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Ethnobotanical exploration and vegetation analysis of medicinal plants in Makmur Village, Central Tapanuli Regency, Indonesia

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ABSTRACT
Medicinal plants are a biological resource utilised by local communities as a source of traditional treatment. This research was conducted from January to March 2026 in the forest and land areas of Makmur Village, Pasaribu Tobing Subdistrict, Central Tapanuli Regency, to identify local community knowledge, the medicinal plant species used, and the diversity of those species. The research employed a descriptive method combining interviews with a vegetation analysis. The results show that the community continues to use medicinal plants in a manner passed down through generations. A total of 75 species of medicinal plants are used to treat around 22 health complaints and ailments. The plant part most commonly used is the leaf, accounting for 61.33%; boiling is the dominant processing method (60%), and oral consumption (drinking) is the most common method of use (65.33%). The vegetation analysis showed that the dominant species at the understorey/seedling level was hairy melastome (senduduk bulu, *Clidemia hirta*) with an Importance Value Index (IVI) of 29.08%; at the sapling level, jengkol (*Archidendron pauciflorum*) with an IVI of 17.85; at the pole level, mahang (*Macaranga* spp.) with an IVI of 44.10; and at the tree level, mahang with an IVI of 43.61. The Shannon-Wiener diversity index (H′) was 3.40 at the understorey/seedling level, 3.22 at the sapling level, 3.01 at the pole level, and 2.8 at the tree level, indicating a diversity level classified as moderate to high.
Keyword: Local Knowledge, Medicinal Plants, Species Diversity, Vegetation Analysis

1. Introduction

Indonesia has high floral diversity, owing to its geographical position within the tropics, which brings high rainfall. This condition means that Indonesia, particularly the North Sumatra region, has highly fertile land that supports a wide range of flora. Floral diversity in Indonesia plays a vital role in sustaining life, given its close relationship with Indonesia's local cultural diversity and the traditional knowledge of the benefits these plants provide [1,2] The exploration of medicinal plants involves fieldwork and identification aimed at gaining greater knowledge of the morphology of medicinal plants such as their species, form, flowers, fruit, leaves, stems, twigs, bark, and roots particularly among the natural resources already present at the study site.

Medicinal plants are an important part of biodiversity, utilised by communities as a source of traditional treatment [3]. Various plant parts, such as the leaves, roots, stems, and fruit, are used because they contain bioactive compounds beneficial to health. Processing is carried out using simple methods, such as boiling, pounding, or steeping, after which the plant material is used either orally or applied topically, depending on the ailment being treated.

Bioactive compounds such as flavonoids, tannins, saponins, steroids, and phenolic compounds [4] are known to exhibit biological activities, including inhibiting fungal growth, disrupting microbial metabolism, and acting as antifeedants and insect toxicants. As such, medicinal plants hold potential for development as an environmentally friendly source of natural materials.

2. Research Methods

2.1. Time and Location of Research

This study was conducted from January to March 2026. The research was conducted in the forest and land areas of Makmur Village, Pasaribu Tobing Subdistrict, Central Tapanuli Regency, North Sumatra Province. Data processing was carried out in Makmur Village, Pasaribu Tobing Subdistrict, Central Ta-panuli Regency, North Sumatra Province, and at the Forest Resource Conservation (KSH) Laboratory, Faculty of Forestry, Forestry Study Program, Bekala Campus II, Universitas Sumatera Utara. The map of the research location is presented in Figure 1.

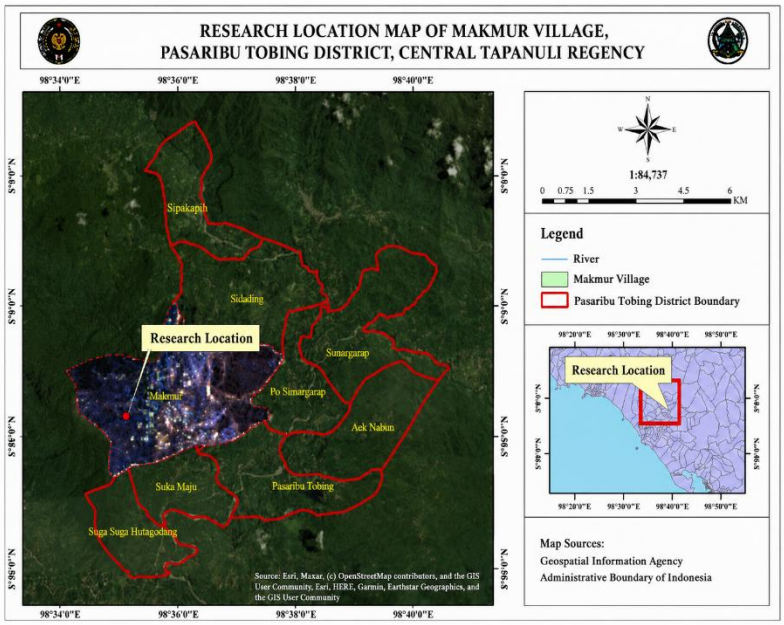

Figure 1. Map of the Research Location in the Forest and Land Area of Makmur Village, Pasaribu Tobing Subdistrict

2.2. Tools and Materials

The tools used in this research were a time-stamp application, large/small plastic bags and baskets, a plant identification application, a compass, a GPS (Global Positioning System) device, scissors, a digital camera, a mobile phone, rope, a machete, a hand trowel, gloves, a measuring tape, marker stakes, a knife, and stationery. The software used for data analysis was Microsoft Excel and Microsoft Word.

The materials used in this research included observation plots, location maps, tally sheets, questionnaires, and relevant previous research from various literature sources, used as supporting references.

2.3. Data Collection Techniques

Observation is a data collection technique in which the researcher directly observes the objects or phenomena in the field that form the focus of the research [5]. Observation was carried out in a structured manner using a guide or checklist, with field conditions recorded as they occurred, ensuring the data obtained were more valid and accurately reflected actual conditions. Interviewing is a data collection technique involving direct interaction between the researcher and informants, aimed at obtaining in-depth information [6]. Interviews may be structured, using a questionnaire.

The vegetation analysis in this research was carried out using the line transect method [7]. Transect lines were established using purposive sampling, taking into account field conditions representative of the characteristics of the research location. Each transect line was 100 meters long, along which vegetation observation plots or points were systematically placed in accordance with the research criteria. Once the 100 m endpoint was reached, the next transect line was established in the opposite direction, with a 50 m interval between lines.

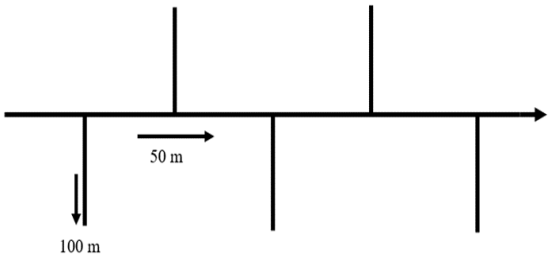

Figure 2. Transect Line Design (100 metres), with a 50 m Interval Distance Between Lines

Vegetation analysis is a method for studying the composition and form of vegetation or plant structure [8]. This research employed a plot sampling method, in which the starting point was determined using purposive sampling, a technique for deliberately determining the initial sampling point based on particular characteristics of the research location, combined with the strip-plot (line-plot) transect method.

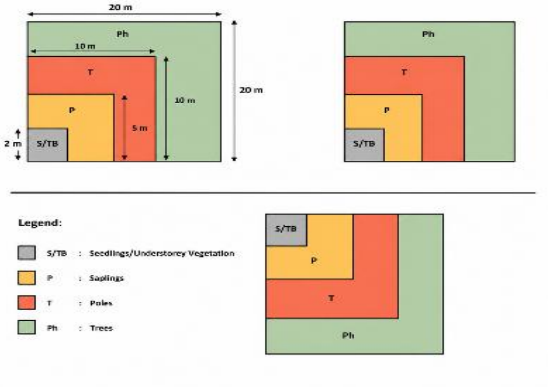

Figure 3. Research Plot Design (Understorey/Seedlings (2 × 2 m), Saplings (5 × 5 m), Poles (10 × 10 m), and Trees (20 × 20 m))

General criteria were used to determine the seedling, sapling, pole, and tree levels, as follows:

a. A 2 × 2 m observation plot for seedlings and understorey vegetation (regeneration from germination up to a height of less than 1.5 m).

b. A 5 × 5 m observation plot for saplings (regeneration with a height of ≥1.5 m and a stem diameter of <10 cm).

c. A 10 × 10 m observation plot for poles (regeneration with a stem diameter of ≥10 cm up to <20 cm).

d. A 20 × 20 m observation plot for trees (regeneration with a stem diameter of ≥20 cm)

2.4. Sampling Intensity

The sampling intensity in this research was 10% of the total area, 36.7 ha, yielding a sampling area of 3.67 ha. With a plot size of 20 × 20 meters (400 m²), 92 sample plots were planned for this research, distributed representatively across the land and forest areas of Makmur Village [9]. This number was considered sufficient to specifically describe the diversity of medicinal plant vegetation at the site.

Data sources are an important component of medicinal plant exploration research, as they determine the validity and representativeness of the research results. Data sources may come from either primary or secondary data [10]. Primary data are obtained directly from field observations, interviews with local communities or traditional medicine practitioners, and laboratory analysis of plant samples tested for their secondary metabolite content [11]. Secondary data may take the form of scientific literature, previous research journals, or herbarium documents that provide additional information about the plant species being studied.

2.5. Data Analysis

Quantitative analysis was performed to determine the percentage occurrence and frequency of medicinal plants in each observation plot [12]. The Shannon-Wiener Diversity Index and the Importance Value Index were used to measure the diversity and distribution of medicinal plants within the forest and land area.

2.6. Importance Value Index (IVI)

The Importance Value Index (IVI) is a quantitative measure used to assess the dominance of a species within a vegetation community [13]. The IVI calculates a species' importance within an ecosystem by combining three key parameters: density, frequency, and dominance.

The data obtained were analyzed using the following formulae:

a. Density of a species (K) (individuals/ha)

$$\mathrm{K} = \frac{\sum number\ of\ individuals\ of\ a\ species}{area\ of\ the\ sample\ plot} \quad (1)$$

b. Relative density of a species (RD) (%)

$$\mathrm{RD} = \frac{K\ of\ a\ species}{K\ of\ all\ species} \times 100\% \quad (2)$$

c. Frequency of a species (F)

$$\mathrm{F} = \frac{\sum sub{-}plots\ in\ which\ \ a\ species\ is\ found}{\sum all\ sample\ sub{-}plots} \quad (3)$$

d. Relative frequency of a species (RF) (%)

$$\mathrm{RF} = \frac{F\ of\ a\ species}{total\ F\ of\ all\ species} \times 100\% \quad (4)$$

e. Dominance (D)

$$\mathrm{D} = \frac{total\ basal\ area\ of\ the\ species}{total\ area\ of\ all\ sample\ plots} \quad (5)$$

f. Relative Dominance

$$\mathrm{RDo} = \frac{Dominansi\ Suatu\ spesies}{Jumlah\ Dominansi\ Seluruh\ spesies} \times 100\% \quad (6)$$

g. Importance Value Index (INP)

$$\mathrm{INP} = \mathrm{RD} + \mathrm{RF}\ \text{(for seedlings and saplings)} \quad (7)$$

$$\mathrm{INP} = \mathrm{RD} + \mathrm{RF} + \mathrm{RDo}\ \text{(for poles and trees)} \quad (8)$$

2.7. Shannon-Wiener Diversity Index

The Shannon-Wiener Diversity Index (H′) is a statistical tool commonly used to measure species diversity within an ecological community, such as medicinal plants [14]. This index takes into account both the number of species (richness) and the distribution of individuals among species. Shannon-Wiener Index formula:

$$H' = -\sum_{i=1}^{S} p_i \ln\ p_i \quad (9)$$

Where: H^' : diversity index
S : number of species
p (i) : proportion of individuals of the i-th species relative to the total number of individuals of all species

2.8. Species Richness Index

The species richness index is used to quantify the number of species within the research plots. The greater the number of species, the higher the R value. The species richness index formula is as follows:

$$R_1 = \frac{S-1}{\ln(N)} \quad (10)$$

R1 :Margalef Richness Index
S :number of species
N :total number of individuals

With the following criteria:

R < 2.5 : Low Margalef Richness Index
R>2.5 -R < 4 : Moderate Margalef Richness Index
R > 4 : High Margalef Richness Index

2.9. Species Evenness Index

The species evenness index is used to assess the evenness of species within the research plots. The evenness of species distribution ranges from 0 to 1 [15]. The species evenness index formula is as follows:

$$\mathrm{E} = \frac{H'}{\ln(S)} \quad (11)$$

Where:
E : species evenness index
H' : species diversity index
S : number of species

With the following criteria:

E: 0 - < 0,3: low evenness
E: > 0,3 - <0,6: moderate evenness
E: > 0,6: high evenness

3. Results and Discussion

3.1. Interview Results and Vegetation Analysis

Research conducted in the forest and land areas of Makmur Village, Pasaribu Tobing Sub-district, Central Tapanuli Regency, North Sumatra Province, identified 75 medicinal plant species. The local community has long used these medicinal plants as traditional remedies.

Table 1. Medicinal Plants Recorded through Interviews with Informants from the Makmur Village Community and through Vegetation Analysis in the Forest and Land Area of Makmur Village, Pasaribu Tobing Subdistrict, Central Tapanuli Regency

No	Local Name	Scientific Name	Plant Part	Processing	Method of Use	Benefit	Evidence of Benefit	Interview/ Vegetation Analysis
1.	Alang-alang	*Imperata cylindrica*	Root	Boiled	Taken orally (drunk)	internal heat/sore throat)	Used directly by the local community	√
2.	Aloban	*Vitex pinnata*	Leaf	Pounded	Applied topically	Wound remedy	[16]	AV
3.	Alumalum	*Emilia sonchifolia*	Leaf	Pounded	Applied topically	Remedy for high fever	Used directly by the local community	√
4	Appa paga	*Centella asiatica*	Leaf	Pounded	Eaten directly	Stomach-ache remedy	Used directly by the local community	√
5	Asam Gelugur	*Garcinia atroviridis*	Fruit	Boiled	Taken orally (drunk)	Hypertension remedy	Used directly by the local community	√

No	Local Name	Scientific Name	Plant Part	Processing	Method of Use	Benefit	Evidence of Benefit	Interview/ Vegetation Analysis
6	Asam Jawa	*Tamarindus indicus*	Leaf	Pounded	Applied topically	Wound remedy	Used traditionally, passed down through generations	√
7	Bacang	*Mangifera foetida Lour.*	Leaf	Boiled	Taken orally (drunk)	Digestive remedy	[17]	AV
8	Baja	*Rhodamnia cinerea Jack.*	Leaf	Boiled	Taken orally (drunk)	Diarrhoea remedy	[18]	AV
9	Bauja	*Clerodendrum colebrookianum*	Leaf	Boiled	Taken orally (drunk)	Hypertension remedy	[19]	AV
10	Balik angin	*Mallotus barbatus*	Leaf	Boiled	Taken orally (drunk)	Diarrhoea remedy	[20]	AV
11	Barangan Duri	*Castanopsis argentea*	Fruit	Boiled	Eaten directly	Digestive remedy	[21]	AV
12	Bayam Duri	*Amaranthus spinosus L.*	Leaf	Boiled	Taken orally (drunk)	Dysentery remedy	Used directly by the local community	√
13	Beringin	*Ficus benjamina*	Leaf	Boiled	Taken orally (drunk)	Diarrhoea remedy	[22]	AV
14	Bosi-bosi	*Timonius flavescens*	Leaf	Boiled	Taken orally (drunk)	Diabetes remedy	Used directly by the local community	√
15	Cacabean	*Ludwigia octovalvis*	Leaf	Boiled	Taken orally (drunk)	Diarrhoea remedy	Used traditionally, passed down through generations	√
16	Cempedak	*Artocarpus integer*	Leaf	Boiled	Taken orally (drunk)	Fever remedy	Used directly by the local community	√
17	Duhut Gorilla	*Clibadium surinamense*	Leaf	Pounded	Applied topically	Wound remedy	Used directly by the local community	√
18	Duku	*Lansium domesticum*	Leaf	Boiled	Taken orally (drunk)	Fever remedy	Used traditionally, passed down through generations	√
19	Durian	*Durio zibethinus*	Leaf	Boiled	Taken orally (drunk)	Fever remedy	Used traditionally, passed down through generations	√
20	Gaharu Cina	*Aquilaria sinensis*	Leaf	Steeped	Taken orally (drunk)	Relaxation	Used traditionally, passed down through generations	√
21	Gambir	*Uncaria gambir*	Sap	Steeped	Taken orally (drunk)	Diarrhoea remedy	Used directly by the local community	√
22	Hapinis	*Sloetia elongata*	Bark	Boiled	Taken orally (drunk)	Stomach-ache remedy	Used traditionally, passed down through generations	√
23	Hau aek	*Gliricidia sepium*	Leaf	Boiled	Taken orally (drunk)	Diarrhoea remedy	Used traditionally, passed down through generations	√

No	Local Name	Scientific Name	Plant Part	Processing	Method of Use	Benefit	Evidence of Benefit	Interview/ Vegetation Analysis
24	Hau dolok	*Syzium grande*	Leaf	Boiled	Taken orally (drunk)	Diarrhoea remedy	Used traditionally, passed down through generations	√
25	Hopong	*Baccaurea macrocarpha*	Fruit	Cleaned	Eaten directly	Stomach-ache remedy	Used directly by the local community	√
26	Inggir inggir	*Solanum indicum L*	Leaf	Pounded	Applied topically	Fever remedy	Used directly by the local community	√
27	Jahe	*Zingiber officinale*	Rhizome	Boiled	Taken orally (drunk)	Remedy for (cold-like malaise)	Used directly by the local community	√
28	Jambu Gunung	*Syzygium antisepticum*	Leaf	Boiled	Taken orally (drunk)	Diarrhoea remedy	Used traditionally, passed down through generations	√
29	Jengkol	*Archidendron pauciflorum*	Seed	Cooked	Eaten directly	Hypertension remedy	Used directly by the local community	√
30	Jeruk Nipis	*Citrus aurantifolia*	Fruit	Squeezed	Taken orally (drunk)	Cough remedy	Used directly by the local community	√
31	Jirak	*Symplocos cochinchinensis*	Bark	Boiled	Taken orally (drunk)	Diarrhoea remedy	Used traditionally, passed down through generations	√
32	Kandis	*Garcinia parvifolia*	Fruit	Boiled	Taken orally (drunk)	Fever remedy	Used directly by the local community	√
33	Kantong Semar	*Nepenthes sp..*	Liquid	Boiled	Taken orally (drunk)	Cough remedy	[23]	AV
34	Kapuk Randu	*Ceiba pentandra*	Leaf	Boiled	Taken orally (drunk)	Fever remedy	Used directly by the local community	√
35	Kareumbi	*Homalanthus populneus*	Leaf	Pounded	Taken orally (drunk)	Diarrhoea remedy	Used directly by the local community	√
36	Kayu Balik Angin	*Mallotus paniculatus (Lam.)*	Bark	Boiled	Taken orally (drunk)	Skin-disease remedy	[24]	AV
37	Kayu Manis	*Cinnamomum burmannii*	Bark	Boiled	Taken orally (drunk)	Diabetes remedy	Used traditionally, passed down through generations	√
38	Kembang Sepatu	*Hibiscus rosa-sinensis*	Leaf	Pounded	Applied topically	Remedy for (internal heat/sore throat)	Used directly by the local community	√
39	Kencur	*Kaempferia galanga*	Rhizome	Boiled	Taken orally (drunk)	Diarrhoea remedy	Used directly by the local community	W
40	Kimiri	*Aleurites moluccana L.*	Oil	Roasted	Applied topically	Hair care	Used directly by the local community	√
41	Kunyit	*Curcuma longa*	Rhizome	Ground	Taken orally (drunk)	Gastritis remedy	Used directly by the local community	√
42	Lempuyang	*Zingiber zerumbet*	Rhizome	Boiled	Taken orally (drunk)	Antibacterial remedy	Used traditionally, passed down	√

No	Local Name	Scientific Name	Plant Part	Processing	Method of Use	Benefit	Evidence of Benefit	Interview/ Vegetation Analysis
							through generations	
43	Lidah buaya	*Aloe vera*	Gel	Grated	Applied topically	Burn remedy	Used directly by the local community	√
44	Mahang	*Macaranga bancana*	Leaf	Boiled	Taken orally (drunk)	Dysentery remedy	Used traditionally, passed down through generations	√
45	Markubung	*Macaranga gigantea*	Leaf	Boiled	Taken orally (drunk)	Dysentery remedy	Used traditionally, passed down through generations	√
46	Meniran	*Phyllanthus dzumacensis*	Leaf	Boiled	Taken orally (drunk)	Kidney-stone remedy	Used directly by the local community	√
47	Nilam	*Pogostemon cablin Benth*	Leaf	Kneaded	Applied topically	Antiseptic	Used by the local community	√
48	Oppu oppu	*Crinum asiaticum L*	Leaf	Cleaned	Applied topically	Bone-fracture remedy	Used directly by the local community	√
49	Petai	*Parkia speciosa*	Seed	Cooked	Dimakan Langsung	Hypertension remedy	[25]	AV
50	Pirdot	*Saurauia bracteosa*	Leaf	Boiled	Taken orally (drunk)	Diabetes remedy	Used traditionally, passed down through generations	√
51	Pokok Kari	*Murraya koenigii*	Leaf	Boiled	Taken orally (drunk)	Diabetes remedy	[26]	AV
52	Porang	*Amorphophallus muelleri*	Tuber	Cooked	Eaten	Hypertension remedy	Used directly by the local community	√
53	Pulai	*Alstonia scholaris*	Leaf	Ground	Taken orally (drunk)	Malaria remedy	Used directly by the local community	√
54	Pultak-pultak	*Physalis angulata*	Fruit	Cleaned	Taken orally (drunk)	Fever remedy	Used directly by the local community	√
55	Purba Jolma	*Hibiscus indicus (Burm.f.) Hochr*	Root	Pounded	Taken orally (drunk)	Fertility remedy	Used directly by the local community	√
56	Pulutan	*Urena lobata L.*	Leaf	Pounded	Applied topically	Wound remedy	Used directly by the local community	√
57	Rambusa	*Passifora foetida*	Fruit	Cleaned	Eaten directly	Remedy for 'panas dalam' (internal heat/sore throat)	Used directly by the local community	√
58	Rambutan	*Nephelium Lappaceum L.*	Bark	Boiled	Taken orally (drunk)	Diarrhoea remedy	Used directly by the local community	√
59	Rambutan Hutan	*Nephelium cuspidatum*	Leaf	Boiled	Taken orally (drunk)	Diarrhoea remedy	Used traditionally, passed down through generations	AV
60	Rumput Israel	*Asystasia gangetica L.*	Leaf	Cleaned	Eaten directly	Wound remedy	[27]	AV
61	Rumput minjangan	*Chromolaena odorata*	Leaf	Boiled	Taken orally (drunk)	Wound remedy	[28]	AV

No	Local Name	Scientific Name	Plant Part	Processing	Method of Use	Benefit	Evidence of Benefit	Interview/ Vegetation Analysis
62	Sanggir-gir	*Rubus moluccanus*	Leaf	Boiled	Taken orally (drunk)	Diarrhoea remedy	Used directly by the local community	√
63	Sarang banua	*Cleodendrum fragrans*	Leaf	Boiled	Taken orally (drunk)	Inflammation remedy	Used directly by the local community	√
64	Senduduk	*Melastoma malabathricum*	Leaf	Boiled	Eaten directly	Stomach-ache remedy	Used directly by the local community	√
65	Senduduk bulu	*Clidemia hirta*	Leaf	Boiled	Eaten directly	Dysentery remedy	Used directly by the local community	√
66	Sereh	*Cymbopogon citratus*	Stem	Boiled	Taken orally (drunk)	Fever remedy	Used directly by the local community	√
67	Sibaguri	*Slida rhombifolia L*	Leaf	Pounded	Applied topically	Bone-fracture remedy	Used traditionally, passed down through generations	√
68	Sirih	*Piper betle*	Leaf	Cleaned	Applied topically	Bone-fracture remedy	Used directly by the local community	√
69	Sirih Hutan	*Piper aduncum*	Leaf	Pounded	Applied topically	Wound remedy	Used directly by the local community	√
70	Sirsak	*Annona muricata*	Leaf	Boiled	Taken orally (drunk)	Hypertension remedy	Used traditionally, passed down through generations	W
71	Sukkit	*Curculigo latifolia*	Root	Boiled	Taken orally (drunk)	Antibacterial remedy	[29]	AV
72	Tabar-tabar	*Costus specious*	Flower	Boiled	Applied topically	Kidney-stone remedy	Used directly by the local community	√
73	Tongkat ali	*Eurycoma longifolia*	Root	Boiled	Taken orally (drunk)	Hypertension remedy	Used directly by the local community	√
74	Toppas para	*Mikania micrantha*	Leaf	Squeezed	Applied as drops	Wound remedy	Used directly by the local community	√
75	Torop	*Artocarpus elaticus*	Leaf	Boiled	Taken orally (drunk)	Diarrhoea remedy	Used traditionally, passed down through generations	√

Where: W: Result from interviews only; √ : Result confirmed through both interviews and vegetation analysis; AV: Result from vegetation survey only

The results of the medicinal plant exploration identified 75 species in Makmur Village, Pasaribu Tobing Subdistrict, Central Tapanuli Regency. The plant parts utilized by the community include leaves, fruit, bark, roots, rhizomes, seeds, stems, sap, gel, liquid, tubers, flowers, and oil, each in differing proportions. Leaves were the most frequently used part, accounting for 61.33% (46 species), followed by fruit at 9.33% (7 species), bark at 6.67% (5 species), roots at 5.33% (4 species), rhizomes at 5.33% (4 species), seeds at 2.67% (2 species), and other parts such as stems, sap, gel, liquid, tubers, flowers, and oil, each accounting for an equal share of 1.33% (1 species).

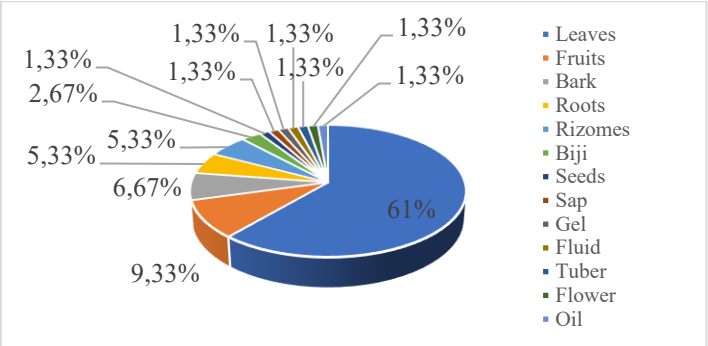

Figure 4. Chart of Plant Parts Used by the Community of Makmur Village

The analysis of medicinal plants used by the Makmur Village community showed that boiling was the dominant processing method, used for 60% (45 species) of plants. This high percentage indicates that boiling is the most commonly used technique, as it is considered practical and effective at extracting active compounds from plant material, particularly for remedies consumed orally. In addition, pounding was quite widely used at 16.00% (12 species) and is generally applied for external treatments such as wounds, swelling, and skin conditions. Other methods, such as cleaning (8.00%, 6 species), cooking (4.00%, 3 species), and grinding (2.67%, 2 species), reflect a range of techniques tailored to the plant type and required treatment. Meanwhile, processing methods with lower percentages included steeping and squeezing (2.67%), as well as roasting, grating, and kneading (1.33%) [30]. The low use of these methods indicates that they are applied only to particular types of plants with specific characteristics, such as those with active compounds that are readily soluble without intensive heating, or to specific plant parts, such as oil and gel.

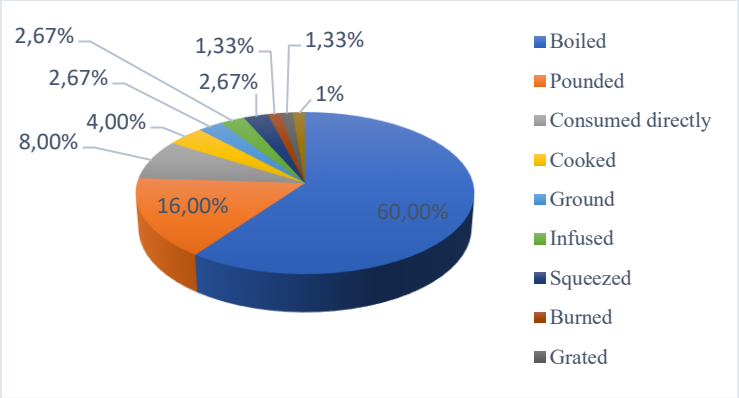

Figure 5. Chart of Processing Methods Used by the Community of Makmur Village

The community of Makmur Village, Pasaribu Tobing Subdistrict, uses medicinal plants in a fairly wide range of ways, although use as an oral remedy (drinking) is dominant. Oral use accounts for 65.33%, indicating that the community relies mostly on medicinal plants for internal treatment. This method is generally carried out after a processing step, such as boiling or steeping, allowing the plant's active substances to be more readily absorbed. Besides oral use, another fairly common method is topical application, accounting for 20%. This is typically used for external treatments such as wounds, sprains, and inflammation, whereby crushed plant material is applied directly to the affected part of the body. Meanwhile, direct consumption (eating) accounts for 13.33% and is generally applied to plant parts such as fruit or leaves that are safe to consume without processing, making it a more practical and rapid method. Application by drops has the smallest share, at 1.33%, and is typically used for specific conditions, such as minor wounds or sensitive parts of the body.

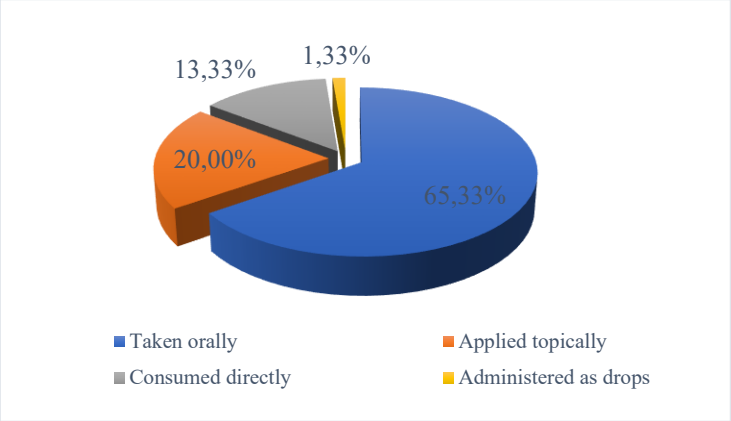

Figure 6. Chart of Methods of Use by the Community of Makmur Village

The research results show that the Makmur Village community uses 75 medicinal plants to treat around 22 health complaints, ailments, and conditions. The most commonly treated ailments are diarrhea and fever. In addition, medicinal plants are also used to treat wounds, stomach aches, hypertension, diabetes, dysentery, coughs, and colds. Several plants are used to address 'masuk angin' (a folk ailment akin to flu-like malaise), 'panas dalam' (a sensation of internal heat, akin to mouth ulcers or a sore throat), gastritis, malaria, gout, and kidney stones. Medicinal plants are also used to treat bone fractures and sprains [31]. Beyond treating illness, several plants are used to support vitality, fertility, burns, and hair care.

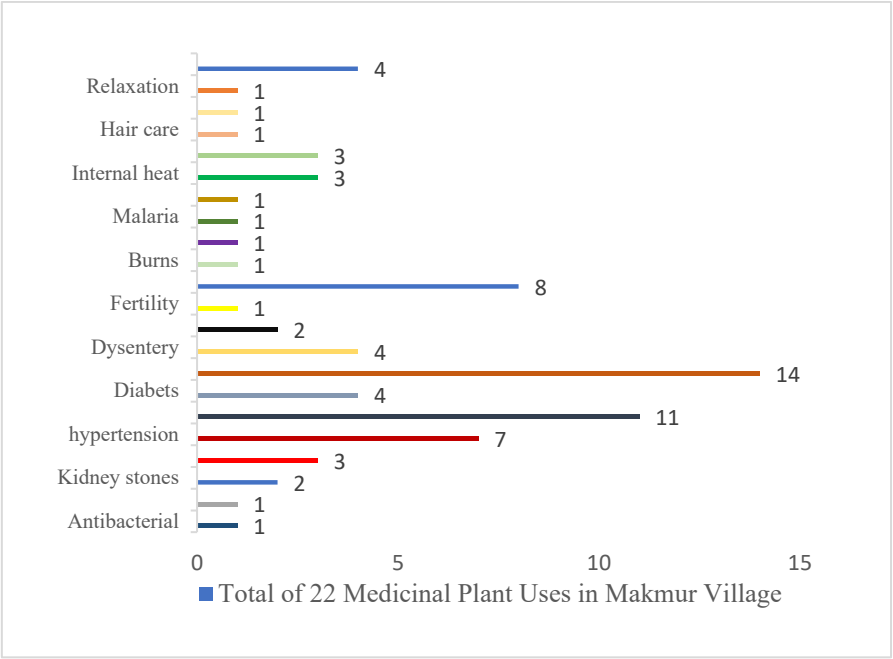

Figure 7. Benefits of the Medicinal Plants Used by the Community of Makmur Village, Pasaribu Tobing Subdistrict

3.2. Vegetation Analysis of Medicinal Plants in the Forest and Land Area of Makmur Village

Table 2 shows that the composition of medicinal plants at the understorey and seedling level in the forest and land area of Makmur Village has a fairly diverse species distribution. The most dominant species was hairy melastome (senduduk bulu, Clidemia hirta), with a relative density of 16.34%, a relative frequency of 12.7%, and an IVI of 29.08%. This value indicates that this species has the greatest number of individuals, the widest distribution, and good adaptability to environmental conditions such as light, temperature, humidity, water, and soil conditions. In addition, several other species play a fairly important role, namely bosi-bosi, cempedak, jambu gunung (mountain guava), and mahang, as they have relatively high density and IVI values and thus also help shape the vegetation structure of medicinal plants at the understorey and seedling levels.

Table 2. Analysis of Medicinal Plant Data at the Understorey and Seedling Level in the Forest and Land Area of Makmur Village, Pasaribu Tobing Subdistrict, Central Tapanuli Regency

No	Species	K	RD%	F	RF%	IVI
1	Alang-Alang	625	4.09	0.08	2.70	6.79
2	Aloban	54	0.36	0.01	0.39	0.74
3	Alummalum	54	0.36	0.01	0.39	0.74
4	Appa Paga	109	0.71	0.01	0.39	1.10
5	Asam Gelugur	27	0.18	0.01	0.39	0.56
6	Bacang	27	0.18	0.01	0.39	0.56
7	Baja	163	1.07	0.05	1.93	3.00
8	Balik Angin	136	0.89	0.04	1.54	2.43
9	Bayam Duri	27	0.18	0.01	0.39	0.56
10	Bosi-Bosi	1,141	7.46	0.15	5.41	12.87
11	Cacabean	109	0.71	0.01	0.39	1.10
12	Cempedak	1,141	7.46	0.14	5.02	12.48
13	Duhut Gorilla	136	0.89	0.03	1.16	2.05
14	Duku	136	0.89	0.03	1.16	2.05
15	Durian	136	0.89	0.02	0.77	1.66
16	Gaharu Cina	109	0.71	0.02	0.77	1.48
17	Gambir	54	0.36	0.01	0.39	0.74
18	Hapinis	109	0.71	0.03	1.16	1.87
19	Hau Dolok	217	1.42	0.04	1.54	2.97
20	Hopong	27	0.18	0.01	0.39	0.56
21	Inggir-Inggir	54	0.36	0.01	0.39	0.74
22	Jahe	163	1.07	0.01	0.39	1.45
23	Jambu Gunung	815	5.33	0.17	6.18	11.51
24	Jengkol	462	3.02	0.12	4.25	7.27
25	Jirak	408	2.66	0.11	3.86	6.53
26	Kantong Semar	109	0.71	0.01	0.39	1.10
27	Kapuk Randu	54	0.36	0.02	0.77	1.13
28	Kareumbi	27	0.18	0.01	0.39	0.56
29	Kayu Balik Angin	82	0.53	0.02	0.77	1.31
30	Kayu Manis	109	0.71	0.02	0.77	1.48
31	Kembang Sepatu	27	0.18	0.01	0.39	0.56
32	Kunyit	109	0.71	0.01	0.39	1.10
33	Jeruk Nipis	27	0.18	0.01	0.39	0.56
34	Lempuyang	136	0.89	0.01	0.39	1.27
35	Lidah Buaya	54	0.36	0.01	0.39	0.74
36	Mahang	842	5.51	0.16	5.79	11.30
37	Markubung	435	2.84	0.09	3.09	5.93
38	Meniran	54	0.36	0.02	0.77	1.13
39	Nilam	109	0.71	0.02	0.77	1.48
40	Oppu-Oppu	27	0.18	0.01	0.39	0.56
41	Pasak Bumi	217	1.42	0.04	1.54	2.97
42	Petai	190	1.24	0.04	1.54	2.79
43	Pirdot	54	0.36	0.01	0.39	0.74
44	Pokok Kari	82	0.53	0.03	1.16	1.69
45	Porang	163	1.07	0.03	1.16	2.22
46	Pulai	353	2.31	0.12	4.25	6.56
47	Pultak-Pultak	27	0.18	0.01	0.39	0.56
48	Pulutan	54	0.36	0.01	0.39	0.74
49	Rambusa	54	0.36	0.02	0.77	1.13
50	Rambutan	54	0.36	0.02	0.77	1.13
51	Rumput Israel	82	0.53	0.01	0.39	0.92
52	Rumput Minjangan	27	0.18	0.01	0.39	0.56
53	Sanggir-Gir	1,005	6.57	0.01	0.39	6.96
54	Sanduduk	54	0.36	0.20	6.95	7.31

55	Senduduk Bulu	2,500	16.34	0.36	12.74	29.08
56	Sereh	326	2.13	0.01	0.39	2.52
57	Sibaguri	82	0.53	0.02	0.77	1.31
58	Sirih	489	3.20	0.08	2.70	5.90
59	Sirih Hutan	326	2.13	0.04	1.54	3.68
60	Sukkit	136	0.89	0.02	0.77	1.66
61	Tabar-Tabar	54	0.36	0.01	0.39	0.74
62	Tompas Para	82	0.53	0.02	0.77	1.31
63	Torop	245	1.60	0.05	1.93	3.53
	Total	15,299	100	3	100	200

In general, the high IVI values observed across several species indicate that the forest and land areas of Makmur Village continue to support the natural growth of medicinal plants. However, several species, such as asam gelugur, bacang, pultak-pultak, hopong, and gambir, showed relatively low occurrence frequencies. This suggests that these species have a more restricted distribution pattern, likely influenced by specific ecological factors, such as habitat suitability, microenvironmental conditions, and the study site's natural regenerative capacity.

In terms of frequency and IVI, species such as jambu gunung, mahang, bosi-bosi, senduduk, and cempedak have a fairly wide distribution. In contrast, asam gelugur, bacang, pultak-pultak, hopong, and gambir have a low frequency of around 0.39%, indicating a more limited distribution and a likelihood of growing only in particular habitats. Frequency is a parameter indicating the degree to which a species is distributed within a plant community; the higher the frequency, the wider the species' distribution at the observation site. Furthermore, [32] species with a high IVI reflect a species' level of ecological success within a vegetation community, demonstrated through greater dominance, distribution, and adaptability to environmental conditions, thereby playing an important role in ecosystem structure and stability. Table 2 shows that the medicinal plant community at the understorey and seedling levels in Makmur Village remains in fairly good condition, with several dominant species playing an important role in maintaining ecosystem stability and supporting the natural potential of medicinal plants.

Table 3. Analysis of Medicinal Plant Data at the Tree Level in the Forest and Land Area of Makmur Village, Pasaribu Tobing Subdistrict, Central Tapanuli Regency

No	Jenis	K	RD (%)	F	RF (%)	D	RDo (%)	IVI
1	Aloban	1.087	1.550	0.043	2.073	0.592	12.960	16.583
2	Asam Gelugur	1.630	2.326	0.033	1.554	0.082	1.786	5.666
3	Asam Jawa	0.815	1.163	0.022	1.036	0.033	0.720	2.919
4	Bacang	1.359	1.938	0.054	2.591	0.069	1.500	6.029
5	Baja	0.543	0.775	0.022	1.036	0.036	0.785	2.596
6	Balik angin	0.543	0.775	0.022	1.036	0.022	0.486	2.298
7	Barangan Duri	0.272	0.388	0.011	0.518	0.049	1.066	1.972
8	Beringin	0.272	0.388	0.011	0.518	0.018	0.384	1.289
9	Bosi-bosi	1.359	1.938	0.043	2.073	0.066	1.451	5.461
10	Cempedak	8.152	11.628	0.217	10.363	0.404	8.840	30.831
11	Duku	0.815	1.163	0.022	1.036	0.053	1.151	3.350
12	Durian	3.533	5.039	0.130	6.218	0.299	6.549	17.805
13	Hapinis	2.989	4.264	0.109	5.181	0.193	4.232	13.677
14	Hau aek	3.533	5.039	0.109	5.181	0.183	4.012	14.232
15	Hau dolok	1.902	2.713	0.043	2.073	0.081	1.783	6.569
16	Hopong	0.272	0.388	0.011	0.518	0.009	0.200	1.106
17	Jambu Gunung	4.348	6.202	0.141	6.736	0.239	5.231	18.168
18	Jengkol	5.707	8.140	0.141	6.736	0.290	6.360	21.235
19	Jirak	2.989	4.264	0.109	5.181	0.141	3.080	12.525
20	Kandis	0.272	0.388	0.011	0.518	0.015	0.326	1.232
21	Kapuk Randu	0.272	0.388	0.011	0.518	0.018	0.392	1.298
22	Kayu Balik Angin	0.543	0.775	0.022	1.036	0.024	0.528	2.339

23	Kayu Manis	0.543	0.775	0.011	0.518	0.022	0.492	1.785
24	Kemiri	0.272	0.388	0.011	0.518	0.020	0.446	1.351
25	Mahang	11.685	16.667	0.293	13.990	0.592	12.960	43.616
26	Markubung	3.261	4.651	0.098	4.663	0.175	3.824	13.139
27	Petai	4.076	5.814	0.152	7.254	0.272	5.965	19.033
28	Pulai	2.174	3.101	0.065	3.109	0.203	4.451	10.661
29	Rambutan Hutan	0.272	0.388	0.011	0.518	0.009	0.200	1.106
30	Torop	4.620	6.589	0.120	5.699	0.358	7.840	20.129
	Total	70.109	100	2.098	100	4.567	100	300

Based on Table 3, the medicinal plant vegetation at the tree level in the forest and land area of Makmur Village shows that mahang is the most dominant species, with the highest IVI of 43.61, influenced by a relative density of 16.66%, a relative frequency of 13.99%, and a relative dominance of 12.96%. This value indicates that mahang has a high number of individuals, a fairly wide distribution, and a large stem size, and thus plays an important role in the vegetation structure at the tree level. Other species that also play a fairly significant role include cempedak, jengkol, torop, aloban, durian, petai, and jambu gunung. In terms of relative dominance, mahang and aloban recorded the highest values at 12.960% each, indicating that both species have larger basal areas or stem sizes than the other species [33]. Species with high dominance have a greater capacity to occupy growing space and utilize environmental resources, and thus play an important role in shaping the structure of the vegetation community.

The IVI indicates the level of dominance of a species within a vegetation community, based on the combined relative density, relative frequency, and relative dominance. Mahang, as the species with the highest IVI, shows greater adaptive ability and competitiveness than other species. A high IVI reflects a species' ability to occupy growing space and compete with other species, thereby enabling it to dominate the vegetation community [34]. Conversely, species with a low IVI, such as ber-ingin (1.28), kandis (1.23), kapuk randu (1.29), and kemiri (1.35) indicate a small number of individuals, a limited distribution, and little influence on the vegetation community. Species with low IVIs are more vulnerable to population decline due to environmental pressures and competition with dominant species.

Table 4. Diversity, Richness, and Evenness Index Values at the Understorey/Seedling, Sapling, Pole, and Tree Levels of Medicinal Plants in the Forest and Land Area of Makmur Village

No	Vegetation Level	Shannon Diversity Index (H′)	Margalef Richness Index (R1)	Evenness Index (E)
1	Understorey/Seedlings	3.40	2.61	0.82
2	Saplings	3.22	1.79	0.88
3	Poles	3	1.80	0.89
4	Trees	2.89	1.80	0.85

Based on Table 4, the Shannon-Wiener diversity index (H′) for medicinal plants in the forest and land area of Makmur Village shows that the understorey/seedling, sapling, and pole levels have high diversity. In contrast, the tree level is classified as moderate. The highest H′ value was found at the understorey/seedling level, at 3.40, followed by saplings at 3.22, poles at 3.00, and trees at 2.89. The high H′ value at the understorey/seedling level indicates that medicinal plant species at this stratum are more diverse and able to grow well under the available habitat conditions. The Shannon-Wiener index measures community diversity by accounting for the number of species and the distribution of individuals among them. Furthermore, [35] states that a high index value indicates a more diverse community with a more balanced distribution of individuals, whereas a low value indicates dominance by only a few species. The higher the diversity index value, the better the environmental conditions of a location, and the greater the potential of its biological resources, including traditional medicinal plants.

The Margalef richness index (R1) values in Table 4 show that the understorey/seedling level has the highest value (2.61), followed by saplings (1.79), poles (1.80), and trees (1.80). This indicates that the highest species richness occurs at the understorey/seedling level, as more medicinal plant species were found in this stratum than in the other strata. The species richness index describes the number of species within a community; the higher the index value, the greater the number of species in that community. Meanwhile, the evenness index (E) values were classified as high across all vegetation levels: 0.82 for understorey/seedlings, 0.88 for saplings,

0.89 for poles, and 0.85 for trees. An E value approaching 1 indicates that the distribution of individuals among species is relatively even and not strongly dominated by any single species. A high evenness value reflects a balanced distribution of individuals within a community, indicating more stable vegetation conditions.

Overall, Table 4 shows that the forest and land areas of Makmur Village continue to maintain fairly good conditions for medicinal plant vegetation. The high diversity at the understorey/seedling, sapling, and pole levels indicates that the regeneration of medicinal plants remains healthy, while the moderate diversity at the tree level indicates that a number of species remain more dominant than others. High values for diversity, richness, and evenness reflect a more stable ecosystem capable of supporting a wide range of plant species. In addition, [36] states that a moderate diversity value indicates that an area still has fairly good ecosystem stability and is able to support the natural growth of vegetation. The forest and land areas of Makmur Village therefore hold significant potential for medicinal plant diversity and should be conserved to ensure these species remain sustainable in the future.

4. Conclusion

1. The local knowledge of the Makmur Village community regarding the use of medicinal plants remains good and continues to be passed down through generations. The community uses 75 species of medicinal plants to treat around 22 health complaints, with leaves being the most widely used part (61.33%), boiling the dominant processing method (60%), and oral consumption (drinking) the most common method of use (65.33%).

2. The identification results show that there are 75 species of medicinal plants in the forest and land area of Makmur Village. The dominant species, based on the vegetation analysis, are senduduk bulu (hairy melastome) at the understorey/seedling level, with an IVI of 29.08%; jengkol at the sapling level, with an IVI of 17.85; and mahang at both the pole level (IVI of 44.10) and the tree level (IVI of 43.61).

3. The diversity of medicinal plants in Makmur Village is classified as moderate to high, with H′ diversity index values of 3.40 for understorey/seedlings, 3.22 for saplings, 3.01 for poles, and 2.8 for trees. This indicates that the forest and land areas of Makmur Village continue to hold significant potential for medicinal plants and that this areas need to be conserved.

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