioxidant activities (Karou et al. 2011; Adewole et al. 2021; Hosseini et al. 2021). Zingiberaceae is known for its importance in Ayurvedic medicine, wherein its species are used for treating a wide range of ailments such as fungal infections, epilepsy, cough, headaches, wounds, vomiting, malignant ulcers, halitosis, pain, and snake bites (Kumar et al. 2013; Gómez-Betancur and Benjumea 2014). Annonaceae species are utilized for their indigenous medicinal properties, such as in treating edema, wounds, inflammatory diseases, fever, and rheumatism (Aziz et al. 2016; Attiq et al. 2017). Dilleniaceae species have served the purpose of being utilized in drug formulation and drug delivery, as well as traditional medicinal uses, as they contain antidiabetic, antioxidant, antidiarrheal, antiprotozoal, antimicrobial, anti0nflammatory, and cytotoxic properties (Sabandar 2017). Species of Moraceae are known to contain active compounds that elicit antibacterial, antiprotozoal, antifungal, anthelmintic, antioxidant, anti-inflammatory, antineoplastic, antidiarrheal, and cardioprotective activities (Dangarembizi et al. 2012).

C. longifolia had the highest UV for both tribes. The *Callicarpa* genus is distributed in both temperate and tropical regions around the world and it is known to possess considerable medicinal and phytochemical properties (Bramley 2013). Plants from this genus have been used for treating coughs and colds, as well as having anti-inflammatory, antitubercular, and antimicrobial activity (Tu et al. 2013). *C. longifolia* specifically possesses bioactive constituents such as diterpenoids and flavonoids (Subramanian et al. 1974). with reported analgesic and antimicrobial activity (Syamsul et al. 2016; Novaryatiin and Mulyani 2018). Accordingly, diseases of the respiratory system had the highest ICF value among all categories for both tribes with *C. longifolia* being the most frequently used medicinal plant for treating coughs.

A. elegans had a 100% FL value with a high UR value used distinctly by both tribes for fevers, indicating high agreement for its utility with high respondent confidence. *A. elegans* contain essential oils that exhibit medicinal properties such as cytotoxins, antioxidants, and some antimicrobial activity (Houdkova et al. 2018; Naive et al. 2019). The Alpinia genus has been used in traditional medicine to achieve anti-inflammatory, bacteriostatic, fungistatic, antitumor, and antiviral effects (Zoghbi 1999; Corbi et al. 2006; Upadhyay et al. 2011; Nguyen et al. 2014)

The leaves were the most frequently used plant part for both tribes. This is similar to previous studies conducted in other Manobo (Dapar et al. 2020c; Paraguison et al. 2020) and Mamanwa communities (Nuneza et al. 2021), as well as other ethnobotanical studies across the country (Olowa et al. 2012; Abe and Ohtani 2013; Pizon et al. 2016; Baddu and Ouano 2018; Tantengco et al. 2018; Cordero et al. 2020). Although the results are similar to previous studies, the difference is that barks are more utilized than the roots by both tribes in Tago and Tandag while the Manobo and Mamanwa of the surrounding provinces utilize the roots more frequently than the barks (Dapar et al. 2020a,c; Nuneza et al. 2021). Many phytochemical compounds exhibiting biological activities are stored and produced in the leaves, which explains their widespread usage for medical purposes (Okoegwale and Omefezi 2001). Moreover, leaves are readily available and abundant that do not cause significant damage to the plant upon collection (Tantengco et al. 2018).

Decoction is the most common method of preparation, and most of the medicines are administered through oral absorption for both tribes. Decoctions are the preferred method of preparation by indigenous groups around the country and oral absorption is the predominant form of medicinal plant administration (Olowa et al. 2012; Blasco et al. 2014; Pizon et al. 2016; Tantengco et al. 2018; Cordero et al. 2020; Dapar et al. 2020c; Nuneza et al. 2021). In the preparation of medicinal plant decoctions, heat application on aqueous extracts hastens the extraction of bioactive constituents (Abubakar and Haque 2020). Furthermore, oral intake of decoction was observed to have higher absorption and effectivity than that of other traditional types of preparation (Yang and Ross 2010). However, excessive heat for long periods may cause severe degradation of bioactive phytochemical ingredients such as phenolic contents (Al Juhaimi et al. 2018).

Ultimately, human health relies on the quality and reliability of environments. Prospecting the biodiversity of medicinal plants in a region is done with ethno-directed methods, wherein plants with medicinal properties are collected based on the knowledge of their ethnic peoples. Indices allow for selective identification of relevant taxa, and what specific disease they treat, since it is almost impossible to assess all medicinal plants at any given time. Integrative molecular confirmation reinforced the identification of morphologically unidentifiable medicinal plant species. The study's current findings may serve as baseline data for future research in new bioactive compounds, further confirming the potential of ethnomedicinal knowledge in novel drug discovery and development. Additional studies should be conducted in parts outside of Tago and Tandag City to further document the biodiversity and potential medicinal plant species of the surrounding areas. It is encouraged that indigenous knowledge of these communities be preserved as it may be lost in the future due to modernization.

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Figure S1. Interview of Manobo and Mamanwa tribes in Surigao Del Sur, Philippines

SEMI STRUCTURED INTERVIEW
(TRANSLATED AND ENGLISH VERSION)

Part 1: Personal Profile
Apelyido (*Surname*):_____ **Ngalan** (*First Name*):_____
Adlaw nga Natawhan_(*Sex*): _____ **Lalaki** (*Male*) ____ **Babaye** (*Female*)
Edad (*Age*): _____ **Edukasyon** (*Education*):_____
Estado Sibil (*Civil Status*): __ **May asawa** (*Married*) __ **Waray Asawa** (*Single*)
Puloy-anan (*Address*):_____ **Trabaho**(*Occupation*):_____

Part 2: Health Problem and Medicinal Plants Used
1. Uno ang mga sakit ang inyo himbaw-an sa inyo panimalay?
What is/are the common health problem/s that you experienced in your household?

2. Sa miagi na panahon nga may nasakit sa iyo pamilya , uno an iyo gibuhat? *The last time you, or somebody in your family had health problem, what did you do?*
a. Ning-adto sa Doktor (*see a doctor*)
b. Nangayo ug tabang sa mananambal (*seek the mystical person's help*)
c. Nigamit sa mga tambal nga tanom (*used medicinal plant/s*)

3. a. Uno nga (mga) tanom ang inyo gigamit? *What is* (*are*) *the plant*(*s*) *you use?*
b. Uno na sakit/balatian na puwede gamiton ini na tanom? *What is the plant used for?*

4. Sa diin kamo nakahibalo sa pag-gamit niini mga tanom? (*With whom did you learn the use of medicinal plants?*)
a. Mga Ginikanan (*Parents*)
b. Mga kaparientihan (*Relatives*)
c. Sa komunidad (*Community*)
d. Kaugalingon nga pamaagi (*Self-discovery*)
e. Iban pa (*Others*)_____

5. Sa diin kamo gapanguha nan mga tanom? (*Where did you get the plant?*)
a. Ginapatubo sa palibot kang balay (*cultivated around the house*)
b. Sa lasang pero dapit sa balay (*in the wild but around the house*)
c. Sa silingan na baryo (*in the neighboring barangay*)
d. Sa kakahuyan (*wood, forest*)
e. Sa tindahan (*from the market*)
f. Sa iban pa na lugar (other places)_____

6. Tiempo ug oras sa pagpanguha sa nga tanom (*Gathering season and/or hour*)

7. Parte sa tanom nga ginagamit sa pagpreparar. (*Part*(*s*) *of plant*(s) *used to prepare the remedy*)
a. Panit (*bark*) **g. Prutas** (*fruit*)
b. Sanga (*stem*) h. **Bukol** (*bud*)
c. Gamot (*root*) i. **Bulak** (*flower*)
d. Tapi (*wood*) j. **Dugos** (*latex or resin*)
e. Liso (*seed*) k. **Ibabaw nga parte** (*aerial parts*)
f. Dahon (*leaf*) l. **Iban pa** (*others*)

8. Porma sa pagtambal (*Administration forms*)
a. Ginakumos sa tubig (*Infusion*) g. **Lubak** (*pounded*)
b. Ginala-ga (*decoction*) h. **Galingon** (*crushed/ground*)
c. Hilaw (*raw*) i. **Pulbos** (*powder*)
d. Ginahuuman sa tubig (*aqueous steeping*) j. **Lana** (*oil*)
e. Ginahuuman sa arkohol (*alcoholic steeping*) k. **Sirup** (*syrup*)
f. Dugos (*juice*) l. **Sabaw** (*broth*)

9. Pamaagi sa Pagtambal (*Administration mode*)
a. Gina-inom (*oral absorption*) e. **Ginapaligo** (*bath*)
b. Diretso dapi (*applying, compress*) f. **Ginasimhutan** (*inhalation*)
c. Ginbulak ang harampol (*poultice*) g. **Ginapatulu-an** (*instillation*)
d. Pahid or masahe (*rubbing or massage*) h. **Iban pa** (*others*)

10. Uno ka dako ang kada tambal : (ang insakto nga kadak-on para sa mga bata)
Quantity or dosage of remedy taken each time: (*precise as to the quantity relative to children*)

11. Pila ka beses sa isa ka adlaw? (ang insakto nga oras sa pagdapat). How many times a day? (precise time of the day).

12. Pila ka adlaw? How many days?

13. Ang tambal may dala nga delikado? May mga kontra alebyo? Can this remedy be dangerous? Are there any counter indications?
a. **yaon** (*Yes*) b. **Wara** (*No*) c. **Wara kahibawo** (*does not know*)

Ikatatlo nga Parte: Ang Mga Ginagamit nga Tanom
Part III. Tabulated form of the Part II questionnaire.

Figure S2. Semi structured interview material