



RESEARCH ARTICLE

Ethnobotanical study of medicinal plants used by the Tualis of Ifugao, Cordillera Administrative Region, Philippines

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Abstract

Indigenous groups have used the ethnomedicinal plants in the country as part of their healthcare, but no record was found among the Tualis of Lamut, Ifugao, Philippines. Thus, this study aims at documenting their ethnomedicinal knowledge. Semi-structured interviews were utilized to obtain the data from twenty informants, which were then evaluated by some quantitative indices for analysis, including the relative frequency of citation (RFC), use value (UV), relative importance (RI), fidelity level (FL) and informant consensus factor (ICF). There were 87 plant species recorded, represented by 47 families, with the majority belonging to the Asteraceae family (9 species). The most prevalent plant part utilized for healing was the leaves (30%). These plants treated 54 diseases and conditions, where the most typical medicinal use was for cough (13.59%) and diarrhoea (6.62%). The most typical preparation method was decoction and drinking was the most commonly used mode of administration. *Moringa oleifera* (0.60) and *Ananas comosus* (0.50) had the highest RFC values. *Annona muricata* (1.0) had the highest UV value, while *Diplazium esculentum* and *M. oleifera* had the highest RI value of 0.88. The plant species mostly used with a 100% fidelity level were *Carica papaya*, *Psidium guajava*, *Senna alata* and *Momordica charantia*. Diseases of the endocrine system (0.60) have the greatest ICF value. These results could aid possible pharmaceutical studies and will help emphasize the value of preserving biodiversity and traditional knowledge.

Keywords

Ethnomedicine, ethnobotany, Tualis, traditional knowledge, Ifugao

Introduction

Humanity has historically benefited greatly from plant species. Understanding how various communities of indigenous groups connect with their resources, especially for medicinal and therapeutic uses, has been made possible via scientific research on these plants (1). Indeed, ethnobotanical studies paved the way for synthetic and natural drug discoveries (2). Ethnobotanical know-how has served as the foundation for numerous fruitful drug screening initiatives recently (3). Globally, almost 80% of people still utilize traditional medicines, especially those who reside in rural areas of developing nations (4). There are almost 374,000 plant species worldwide (5); South Asia is home to 7,000 of these species (6), and Southeast Asia has roughly 6,500 species (7). Conversely, more than half of all medical products have their roots in ethnomedicine (8).

There are over 1500 known medicinal plants in the Philippines that are utilized by conventional healers (9), and 120 of those species were evaluated for their efficacy and safety, as verified by studies (10). Long before the Spanish colonization, the Filipino people used medicinal plants for generations. This culture is still in place today, especially in remote areas where access to modern medicine is limited (11). A number of studies were carried out around the nation to document various plant species used by the indigenous groups (10, 12–13). The scope and depth of the indigenous groups' vast amount of traditional knowledge, as well as that of other major rural populations with abundant plant gene resources, remain unexplored despite the surveys that have already been carried out among them (10). In addition, the country possesses a wealth of ethnomedical knowledge among indigenous populations; however, this insight is only passed through oral traditions and firsthand experience to the following generation and this competence has decreased due to the younger generation's lack of interest (12). Moreover, ethnobotanical research is being emphasized these days to preserve the knowledge held by these indigenous groups, as this knowledge has the potential to generate novel medicines, address the biodiversity crisis for coming generations and guarantee the survival of their valuable and abundant plant genetic resources (14).

The Cordillera Administrative Region is one of the nation's ethnographic regions and is characterized by towering mountain ranges, breezy plateaus, warm valleys, numerous rice paddies, lush forests, shallow but swift rivers and kaingin on the sides of mountains (15). It is the homeland of various indigenous groups, each having their own culture, languages, heritage and livelihoods (16). There are some ethnobotanical studies conducted in the region, like Conklin's publication on the 156 economically significant plants in Banaue and Kiangan, Ifugao, that made significant contributions to Philippine ethnobotany (17). Other research studies included Ibalois of Benguet (18), Igorots of Kalinga (19), Mayoyao, the province of Ifugao (20), Kalanguyas of Ifugao (21), Benguet (22), and Ayangans of Aguinardo, Ifugao (23). Despite all these studies, there is still a need to explore the traditional knowledge of other indigenous groups in the region since it is a precious resource (24).

Ifugao is one of the region's provinces, which is inhabited mainly by indigenous communities like the Tualis, Ayangans and Kalanguyas, as identified by the National Commission on Indigenous Peoples (15). The people's rich cultural heritage includes the use of natural remedies (24). In their healthcare system, traditional medicine is very important and oral traditions have been used for generations to pass down the knowledge of medicinal plants (12). The Tualis of Lamut, Ifugao, have no recorded data on ethnomedicinal plant utilization. Also, no quantitative ethnomedicinal studies have been conducted among the indigenous people in the province. Furthermore, according to the literature review in the Cordillera, ethnobotanical research in the province of

Ifugao was carried out in selected towns several years ago: Banaue and Kiangan (17), Mayoyao (20), Tinoc (21) and Aguinardo (23). Hence, to better understand the botanical remedies utilized by the Tualis of Ifugao, this study intends to provide information on the scientific names in alphabetical order with voucher specimen numbers, Tualis names, families, ethnomedicinal applications, plant parts used, preparation methods, administration methods, relative frequency of citation (RFC), use value (UV), relative importance (RI), fidelity level (FL) and informant consensus (ICF) values.

Materials and Methods

Study Area

Lamut, Ifugao, is one of the eleven municipalities in the landlocked province of Ifugao, in the Cordillera Administrative Region, Philippines (Figure 1). It is located on the south eastern portion and the south entry point of the province. It is approximately 16° 39' North, 121° 13' East and it lies on the eastern foot of the Cordillera Mountains with an elevation of about 267 feet above sea level and 159.65 square kilometers of land area (20). It is bisected by the national road in a north-south direction from Lagawe to the province of Nueva Vizcaya; on the east, it is bound by the Ibulao River; and on the west, partly by the Lamut River, which traverses through south western barangays. It is a fourth-class municipality with 18 barangays, namely Bimpal, Ambasa, Hapid, Hollowon, Lawig, Lucban, Mabatobato, Magulon, Nayon, Pieza, Pugol, Poblacion East, Poblacion West, Panopdopan, Payawan, Sanafe, Salamague and Umilag. The terrain is quite rough and rugged, basically mountainous in the northern and western parts; the south eastern parts have the lowest slope grade and the lowest elevations. December through April is considered the dry season, whereas May through November is considered the wet season. Nevertheless, both the wet and dry seasons occur year-round, frequently varying daily and occasionally resulting in extended periods of either dry or wet weather. The soil is mostly clay loam and sandy loam. The rocks are predominantly composed of sedimentary rocks. In terms of vegetation, it has a diverse range due to its topical climate, which includes rice fields, forested areas, indigenous plant species, agricultural crops, grasslands and open spaces. Its population, as of the 2020 census, is 26,235, with 160 people per square kilometer of density (25). It is a multicultural metropolitan municipality primarily inhabited by the Ayangans and Tualis, both of the province's ethnolinguistic groups, as well as other groups like the Tagalogs, Ilocanos and others.

Ethnobotanical Data Collection

The Ifugao State University Review Committee first approved this undertaking prior to the collection of data. Fieldworks were undertaken based on the purpose of the study from January to March 2023. A free prior informed consent was obtained, permits were secured, semi-structured interviews were conducted, group discussions were held, plants and field observations were made and

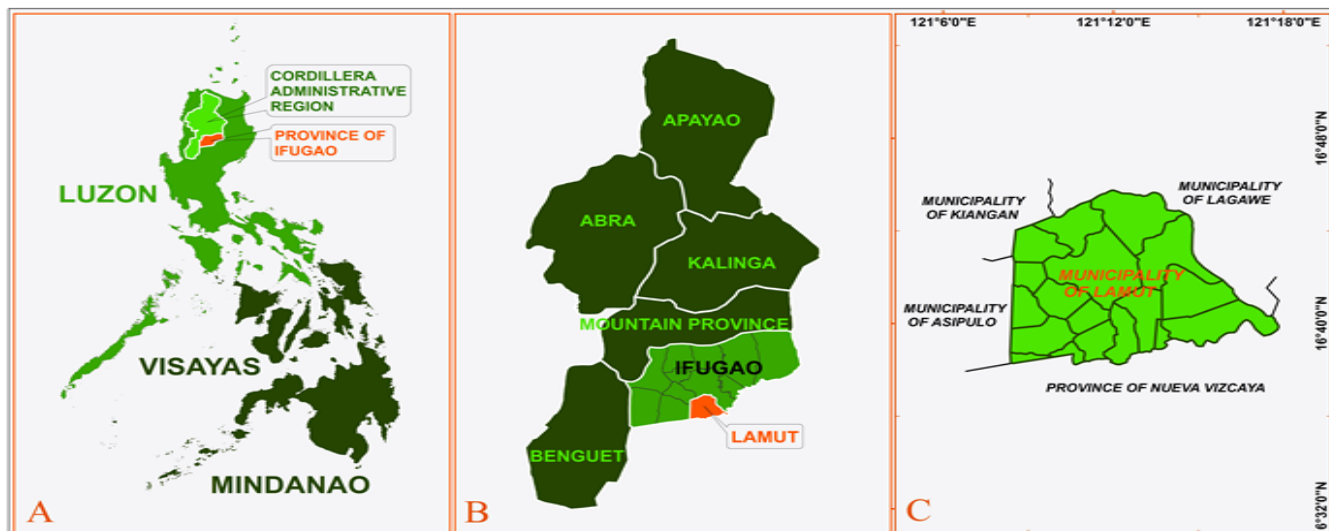


Fig. 1. Location of the study area in shade: A. Province of Ifugao, Cordillera Administrative Region in the Philippine archipelago; B. Municipality of Lamut, Ifugao in the Cordillera Administrative Region; C. Municipality of Lamut

medicinal plant species were collected. This study is purely academic, and the survey was coordinated with the local officials of Lamut, Ifugao.

Purposive sampling was used to conduct interviews with twenty informants. A semi-structured questionnaire was used to elicit the demographic and socioeconomic profile of the informants, specifically their gender, location/ barangay, age, education, occupation, monthly income and expertise about the different ethnomedicinal plants they use or know about in case of health problems. They were also asked about the Tawali name or vernacular, ethnomedicinal application, plant parts used, preparation method and administration method.

Interviews and field trips with the informants were carried out to gather ethnomedicinal plant information and to take photo documentation. The gathered plant samples were labelled and information about the plants was noted. Plant specimens were collected and then they were immediately pressed, dried and kept following conventional herbarium procedures (26).

Phytoimages (27), Co's Digital Flora of the Philippines (28) and Plants of the World (29), among other internet databases, were utilized as sources to identify the many medicinal plants. Other species that were not identified were forwarded to the Philippine National Herbarium for authentication and identification. Their family and scientific names were verified using the World Flora Online (30), Tropicos (31), and the International Plant Names Index (32) databases. All voucher specimens were kept at the Ifugao State University Herbarium (IFSUH) for reference and future study.

Data Analysis

The relative frequency of citation (RFC) indicates the significance of each plant species among the Tawalis of Lamut, Ifugao. It was computed using the formula (33): $RFCs = (\text{number of informants who mentioned the use of a plant species}) / (\text{total number of informants})$.

The use value (UV), an indicator that measures the relative importance of useful plants, was obtained by the formula (34): $UV = (\text{number of citations per species}) / (\text{total number of informants})$.

The relative importance (RI) of the medicinal plants was calculated using the formula (33): $RIs = [RFCs_{(max)} + RNUs_{(max)}] / 2$, where $RFCs_{(max)}$ were calculated by dividing the frequency citation of a given species by the frequency citation of the species with the highest frequency citations, while $RNUs_{(max)}$ were calculated by dividing the number of use or disease categories of a given species by the number of use categories of the species with the highest number of use or disease categories.

The fidelity level (FL) was used to calculate the proportion of the most valued and recommended medicinal plant for a certain condition or use category using the formula (35): $FL = (\text{number of informants who cited or mentioned the use of a medicinal plant for a particular disease category}) / (\text{total number of informants who cited that plant for any other use or purpose})$.

Informant consensus factor (ICF) was the degree of agreement among study participants about the use of a certain plant species to cure a particular disease. It was calculated using the formula (36): $ICF = (N_{ur} - N_t) / (N_{ur} - 1)$, where N_{ur} is the number of use reports or citations for each illness category and N_t denotes the number of species utilized in that category.

Results

Table 1 shows the demographic and socioeconomic status of the informants. The Tawali informants, of whom fifteen (75%) were female and five (25%) were male, were aged between 45 male and 75 years old, with a mean female age of 64. They completed primary school (50%), higher education (30%) and high school (20%). The majority (65%) were farmers, followed by retired teachers (20%) and health workers (15%). Most (35%) of the informants earn more than P20,000 per month, followed by those earning between P5001 and P10,000 (30%) and the lowest (15%) earn between P10,001 and P20,000.

Table 1. Demographic and socioeconomic status of the informants

Category	Sub-category	Number of Informants, f	Percentage, %
Gender	Male	15	75
	Female	5	25
Location/Barangay	Nayon	8	40
	Bimpal	8	40
	Payawan	4	20
Age	≤49	1	5
	50-59	2	10
	60-69	7	35
	≥70	10	50
Education	Primary	10	50
	Secondary	4	20
	Higher Education	6	30
Occupation	Farming	13	65
	Health Workers	3	15
	Teaching (Retired)	4	20
Income (in terms of Pesos)	<P5000.00	4	20
	P5001-P10,000	6	30
	P10,001-P20,000	3	15
	>P20,000	7	35

This ethnomedicinal investigation identified 87 plant species in about 47 families used by the Tuwalis of Lamut, Ifugao, Cordillera Administrative Region, Philippines (Table 2). The complete inventory of the ethnoflora consists of scientific names in alphabetical order with voucher specimen numbers, Tawali names, families, ethnomedicinal applications, plant parts used, preparation methods, administration methods, RFC, UV, and RI values.

The families Asteraceae with nine species, Poaceae with five species, Myrtaceae with four species, Moraceae with four species, Solanaceae with four species and Fabaceae with four species contain the majority of medicinally important plant species (Figure 2).

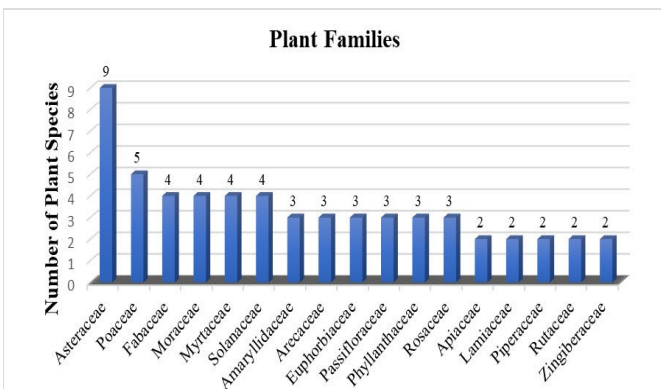


Fig. 2. The different families of ethnomedicinal plants used by the Tuwalis of Lamut, Ifugao

To combat a diversity of diseases, all plant parts from numerous species of plants were used, as shown in Figure 3. The leaves were the most often used parts for therapeutic purposes (39%), followed by the fruits (32%), the root (8%), the stem (6%), the bark (3%), the flower (3%) and the seeds (3%).

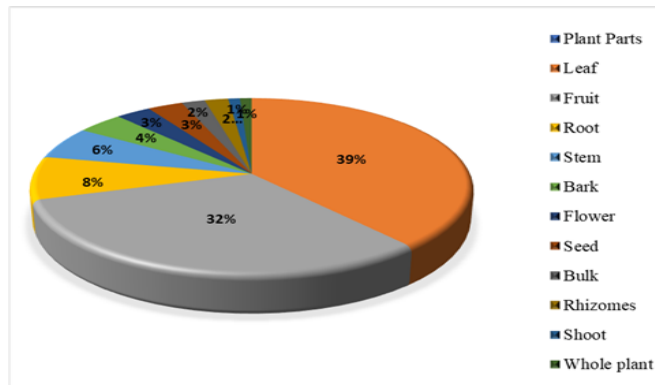


Fig. 3. Different plant parts used by the Tuwalis of Ifugao, Philippines

The medicinal applications of the Tuwalis are shown in Figure 4. There were 54 diseases that were treated by these medicinal plants. The most frequent medicinal applications were cough (13.59%), followed by diarrhea (6.62%), wounds (6.62%), the common cold (5.92%), dysentery (3.83%), lowering blood pressure (3.48%) and urinary tract infection (3.48%). The lowest medicinal applications were reported for the 23 medical diseases and conditions.

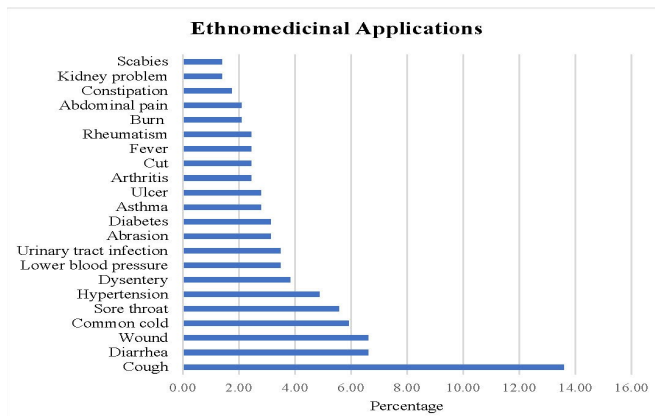


Fig. 4. Different ethnomedicinal applications by the Tuwalis of Lamut, Ifugao

Decoction (47 plants), raw (35 plants), extraction (29 plants), heating or blanching (7 plants) and infusion (1 plant) were the most commonly utilized methods to prepare medicinal plants (Figure 5).

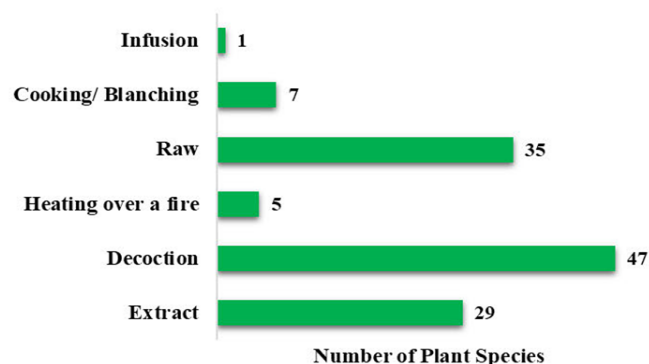


Fig. 5. Different preparations used by the Tuwalis of Lamut, Ifugao

Table 2. Ethnomedicinal plants used by the Tualis of Lamut, Ifugao

Scientific Name	Tuwali Name	Family	Ethno medicinal Application	Plant Part Used	Preparation Method	Administration Method	RFC	UV	RI
<i>Ageratum conyzoides</i> L.	Hapon-hapon	Asteraceae	Wound, abrasion, rheumatism, burn, cough	Leaf, stem, Flower	Pound/ crush the leaves, stem, and flower; Boil the leaves, stem, and flower, then separate the decoction	Apply the extract directly to the affected body part; Drink decoction	0.35	0.71	0.60
<i>Allium cepa</i> L.	Danggu	Amaryllidaceae	Lower blood pressure, cough, asthma	Bulb, Leaf	Clean and eat the raw bulb and leaves; Boil the bulb and leaves, then separate the decoction.	Directly eaten; Drink decoction	0.25	0.60	0.40
<i>Allium ramosum</i> Linn.	Kutchay	Amaryllidaceae	Wound, burn, scabies, headache, fever	Leaf	Heat and pound/ crush the leaves	Apply directly to the affected body part	0.45	0.56	0.69
<i>Allium sativum</i> L.	Amput	Amaryllidaceae	Lower blood pressure, cough, lower cholesterol, diabetes	Bulb	Clean and wash the bulb; Heat over the fire the bulb of the Amput	Directly eaten	0.4	0.50	0.58
<i>Alpinia</i> sp.	Kalawag	Zingiberaceae	Diarrhea, wound, abrasion, ringworm	Fruit, Rhizome	Pound the rhizome; Peel and slice the fruit	Apply extract directly to the affected body part; Directly eat the fruit	0.3	0.67	0.50
<i>Amaranthus spinosus</i> L.	Alayyon	Amaranthaceae	Burn, wound, snake bite	Leaf	Pound/ crush the leaves; Boil the leaves, stem, and flower, then separate the decoction	Apply extract directly to the affected body part; Drink decoction	0.25	0.60	0.40
<i>Ananas comosus</i> (L.) Merr.	Pinya	Bromeliaceae	Cough, common cold, sore throat, lower blood pressure, hypertension, wound, abrasion	Leaf, Fruit	Pound/crush the leaves; Peel the fruit and slice	Apply extract directly to the affected part; Directly eat the fruit	0.5	0.70	0.85
<i>Annona muricata</i> L.	Guyabano	Annonaceae	Uric acid, arthritis, cough, common cold, sore throat, diabetes, hypertension, lower blood pressure	Leaf, Fruit	Boil the leaves, then separate the decoction; Slice the fruit	Drink decoction; Directly eat the fruit	0.4	1.00	0.83
<i>Antidesma bunius</i> (L.) Spreng.	Bunne	Phyllanthaceae	Urinary tract infection, cough, common cold, diabetes, kidney problem	Leaf, Bark, Fruit	Boil the leaves and bark, then separate decoction; Wash the fruit	Drink decoction; Directly eat the fruit	0.3	0.83	0.56
<i>Antidesma ghaesembilla</i> Gaertn.	Podpod	Phyllanthaceae	Hypertension, cough	Fruit	Wash the fruit, then eat	Eat directly the fruit	0.15	0.67	0.25

<i>Antidesma montanum</i> Blume	Bunne	Phyllanthaceae	Cough, common cold, ulcer, constipation, abdominal pain	Fruit, Leaf	Boil the leaves then separate the decoction; Wash the fruit	Drink decoction; Directly eat the fruit	0.35	0.71	0.60
<i>Areca catechu</i> L.	Moma	Arecaceae	Tapeworm infection	Fruits	Slice and chew the fruit	Eat the fruit	0.1	0.50	0.15
<i>Artemisia vulgaris</i> L.	Herbaka	Asteraceae	Cough, scabies	Leaf	Boil the leaves, then separate the decoction	Drink decoction or use decoction for washing the affected body part	0.25	0.40	0.33
<i>Artocarpus heterophyllus</i> Lam.	Langka	Moraceae	Tapeworm infection, ulcer, diarrhea, boil, abdominal pain, skin infection, asthma	Seed, Leaf	Boil or grill the seeds; boil the leaves, then separate the decoction	Directly eat the cooked seed; Drink decoction; Use decoction for washing skin infections	0.4	0.88	0.77
<i>Averrhoa bilimbi</i> L.	Piyas	Oxalidaceae	Cough, lower blood pressure, hypertension	Fruit	Wash the fruit	Eat directly	0.2	0.75	0.35
<i>Bidens pilosa</i> L.	Onwad	Asteraceae	Wound, abrasion, ulcer, diabetes	Leaf, Stem, Flower, Root	Pound/ crush the leaves, stems and flowers; Boil the roots, then separate the decoction	Apply extract directly to the affected body part; Drink decoction	0.3	0.67	0.50
<i>Blumea balsamifera</i> (L.) DC.	Sambung	Asteraceae	Urinary tract infection, cough, asthma, abdominal pain, diarrhea	Leaf	Boil the leaves and separate the decoction	Drink decoction	0.3	0.83	0.56
<i>Calamus rotang</i> L.	Lituku	Arecaceae	Cough, kidney problems, urinary tract infection, diarrhea	Fruit, Root	Boil the roots; Eat the fruit	Drink decoction; Directly eat the fruit	0.4	0.50	0.58
<i>Capsicum frutescens</i> L.	Paktiw	Solanaceae	Boil, cut, cough, dog bite	Fruit, Leaf	Pound the fruit; Boil the leaves, then separate the decoction	Apply extract directly to the affected body part; Drink decoction	0.4	0.50	0.58
<i>Carica papaya</i> L.	Tupaya	Caricaceae	Wound, rabies, dog bites	Fruit	Peel a portion of the fruit for the sap to flow	Apply sap directly to the affected body part	0.2	0.75	0.35
<i>Centella asiatica</i> (L.) Urb.	Kannapa	Apiaceae	Wound, abrasion, cough, fever	Leaf	Pound/ crush the leaves; Boil the leaves, then separate the decoction	Apply extract directly to the affected body part; Drink decoction	0.35	0.57	0.54
<i>Chrysophyllum cainito</i> L.	Star apple	Sapotaceae	Diarrhea	Fruit	Slice the fruit	Directly eat the fruit	0.1	0.50	0.15
<i>Citrus aurantiifolia</i> (Christm.) Swingle	Dalayap	Rutaceae	Cough, common cold, hypertension, lower blood pressure	Fruit, Leaf	Slice the fruit and extract the juice; Boil the leaves, then separate the decoction	Drink the extract directly; Drink decoction	0.3	0.67	0.50
<i>Citrus microcarpa</i> Bunge	Kalamansi	Rutaceae	Cough, common cold, hypertension, lower blood pressure	Fruit	Slice the fruit and extract the juice	Drink extract	0.3	0.67	0.50

<i>Cocos nucifera</i> L.	Niyug	Arecaceae	Urinary tract infection, kidney	Fruit	Open the fruit and pour the juice in a	Drink the juice	0.2	0.50	0.29
<i>Coffea arabica</i> L.	Kapeh	Rubiaceae	Dyspepsia	Fruit	Pound the roasted seeds, then boil	Drink directly	0.15	0.33	0.19
<i>Colocasia esculenta</i> (L.) Schott	Pihing	Araceae	arthritis, skin disorders	Stem, Leaf	Cut a portion of the stem or leaf	Apply sap directly to the affected body part	0.15	0.67	0.25
<i>Crassocephalum crepidioides</i> S.Moore	Onwad	Asteraceae	Wound, abrasion, abdominal pain, indigestion	Leaf	Pound/ crush the leaves; Boil the leaves, then separate the decoction	Apply extract directly to the affected body part; Drink decoction	0.3	0.67	0.50
<i>Cyanthillium cinereum</i> (L.) H.Rob.	Apiit	Asteraceae	Cough, asthma, diarrhea	Leaf, Stem, Root	Boil the leaves, stems, and roots, then separate the decoction	Drink decoction	0.2	0.75	0.35
<i>Cymbopogon citratus</i> (DC.) Stapf	Tanglag	Poaceae	Diarrhea, dyspepsia, hypertension, abdominal pain	Leaf	Boil the leaves, then separate the decoction	Drink decoction	0.3	0.67	0.50
<i>Cyperus cyperoides</i> (L.) Kuntze	Laduloy	Cyperaceae	Rheumatism, arthritis	Leaf	Pound/ crush the leaves	Apply the extract to the affected body part	0.15	0.67	0.25
<i>Cyperus imbricatus</i> Retz.	Balayyang	Cyperaceae	Tapeworm infection	Root	Boil the roots, then separate the decoction	Drink decoction	0.1	0.50	0.15
<i>Daucus carota subsp. sativus</i> (Hoffm.) Arcang.	Karots	Apiaceae	Constipation, ulcer, improve eyesight	Root	Boil the roots, then separate the decoction; Peel the skin	Drink extract; Eaten directly	0.35	0.43	0.48
<i>Debregeasia longifolia</i> (Burm.f.) Wedd.	Ngamoy	Urticaceae	Scabies, dysentery	Leaf	Pound/ crush the leaves	Apply extract directly to the affected body part	0.2	0.50	0.29
<i>Dillenia philippinensis</i> Rolfe	Ukapon	Dilleniaceae	Cough, chest pain due to coughing	Fruit	Wash the fruit	Eat directly the fruit	0.15	0.67	0.25
<i>Diplazium esculentum</i> (Retz.) Sw.	Appaku	Athyriaceae	diarrhea, rheumatism, dysentery, headache, fever, wounds, hypertension, constipation	Leaf, Stem	Boil the leaves/ stem, then separate the decoction; Pound/ crush the leaves/ stem; Cook/ blanch the leaves/stem	Drink decoction; Wash the affected body part using the decoction; Eat directly the cooked/ blanched leaves/ stem	0.45	0.89	0.88
<i>Elaeocarpus bontocensis</i> Merr.	Hawili	Elaeocarpaceae	Diarrhea, dyspepsia, dysentery	Seeds	Pound the seeds, then soak in water	Drink directly	0.35	0.43	0.48
<i>Euphorbia hirta</i> L.	Tawa-tawa	Euphorbiaceae	Fever, dengue, urinary tract infection, body pains	Bark, Leaf, Stem	Boil the leaves, then separate the decoction; Heat the bark, then pound; Pound the leaf and stem	Drink decoction: Apply extract to the affected area	0.35	0.57	0.54
<i>Ficus minahassae</i> Miq.	Alimit	Moraceae	Rheumatism	Leaf	Pound/ crush the leaves	Apply extract directly to the affected body part	0.1	0.50	0.15

<i>Ficus pseudopalma</i> Blanco	Niniog	Moraceae	Urinary tract infection, kidney stone	Leaf	Boil the leaves, then separate the decoction	Drink decoction	0.2	0.50	0.29
<i>Hibiscus rosa-sinensis</i> L.	Gumamela	Malvaceae	Boil	Flower	Pound/ crush the flower	Apply extract to the affected part	0.1	0.50	0.15
<i>Imperata cylindrica</i> (L.) Raeusch.	Gulun	Poaceae	Urinary tract infection, kidney problem	Root	Boil the roots, then separate the decoction	Drink decoction	0.2	0.50	0.29
<i>Ipomoea batatas</i> (L.) Lam.	Luktu	Convolvulaceae	Anemia	Shoot	Cook/blanch the shoots; Boil the shoots, then separate the decoction	Eat directly the cooked shoots; drink decoction	0.1	0.50	0.15
<i>Jathropa curcas</i> L.	Gatawa	Euphorbiaceae	Swollen muscle, rheumatism, arthritis, fracture, sprain	Stem, Bark, Leaf	Heat the stem, bark, and leaves, then pound	Apply directly to the affected body part	0.4	0.63	0.65
<i>Kalanchoe pinnata</i> (Lam.) Pers.	Katakataka	Crassulaceae	Wound, diarrhea, kidney stone, urinary tract infection, cough, arthritis	Leaf	Pound/ crush the leaves; Boil the leaves, then separate the decoction	Apply extract directly to the affected body part; Drink decoction	0.35	0.86	0.67
<i>Lagerstroemia speciosa</i> (L.) Pers.	Banaba	Lythraceae	Urinary tract infection, diabetes, lower blood sugar, hypertension	Leaf, Bark	Boil the leaves and bark, then separate decoction; Wash the fruit	Drink decoction	0.3	0.67	0.50
<i>Mahinot esculenta</i> Crantz	Kahoy	Euphorbiaceae	Fever, headache	Leaf	Boil the leaves, then separate decoction	Drink decoction	0.2	0.50	0.29
<i>Mangifera indica</i> L.	Manggah	Anacardiaceae	Cough, common cold, sore throat, dyspnea	Fruit, Leaf	Boil the leaves, then separate decoction; Peel and slice the fruit	Drink decoction; Eat fruit	0.4	0.50	0.58
<i>Melastoma malabathricum</i> L.	Butgi	Melastomataceae	Diarrhea, cough, common colds, sore throat	Fruit	Peel the fruit	Eat directly	0.3	0.67	0.50
<i>Mikania scandens</i> (L.) Willd.	Kawal	Asteraceae	Wound, ulcer, cut	Leaf	Pound/ crush the leaves	Apply extract to the affected body part	0.25	0.60	0.40
<i>Mimosa pudica</i> L.	Bain-bain	Fabaceae	Dysentery, urinary tract, toothache	Flower	Boil the flower, then separate decoction; Pound/ crush flower then apply to the affected body part	Drink decoction; Apply extract directly to the affected body part	0.3	0.50	0.44
<i>Miscanthus sinensis</i> Andersson	Bilau	Poaceae	Diarrhea	Leaf, Root	Boil the leaves/ roots, then separate decoction	Drink decoction	0.1	0.50	0.15
<i>Momordica charantia</i> L.	Apapet	Cucurbitaceae	Diabetes, abdominal pain, cough, lower blood sugar	Leaf, Fruit	Boil the leaves, then separate decoction; Cook the fruit	Drink decoction; Eat directly the fruit	0.3	0.67	0.50
<i>Moringa oleifera</i> Lam.	Marunggay	Moringaceae	Hypertension, diabetes, lactation, wound, cut, cough	Leaf	Pound/ crush the leaves; Boil the leaves, then separate the decoction	Apply extract directly to the affected body part; Drink decoction	0.6	0.50	0.88

<i>Morus alba</i> L.	Malberi	Moraceae	Lower cholesterol, wounds, abrasion	Leaf, Fruit	Wash the fruit; Pound/ crush the leaves	Eat fruit; Apply extract directly to the affected body part	0.25	0.60	0.40
<i>Muntingia calabura</i> L.	Saraisa	Muntingiaceae	Diarrhea, dehydration	Fruit	Wash and eat the fruit	Eat directly the fruit	0.15	0.67	0.25
<i>Musa acuminata</i> Colla	Balat	Musaceae	Diarrhea, cuts, burn, abrasion	Fruit	Peel the half-ripe fruit	The fruit is directly eaten; Put the banana peelings in the affected body part	0.3	0.67	0.50
<i>Nepeta cataria</i> L.	Katnip	Lamiaceae	Cough, diarrhea, Asthma	Leaf, Fruit	Wash the fruit; Boil the leaves, then separate the decoction	Eat the fruit; Drink decoction	0.25	0.60	0.40
<i>Oryza sativa</i> L.	Boga	Poaceae	Dyspepsia, stomach upset, heartburn	Seed	Cook the rice grain, then remove the rice water when it is boiling	Drink the hot rice water	0.25	0.60	0.40
<i>Passiflora edulis</i> Sims	Masaplora	Passifloraceae	Sore throat, common cold, cough	Fruit	Slice the fruit	Eat directly the fruit	0.25	0.60	0.40
<i>Passiflora foetida</i> L.	Masaplora	Passifloraceae	Sore throat, common cold, cough	Fruit	Slice the fruit	Eat directly the fruit	0.25	0.60	0.40
<i>Peperomia pellucida</i> (L.) Kunth	Panpansit	Piperaceae	Sore throat, burn diarrhea, cut, rheumatism, gout	Leaf	Boil the leaves, then separate the decoction; Pound/ crush the leaves	Drink decoction; Apply extract directly to the affected body part	0.4	0.75	0.71
<i>Persea americana</i> Mill.	Abukadu	Lauraceae	Diarrhea	Leaf, Bark	Boil the leaves or bark, then separate the decoction	Drink decoction	0.1	0.50	0.15
<i>Physalis angulata</i> L.	Kamkamatis	Solanaceae	Asthma, fever, malaria, wound, cut	Leaf	Boil the leaves, then separate the decoction; Pound/ crush the leaves	Drink decoction; Apply extract directly to the affected body part	0.35	0.71	0.60
<i>Piper betle</i> L.	Hapid	Piperaceae	Wound, cut	Leaf	Pound/ crush the leaves	Apply extract directly to the affected area	0.15	0.67	0.25
<i>Plectranthus amboinicus</i> (Lour.) Spreng.	Oregano	Lamiaceae	Asthma, cough	Leaf	Boil the leaves, then separate the decoction	Drink decoction	0.2	0.50	0.29
<i>Portulaca oleracea</i> L.	Papait	Portulacaceae	Wound, burn, skin inflammation, diarrhea, dysentery	Leaf	Pound/ crush the leaves; Boil the leaves, separate the decoction	Apply extract directly to the affected body part; Drink decoction	0.35	0.71	0.60
<i>Psidium guajava</i> L.	Bayyahbat	Myrtaceae	Diarrhea, wound, dysentery, skin pruritus	Fruit, Leaf	Wash the unripe fruit; Boil the leaves, then separate the decoction	Eat directly the unripe fruit; Decoction is used for washing the affected body part	0.4	0.50	0.58
<i>Psophocarpus tetragonolobus</i> (L.) DC.	Bulligan	Fabaceae	Ulcer	Fruit	Cook/ blanch the fruit	Eat directly	0.1	0.50	0.15
<i>Pteridium aquilinum</i> (L.) Kuhn	Appaku	Dennstaedtiaceae	Arthritis, diarrhea, constipation, ulcer	Rhizomes	Boil the rhizome, then separate the decoction	Drink decoction	0.3	0.67	0.50

<i>Rorippa indica</i> (L.) Hiern.	Kunde	Brassicaceae	Cough, common cold, burn, toothache	Whole plant	Boil the whole plant, then separate the decoction	Drink decoction; Decoction is also use to wash the affected body part	0.3	0.67	0.50
<i>Rubus ellipticus</i> Sm.	Buyot	Rosaceae	Cough, fever, sore throat	Fruit	Wash and eat the fruit	Eat the fruit directly	0.2	0.75	0.35
<i>Rubus fraxinifolius</i> Poir.	Pinit	Rosaceae	Sore throat, common cold, cough	Fruit	Wash the fruit	Eat the fruit directly	0.25	0.60	0.40
<i>Rubus rosifolius</i> Sm.	Pinit	Rosaceae	Sore throat, common cold, cough	Fruit	Wash the fruit	Eat the fruit directly	0.25	0.60	0.40
<i>Senna alata</i> (L.) Roxb.	Akapulko	Fabaceae	Ringworm, athlete's foot, scabies	Leaf	Pound/ crush the leaves	Apply extract directly to the affected body part	0.3	0.50	0.44
<i>Sicyos edulis</i> Jacq.	Sayote	Cucurbitaceae	Hypertension	Fruit	Cook or boil the fruit	Eat directly	0.15	0.33	0.19
<i>Solanum lycopersicum</i> L.	Kamatis	Solanaceae	Cough, common cold, sore throat	Fruit	Slice the fruit	Eat the fruit	0.25	0.60	0.40
<i>Solanum nigrum</i> L.	Amti	Solanaceae	Toothache, sore throat	Leaf	Pound/ crush the leaves; Boil the leaves, then separate the decoction	Apply extract directly to the affected body part; Drink decoction	0.15	0.67	0.25
<i>Solanum pimpinellifolium</i> L.	Kammatit	Solanaceae	Burns, sunburn	Fruit	Slice the fruit	Apply extract directly to the affected body part	0.15	0.67	0.25
<i>Sonchus arvensis</i> L.	Gagatang	Asteraceae	Cough, asthma	Root	Boil the roots, then separate the decoction	Drink decoction	0.15	0.67	0.25
<i>Syzygium cumini</i> (L.) Skeels	Tabuyug	Myrtaceae	Cough, common cold, sore throat, hypertension, lower blood pressure	Fruit	Peel the fruit	Eat the fruit directly	0.45	0.56	0.69
<i>Syzygium polycephaloides</i> (C.B.Rob.) Merr.	Bulinayu	Myrtaceae	Cough, common cold, sore throat, hypertension, lower blood pressure	Fruit	Wash the fruit	Eat directly the fruit	0.35	0.71	0.60
<i>Syzygium samarangense</i> (Blume) Merr. & L.M.Perry	Upang	Myrtaceae	Cough, common cold, sore throat	Fruit	Wash the fruit	Eat the fruit directly	0.2	0.75	0.35
<i>Vaccinium jagorii</i> Warb.	Gutmo	Ericaceae	Diabetes, hypertension, lower blood pressure	Fruit	Wash the fruit	Eat the fruit directly	0.25	0.60	0.40
<i>Vigna unguiculata</i> (L.) Walp.	Antak	Fabaceae	Constipation	Fruit	Cook/ blanch the fruit; Boil the fruit, then separate decoction	Eat the fruit directly; Drink decoction	0.1	0.50	0.15
<i>Vitex negundo</i> L.	Lagundi	Lamiaceae	Cough	Leaf	Boil the leaves, then separate the decoction	Drink decoction	0.1	0.50	0.15
<i>Zingiber officinale</i> Roscoe	Laya	Zingiberaceae	Arthritis, rheumatism, cough, sore throat	Root	Boil the pounded roots, then separate decoction	Drink decoction	0.45	0.44	0.63

The most frequent method of administration was to consume the infusion or decoction of the 47 medicinal herbs (Figure 6). Eating raw or cooked medicinal plants (38 plants), applying the plants topically to the infected body parts (34 plants) and bathing or washing (5 plants) were the other forms of administration.

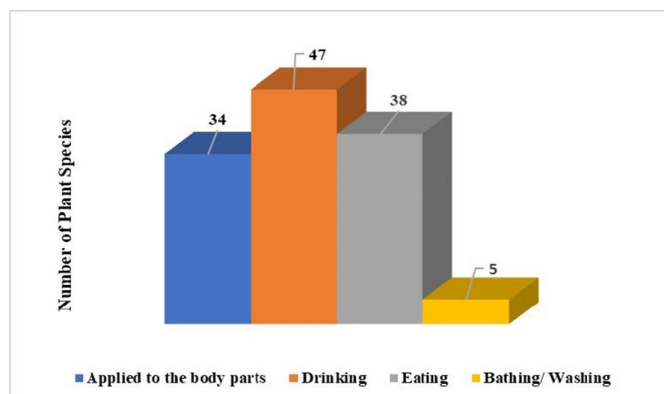


Fig. 6. Different method of administrations used by the Tuwalis of Lamut, Ifugao

The high frequency of reference or mention by all informants (RFC) establishes the usefulness of the plant (24). RFC ranged from 0.10 to 0.60, with a mean of 0.26. *Moringa oleifera* Lam. (0.60) has the highest RFC, followed by *Ananas comosus* (L.) Merr. (0.50), *Allium ramosum* Linn. (0.45), *Diplazium esculentum* (Retz.) Sw. (0.45), *Syzygium cumini* (L.) Skeels (0.45) and *Zingiber officinale* Roscoe (0.45). The lowest RFC (0.10) was obtained for the 11 plant species (Table 3).

Table 3. Medicinal plants with the most RFC, UV, and RI

Rank	Medicinal Plants	RFC	Rank	Medicinal Plants	UV	Rank	Medicinal Plants	RI
1	<i>Moringa oleifera</i>	0.6	1	<i>Annona muricata</i>	1.00	1	<i>Diplazium esculentum</i>	0.88
2	<i>Ananas comosus</i>	0.5	2	<i>Diplazium esculentum</i>	0.89	1	<i>Moringa oleifera</i>	0.88
3	<i>Allium ramosum</i>	0.45	3	<i>Artocarpus heterophyllus</i>	0.88	2	<i>Ananas comosus</i>	0.85
3	<i>Diplazium esculentum</i>	0.45	4	<i>Kalanchoe pinnata</i>	0.86	3	<i>Annona muricata</i>	0.83
3	<i>Syzygium cumini</i>	0.45	5	<i>Antidesma bunius</i>	0.83	4	<i>Artocarpus heterophyllus</i>	0.77
3	<i>Zingiber officinale</i>	0.45	5	<i>Blumea balsamifera</i>	0.83	5	<i>Peperomia pellucida</i>	0.71

Table 4. Medicinal plants with 100% FL

Medicinal Plants	Local Name	Medicinal Uses	Fidelity Level (%)
<i>Carica papaya</i>	Tupaya	Dog bites	100
<i>Psidium guajava</i>	Bayyahbat	Diarrhea	100
<i>Senna alata</i>	Akapulko	Ringworm	100
<i>Momordica charantia</i>	Apapet	Diabetes	100

For the various plant species, the UV levels varied from 0.33 to 1.0, with a mean of 0.61. *Annona muricata* L. (1.0) had the greatest UV, followed by *D. esculentum* (0.89), while the lowest were *Coffea arabica* L. (0.33) and *Sicyos edulis* Jacq. (0.33) (Table 3).

A medicinal plant with a high RI value is often utilized in various illness categories and has a high frequency of citations from informants. The RI values had a mean of 0.43, ranging from 0.15 to 0.88. *D. esculentum* (0.88), *M. oleifera* (0.88), *A. comosus* (0.85) and *A. muricata* (0.83) had the highest RI values. The lowest RI values (0.09) were reported for 11 plant species (Table 3).

A high FL value signified that a considerable number of informants within the ethnic group strongly suggested and favored a certain type of medicinal plant as a remedy for a specific illness. The most commonly used medicinal plants with a 100% fidelity level were *Carica papaya* L., *Psidium guajava* L., *Momordica charantia* L. and *Senna alata* (L.) Roxb. (Table 4).

The different diseases and conditions were categorized based on their indigenous uses as described by the informants and ICF results were obtained from each group. Endocrine system diseases had the greatest ICF value of 0.60, such as diabetes and lower blood sugar. The second highest ICF values were for other diseases (0.57) like abdominal pain, dehydration and improved eyesight, while the least ICF was reported for fever (Table 5).

Table 5. ICF values of the different disease categories mentioned by the Tualis of Lamut, Ifugao

Categories of Indigenous Uses	N _{ur}	N _t	ICF
Endocrinological (diabetes)	11	5	0.60
Others (abdominal pain, dehydration, improve eyesight)	8	4	0.57
Dermatological (wound, cuts, burns, scabies, skin inflammation, skin pruritus, boil, skin inflammation, boil, ring worm, abrasion, skin infection, athletes' foot)	58	27	0.54
Otorhinolaryngological (cold, toothache, sore throat)	35	18	0.50
Urological (urinary tract infection, kidney problem, kidney stone)	15	8	0.50
Gynecological-Obstetrics (lactation)	3	2	0.50
Neurological (headache)	3	2	0.50
Musculoskeletal (swollen muscle, rheumatism, sprain, fracture, uric acid, arthritis, gout)	19	11	0.44
Cardiovascular (hypertension, lower blood pressure, lower cholesterol)	26	16	0.40
Gastrointestinal (dyspepsia, diarrhea, tapeworm infection, constipation, dysentery, ulcer, indigestion, stomach upset, heart burn)	47	30	0.37
Animal bites (rabies)	4	3	0.33
Hematologic (dengue, anemia, malaria)	4	3	0.33
Respiratory (cough, asthma)	48	38	0.21
Fever	7	7	0

Discussion

This ethnobotanical research illustrates the various medicinal species used by the Tualis of Lamut, Ifugao. The most represented family is Asteraceae. This family was the most represented in previous ethnobotanical studies among ethnic tribes like the Manobo (10), Mamanwa (12), and Eskaya (13) in the Philippines and other countries (37-38). The Asteraceae family of plants is extensively utilized in ethnomedicine for the treatment of wound healing, pyretic, hematemesia, parasitic infections and pruritus (39). Phytochemicals belonging to this family, including polyphenols, flavonoids and diterpenoids, have demonstrated antibacterial, anti-inflammatory, anticancer and antifungal activities (40).

The leaves are the most prevalent part of the plant due to their abundance, accessibility and sustainability (13). This finding agrees with previously reported ethnomedicinal studies in the Philippines (10, 12-13, 41). Most informants mentioned more than one plant part used for medical applications, like the leaves, fruits, roots, stems, barks, flowers and seeds. At times, mixtures of the different plant parts were made for a more effective treatment.

The majority of Tualis' use of herbal remedies was for treating coughs and diarrhea. Accordingly, herbal remedies are usually used among children and the elderly. The informants explained that when there are abrupt weather changes, coughing is common in children and the elderly. Their immediate response to coughing is to extract the juice of *Citrus aurantiifolia* (Christm.) Swingle or *Citrus microcarpa* Bunge. For some, they drink the decoction made from *Z. officinale* and *Vitex negundo* L. Others just eat the fruits of *A. comosus*, *A. muricata*, *Calamus rotang* L., *Mangifera indica* L., *Passiflora edulis* Sims, *P. guajava* and *S. cumini*. Additionally, the informants revealed that diarrhea is a common illness, especially for children. Their immediate treatment is to eat *P. guava* (unripe), *Musa acuminata* Colla (half-ripe) and *Chrysophyllum cainito* L.

Other informants drink the decoctions of *Cymbopogon citratus* (DC.) Stapf and *D. esculentum* as their immediate treatment.

The most preferred preparation methods of medicinal plants for therapeutic purposes among the Tualis communities were decoction, raw, extraction, cooking or blanching and infusion. Similar results have been observed in the country (12-14, 42-43). Most of the remedies were prepared by drinking the decoctions, like those of *A. muricata*, *Antidesma montanum* Blume and *Artemisia vulgaris* L. for cough. The informants crushed or pounded the different plant parts of *Ficus minahassae* Miq. then extract the juice and apply it to the body part for rheumatism. Other informants cooked or blanched the leaves, like those of *Ipomoea batatas* (L.) Lam and the infusion of the seeds of *Elaeocarpus bontocensis* Merr.

The most favoured administration methods were drinking, eating, topical application and bathing or washing. A comparable result has been noted in the nation (10, 12-13). Drinking the decoction of *Euphorbia hirta* L., the infusion like that of *E. bontocensis*, the extracted juice of *C. aurantifolia* or directly drinking the juice of *Cocos nucifera* L. was the most common mode of administration. The informants revealed that they directly eat the fruits of *Averrhoa bilimbi* L. for the remedy of cough and by blanching the shoot of *Ipomoea batatas* L. for anaemia. External application of the medicinal plants entails direct application to the affected body parts, like the sap of *C. papaya* for snake and dog bites, crushing the flower of *Hibiscus rosa-sinensis* L. for boils and heating and pounding the bark or leaves of *Jathropha curcas* L. and wrapping them around a fractured body part. Bathing or washing using the decoction of *D. esculentum* is usually applied to wash the wound in dermatological conditions. As to dosage, the informants explained that plant sources are safe and natural, so there are no limitations on the frequency of administration.

According to their RFC values, the most well-known species of the Tawali communities with the highest RFC is *M. oleifera*, which is applied to cure six medical conditions in six disease categories. The majority of informants strongly favour using it to treat coughs, wounds, cuts, lactation, hypertension and diabetes. Other ethnobotanical studies in the country mentioned its efficacy against wounds (13, 43) and cuts, coughs and diabetes (43). The informants frequently cited this particular plant species due to its nutritional values and it is mostly cultivated in the study area. Research has verified that *M. oleifera* is a nutrient-dense, vitamin-and mineral-rich and medicinally valuable species (44). It contains vitamins in the form of pyridoxine, folic acid, nicotinic acid, and beta-carotene (37). It has phytochemicals like reducing sugar, tannins, alkaloids, sterols, anthraquinones, flavonoids, saponins and terpenoids. It also contains glycoside chemicals, isothiocyanates, glucosinolates and glycerol-1-9-octadecanoate, which are anticancer agents (38). Pharmacological studies revealed its anticancer, anti-inflammatory, antidiabetic, antioxidant and antibacterial activities (44).

Of all the plant species that have been identified, *A. muricata* is the most useful and is suggested for the treatment of eight medical conditions in five different disease categories. It is for the treatment of high blood pressure, diabetes, uric acid, coughs, colds, sore throats, hypertension and arthritis. Research of a similar nature confirms its effectiveness against diabetes, hypertension, cough and sore throat and lower blood pressure (45). It possesses antioxidant, antibacterial, anti-inflammatory, anti-protozoan and anti-neoplastic properties (46). The Tawalis have been cultivating this plant as one of their food sources.

D. esculentum had the highest RI values and a high UV among the Tawali communities. It is locally known as Appaku, and it is endemic in the study area. It is used to cure eight medical conditions in eight disease categories. According to the informants, this plant is a remedy for rheumatism, diarrhoea, fever, dysentery, wounds, headaches, constipation and hypertension. Similar results confirm its efficacy against rheumatism, dysentery, wounds, and headaches (41, 47). It has many useful properties, such as the ability to reduce inflammation, fight free radicals, lower blood sugar, kill microbes, and change the immune system. These properties may help this plant species' preventative and therapeutic uses (47). This plant is also harvested for its economic value.

Among the most cited plant species are *C. papaya*, *P. guajava*, *S. alata* and *M. charantia*. The diseases treated by *C. papaya* are dog bites, *P. guajava* is diarrhoea; *S. alata* for ringworm and *M. charantia* for diabetes. This finding is in agreement with other ethnomedicinal studies (48). Only three of these ethnomedicinal plants were approved by the Department of Health (DOH) of the Philippines for their use (49). This confirms the therapeutic beliefs and practices of medicinal plants of the Tawali communities. However, further research and testing in the scientific

community are necessary to confirm the therapeutic properties of *C. papaya*.

Diseases of the endocrine system have the highest ICF value, which includes diabetes. In this category, *M. charantia* was the most often utilized plant species with 100% FL. This plant is among those authorized by the Health Department of the Philippines as therapeutic remedies for diabetes (49). To lower the blood sugar, the informants drink the decoction of the stem and leaves or blanch the leaves or fruit. Other disease categories include abdominal pain, dehydration and improving eyesight. The most frequently used plant in this category was *Daucus carota subsp. sativus* (Hoffm.) Arcang. (85.71% FL). The roots are usually eaten raw to improve eyesight, or they are juiced with a juicer to extract the juice to drink. Fruit extracts from *D. carota subsp. sativus* are said to have antinociceptive and anti-inflammatory properties, along with anticancer and antioxidant properties (50).

Conclusion

This is the first quantitative ethnobotanical study that I am aware of on the therapeutic plants utilized by the Tawalis of Lamut, Ifugao. A total of eighty-seven plant species, represented by 47 families, were recorded for treating 54 diseases and conditions in their communities. The results of this research will promote the use of readily available and accessible plants that are medicinal in their localities. It will also contribute to raising consciousness about the importance of conserving biological diversity and traditional knowledge. Moreover, it will provide a foundation for future pharmacological studies, particularly on the most preferred, common, used, valued and significant medicinal herbs.

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Authors' contributions

The author is the sole contributor to the study.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

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