Ethnomedicinal appraisal and conservation status of medicinal plants among the Manobo tribe of Bayugan City, Philippines

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Abstract. Dapar MLG, Meve U., Liede-Schumann S., Alejandro GJD. 2020. Ethnomedicinal appraisal and conservation status of medicinal plants among the Manobo tribe of Bayugan City, Philippines. Biodiversitas 21; 3843-3855. Manobo tribe is one of the most populated indigenous communities in the Philippines clustered in various parts of Mindanao archipelago with distinct cultural traditions and medicinal practices. This study aims to document the Agusan Manobo tribe medicinal plant uses and knowledge and to assess the conservation status of their medicinal plants found in upland ancestral lands where ethnomedicinal practices still prevail. Ethnomedicinal data were gathered from 95 key informants through semi-structured interviews, focus group discussions, and guided field walks in five selected upland barangays of Bayugan City. Family importance value (FIV) and relative frequency of citation (RFC) were quantified. The conservation status of their medicinal plants was assessed based on the international and national listing of threatened species. A total of 90 species belonging to 82 genera and 41 families were identified as ethnomedicinally important. Highest FIV (98.9) was reported for Piperaceae in treatment for skin diseases and infections. The most cited medicinal plant species was Piper decumatum L. (RFC=0.95), which is primarily used in treatment for insect and snake bites. Conservation assessment revealed that the five upland areas of the Agusan Manobo tribe are habitats of endemic, endangered, vulnerable and threatened species. The results of this study present the rich ethnomedicinal knowledge of Agusan Manobo cultural community, which could serve as a useful source of information to improve community healthcare and environmental conservation and management. Local people and the government should actively participate in shared management responsibilities for viable conservation strategies and sustainable use of the cultural community resources.

Keywords: Ethnobotany, Manobo tribe, medicinal plants, Mindanao, Philippines

INTRODUCTION

Recent biodiversity global assessment reported around one million animal and plant species (SDG 2019), and more than 28,000 species (IUCN 2019) are now threatened with accelerating extinction rate more than ever before in human history. Given this emerging biodiversity crisis, ancestral lands governed by indigenous communities are significantly declining at a slower rate (IPBES 2019). The rich knowledge, ecological understanding, resource management, and conservation practices of the locals and indigenous peoples are recognized as imperative partners in environmental management because they act as stewards of their ancestral territories (UNESCO 2019). Indigenous and local knowledge (ILK) is accepted among researchers and policymakers as essential for biodiversity conservation worldwide (Reyes-Garcia and Benyey 2019). Indigenous communities have long experienced, coped, and adjusted to environmental changes over the years (Vinyeta and Lynn 2013). Considering the experience of indigenous people, their knowledge must play an integral role in sustaining global biodiversity and protect world heritage.

An estimated 22% of the world’s land surface was acknowledged as indigenous ancestral lands, which correspond to about 80% of the plant’s biodiversity areas (WRI 2005). Despite the indigenous transformation of various cultural knowledge systems and traditional practices in sustaining forest reserves, biodiversity has prevailed in the Philippines (Camacho et al. 2015). The Philippine archipelago is comprised of more than 7,100 islands and islets. This country is considered significantly crucial to global biodiversity due to its exceptional levels of narrow endemism in various ecosystems (Myers et al. 2000; Carpenter and Springer 2005; Posa et al. 2008). Aside from being renowned as a megadiverse country worldwide (Conservation International 2012) and one of the world’s eight biodiversity hottest spots (Myers et al. 2000), the Philippines is also recognized as culturally megadiverse in ethnicity accounting for 110 divergent ethnonlinguistic groups (ILO 2014, PSA 2016). These various indigenous communities have a prominent and unique identity, language, and cultural practices (NCIP 2010). Mindanao is mostly occupied with 61% of the total number of indigenous peoples (IPs) in the Philippines (UNDP 2010). One of the largest groups of IPs in Mindanao is the Manobo tribe, mainly inhabiting the province of Agusan del Sur known as the Agusan Manobo.
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Despite the significant role of indigenous contributions to biodiversity conservation, limited studies have so far been conducted in the Philippines among Indigenous Cultural Communities/Indigenous Peoples (ICCs/IPs) in documenting relative importance and conservation status of their medicinal plants. Bayugan City, the only component city in the province of Agusan del Sur and known to be occupied with the large number of Agusan Manobo who serve as stewards of their abundant natural resources, remains undocumented. Hence, it is paramount to evaluate plant resources like medicinal plants among indigenous communities and check for their conservation status as baseline information and justification for future conservation. Thus, this study aims to document ethnomedicinal importance and to assess the conservation status of the medicinal plants used by the Agusan Manobo in upland areas of Bayugan City, Agusan del Sur, Philippines.

MATERIALS AND METHODS

Study area

The fieldwork was undertaken in the City of Bayugan as the only component city in the province of Agusan del Sur, Philippines, as shown in Figure 1. This landlocked city is located in the coordinates 8° 71'44” N, 125° 74'81” E with type II climate having no dry season but very pronounced wet season with heavy precipitation. It is geographically situated below the typhoon belt near or alongside the eastern coast of Mindanao, which is typically affected by tropical depression and typhoon passing the province of Surigao del Norte and Visayas regions. From the total of 43 barangays of the city, five upland barangays, namely Mt. Ararat (523.7 masl), Mt. Carmel (360.8 masl), Mt. Olive (323.2 masl), New Salem (628.5 masl), and Pinagalaan (523.1 masl), were purposively selected for the reasons of availability, accessibility, and security with the approved consent of the tribal council, provincial administration of Agusan del Sur, the National Commission on Indigenous Peoples (NCIP) of the LGU and CARAGA Administrative Region, and the Provincial Environment and Natural Resources Office (PENRO) of Agusan del Sur, and the Department of Environment and Natural Resources (DENR) of CARAGA. These five study sites partly comprised the 74% forestland areas and 26% alienable and disposable (A&D) areas of the province (PENRO Agusan del Sur 2019). There were three hospitals in the downtown city, which is distant from the five remote barangays of the study, therefore, with poor access to the city healthcare.

Figure 1. Location map of Bayugan City (C), Agusan del Sur (A, B), Philippines (Maps by Google Earth)
Field survey

Fieldwork was carried out from March 2018 to April 2019. The work consisted of the acquisition of ethics approval, consents, resolution, certification, and permit before the actual interview, field survey, and collections in the selected five upland barangays. Consultative assembly was conducted with the tribal council of elders in cooperation with the city administration to talk about the research intent as wholly academic. After consultations and meetings, the fieldwork was followed by ritual observation resulting in mutual agreement and respect. As approved by the council of elders, the survey and sampling were certified by the NCIP-LGU and NCIP-CARAGA following their by-laws for the welfare and protection of IPs.

A total of 95 purposively and snowball sampled AgusanManobo key informants, more than 10% of the total population of selected barangays, comprising of the tribal council of elders and members, were interviewed using the semi-structured open-ended interview. Key informants were composed of 39 females and 56 males with an age range from 18 to 77 years old and the median age is 38. Ethnomedicinal data were consolidated from the interviews and corner meetings with the key informants. An accurate translation to the Manobo dialect, known as Minaniba, with the help of the tribal elders, was secured. Focus group discussions (FGD) among respondents have jointly participated with the respective barangay tribal leaders and the only tribal healer and in cooperation with the city Indigenous Peoples Mandatory Representative (IPMR) as a consultant. FGD is helpful to clarify the main points, ideas, and perceptions on the use of traditional folk medicines, awareness about the conservation of their medicinal plant cultural resources and indigenous knowledge.

Collection and identification

All collected medicinal plants during field walks and sampling were carefully pressed, alcohol-preserved, dried, and mounted on herbarium sheets. Voucher specimens were deposited in the University of Santo Tomas Herbarium (USTH). Recorded vernacular names were compared to the Dictionary of Philippines Plant Names by Madulid (2001). Plant identification was verified by Mr. Danilo Tandang, a botanist and researcher at the National Museum of the Philippines. All scientific names were checked for spelling and synonyms, and family classification using The Plant List (2013), World Flora Online (2019), the International Plant Names Index (2019), and Tropicos (2019). Medicinal plant species occurrence, distribution, and species identification were further confirmed in the updated Co’s Digital Flora of the Philippines (CDFP; Pelser et al. 2011 onwards).

Family importance value (FIV)

FIV determines the local importance of the families of medicinal plant species (Ali et al. 2018). This value is calculated based on the number of informants citing the family using the formula: FIV = (FC/N) x 100, where FC is the frequency of citation of the plant family, and N is the total number of informants. FIVranges in value from 0 to 100, with the most important family having values closer to 100. FIV distinguishes the most important family based on the number of citation reports of informants and the number of medicinal plant species for treatment.

Relative frequency of citation (RFC)

RFC identifies the local importance of each medicinal plant species (Ugulu et al. 2009). This index is calculated using this formula: RFC = FC/N, where FC (frequency of citation) is the number of informants who stated the medicinal plant, and N is the total number of informants. FC assigned the most preferred or more used medicinal plant species. At the same time, RFC determines the traditional importance of plant species in the study site ranging in value from 0 to 1, with the most critical species having values closer to 1.

Conservation status and endemicity

Conservation status of the medicinal plants was assessed based on the international data of the IUCN (2019) updated national list of threatened Philippine plants and their categories of the DENR Administrative Order No. (DAO) 2017-01 (DENR Administrative Order 2017) and the consolidated national online flora database of Co’s Digital Flora of the Philippines (CDFP; Pelser et al. 2011 onwards). The collected medicinal plants were further checked for their occurrence and distribution in the Philippines and to check their endemicity.

RESULTS AND DISCUSSION

Characteristics of medicinal plants

During the ethnomedical survey of medicinal plants, a total of 90 species belonging to 82 genera and 41 families were identified and recorded with medicinal uses, as shown in Table 1. Most of the documented medicinal plants were trees (35%), followed by herbs (33%), shrubs (20%), and climbers (12%), as depicted in Figure 2. Several plant parts are used by AgusanManobo for various health problems, as shown in Figure 3. The most medicinally most used plant parts are the leaves (39%), followed by roots (22%), stems and bark (12%), while the least used ones are rhizomes (3%), shoots (2%), fruits (2%), flowers (2%), and branches (1%).

Family importance value

Analysis of FIV revealed that Piperaceae has the highest value (98.9), followed by Lauraceae (96.8), Apocynaceae (94.7), and Euphorbiaceae (90.5). These families were highly cited by the informants as frequently used for treatment against skin diseases and infections, cough, wounds, and fever, respectively.

Relative frequency of citation

The highest RFC values were recorded for Piper decumumum L. (0.95), followed by Anodendron borneense (King & Gamble) D.J.Middleton (0.89), Micromelum minutum (G.Forst.) Wight & Arn. (0.81), Arcangelista flava (L.) Merr. (0.81), and Cinnamomum mercadoi S.Vidal (0.79). These medicinal plants are highly cited as a treatment for insect and snake bites, pregnancy problems (impotence and sterility), cancer, ulcer, and diarrhea, respectively.
| Scientific name | Voucher No. | FIV | RFC | Conservation status | Endemicity (CDFP) | Parts used* | Medicinal uses |
|-----------------|-------------|-----|-----|---------------------|------------------|-------------|---------------|
| **Acanthaceae** |             |     |     |                     |                  |             |               |
| *Rhinacanthus nasutus* (L.) Kurz | USTH 015622 | 68.42 | 0.52 | NA | NE | Lf | Colds, beriberi, diabetes, diarrhea, fatigue, spasm |
| **Anacardiaceae** |             |     |     |                     |                  |             |               |
| *Mangifera indica* L. | USTH 015591 | 63.16 | 0.20 | DD | NE | Fr, Lf | Constipation, cough, diarrhea, stomach trouble |
| *Spondia spinosa* (L.f.) Kurz | USTH 015599 | 0.33 | NA | NE | Bk, Lf | Colds, cough, diabetes, fever |
| **Annonaceae** |             |     |     |                     |                  |             |               |
| *Friesodelsia lanceolata* (Merr.) Steen. | USTH 015558 | 36.84 | 0.18 | NA | EN | Bk, Lf, Rz | Postpartum care and recovery |
| *Uvaria zschokkei* Elmer | USTH 015662 | 0.17 | NA | EN | St | Amoebiasis, hypertension, fatigue |
| **Apocynaceae** |             |     |     |                     |                  |             |               |
| *Alstonia macrophylla* Wall. ex G.Don | USTH 015546 | 94.74 | 0.35 | LC | NE | Bk | Animal bites, skin diseases and infections, wounds |
| *Anodendron borneense* (King & Gamble) D.J.Middleton | USTH 015639 | 0.89 | NA | NE | St | Arthritis, body pain, cancer, diabetes, fatigue, pregnancy (impotence and sterility), skin diseases, spasm, wounds |
| **Araceae** |             |     |     |                     |                  |             |               |
| *Alocasia zebrina* Schott ex Van Houtte | USTH 015614 | 9.47 | 0.05 | NA | VU | EN | St | Snake bites and wounds |
| *Homalomena philippinensis* Engl. ex Engl. &K.Krause | USTH 015597 | 0.04 | NA | EN | Rz | Labor and delivery enhancer, rheumatism, wounds |
| **Araliaceae** |             |     |     |                     |                  |             |               |
| *Hydrocotyle vulgaris* L. | USTH 015563 | 29.47 | 0.23 | LC | NE | Lf | Diabetes, hypertension |
| **Arecaceae** |             |     |     |                     |                  |             |               |
| *Calamus megaphyllus* Becc. | USTH 015608 | 22.11 | 0.15 | NA | NT | EN | Rz | Arthritis, asthma, diabetes, hypertension |
| **Asteraceae** |             |     |     |                     |                  |             |               |
| *Acmella grandiflora* (Turcz.) R.K.Jansen | USTH 015548 | 88.42 | 0.35 | NA | NE | Fw | Skin rashes and itchiness, toothache |
| *Artemisia vulgaris* L. | USTH 015619 | 0.33 | LC | NE | Lf | Asthma, body pain, cough, fever, spasm |
| *Bidens pilosa* L. | USTH 015582 | 0.20 | NA | NE | Rt | Body pain, diarrhea, fatigue, gas pain and flatulence |
| *Blumea balsamifera* (L.) DC. | USTH 015573 | 0.37 | LC | LC | NE | Lf | Cough, fatigue, fever, headache, hypertension, spasm |
| *Chromolaena odorata* (L.) R.M.King&H.Rob. | USTH 015632 | 0.40 | NA | NE | Lf | Burns, fever, skin diseases, wounds |
| *Cynanthis cinereum* (L.) H.Rob. | USTH 015587 | 0.43 | NA | NE | Lf, Rt | Animal bites, colds, malaria, measles, skin diseases, spasm, tuberculosis |
| **Erechtites valerianifolius** (Link ex Spreng.) DC. | USTH 015666 | 0.19 | NA | NE | Lf | Gas pain and flatulence, stomach trouble, wounds |
| *Mikania cordata* (Burm.f.) B.L.Rob. | USTH 015543 | 0.36 | NA | NE | Lf | Animal and insect bites, skin diseases and infections, ulcer, wounds |
| *Pseudelephantopus spicatus* (Juss.) Rohr | USTH 015564 | 0.45 | NA | NE | Lf, Rt | Kidney problem, menstrual problem, skin diseases, snakebite, wounds |
| Family          | Common Name                          | Code    | Predation | Present | Use(s)                                                                 |
|-----------------|--------------------------------------|---------|-----------|---------|-----------------------------------------------------------------------|
| Athyriaceae     | *Diplazium esculentum* (Retz.) Sw.   | USTH 015545 | 0.19     | LC      | NE Sh Diarrhea, fever, postpartum care and recovery                     |
| Boraginaceae    | *Ehretia microphylla* Lam.           | USTH 015638 | 0.30     | NA      | NE Lf Allergy, diabetes, hyperacidity                                  |
| Byttneriaceae   | *Abroma augusta* (L.) L.f.           | USTH 015637 | 0.29     | NA      | NE Bk, Lf, Rt Diabetes, menstrual problem, skin diseases and infection, stomach problem, wounds |
| Melochiaceae    | *Melochia umbellata* (Houtt.) Stapf  | USTH 015649 | 0.24     | NA      | NE Lf Body pain, burns, canker sore, rheumatism                        |
| Boraginaceae    | *Ehretia microphylla* Lam.           | USTH 015638 | 0.30     | NA      | NE Lf Allergy, diabetes, hyperacidity                                  |
| Byttneriaceae   | *Abroma augusta* (L.) L.f.           | USTH 015637 | 0.29     | NA      | NE Bk, Lf, Rt Diabetes, menstrual problem, skin diseases and infection, stomach problem, wounds |
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| Boraginaceae    | *Ehretia microphylla* Lam.           | USTH 015638 | 0.30     | NA      | NE Lf Allergy, diabetes, hyperacidity                                  |
| Byttneriaceae   | *Abroma augusta* (L.) L.f.           | USTH 015637 | 0.29     | NA      | NE Bk, Lf, Rt Diabetes, menstrual problem, skin diseases and infection, stomach problem, wounds |
| Melochiaceae    | *Melochia umbellata* (Houtt.) Stapf  | USTH 015649 | 0.24     | NA      | NE Lf Body pain, burns, canker sore, rheumatism                        |
| Boraginaceae    | *Ehretia microphylla* Lam.           | USTH 015638 | 0.30     | NA      | NE Lf Allergy, diabetes, hyperacidity                                  |
| Byttneriaceae   | *Abroma augusta* (L.) L.f.           | USTH 015637 | 0.29     | NA      | NE Bk, Lf, Rt Diabetes, menstrual problem, skin diseases and infection, stomach problem, wounds |
| Melochiaceae    | *Melochia umbellata* (Houtt.) Stapf  | USTH 015649 | 0.24     | NA      | NE Lf Body pain, burns, canker sore, rheumatism                        |
| Boraginaceae    | *Ehretia microphylla* Lam.           | USTH 015638 | 0.30     | NA      | NE Lf Allergy, diabetes, hyperacidity                                  |
| Byttneriaceae   | *Abroma augusta* (L.) L.f.           | USTH 015637 | 0.29     | NA      | NE Bk, Lf, Rt Diabetes, menstrual problem, skin diseases and infection, stomach problem, wounds |
| Melochiaceae    | *Melochia umbellata* (Houtt.) Stapf  | USTH 015649 | 0.24     | NA      | NE Lf Body pain, burns, canker sore, rheumatism                        |
| Boraginaceae    | *Ehretia microphylla* Lam.           | USTH 015638 | 0.30     | NA      | NE Lf Allergy, diabetes, hyperacidity                                  |
| Byttneriaceae   | *Abroma augusta* (L.) L.f.           | USTH 015637 | 0.29     | NA      | NE Bk, Lf, Rt Diabetes, menstrual problem, skin diseases and infection, stomach problem, wounds |
| Melochiaceae    | *Melochia umbellata* (Houtt.) Stapf  | USTH 015649 | 0.24     | NA      | NE Lf Body pain, burns, canker sore, rheumatism                        |
| Boraginaceae    | *Ehretia microphylla* Lam.           | USTH 015638 | 0.30     | NA      | NE Lf Allergy, diabetes, hyperacidity                                  |
| Byttneriaceae   | *Abroma augusta* (L.) L.f.           | USTH 015637 | 0.29     | NA      | NE Bk, Lf, Rt Diabetes, menstrual problem, skin diseases and infection, stomach problem, wounds |
| Melochiaceae    | *Melochia umbellata* (Houtt.) Stapf  | USTH 015649 | 0.24     | NA      | NE Lf Body pain, burns, canker sore, rheumatism                        |
| Boraginaceae    | *Ehretia microphylla* Lam.           | USTH 015638 | 0.30     | NA      | NE Lf Allergy, diabetes, hyperacibility                                  |
**Melastomataceae**

- *Melastoma malabathricum* (L.) Pers.  
  USTH 015661  
  0.34 NA LC NE Lf  
  Asthma, body pain, fatigue, muscle pain, spasm, ulcer

- *Medinilla* L.  
  USTH 015617  
  0.34 NA NE Lf  
  Abdominal pain, asthma, cough, gas pain and flatulence

- *Coleus anticinus* Lour.  
  USTH 015644  
  0.37 NA NE Lf  
  Anemia, asthma, cough, gas pain and flatulence, pneumonia, tuberculosis, ulcer

- *Angiopteris* Sw.  
  USTH 015635  
  0.30 LC NE Lf  
  Gas pain and flatulence, maternal care, stomach bloating, wounds

- *Urena* L.  
  USTH 015574  
  0.45 NA NE Lf  
  Diarrhea, gas pain and flatulence, new-born baby care, wounds

- *Gossypium* L.  
  USTH 015630  
  0.35 NA NE Sh  
  Constipation, cough, diarrhea, menstrual problem, postpartum care and recovery

- *Liensia* Bakh.  
  USTH 015603  
  0.11 LC NE Rt, St  
  Beriberi, body pain, labor and delivery enhancer, muscle pain, spasm

- *Vitex* L.  
  USTH 015562  
  0.43 NA NE Lf  
  Cough, gas pain and flatulence, headache, postpartum care and recovery

**Lauraceae**

- *Cinnamomum camphora* S. Vidal  
  USTH 015585  
  0.76 VU OTS EN  
  Bk, Br, Lt, Rc  
  Amoebiasis, cancer, cough, diarrhea, fatigue, hyperacidity, kidney problem, spasms, urinary problem

- *Litsea* (Jack) Hook.f.  
  USTH 015580  
  0.28 NA NE Bk, Rt  
  Asthma, cough, goiter, myoma, pneumonia, tumor

- *Machilus philippinensis* Merr.  
  USTH 015576  
  0.07 NA OTS NE  
  St  
  Cough, fatigue

**Lythraceae**

- *Lagerstroemia speciosa* (L.) Pers.  
  USTH 015596  
  0.35 NA NE Lf  
  Body pain, fever, kidney problem, ulcer, urinary problem

- *Gossypium hirsutum* L.  
  USTH 015553  
  0.25 VU NE Bk, St  
  Body pain, chilling, fever, hemorrhage, postpartum care and recovery

- *Sidar rhombifolia* L.  
  USTH 015601  
  0.69 NA NE Lf, Rt  
  Body pain, chickenpox, cough, kidney, menstrual, prostate and stomach problems, skin infection, wounds

- *Urena lobata* L.  
  USTH 015664  
  0.43 NA NE Wh  
  Animal bites, arthritis, bruises, fracture and dislocation, labor and delivery enhancer, postpartum care and recovery, rheumatism

**Marattiaceae**

- *Angiopteris evecta* Sw.  
  USTH 015658  
  0.11 NA OTS NE  
  Rt  
  Cramp and spasm, postpartum care and recovery

- *Medinilla teysmannii* Miq.  
  USTH 015581  
  0.25 NA NE Lf  
  Gas pain and flatulence, muscle pain, sprain and swellings

- *Melastoma malabathricum* L.  
  USTH 015588  
  0.25 NA NE Sh  
  Diarrhea, dysentery, fever, headache, hemorrhoids
| Family          | Species                                      | Accession Numbers | LC | NE | Rt | Bk | Lf | Description                                                                 |
|-----------------|----------------------------------------------|-------------------|----|----|----|----|----|-----------------------------------------------------------------------------|
| Meliaceae       | *Sandoricum koetjape* (Burm.f.) Merr.         | USTH 015624       | 0.41| LC | NE | Bk | Lf | Abdominal pain, diarrhea, skin diseases and infections                      |
|                 | *Swietenia mahagoni* (L.) Jacq.              | USTH 015671       | 0.30| EN | NE | Bk |    | Amoebiasis, cough, diarrhea, fever, hypertension                           |
| Menispermacae   | *Arcangelisia flavia* (L.) Merr.              | USTH 015600       | 0.81| NA | NE | Rt | St | Diabetes, jaundice, menstrual problem, myoma, skin diseases and infections, tumor, ulcer |
| Tinospora       | *crispa* (L.) Hook. f. & Thomson             | USTH 015566       | 0.70| NA | NE | St |    | Arthritis, body pain, diarrhea, malaria, menstrual problem, rheumatism, stomach trouble, ulcer, wounds |
| Moraceae        | *Ficus concinna* (Miq.) Miq.                  | USTH 015552       | 0.54| LC | NE | Bk | Lf | Rt | Arthritis, cancer, cyst, fracture and dislocation, kidney and prostate problems, tumors, wounds |
|                 | *Ficus fistulosa* Reinv. ex Blume            | USTH 015561       | 0.43| LC | NE | Bk | Rt | Asthma, colds, cough, diabetes, fatigue, hypertension, respiratory problem |
|                 | *Ficus pseudopalma* Blanco                   | USTH 015636       | 0.30| NA | EN | Lf | Rt | Diabetes, hemorrhage, hypertension, kidney problem, postpartum care and recovery, spasm, stomach trouble |
|                 | *Ficus septic* Burm.f.                       | USTH 015623       | 0.52| LC | NE | Lf | Rt | Asthma, body pain, cataract, fatigue, fever, herpes simplex, muscle pain, skin diseases and infections, stomach trouble, warts |
| Muntingiaceae   | *Morus alba* L.                              | USTH 015549       | 0.25| NA | NE | Lf |    | Asthma, colds, cough, muscle pain, pneumonia, spasm                        |
|                 | *Muntingia calabura* L.                      | USTH 015629       | 0.15| NA | NE | Lf |    | Abdominal pain, colds, diarrhea, headache, stomach trouble, ulcer          |
| Myristicaceae   | *Myristica agusansensis* Elmer               | USTH 015611       | 0.17| VU | EN | Bk |    | Measles, bronchitis and other respiratory diseases                          |
| Pandanaceae     | *Pandanus amaryllifolius* Roxb.              | USTH 015555       | 0.18| NA | NE | Lf |    | Heart, kidney, prostate and urinary problems                               |
| Phyllantaceae   | *Phyllanthus amarus* Schumach. &Thonn.       | USTH 015590       | 0.41| NA | NE | Wh |    | Colds, fever, jaundice, kidney, new-born baby care, stomach and urinary problems |
| Piperaceae      | *Piper aduncum* L.                           | USTH 015568       | 0.26| LC | NE | Lf |    | Asthma, cough, fracture and dislocation                                     |
|                 | *Piper decumum* L.                           | USTH 015544       | 0.95| NA | NE | St |    | Arthritis, body pain, cancer, cyst, diarrhea, poisoning, skin diseases and infections, tuberculosis, snake and insect bites, tumor, ulcers, wounds |
|                 | *Pipercl. nigrum*, ‘wild’                    | USTH 015560       | 0.74|    |    |    |    | Acne, animal bites, body pain, cancer, cyst, diarrhea, gas pain and flatulence, poisoning, skin diseases and infections, tumor, wounds |
| Poaceae         | *Eleusine indica* (L.) Gaertn.               | USTH 015569       | 0.43| LC | NE | Wh |    | Arthritis, diabetes, diarrhea, internal bleeding, kidney problem, postpartum care and recovery, spasm |
|                 | *Imperata cylindrica* (L.) P.Beauv.          | USTH 015605       | 0.10| LC | NE | Wh |    | Chickenpox, diarrhea, fever, measles, toothache, urinary problem,          |
|                 | *Paspalum conjugatum* P.J.Bergius            | USTH 015627       | 0.11| LC | NE | Rt |    | Diarrhea, dysentery, hair loss, wounds                                      |
| Family          | Scientific Name                      | Common Name                  | Code    | IUCN Status | Part(s) Used | Main Uses                                                                 |
|-----------------|--------------------------------------|------------------------------|---------|-------------|--------------|---------------------------------------------------------------------------|
| Rubiaceae       | *Uncaria lanosa* Wall.               |                               | USTH 015557 | NE          | St           | Diarrhea, stomach trouble                                                  |
| Rutaceae        | *(Melicope latifolia (DC.) T.G.Hartley) &*(Melicope cf. triphylla) &*(Micromelum minutum (G.Forst.) Wight & Arn.* |                               | USTH 015540 | NE          | Bk            | Cough                                                                     |
|                 |                                      |                               | USTH 015659 | NE          | St            | Carbuncle                                                                |
|                 |                                      |                               | USTH 015538 | NE          | Lf, St, Rt   | Arthritis, animal and insect bites, body pain, cancer, rheumatism, skin diseases and infections, swellings, ulcer, wounds |
| Solanaceae      | *Capsicum annuum* L.                 |                               | USTH 015626 | LC          | Lf           | Appetite enhancer, insect bites, skin diseases and infections              |
| Sparmanniaceae  | *Grewia laevigata* Vahl              |                               | USTH 015547 | LC          | Bk, Lf, Rt   | Body pain, diabetes, fatigue, fever, hypertension, labor and delivery enhancer, relapse, spasm |
| Urticaceae      | *(Dendrocnide luzonensis (Wedd.) Chew)* &*(Oreocnide erubescens (Blume) Miq.)* &*(Pipturus arborescens (Link) C.B.Rob.)* &*(Poaikilospermum acuminatum (Trecul.) Merr.* |                               | USTH 015572 | EN          | Rt            | Constipation, cough, fatigue, fever, hormonal imbalance, myoma          |
|                 |                                      |                               | USTH 015676 | LC          | Lf            | Cough, fever, stomach trouble                                           |
|                 |                                      |                               | USTH 015673 | NA          | Bk, Lf        | Anxiety and depression, body pain, fatigue, hyperacidity, skin diseases and infections, wounds |
|                 |                                      |                               | USTH 015655 | NA          | St, Rt        | Animal and insect bites, postpartum care and recovery, skin diseases and infections, sore eyes, ulcer |
| Verbenaceae     | *(Stachytarpheta jamaicensis (L.) Vahl)* &*(Xanthorrhoeacae)* &*(Diunella ensifolia (L.) DC.* |                               | USTH 015594 | NA          | Lf, Rt         | Ascariasis, boils, bruises, fever, sprain                                 |
|                 |                                      |                               | USTH 015656 | NA          | Lf, Rt        | Maternal care, milk production enhancer, postpartum care and recovery    |
| Zingerberaceae  | *(Curcuma longa* L.                   |                               | USTH 015674 | NA          | Rz            | Arthritis, diabetes, cough, fever, gas pain and flatulence, insect bites, menstrual problem, wounds |

Note: *IUCN: NA: Not Assessed, DD: Data Deficient, LC: Least Concern, VU: Vulnerable, EN: Endangered. *DENR Administrative Order 2017-11, CDFP: LC: Least Concern, NT: Near Threatened, OTS: Other Threatened Species. *CDFP: EN: Endemic, NE: Not Endemic. *Bk: barks; Br: branches; Fr: fruits; Fw: flowers; Lf: leaves; Rt: roots; Rz: rhizomes; Sh: shoots; St: stems; Wh: whole plants.
Conservation status and endemicity

While most of the medicinal plants identified from the five barangays of Bayugan City were not assessed for their conservation status based on the international (IUCN 2019) lists of threatened species, 38 plant species were recounted in different categories (Table 1; Figure 4). Conservation status of the documented medicinal plants showed 22 species as Least Concern (LC), three species as Vulnerable (VU), two species as Data Deficient (DD), and a single species as Endangered (EN), namely *Swietenia mahagoni* (L.) Jacq. The national list of threatened species (DENR Administrative Order 2017; CDFP; Pelser et al. 2011 onwards) revealed three species as Other Threatened Species (OTS), namely *Cinnamomum mercadoi* S.Vidal, *Machilus philippinensis* Merr., and *Angiopteris evecta* Sw; and a Near Threatened (NT) species, namely *Calamus megaphyllus* Becc.

Species distribution in terms of endemicity listed 11 species as endemic (12.6%) while the majority of species are distributed in other countries (87.4%), which are assumed to have been introduced or naturalized in the Philippines (CDFP; Pelser et al. 2011 onwards).

Discussion

Medicinal plants remain a valuable source of medicine in the healthcare system among the Agusan Manobo community in five upland barangays of Bayugan City, Philippines. All medicinal plants were evaluated equally among the Agusan Manobo community, and consistency of folk knowledge was observed.

The highest percentage of using leaves for treating diseases was also previously reported in earlier ethnomedical studies in the Philippines (Abe and Ohtani 2013; Ong and Kim 2014) and some other countries (Namukobe et al. 2011; Ahmad et al. 2015; Polat et al. 2015). The Agusan Manobo sometimes prepares more than one plant parts like leaves, stems, and bark of the same species and in combination with other species for a synergistic efficiency against certain diseases.

The highest FIVs among the documented medicinal plants could be supported by some related studies of the same family. Piperaceae (pepper family) comprising ca.
1,000 species of herbs distributed in tropical areas of India, Southeast Asia, and Africa (Scott et al. 2008) are known to have potential gastroprotective, antibacterial, antioxidant, and anticancer activities (Rekha et al. 2014). The Piper extracts are widely known, particularly in South Asian medicinal practices as an effective antibacterial and fever-reducing treatment (Scott et al. 2008). These reported bioactivities of Piper species may support ethnomedicinal claims of Agusan Manobo for Piperaceae as an effective treatment for skin diseases and infections.

Lauraceae (laurel family) with more than 2,500 species are distributed within the subtropics and tropics of eastern Asia, and South and North America (Simie et al. 2004). This family was found to have potential sources for chemopreventive agents (Shen et al. 2014). Bioactivity investigation of 27 Lauraceae trees by Lin et al. (2007) revealed great potential as cancer chemoprevention agents. Al-Dhubiab (2012) validated the traditional uses of Cinnaomum burmannii (Nees & T.Nees) Blume as treatment of diseases like nausea, flatulent dyspepsia, coughs, and chest complaints in Mexico. Also, C. burmannii exhibited pharmacological activities like analgesic, antibacterial, antioxidant, and antitumor activities (Al-Dhubiab 2012). These findings could support the key informants’ highest citation of Lauraceae for cough treatment.

Apocynaceae (dogbane family) consists of ca. 5,350 recognized species in 378 genera (Endress et al. 2018). Plant habits of this family are trees, shrubs, and sometimes herbs or vines, and their characteristic feature is usually the possession of milky sap (Wiart 2006). This family is one of the traditional medicinal families investigated as useful in treatment for boils, burns, and wounds (Patel 2014) as well as several skin problems (Alamgeer et al. 2018). These pharmacological properties could support the common uses of Apocynaceae for wound healing.

Euphorbiaceae (spurge family) consists of ca. 300 genera and ca. 7,500 species of mostly herbs and some shrubs or trees (Rahman and Akter 2013). A total of 16 species belonging to 8 genera of Euphorbiaceae were identified medicinally important aside from the economic value of the family (Ernst et al. 2015). Global medicinal uses of Euphorbia L. were reported as an effective treatment for digestive system disorders, skin ailments, respiratory complaints, inflammation, and injuries (Ernst et al. 2015). These findings could support the high citation of Euphorbiaceae among the Agusan Manobo as antipyretic medicinal plant species.

Moreover, this study showed P. decumnum has the highest RFC, which reveals new ethnomedicinal information as an antitode for insect and snake bites to date. Recently, P. decumnum was evaluated containing alkaloids, flavonoids, saponins, steroids, tannins, and fatty acids, and showed low toxicity when the stem ethanolic extract was subjected to normal lymphocytes from human blood (Dapar et al. 2020b). This species seems to be characterized distinctly as ant-associated Piper species (Dyer and Palmer 2004). A significant amount of an amide alkaloid, Piplartine, was also observed in Piper species, which is a potent anticancer agent (Raja et al. 2018). Several bioactive compounds and essential oils of other Piper species as strong agents of antioxidant, antibacterial, antifungal, and effective treatment for insect and snake bites were comprehensively reviewed by Salehi et al. (2009) which does not include the P. decumnum yet. An earlier study also revealed that Piper species were cited to be the most frequently used medicinal plant species for cuts and wounds among the Agusan Manobo of Sibagat, Philippines (Dapar et al. 2020c). The molecularly confirmed P. aduncum folk medicinal plant of Agusan Manobo possess antimicrobial activity and active constituents against pathogenic bacteria and low cytotoxic effect, which supported its wound healing potential (Dapar and Demayo 2017; Dapar et al. 2018; Dapar et al. 2020b). The presence of reported phytochemicals may also support the Agusan Manobo use of P. decumnum in treatment for insect and snake bites.

Of all documented species, Anodendron borneense remains no record of ethnobotanical and pharmacological investigations. However, a new triterpene ester and other chemical constituents from the aerial parts of Anodendron paniculatum A.DC. have been isolated for the first time, which exhibited significant cytotoxic activity against human cancer cell lines (Ho et al. 2018). However, no existing studies of A. paniculatum as a potential cure for problems of impotence and sterility as highly cited among the respondents in this study. Hence, the present study recommends further investigation of the biological and biochemical activities of both Anodendron species.

Koriem et al. (2013) demonstrated the antihyperglycemic, antihyperlipidemic and antiapoptotic activities of Micromelum minutum, which are all related to Micromelumin coumarin ingredient of the plant seeds. Identified chemical constituents for M. minutum also have potential biological property containing coumarins as potent cytotoxic agents against the T-lymphoblastic leukemia cell line (Susidarti et al. 2009). This finding supports the ethnomedicinal claims among Agusan Manobo for M. minutum as a treatment for cancer.

For Arcangelisiva flava, its yellow root revealed to have antimicrobial and acidity-stabilizing effects (Heryani and Nugroho 2015) while the stems demonstrated antioxidant and cytotoxic activities (Keawpradub et al. 2005). This plant has been scientifically investigated to contain several alkaloids (Verpoorte et al. 1982). The presence of its primary alkaloid, berberine, has been known to be active antimicrobial and antimalarial agents (Subeki et al. 2005). The presence of these alkaloids may support the tribal claims of A. flava as a treatment for ulcers.

Crude methanolic extracts of Cinnaomummercadoi exhibited antibacterial and antioxidant activities (Fuentes et al. 2010) as well as analgesic activity (Torres et al. 2003). Other Cinnaomum species like C. zeylanicum Breyne and C. cassia (L.) J.Presl were reported with antimicrobial activity and antitumor property, respectively, due to the present essential oils (Sharifi-Rad et al. 2017). These results could support the ethnomedicinal uses of C. mercadoi by the Agusan Manobo against diarrhea. C. mercadoi was also recorded with the highest RFC medicinal tree used among indigenous communities in
Esperanza, Agusan del Sur (Dapar et al. 2020d). C. mercadoi has also been reviewed for a number of local medicinal uses and phytochemical investigations as one of the interesting medicinal plants in Southeast Asia (Dapar 2020e).

Biological and biochemical investigations of all reported species under the same genus or family may imply comparable pharmacological activities in treatment against various health problems and conditions. Pharmacological investigations were recently conducted to validate medicinal plants utilized among the locals and tribal communities in Mindanao such as Gliricidia sepium (Jacq.) Kunth ex Steud. (Abdulaziz et al. 2019), Dracontomelon dao (Blanco) Merr. & Rolfe (Dela Peña 2019), Cocos nucifera L. (Uy et al. 2019), Atuna racemosa Raf. (Nadayag et al. 2019), and Allium ampeloprasum L. (Añídes et al. 2019).

The results of this study also revealed the occurrence and distribution of medicinal flora in the upland areas of the Agusan Manobo tribe in Bayugan City. Their ancestral territories are habitats of abundant medicinal plant resources that should be extensively documented and protected. These findings support the issuance of Certificate of Ancestral Domain Title (CADT) by the NCIP and DERN among indigenous communities, which serve as critical components in biodiversity preservation strategy. Indigenous protected areas program should be initiated by the LGU, which confer considerable economic and cultural benefits among the Manobo and other ICCs/IPs. The government should also reinforce the IPs right to use, access, and act as stewards of their ancestral lands. Both local people and the LGU should positively get involved in biodiversity conservation programs and strategies for sustainable protection and management of medicinal plant resources as part of the world’s cultural heritage.

This study presents the rich medicinal plant knowledge of Agusan Manobo living in five upland areas of Bayugan City, Agusan del Sur. Anthropogenic activities in the upland areas such as overexploitation, poaching, logging, and deforestation, hence, a need for conservation policy and strict protection must be implemented by the local government units. It is highly recommended for the Manobo peoples’ intervention to actively participate as key informants in governmental programs for conservation to sustain their cultural heritage of traditional medicine and conserve these cultural community resources. Ethnomedicinal appraisal such as this study could pave the way for further pharmacological investigations and clinical studies to validate folk medicinal uses of these plants.

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