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Ethnobotanical and phytochemical study of the medicinal plants used by Kanawan Aytas in Morong, Bataan, Philippines

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This study systematically evaluated the medicinal plants used by the Magbukún Ayta Negrito indigenous group in Sitio Kanawan, Morong, Bataan, Philippines, through ethnobotanical methods i.e., Use Value (UV), Fidelity Level (FL) and Informant Consensus Factor (ICF). Semi-structured interviews were used to gather data from 35 informants. All the plants mentioned were collected and identified. The World Health Organisation (WHO) use category and the number of use report for each botanical specimen were taken into account as well. The therapeutic uses of 61 plant taxa were documented against 12 categories of ailments. *Psidium guajava* and Category II (Neoplasms) had the highest UV and ICF values respectively. Five plants with notable ethnobotanical index values were subjected to phytochemical screening for bioactive compounds; all tested positive for sterols, flavonoids, glycosides and tannins, while *Alstonia scholaris* (Linn.) R. Br. and *Gonocaryum calleryanum* (Baill.) Becc. showed abundant amounts of alkaloids. This study highlights the rich culture and traditions of the Ayta Negrito indigenous group, although the results also indicate that ethnomedicinal knowledge is fading away. Nevertheless, this study opens up various avenues in pharmacological research and pharmacognosy.

Keywords: Ethnobotany, Kanawan Aytas, Medicinal plants, Pharmacognosy, Phytochemistry

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Ethnobotany encompasses the study of the indigenous perception, utilisation and management of plants by a specific community[1]. Eventually, it has evolved into a multi-disciplinary field of science that examines not only the plant-human relationship but also the ecological, economical, pharmacological and public health aspects[2]. At present, quantitative methods have been developed by pioneer ethnobotanists to describe the culinary, nutritional, and medicinal values of various plant species for a particular group of people[3-7].

As a multi-cultural nation, the Philippines has over 140 recognised living indigenous groups among the approximately 170 recorded ethnolinguistic groups[8]. With an estimated 12 million members, these indigenous people represent 10–20% of the total population of the country. Generally, the major classifications of the Philippine indigenous populations include *Ilongot, Igorot*, *Lumad*, *Mangyan*, *Negrito,* and *Palawan*[9].

Moreover, due to the lack of access to mainstream medicine, geographical issues, and poverty, the majority of indigenous people all around the world still heavily rely on medicinal plants to address health-related concerns[10]. Likewise, the immense knowledge of the Ayta Negrito indigenous groups as medicinal plant peddlers has been acknowledged by the Philippine National Commission on Indigenous Peoples.

Thus, this study was conducted to document the medicinal plants utilised by the Magbukún Ayta Negrito indigenous group in Sitio Kanawan, Morong, Bataan, and to evaluate their significance through pertinent ethnobotanical indices. This study hypothesised that culturally important medicinal plants contain high amounts of bioactive compounds. This research might serve as a preliminary basis for further elucidating pharmacological mechanisms and specifying the phytochemicals of the medicinal plants identified in this study.

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Methodology

Study area

Fieldwork was undertaken at the Kanawan Negrito Reservation Area or KNRA (14°41′N 120°16′E), the Magbukún Ayta settlement in Sitio Kanawan, Morong, Bataan (Fig. 1). KNRA is a portion of Aeta's 100 km^2 ancestral domain that includes areas of Subic Bay Forest Reserve and Bataan Natural Park[11].

Data collection

Random sampling was used to collect informant data from 35 informants during 6 weekends from November 2016 to February 2017[12]. The community's free, prior, and informed consent was obtained through the Tribal Council. Informants were asked to provide their name, age, sex, occupation, place of residence, all the medicinal plants they know, the illnesses these plants purportedly cure, and the preparation and route of administration of these medicinal plants. Interview in the Tagalog language was carried out individually and in isolation to avoid bias and influence in the answers. Voucher specimens of the medicinal plants mentioned were collected from the surrounding forests with the assistance of the Magbukún Ayta volunteers.

Species identification

The local names and descriptions of the samples were noted. Subsequent species identification was conducted with the aid of the Jose Vera Memorial Herbarium (PUH) of the University of the Philippines Diliman (UPD) Institute of Biology.

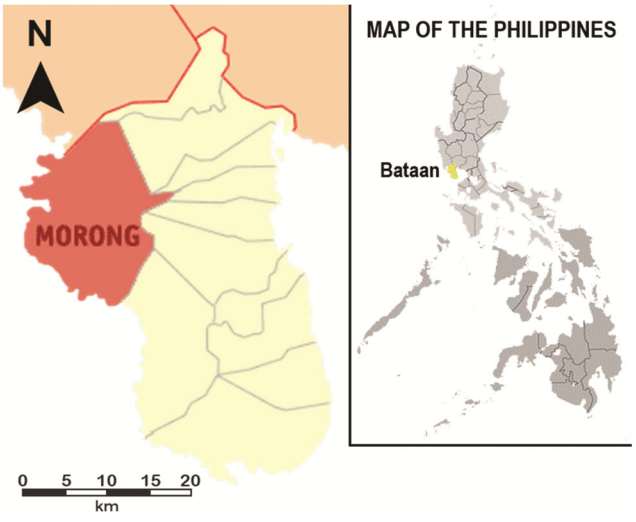

Fig. 1 — Location of the study site in the Bataan Peninsula (Google Maps, 2017)

Ethnobotanical data analyses

The following ethnobotanical indices were computed using the informant data gathered from the semi-structured interviews.

Use categories

Medicinal plant uses were grouped into categories provided by the International Classification of Diseases (ICD) of the World Health Organisation (WHO)[13]. The ICD categories are (I) parasitic and infectious diseases, (II) tumors and neoplasms, (III) metabolic and hormone-related disorders, (V) eye infections, (VII) cardiovascular diseases, (VIII) respiratory diseases, (IX) gastrointestinal tract infections, (X) integumentary diseases, (XI) diseases of the connective tissues, muscles, and bones, (XII) urogenital tract infections, (XIII) pregnancy, childbirth, newborn-related illnesses, (XIV) Unusual clinical signs and symptoms not elsewhere classified and (XV) other external trauma, poisoning, and injury.

Use Report

One use-report (UR) was counted each time an informant mentioned a plant taxon being used for a specific purpose; if more than one was under the same category, it was still considered as a single UR[14]. When at least two informants reported the same use for the same taxon, it was considered a multiple UR.

Use Value

Use value (UV) provides a weighted measure of the importance of each plant taxa based on the number of uses and the number of people that cite a given plant[15]. UV was computed using the formula:

$$UV = \Sigma U_i / N$$

Where, U_i is the UR count cited by each informant for a given taxon, and N is the number of people interviewed. Since use value is positively correlated with use-reports, a high use value implies the relative importance of that species. It should be noted, however, that UV does not take into consideration whether a taxon is used for either one or more purposes.

Fidelity Level

Fidelity Level (FL) determines which plant species are most preferred in treating a particular illness[16]. The higher the FL, the more popular a medicinal plant species is in the community. The index is expressed as the ratio between the number of informants who reported the plant's medicinal use for a specific

treatment and the overall number of informants who reported the taxon for any other usage inclusive of all other categories. The formula is:

$$FL = (I_p/I_u) \times 100$$

where I_p refers to the people who individually reported the use of a plant for a specific purpose, and I_u is the overall number of people who reported the plant for all purposes. The higher the FL value, the more exclusive a plant taxon is used for a particular purpose. Low FL values, on the other hand, indicate that a species is used for treating a wide variety of ailments.

Informant Consensus Factor

As a means to analyse the community's agreement on medicinal plant use per category, the Informant Consensus Factor (ICF) method was utilised. Initially termed Informant Agreement Ratio[17] (IAR), ICF has since been developed into a widely used index useful for identifying species with notable bioactive compounds[18]. It was determined using the following formula:

$$ICF = (N_{ur} - N_t) / (N_{ur} - 1)$$

Where, N_{ur} is the number of use-report per category, and N_t is the number of reported species utilized for that specific category. For categories where only a few medicinal plant taxa are used, high ICF values, i.e., close to 1.00 are generated, while in categories where there is disagreement on which species to use, the ICF value is expected to be low[19].

Phytochemical screening

Five (5) whole plant specimens with no table ethnobotanical index values, namely *Gonocaryum calleryanum* (Baill.) Becc., *Alstonia scholaris* (Linn.) R. Br., *Ficus septica* Burm.f., *Helianthus annuus* L., and Katuod (unidentified specimen) were sent to the Organic Chemistry Laboratory of the Standards and Testing Division of the Department of Science and Technology (DOST) Industrial Technology Development Institute (ITDI) for phytochemical screening.

AOAC extraction method followed by a respective test for the seven (7) following phytochemicals: alkaloids, flavonoids, glycosides, saponins, sterols, tannins, and triterpenes was done[20]. Qualitative results were then recorded and reported.

Permit and informed consent

Permit to conduct the study was granted by the Philippine National Commission on Indigenous Peoples pursuant to their implementing guidelines. The research objectives and significance were discussed to the participants with the assistance of the Tribal Council. Withdrawal from the interview any instance was presented as an option.

Results

Each informant's age was plotted in the graph below (Fig. 2) versus the number of medicinal plant taxa they mentioned (N_t). The initial coefficient of correlation (R^2) value was computed to be 0.717. However, after disregarding a single outlier, a relatively higher R^2 value of 0.8027 was garnered.

This study systematically documented 61 medicinal plant taxa used by the community from 28 plant families. One taxon was recorded from each of the following families: Amaranthaceae, Anacardiaceae, Apiaceae, Aristolochiaceae, Cactaceae, Cardiopteridaceae, Cyperaceae, Euphorbiaceae, Lygodiaceae, Lythraceae, Meliaceae, Moringaceae, Musaceae, Myrtaceae, Oxalidaceae, Phyllanthaceae, Sapindaceae, Sapotaceae, Selaginellaceae, Verbenaceae, and Zingiberaceae; two taxa from the family Annonaceae; three taxa from both the families Poaceae and Lamiaceae; four from both the families Apocynaceae and Asteraceae; five from the family Moraceae; and six from the family Fabaceae. Twelve plant taxa were not taxonomically identified due to the lack of samples available for collection during the span of the fieldwork.

The illnesses purportedly cured by the medicinal plants mentioned by the informants were categorized

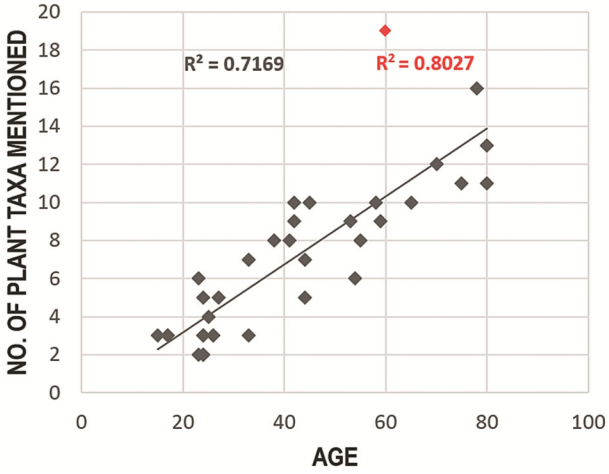

Fig. 2 — Age of each informant (x-axis) versus the number of medicinal plant taxa they mentioned. Shown is the initially computed R^2 value and the computed R^2 value after disregarding the outlier (◆).

into the ICD-10 categories using WHO guidelines (Table 1). The categorisation was verified by a licensed medical practitioner. ICD-10 Category II (Neoplasms) was found to have the highest FL value (1.00). Likewise, this category also garnered the highest ICF value along with Category X. Categories VIII and XI also both garnered high ICF values (0.85 and 0.86, respectively).

The plant taxon with the highest UV was *Psidium guajava* (0.54); followed by *Blumea balsamifera* (0.43) and *Vitex negundo* (0.43); then followed by *Streblus asper* (0.29), *Gonocaryum calleryanum* (0.29) and *Artemisia vulgaris* (0.29). All UV of each plant taxa are listed in Table 2.

The results of the phytochemical screening are summarized in Table 3. Notably, *Alstonia scholaris*

Table 1 — ICD-10 categories of the reported illnesses with corresponding FL of the most used taxon and ICF values

ICD-10 Classification	Category	Reported Diseases or Uses	FL%	ICF
Parasitic and infectious diseases	I	Malaria; measles	37.5	0.78
Tumors and neoplasms	II	Cancer	100.0	1.00
Metabolic and hormone-related disorders	III	Diabetes; kidney stones	26.3	0.40
Cardiovascular diseases	VII	Hypertension	33.3	0.50
Respiratory diseases	VIII	Cough; asthma	30.2	0.85
Gastrointestinal tract infections	IX	Toothache; constipation; diarrhea; intestinal worms; mouth sores	26.2	0.72
Integumentary diseases	X	Boil; skin eruptions	40.0	1.00
Connective tissue, muscle, and bone diseases	XI	Arthritis	62.5	0.86
Urogenital tract infections	XII	Irregular or delayed menstruation	83.3	0.80
Pregnancy and newborn-related illnesses	XIII	Abortion; post-natal care	33.3	0.40
Unusual and abnormal clinical signs and symptoms	XIV	Stomachache; headache; spams; fever, backache; u*sog* (affliction attributed to an encounter with a stranger)	9.0	0.58
Other external trauma, poisoning, and injury	XV	Wounds; snakebites; dislocations and fractures	25.0	0.71

Table 2 — Medicinal plants used by the Kanawan Aytas in Morong, Bataan, Philippines

Family, Species	Local Name	UR	UV	Part Used	Medicinal Use	Utilization
Amaranthaceae						
Hebanthe eriantha	*Suma*	3	0.09	Roots; Bark	Wounds; stomachache; abortive	E Boiled then applied to wound area; I decoction drank
Anacardiaceae						
Spondias purpurea	*Sinigwelas*	2	0.06	Bark	Mouth sores	E Sap applied to affected area
Annonaceae						
Annona muricata L.	*Guyabano*	6	0.17	Leaves	Hypertension; kidney stones; fever; spasms	I Boiled then decoction drank
Goniothalamus amuyon (Blanco) Merr.	*Amuyong*	2	0.06	Fruit; seeds	*Usog* (affliction attributed to an encounter with a stranger)	E Worn as necklace
Apiaceae						
Centella ulugurensis (Engl.) Domin	*Takip Kohol*	5	0.14	Leaves	Diarrhea; stomachache; constipation	I Heated then sap drank
Apocynaceae						
Alstonia scholaris (Linn.) R. Br.	*Darita/Dirita*	8	0.22	Bark; Leaves	Malaria; stomachache; abortive agent	I Boiled then decoction drank
Rauvolfia serpentina	*Serpentina*	4	0.11	Leaves	Cough; fever; constipation; abortive	I Decoction drank
Tabernaemontana macrocarpa Jack	*Lampada*	4	0.11	Leaves	Cough; Irregular or delayed menstruation	I Boiled then decoction drank
Tabernaemontana pandacaqui Poir.	*Pandakaki*	4	0.11	Shoots; Leaves	Headache; wounds	E Applied as salve on the head; Applied to the affected area
Aristolochiaceae						
Aristolochia tagala Cham.	*Malaube*	5	0.14	Bark; roots	Stomachache; fever	I Crushed then decoction drank

(*Contd.*)

Table 2 — Medicinal plants used by the Kanawan Aytas in Morong, Bataan, Philippines (*Contd*.)

Family, Species	Local Name	UR	UV	Part Used	Medicinal Use	Utilization
Asteraceae						
Artemisia vulgaris L.	*Damong-maria*	10	0.29	Leaves	Cough	I Boiled then decoction drank
Blumea balsamifera (L.) DC.	*Sambong*	15	0.43	Leaves	Cough	I Boiled then decoction drank
Chromolaena odorata (L.) R.M. King & H. Rob	*Hagonoy/ Latok*	4	0.11	Leaves	Wounds and cuts	E Sap applied to affected area
Helianthus annuus L.	*Mirasol*	5	0.14	Leaves	Fractures; dislocations	E Heated then applied to affected area
Cactaceae						
Opuntia cochenillifera (L.) Mill.	*Dilang Baka*	1	0.03	Roots	Fever	I Chewed
Cardiopteridaceae						
Gonocaryum calleryanum (Baill.) Becc.	*Lunas Bundok*	10	0.29	Leaves	Constipation; stomachache; malaria; snake bites	I Boiled then decoction drank
Cyperaceae						
Cyperus rotundus	*Mutha*	3	0.09	Roots	Fever	I Boiled then decoction drank
Euphorbiaceae						
Antidesma bunius	*Bignay*	1	0.03	Bark	Kidney stones	I Boiled then decoction drank
Fabaceae						
Gliricidia sepium (Jacq.) Steud.	*Kakawate*	7	0.20	Leaves	Severe wounds; rashes	E Crushes then applied to affected area
Lablab purpureus	*Bataw*	2	0.06	Leaves	Wounds	E Directly applied to affected area
Mimosa pudica L.	*Makahiya*	2	0.06	Roots	Fever	I Boiled then decoction drank
Pachyrhizus erosus	*Singkamas*	1	0.03	Tuber	Pink eye	E Juice applied to eyes
Pithecellobium dulce (Roxb.) Benth.	*Kamatsile*	1	0.03	Bark	Toothache	E Boiled then chewed
Tamarindus indica L	*Sampalok*	3	0.09	Leaves	Cough; spasms; fever	I Boiled then decoction drank
Lamiaceae						
Hyptis suaveolens (L.) Poit.	*Lukolukong Kabayo*	5	0.14	Leaves	Diarrhea; constipation	I Heated then sap drank; boiled then decoction drank
Origanum vulgare	*Oregano*	3	0.09	Leaves	Cough	I Boiled then decoction drank
Vitex negundo L.	*Lagundi*	15	0.43	Leaves	Cough	I Boiled then decoction drank
Lauraceae						
Persea americana Mill.	*Avocado*	2	0.06	Leaves	Diarrhea; stomachache	I Boiled then decoction drank
Lygodiaceae						
Lygodium circinatum (Burm. f.) Sw.	*Nito*	5	0.14	Leaves; Roots	Kidney stones	I Boiled then decoction drank
Lythraceae						
Lagerstroemia speciosa (L.) Pers	*Banaba*	5	0.14	Roots	Kidney stones; fever; spasms	I Boiled then decoction drank
Meliaceae						
Sandoricum koetjape (Burm.f.) Merr.	*Santol*	1	0.03	Leaves	Fever	E Boiled then decoction used for bathing

(*Contd*.)

Table 2 — Medicinal plants used by the Kanawan Aytas in Morong, Bataan, Philippines (*Contd.*)

Family, Species	Local Name	UR	UV	Part Used	Medicinal Use	Utilization
Moraceae						
Ficus balete Merr.	*Balite*	1	0.03	Bark	Fractures	E Crushed then applied to affected area
Ficus nota (Blanco) Merr.	*Tibig*	3	0.09	Leaves	Backache	E Directly applied to affected area
Ficus pseudopalma	*Lubi-lubi*	4	0.11	Bark; roots	Diabetes	I Boiled then decoction used for bathing
Ficus septica (Burm. f)	*Hawili*	2	0.06	Leaves	Cancerous tumors	E Applied as salve
Streblus asper Lour.	*Takang Usa*	10	0.29	Leaves	Malaria; diarrhea;	I Boiled then decoction drank
Moringaceae						
Moringa oleifera	*Malunggay*	5	0.14	Leaves	Toothache; wounds	I Decoction drank; crushed then applied to affected area
Musaceae						
Musa spp.	*Saging*	5	0.14	Leaves	Stomachache	E Heated then applied to stomach area
Myrtaceae						
Psidium guajava	*Bayabas*	19	0.54	Shoots; leaves	Diarrhea; wounds	I Boiled the decoction drank; E heated, crushed, then applied to affected area
Oxalidaceae						
Averrhoa bilimbi	*Pias*	5	0.14	Leaves	Measles	E Boiled then decoction used for bathing
Phyllanthaceae						
Glochidion spp.	*Marantik*	2	0.06	Roots	Toothache; malaria	I Decoction drank
Poaceae						
Cymbopogon spp.	*Tanglad*	2	0.06	Leaves	Hypertension	I Boiled then decoction drank
Imperata cylindrica	*Cogon*	8	0.23	Roots	Fever	I Boiled then decoction drank
Schizostachyum lumampao (Blanco) Merr.	*Buho*	3	0.09	Leaves	Fever	I Boiled then decoction drank
Sapindaceae						
Lepisanthes fruticosa (Roxb.) Leenh.	*Balinawnaw*	3	0.09	Leaves	Backache	E Directly applied to affected area
Sapotaceae						
Chrysophyllum cainito	*Caimito*	1	0.03	Leaves	Diarrhea	I Boiled then decoction drank
Selaginellaceae						
Selaginella sp	*Kayumkom*	4	0.11	Leaves	Cough	I Boiled then decoction drank
Verbenaceae						
Lantana camara L.	*Sapinit*	5	0.14	Roots; Leaves	Diarrhea	I Boiled then decoction drank
Zingiberaceae						
Curcuma longa	*Luyang Dilaw*	1	0.03	Rhizome	Hypertension	I Crushed, boiled, then decoction drank
Unidentified						
-	*Balbagawak*	2	0.06	Leaves	Stomachache	E Heated then applied on the stomach
-	*Balintato*	2	0.06	Leaves; Bark	Post-natal care; fever	I Boiled then decoction drank

(*Contd.*)

Table 2 — Medicinal plants used by the Kanawan Aytas in Morong, Bataan, Philippines (*Contd.*)

Family, Species	Local Name	UR	UV	Part Used	Medicinal Use	Utilization
-	*Gabi-gabihan*	4	0.11	Leaves	Boils	E Heated then applied to boil
-	*Kahoy Dalaga*	5	0.14	Roots; Leaves	Irregular or delayed menstruation	I Boiled then decoction drank
-	*Kalinag*	1	0.03	Bark	Fever	E Directly applied to forehead
-	*Katuod*	7	0.2	Leaves	Diarrhea	I Heated then sap drank
-	*Kulot-kulotan*	2	0.06	Leaves	Stomachache	E Directly applied to stomach
-	*Kaytana*	4	0.11	Roots	Post-natal care	I Boiled then decoction drank
-	*Pintalbuli*	3	0.09	Leaves; Roots; Bark	Spasms	I Heated then sap drank
-	*Samat-samatan*	6	0.17	Leaves	Arthritis; wounds; purgative	I Boiled then decoction drank; E sap applied to affected area
-	*Tagiwalay*	3	0.09	Leaves	Kidney stones	I Boiled then decoction drank
-	*Talapan*	1	0.03	Bark	Wounds	E Crushed and applied to affected area

Utilization: I, internal route of administration; E, denotes external

Table 3 — Phytochemical screening results

	Ficus septica (Burm. F)	Katuod (unidentified specimen)	*Helianthus annuus* L.	*Gonocaryum calleryanum* (Baill.) Becc.	*Alstonia scholaris* (Linn.) R. Br.
Sterols	++	++	+	+	++
Triterpenes	-	+	+	+	+
Flavonoids	+	+	+	+	+
Alkaloids	++	++	+	+++	+++
Saponins	-	+	-	-	+
Glycosides	+	+	+	+	+
Tannins	+	+	+	+	+

Note: (-) absence of constituents; (+) traces; (++) moderate; (+++) abundant

(Linn.) R. Br. and *Gonocaryum calleryanum* (Baill.) Becc. tested positive for alkaloids in abundant amounts.

Discussion

Descriptive statistics revealed that there is an accepted degree of correlation (R^2 = 0.7169—0.8027) between the age of an informant and an increase in the number of medicinal plant taxa known (Fig. 2). The outlier removed from the second determination of correlation coefficient was found to be the Magbukún tribal elder leader. As such, he is expected to possess more knowledge of traditional therapeutic practices. Therefore, in future ethnobotanical studies, he can be tapped as a valuable key informant.

Expectedly, older members of the community were able to name more medicinal plant taxa when interviewed, due largely perhaps to their cumulative learning. A notable implication of this, however, is that younger members of the community may not be as immersed in this tradition. In fact, no one from the community's youth has reported participating in medicinal plant collection and use.

This apparent generational difference reflects the community's varying, and ultimately, changing, experiences with the world around them. The longstanding tradition of the Aytas' reliance on medicinal plants, like all cultural phenomena, is invariably linked to and therefore affected by the ever-changing conditions of society[21]. Unfortunately, the data garnered in this study suggests that the community's rich medicinal plant tradition is in a state of decline and might disappear in the future without intervention[22].

The best-represented families of plant were Fabaceae with 6 species mentioned, Moraceae with 5, and both Apocynaceae and Asteraceae with 4 each. Plants under the Fabaceae family have been widely utilized by the pharmaceutical industry due to the valuable medicinal properties they possess[23].

A host of plant species (e.g. *Ficus carica*) from the Moraceae family has also been documented to exhibit anticancer, hepatoprotective, antihyperglycemic, and antimicrobial activities[24]. Likewise, certain plants from the Apocynaceae family have been proven to exhibit analgesic, anti-inflammatory, antihypertensive, antiplasmodial, antimicrobial, anti-ulcer, and antitumorigenic activities[25]. Many Asteraceae species on the other hand exhibit the presence of triterpenoids, flavonoids, coumarins, quinones, volatile oils, carotenoids, and amino acids and have therefore been used in cytotoxic, spasmolytic, and spasmogenic studies[26].

The systematic data tabulated in Table 2 could be of great help for future researchers and investigators in comparing available knowledge, especially in the field of pharmacognosy. *Psidium guajava*, the plant with the highest determined UV (0.54), is the most important medicinal plant in their culture, as it garnered the highest number of UR. *Psidium guajava*, listed among the 10 medicinal plants endorsed by the Philippine Department of Health, has also been reported to be utilised by other Ayta Negrito communities in the country for a variety of medicinal purposes including for pregnancy care and as a remedy for diarrhea, stomachache, dizziness, toothache, phlegm, colds, indigestion, oral sores, and wounds.[27.]

Vitex negundo and *Blumea balsamifera* also garnered relatively high UV's (both 0.43). At present, *Vitex negundo* has been widely commercialised as cough medicine. In terms of conservation issues, species which are the most important based on UV might be prone to be excessive harvesting[28]. There has been an instance of the overharvesting of *Blumea balsamifera* in an Ati community in Guimaras[22]. Therefore, conservation measures must be undertaken against overharvesting of important plants in their culture based on the determined UV's.

It was found that *Ficus septica* Burm.f. (Hawili) was exclusively used for treating neoplasms (100% FL). This entails exclusivity in its medicinal plant usage. As such, efficacy can be inferred. This has been the basis for its selection in phytochemical screening for bioactive compounds. Another Philippine indigenous community, the Ifugao, reportedly utilise *Ficus septica* for treating diarrhea, cough, malaria, and stomach problems[29].

The ICF value of each of the 12 categories was computed using UR and ranged from 0.40 to 1.00 as shown in Table 2. Category II (Neoplasms) and Category XII to X (Diseases of the subcutaneous tissue) both garnered ICF values of 1.00. This means that only a single plant was used in treating those illnesses under those categories. The plants under categories with high ICF values generally contain bioactive compounds[19]. This was used as the basis for selecting plants to undergo phytochemical screening.

Plant sterols have long been studied for the beneficial effects on diseases like prostate hyperplasia, colon cancer, and skin xanthomas due to their anti-atherogenic properties, cholesterol acyltransferase and lipoprotein lipase activities[30]. All the medicinal plants screened for phytochemicals tested positive for the presence of sterols. This might explain their wide usage in treating a huge variety of illnesses.

All of the medicinal plants screened also tested positive for the presence of triterpenes. These phytochemicals have been implicated in various pharmacological mechanisms such as being immunomodulator compounds[31]. Again, this lends credence to the efficacy of the medicinal plants tested in treating various ailments.

Flavonoids, long been known to exhibit anti-inflammatory activities, have also been found in all the plants tested; many of these are utilized to address allergic reactions problems[32].

Alkaloids have also been found to be present in all the plants tested in which *Alstonia scholaris* (Linn.) R. Br. and *Gonocaryum calleryanum* (Baill.) Becc. in particular showed abundant amounts. Specific alkaloids like quinine, ephedrine, homoharringtonine, vincamine, quinidine, morphine, and chelerythrine are reported to have anti-malarial, anti-asthma, anti-cancer, vasodilatory, anti-arrhythmic, analgesic and antibacterial properties, respectively[33,34]. Further studies should be performed, however, to fully characterise the alkaloids in these plants and investigate *in vivo* pharmacological mechanisms. The Ayta Negrito communities in Dinalupihan, Bataan have also been reported to use *Alstonia scholaris* in treating cough, colds, phlegm, and malaria and as an anti-septic for post-pregnancy care[27].

Glycosides and tannins were also found present in all the plant specimens. Both of these phytochemicals have anti-diarrheal properties and certain tannins are known to be antimicrobial and anti-helminthic[35,36].

Conclusion

This study has documented and evaluated the medicinal plants used by the Ayta Negrito indigenous group in Sitio Kanawan, Morong, Bataan. This study

has also confirmed that medicinal plants are still the major source of healthcare in the community and are still the most popular source for primary healthcare needs. It was however found that the knowledge of the younger generation of Aytas on medicinal plants is declining and that measures must be undertaken to preserve this invaluable indigenous knowledge. The plants screened for secondary metabolites all tested positive for bioactive compounds and can thus be used in the future for pharmacognosy.

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Conflict of Interest

The authors declare no competing or conflict of interest.

Authors' Contributions

Conceptualization: NCB; Application for study permits: NCB; Supervision and coordination of the study: RJGT; Conducting of the interviews: NCB and RJGT; Data analysis: NCB and RJGT; Approval of the final version of the manuscript: NCB and RJGT.

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