

Use and assessment of the economic value of traditional medicinal plants by the Soputan Dayak tribe, East Kalimantan Province, Indonesia

RUJEHAN^{*}, SETIAWATI, PAULUS MATIUS, ROCHADI KRISTININGRUM, YULIANA OKTAVIA HALU

Faculty of Forestry, Universitas Mulawarman. Jl. Penajam, Kampus Gunung Kelua, Samarinda 75123, East Kalimantan, Indonesia.
Tel.: +62-541-749068, Fax.: +62-541-735379, ^{*}email:rujehan56@gmail.com

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Abstract. *Rujehan, Setiawati, Matius P, Kristiningrum R, Halu YO. 2024. Use and assessment of the economic value of traditional medicinal plants by the Soputan Dayak tribe, East Kalimantan Province, Indonesia. Biodiversitas 25: 2393-2403.* The Soputan Dayak tribe, who live in Long Penaneh III, Long Apari Sub-district, East Kalimantan, apparently still adhere to local wisdom values in using plants as medicine and contributing to the household economy. This study aims to identify the local wisdom of the Soputan Dayak tribe in using medicinal plants and determine the economic value of medicinal plant use. Using a snowball sampling technique, the methods used were observation and direct interviews with 15 households. The data were analyzed descriptively and qualitatively using logical explanation through a substitute-market approach to determine economic value. The results showed that the use of medicinal plants in the village of Long Penaneh III covered 41 families of 64 species with various benefits. The most used plant organs were leaves (50%) and roots (24%), with the rest comprising tubers, stems, fruit, shoots, skins, flowers, and cambium. The main diseases treated with medicinal plants were back pain (17%), cholesterol (14%), high blood pressure and leukorrhea (12% each), and flu, fever, hypoglycemia, ulcers, and kidney concerns (9% each). The economic value assessment from the 64 species showed IDR 36,685,000 per year could be obtained, based on the information of 15 respondents, with an average per household of IDR 2,445,666.67 per year. The economic value obtained is sufficient to support the household economy.

Keywords: Economic value, Long Penaneh III, medicinal plants, Soputan Dayak traditional medicine

INTRODUCTION

Natural resources have been used to meet the needs of life in various regions but have not been fully utilized in several countries (Rujehan and Matius 2018). Indonesia has abundant natural resources that can be used for medicinal purposes. Around 300 species of plants are used for traditional medicine (Handayani and Rusmita 2017). According to Nugroho et al. (2015), as many as 180 species of medicinal plants have been used for herbal products and the herbal medicine industry.

Since ancient times, most people have used medicinal plants to treat various diseases (Qureshi et al. 2016). Medicinal plants continue to interest modern medicine, especially in the pharmaceutical field (Rivera et al. 2005). An estimated 80% of the world's population uses herbal medicines (Miraldi and Baini 2018), and they have been widely used in rural and urban areas in developed and developing countries for centuries (Kidane et al. 2018; Hu et al. 2020; Elfrida et al. 2021; Pathy et al. 2021). Aziz et al. (2018) noted that due to the lack of modern medical facilities in developing countries, traditional medicines are an inexpensive source of primary health care.

Traditional medicine is recognized as an important part of the treatment system in many developing countries. More than 30% of the world's plant species are used for medicinal purposes, and over 80% of the world's population

uses 200 drugs to treat their diseases (Khesht et al. 2021). Traditional medicines were even used as alternative medicines to prevent and treat COVID-19 during the pandemic (Deng et al. 2020). The dominant source of pharmacological drugs to treat and cure diseases is plants. However, selecting the most biologically active plant species to treat disease has challenges (Zaman et al. 2021). Concerning primary health care, around 80% of traditional communities depend on medicinal plants (Sharma et al. 2021; Khan et al. 2021; Rehman et al. 2023). China is the leading country, with 40-50% of the population using herbal medicine as supplemental health care, followed by Germany (40-50%), France (49%), Australia (48%), and the USA (42%), (Kassaye et al. 2006; Bibi et al. 2014). Medicinal plants can improve the economy and create livelihoods (Zahra et al. 2019).

Among many tribes in Indonesia, the Dayak tribe on the island of Kalimantan still maintains the tradition of using plants from their environment for medicine or health care. Even though health services are becoming more available in remote areas, they are not evenly distributed, so traditional medicines are still used in local communities. This is supported by traditional knowledge that has been passed down of using plants for curing disease, which can contribute to medical expenses. Moreover, the synthetic drugs price is already high, and they may have adverse health effects. Therefore, increasing knowledge of using natural resources as traditional medicines is necessary.

The Soputan Dayak tribe is one of the various ethnic Dayak tribes who live in Long Apari Sub-district, Mahakam Ulu District, East Kalimantan. They still firmly hold their customs, distinctive culture, and traditional wisdom values in using forest flora daily. The tribe's condition should be preserved so that it does not disappear along with rapid development (Pathy et al. 2021). Witjoro et al. (2016) reported that knowledge of the use of medicinal plants in rural communities began to decrease because the use of synthetic drugs had influenced them. Additionally, Karki et al. (2023) found in Nepal that traditional wisdom on the use of medicinal plants was concentrated among elderly people more than younger individuals. This is also in line with research conducted in Indonesia by Nomleni et al. (2021) and Nurhidayah et al. (2023), which states that traditional medicine is natural ingredients or concoctions derived from plants that have been passed down for generations have been used for the treatment of various types of diseases based on experience. The traditional knowledge possessed by a tribe or ethnicity is passed down through inheritance from generation to generation, including using plants as traditional medicine.

Therefore, it is crucial to ascertain the community's varieties of medical plants and assess their economic value. This study aims to identify the local wisdom of the Soputan Dayak tribe in using medicinal plants and determine the economic value of medicinal plant use. This study's results are expected to serve as a basis for conserving and passing down knowledge to the younger generation, particularly concerning the plant species suitable for traditional medicine and their economic significance.

MATERIALS AND METHODS

Study area

This study was conducted in Long Apari Sub-district, Mahakam Ulu District, East Kalimantan Province, Indonesia (Figure 1) from June 2022 to November 2022. Those sub-districts resulted from the division of Long Pahangai Sub-district in 1964. Its capital is the village of Tiong Ohang, adjacent to Long Penaneh III Village, the study area, and the residents of those villages are the Soputan Dayak tribe.

Data collection

Data collection was carried out using Participatory Rural Appraisal (PRA) (Haruna et al. 2022), where this study involves the active role of the community in research through in-depth interviews, including types of plants that can be used as medicine as well as uses and methods of the plant concoctions. Apart from interviews, direct observations were also conducted to see the conditions at the research location and then documented the medicinal plant types. Respondents were selected using a snowball sampling technique, namely by determining key respondents who were local people at the research location (Aprillia et al. 2020), as many as 15 people consisting of 6 men and 9 women with an age range of 40 to 60 years old and is a native Soputan Dayak tribe in Long Penaneh III Village. These key respondents are traditional healers, chieftains, community leaders, and housewives who know traditional medicine according to information from previous respondents, namely people who have experienced the types of plants used as medicine, the parts used, the type of disease being treated and how to use the traditional medicine (Irwanta et al. 2015; Qomariah et al. 2020).

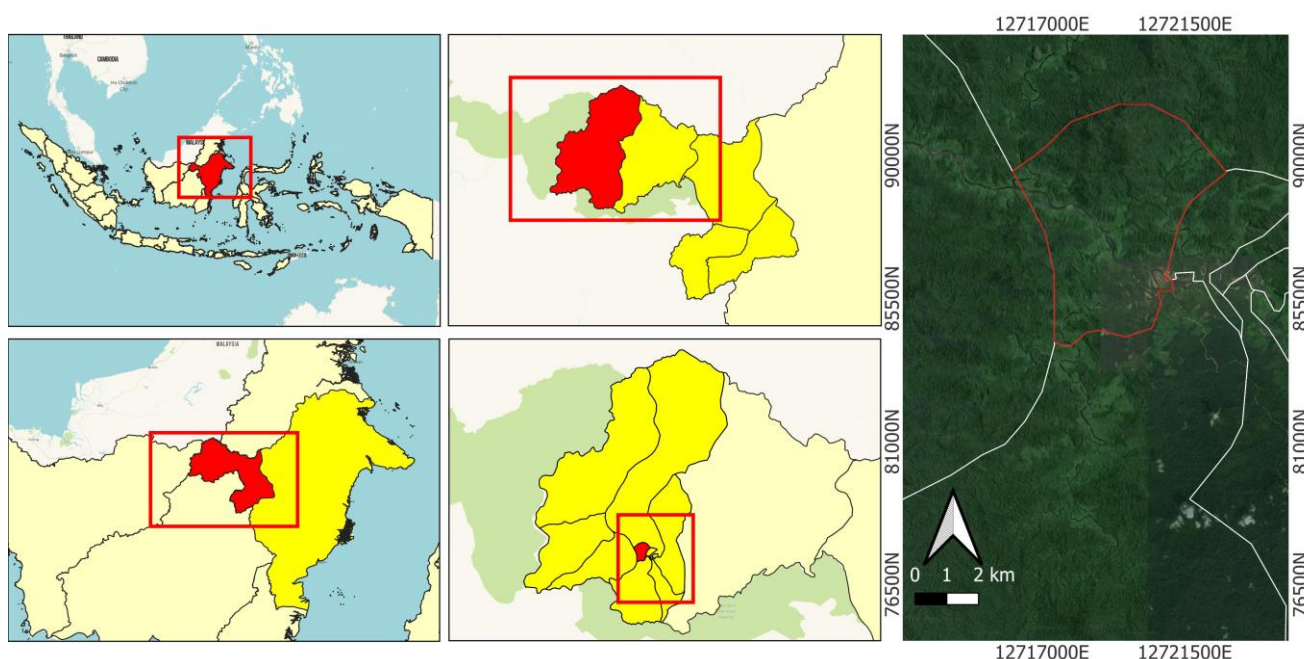


Figure 1. Study location in Long Penaneh III, Long Apari Sub-district, Mahakam Ulu District, East Kalimantan Province, Indonesia

Data analysis

Interview data were processed and analyzed descriptively and qualitatively with logic approaches (Hadijah et al. 2016; Jamun et al. 2020). Therefore, to ensure the plant species are used as medicines, documentation is carried out, and the species are identified through official flora sites such as www.asianplant.net, www.theplantlist.org, the Plants of the World Online (POWO), and other sites to make it easier to identify types of medicinal plants by matching images or the name of the species or family. Regarding the quantification of the value of medicinal plants and their use, an economic valuation is carried out using the surrogate market price method (Hasibuan 2014), where plants that have been identified for medicinal use are calculated based on the price of chemical or synthetic drugs on the market.

RESULTS AND DISCUSSION

Identification of medicinal plants and their properties

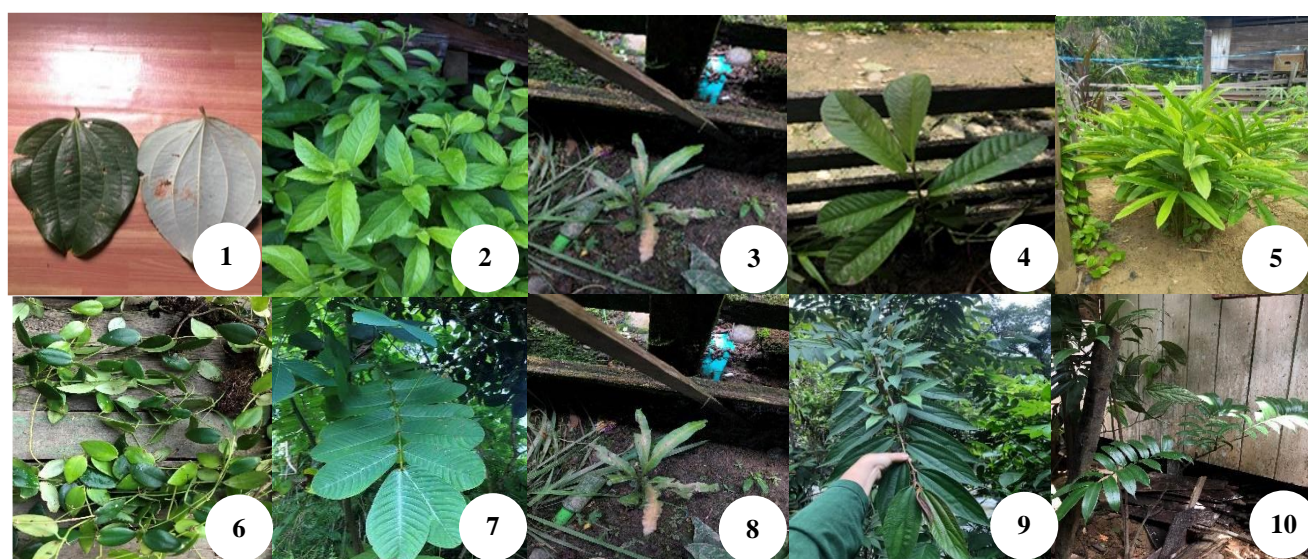
Using identical plant species across different locations could be attributed to their wide distribution, specific purposes, or association with closely guarded traditional knowledge (Tugume and Nyakoojo 2019). The abundance of shrub species in the study area may account for the extensive use of medicinal plants, which aligns with Ullah et al. (2020). However, this contradicts Ani et al. (2021), who observed that trees were the dominant type of medicinal plant in Ndano Village, West Nusa Tenggara. The respondents indicated that shrubs were commonly planted in yards due to the latter's small size. Apart from their medicinal applications, some species also serve as food and ornamental plants. In rural areas, plants are cultivated in yards for various purposes, including medicine, ornamental display, food, family income, and traditional ceremonies (Elfrida et al. 2020; Suwardi et al. 2020; Sutrisno et al. 2021). The richness of bioactive compounds in cultivated

plants may explain the frequency of medicinal plant species appearing in home gardens. Tugume and Nyakoojo (2019) noted that harvesting from yards is encouraged by the need to have medicinal plant species near the population and avoid the long distances required for exploring medicinal plant species in the wild.

Based on the interviews with key informants in Long Penaneh III Village, the Soputan Dayak tribe uses 41 families of 64 species of medicinal plants (Figure 2). Table 1 presents the species of medicinal plants mentioned as follows.

Table 1 shows 41 families or 64 species of medicinal plants used by the Soputan Dayak tribe in Long Apari Sub-district, East Kalimantan. Meanwhile, based on the traditional wisdom of the Jangkang Dayak tribe in Sanggau District, West Kalimantan, 38 families of 65 species of medicinal plants are used (Sari et al. 2015). Andari et al. (2020) found in their study on the Kendawangan Dayak tribe in Rangkung Village, West Kalimantan, that only 52 plant species were used as medicinal. Navia et al. (2021) reported that local communities used 46 species of medicinal plants from 40 genera and 26 families to address 28 diverse ailments. This difference is because various tribes and cultures have local knowledge and traditions in using plants capable of providing healing or treatment benefits for various diseases (Muktiningsih et al. 2001; Siregar et al. 2020). In addition, a lack of openness among other people exists in the local community that uses medicinal plants.

The plants used in traditional medicine still rely on inherited knowledge from generations; generally, this inheritance system is closed to one lineage or family (Haryadi 2011). Regarding the origin of knowledge of plants in southern Brazil, 61% of participants acknowledged the significant role of their mothers, while 25% attributed it to their grandmothers, and 18% mentioned other female relatives (mothers-in-law, sisters-in-law, sisters, and aunts). These findings underscore the crucial role of women in knowledge production (Casagrande 2023).



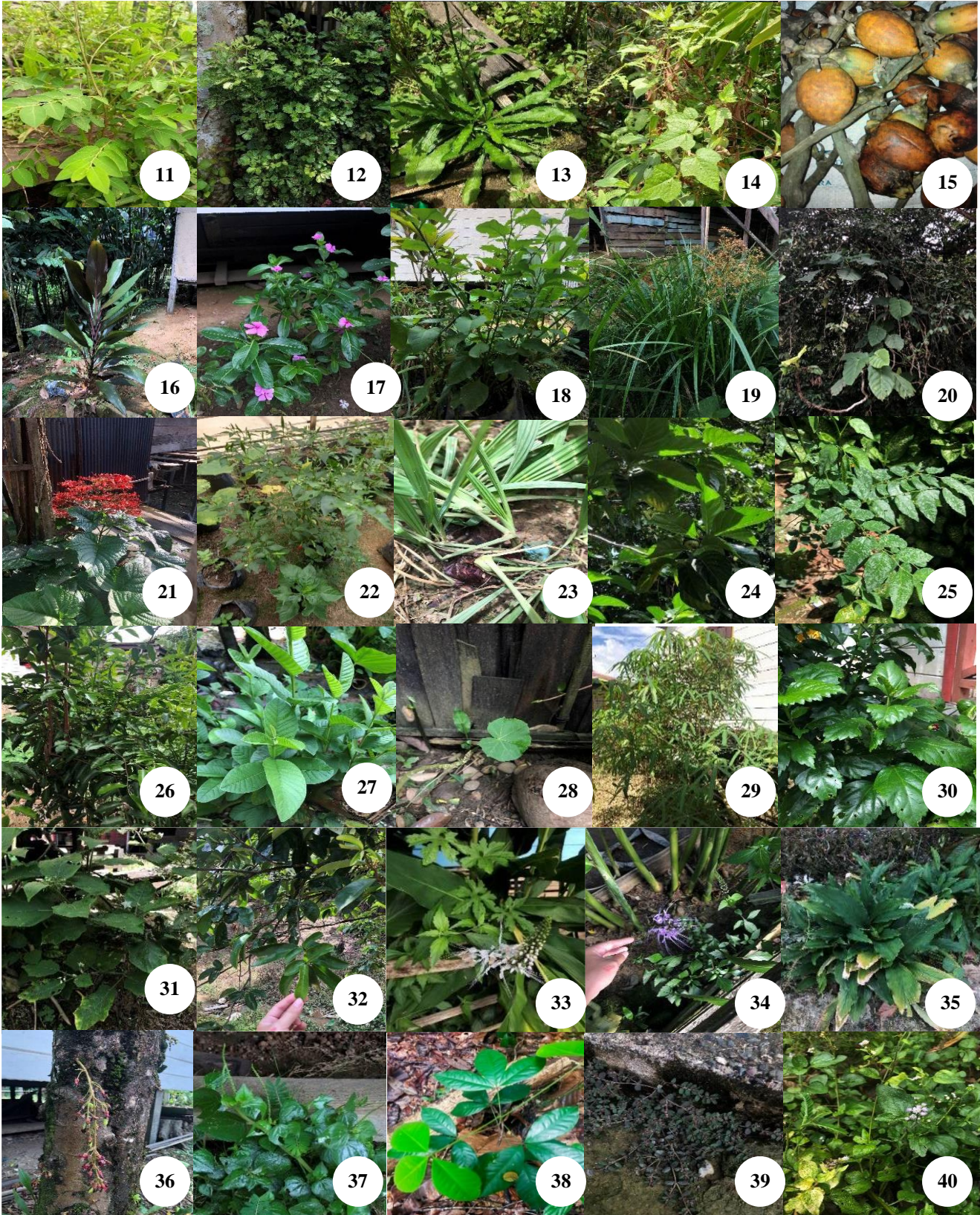




Figure 2. Habitus of medicinal plants used by the Soputan Dayak tribe, East Kalimantan, Indonesia: 1. *Utang irop* (*Piper reticulatum*); 2. *Sambung Nyawa* (*Gynura procumbens*); 3. *Tunjuk Langit* (*Helminthostachys zeylanica*); 4. *Batang Toruq* (*Goniotalamus macrophyllus*); 5. *Lengkuas* (*Alpinia galanga*); 6. *Uru Usus Buntu* (*Aeschynanthus tricolor*); 7. *Krengang/Gelinggang* (*Cassia alata*); 8. *Tunjuk Langit* (*Helminthostachys zeylanica*); 9. *Mokotelaq* (*Conostegia xalapensis*); 10. *Paku Atiq/Pakis Hati Merah* (*Angiopteris evecta*); 11. *Uru Maag* (*Breynia disticha*); 12. *Daun Patah Tulang* (*Polyscias guilfoylei*); 13. *Oke Kotu* (*Elephantopus tomentosus*); 14. *Itun Beq* (*Passiflora foetida*); 15. *Pa'an/Buah Piang* (*Areca catechu*); 16. *Hanjuang* (*Cordyline fruticosa*); 17. *Tapak Dara* (*Catharanthus roseus*); 18. *Daun Encok* (*Plumbago zeylanica*); 19. *Uru Selopiring* (*Cyperus rotundus*); 20. *Uka Mohung* (*Poikilospermum suaveolens*); 21. *Derang Ehaq Tevoriq* (*Clerodendrum paniculatum*); 22. *Itun Pahang/Daun Lombok* (*Capsicum frutescens*); 23. *Bawang Luvaq/Bawang Dayak* (*Eleutherine bulbosa*); 24. *Buah Mengkudu* (*Morinda citrifolia*); 25. *Daun Katuk* (*Sauropus androgynus*); 26. *Daun Gaharu* (*Aquilaria malaccensis*); 27. *Libuq Tevoriq/Jambu Merah* (*Psidium guajava*); 28. *Daun Jarak* (*Jatropha curcas*); 29. *Daun Singkong* (*Manihot esculenta*); 30. *Kembang Sepatu* (*Hibiscus rosa sinensis*); 31. *Ulom/Terong Pipit* (*Solanum torvum*); 32. *Daun Sirsak* (*Annona muricata*); 33. *Kumis Kucing Putih* (*Orthosiphon stamineus*); 34. *Kumis Kucing Ungu* (*Orthosiphon aristatus*); 35. *Kunyit Putih* (*Curcuma zedoaria*); 36. *Kembang Belimbing Telunjuk* (*Averrhoa bilimbi*); 37. *Daun Sirih Cina* (*Peperomia pellucida*); 38. *Daun Sambung Nyawa* (*Gynura procumbens*); 39. *Daun Patikan Cina* (*Euphorbia serpens*); 40. *Babadatoan* (*Ageratum conyzoides*); 41. *Loving Tiong* (*Cheilocostus speciosus*); 42. *Tovu Tevoriq/Tebu Merah* (*Saccharum officinarum*); 43. *Seluang Belum* (*Luvunga crassifolia*); 44. *Sarang Semut* (*Myrmecodia pendas*); 45. *Karamunting* (*Rhodomyrtus tomentosa*); 46. *Akar Kuning* (*Arcangelisia flava*); 47. *Uru Sipaq Tevoriq/Sirih Merah* (*Piper crocatum*); 48. *Daun Vetsin/Sangkubak* (*Pycnarrhena longifolia*); 49. *Akar Seribu* (*Tinospora crispa*); 50. *Itun Atung* (*Episcia reptans*); 51. *Uru Mata Katarak* (*Hippobroma longiflora*); 52. *Uru Batuk* (*Alternanthera brasiliana*); 53. *Tokong Belang* (*Rellia simplex*); 54. *Kunyit* (*Curcuma domestica*); 55. *Derang Ehaq Putih* (*Clerodendrum paniculatum*); 56. *Binahong* (*Anredera cordifolia*); 57. *Kaki Tiga* (*Vitex trifolia*); 58. *Pohon Langsung* (*Lansium domesticum*); 59. *Cocor Bebek* (*Kalanchoe pinnata*); 60. *Obat Pelungsur* (*Lindernia crustacea*); 61. *Uka Tatok Konyu/Bajakah* (*Spatholobus littoralis*); 62. *Pasak Bumi* (*Eurycoma longifolia*); 63. *Onya/Kelapa* (*Cocos nucifera*); 64. *Bakung Keloq* (*Crinum asiaticum*)

Table 1. Identification and use of traditional medicinal plants by the Soputan Dayak Tribe, East Kalimantan, Indonesia

Family	Botanical name	Local name	Medicinal plant properties (Prevention/Treatment)	Utilized part
Acanthaceae	<i>Rellia simplex</i> C. Wright	<i>Tokong Belang</i>	Cysts	Leaf
Amaranthaceae	<i>Alternanthera brasiliensis</i> Forsskal	<i>Uru Batuk</i>	Cough	Leaf
Amaryllidaceae	<i>Crinum asiaticum</i> L.	<i>Bakung Keloq</i>	Sprains	Leaf
Annonaceae	<i>Annona muricata</i> L.	<i>Daun Sirsak</i>	Cholesterol and hypertension	Leaf
	<i>Goniothalamus macrophyllus</i> (Blume) Zoll	<i>Batang Toruq</i>	Leucorrhoea and cysts	Root
Apocynaceae	<i>Catharanthus roseus</i> (L.) G. Don	<i>Tapak Dara</i>	Diabetes, brain cancer, cholesterol	Leaf, root
Araliaceae	<i>Polyscias guilfoylei</i> (W Bull) L.H. Bailey	<i>Daun Patah Tulang</i>	Broken bones, bruises, and sprains	Leaf
Arecaceae	<i>Areca catechu</i> L.	<i>Pa'an/Buah piang</i>	Indigestion	Fruit
	<i>Cocos nucifera</i> L.	<i>Onya/Kelapa</i>	Kidneys, heartburn and smallpox	Root, fruit
Asparagaceae	<i>Cordyline fruticosa</i> A. Chev.	<i>Hanjuang/Andong</i>	Itching in the genitals	Root
Basellaceae	<i>Anredera cordifolia</i> (Ten.) Steenis	<i>Binahong</i>	Diabetes and itching	Leaf
Campanulaceae	<i>Hippobroma longiflora</i> (L.) G. Don	<i>Uru Mata Katarak</i>	Cataracts	Leaf, flower
Compositae	<i>Elephantopus tomentosus</i> L.	<i>Oke Kotu</i>	Fever, dysentery, dengue fever, kidney and appendicitis	Leaf
	<i>Ageratum conyzoides</i> L.	<i>Daun babadatoan</i>	Dysentery	Leaf
	<i>Gynura procumbens</i> (Lour) Merr.	<i>Sambung Nyawa</i>	Cysts, tumors, and cancer	Leaf
Costaceae	<i>Cheilocostus speciosus</i> (J. Konig.) Sm.	<i>Loving Tiong</i>	Cold, cough, and hemorrhoids	Stem
Crassulaceae	<i>Kalanchoe pinnata</i> Pers	<i>Cocor Bebek</i>	High fever and hypertension	Leaf, root
Cyperaceae	<i>Cyperus rotundus</i> L.	<i>Uru Selopiring</i>	Mouth ulcer and sore throat	Root
Euphorbiaceae	<i>Euphorbia serpens</i> Kunth.	<i>Daun Patikan Cina</i>	Leucorrhoea and cleaning the vaginal area	Leaf
	<i>Manihot esculenta</i> Crantz	<i>Daun Singkong</i>	Gout	Leaf
	<i>Jatropha curcas</i> L.	<i>Daun Jarak</i>	Bloating in baby	Leaf
Gesneriaceae	<i>Aeschynanthus tricolor</i> Hook	<i>Uru Usus Buntu</i>	Appendicitis	Leaf
	<i>Episicia reptans</i> Mart.	<i>Uru Atung</i>	Skin ulcers and ear infection	Leaf, shoots
Iridaceae	<i>Eleutherine bulbosa</i> (Mill) Urb.	<i>Bawang Luvaq</i>	Cough, cancer, and lungs	Tubers
Lamiaceae	<i>Orthosiphon aristatus</i> (Blume) Miq	<i>Kumis Kucing Ungu</i>	Rheumatism, diabetes, and kidney	Root
	<i>Orthosiphon stamineus</i> Benth	<i>Kumis Kucing Putih</i>	Gallstones	Leaf
	<i>Clerodendrum paniculatum</i> L.	<i>Derang Ehaq Tevoriq</i>	Back pain, leucorrhoea, vaginal lump, impotence, and poisoning	Root
	<i>Vitex trifolia</i> L.	<i>Kaki Tiga</i>	Itching in children	Leaf
Lauraceae	<i>Eusideroxylon zwageri</i> T. Et B.	<i>Ulin</i>	Back pain and urinary	Root
Leguminosae	<i>Spatholobus littoralis</i> Hassk	<i>Uka Tatok Konyu</i>	Prevent cancer, diabetes, and liver	Root
	<i>Cassia alata</i> L.	<i>Daun Krengang</i>	Ringworm and body slimming	Leaf
Linderniaceae	<i>Lindernia crustacea</i> (L.) F. Muell	<i>Obat Pelungsur</i>	After giving birth	Leaf
Malvaceae	<i>Hibiscus rosa sinensis</i> L.	<i>Kembang Sepatu</i>	Fever	Leaf
Marattiaceae	<i>Angiopteris evecta</i> (G. Forst.) Hoffm.	<i>Paku Atiq</i>	Neutralize poison	Tubers
Melastomataceae	<i>Conostegia xalapensis</i> (Bonpl.) D. Don	<i>Mokotelaq</i>	Dysentery	Leaf
Meliaceae	<i>Lansium domesticum</i> Corr	<i>Pohon Langsat</i>	Typhus and malaria	Cambium
Menispermaceae	<i>Arcangelisia flava</i> (L.) Merr.	<i>Akar Kuning</i>	Antibiotics, indigestion, immune system, liver, hepatitis A and B	Root
	<i>Tinospora crispa</i> L.	<i>Akar Seribu</i>	High fever, body aches, hepatitis	Stem
	<i>Pycnarrhena longifolia</i> (Decne. Ex Miq)	<i>Daun Vetsin/Sangkubak</i>	Hypertension, heart disease, asthma and back pain	Leaf, root
Myrtaceae	<i>Psidium guajava</i> L.	<i>Libuq Tevoriq</i>	Diarrhea and dengue fever	Leaf, root
	<i>Rhodomyrtus tomentosa</i> (Aiton) Hassk	<i>Karamunting</i>	Mouth ulcers, toothaches, and diabetes	Fruit, root, shoots
Ophioglossaceae	<i>Helminthostachys zeylanica</i> (L.) Hook	<i>Tunjuk Langit</i>	Back pain	Root
Oxalidaceae	<i>Averrhoa bilimbi</i> L.	<i>Kembang Belimbing</i>	Cold and cough	Flower
		<i>Telunjuk</i>		
Passifloraceae	<i>Passiflora foetida</i> L.	<i>Itun Beq</i>	After giving birth and blood circulation	Leaf
Phyllanthaceae	<i>Sauropus androgynus</i> (L.) Merr.	<i>Daun Katuk</i>	Defecation	Leaf
	<i>Breynia disticha</i> J.R. Forst & G Forst	<i>Uru Maag</i>	Indigestion	Leaf
	<i>Breynia androgyna</i> (L.) Chacrab& N. Balakr	<i>Uru Keputihan</i>	Leucorrhoea	Leaf
Piperaceae	<i>Peperomia pellucida</i> L.	<i>Daun Sirih Cina</i>	Cholesterol and gout	Leaf
	<i>Piper reticulatum</i> L.	<i>Utang Irop</i>	Bleeding after giving birth	Leaf
	<i>Piper crocatum</i> Ruiz and Pav	<i>Uru Sipaq Tevoriq</i>	Cholesterol, asthma, diabetes	Leaf
	<i>Piper betle</i> L.	<i>Uru Sipaq Sanit</i>	Asthma	Leaf
Plumbaginaceae	<i>Plumbago zeylanica</i> L.	<i>Daun Encok</i>	Skin ulcers	Leaf
Poaceae	<i>Saccharum officinarum</i> L.	<i>Tovu Tevoriq</i>	Hematemeses	Stem, bark
Rubiaceae	<i>Myrmecodia pendens</i> Merr. & L.M. Perry	<i>Sarang Semut</i>	Cholesterol, hypertension, gout	Tubers
	<i>Morinda citrifolia</i> L.	<i>Buah Mengkudu</i>	Scars	Fruit
Rutaceae	<i>Luvunga crassifolia</i> Tanaka	<i>Seluang Belum</i>	Back pain and maintain stamina	Root
Simaroubaceae	<i>Eurycoma longifolia</i> Jack	<i>Pasak Bumi</i>	Back pain and maintain stamina	Root

Solanaceae	<i>Capsicum frutescens</i> L.	<i>Itun Pahang</i>	Skin ulcers	Leaf
	<i>Solanum torvum</i> Sw.	<i>Ulom</i>	Cataracts and liver	Fruit, root
Thymelaeaceae	<i>Aquilaria malaccensis</i> Lamk	<i>Daun Gaharu</i>	Lungs	Leaf
Urticaceae	<i>Poikilospermum suaveolens</i> (Blume) Merr.	<i>Uka Mohung</i>	Hypertension, cholesterol, appendicitis and kidney	Root
Zingiberaceae	<i>Curcuma zedoaria</i> (Christm.) Roscoe	<i>Kunyit Putih</i>	Deep wounds or wounds after surgery and skin ulcers	Tubers
	<i>Curcuma domestica</i> Val.	<i>Kunyit</i>	Scars	Tubers
	<i>Alpinia galanga</i> (L.) Willd	<i>Lengkuas</i>	Tinea versicolor	Tubers

In the Dayak community, even though they belong to the same tribe, each family may have different traditional medicinal knowledge from their ancestors. Transferring knowledge of medicinal plants is carried out orally, closely, and not documented (Noorcahyati 2012; Prasetyo 2021); this makes knowledge of traditional medicinal difficult to develop, and it gradually decreases due to differences in each person's understanding of the transfer process. According to the local community, based on the beliefs of their ancestors, the Sopotan Dayak believe that plants used as medicinal can prevent and cure various diseases.

Several medicinal plants have special requirements when receiving traditional treatment from a physician, called a hardener or *ketuo*, in the form of rice, a glass plate, a knife, one chicken, *caul batik*, white cloth, and a sufficient amount of money. However, due to modern development, local people who want treatment can choose from the requirements they would like to give the physician so that the traditional medicines are effective. When taking traditional medicinal plant species, methods or signals must also be followed by a community leader who comprehends traditional medicinal plants. For example, while taking a medicinal plant such as red *Cycas rumphii* Miq. must use a knife and nails driven into the ground where it grows; this method also applies to other various species of medicinal plants.

In general, the Sopotan Dayak tribe uses medicinal plants as first aid. After that, the local people go to the doctor or health center to ensure that the disease has recovered. Medicinal plants are also often used as a final option in cases where modern medicine fails to provide satisfactory outcomes. This indicates that disease curing still combines the two types of treatments.

Various types of medicinal plants employed by the Sopotan Dayak tribe are almost the same as those used by other tribes in Kalimantan. For example, the Benuaq Dayak tribe uses aerial roots of *Tinospora crispa* for malaria, kidney stones, and tonsil complaints (Falah et al. 2013), while the Sopotan Dayak tribe uses it as a medicine for high fever, body aches, and jaundice. The Kutai tribe uses betel leaf (*Piper betle*) to treat leucorrhea after childbirth (Efremila et al. 2015; Hadijah et al. 2016), and the Sopotan Dayak tribe uses it as asthma medicinal. The Maanyan Dayak tribe uses the inner stem of *karamunting* (*Rhodomyrtus tomentosa*) to cure menstrual cramps (Noorcahyati 2012), and the Sopotan Dayak tribe use the roots to treat toothache and the dried shoots and fruit to treat mouth ulcers. In addition, the Jangkang Dayak tribe in Sanggau District treats wounds with leaves and roots (Sari et al. 2015). The plant organs used for treatment proportion are presented in Figure 3.

Figure 3 shows that leaves are most widely used by the community, with a percentage of 46%, followed by roots at 25%. In Karangwangi, Cianjur District, leaves constituted the most used plant parts, accounting for 52%, with stems following closely at 23%, and the most common preparations were decoction, poultice, and squeezed plants (Malini et al. 2017). Falah et al. (2013), Ismail and Ahmad (2019), and Siahaan et al. (2022) also found that the most commonly used part of the plant as a medicine was the leaves (64%) and the predominant method of processing involved boiling. Aftab et al. (2023) similarly reported that leaves were the most frequently used plant parts (35%), followed by seeds (16%), roots (12%), fruits (10%), flowers (9%), stem (5%), bark (3%), latex (3%), aerial parts (3%), whole plants (2%), and wood (1%). This aligns with the findings of Navia et al. (2021), who also identified leaves (50%) as the most commonly used plant part and oral administration (65%) as the prevailing method of administering traditional medicine.

Tantengco et al. (2018) reported that medicinal plant use contributes to a community's cultural identity and heritage, providing plant protection and ensuring long-term plant survival. Leaves can synthesize a wide variety of secondary metabolites, including saponins, phenols, and alkaloids, compounds that may be relevant to therapeutic benefits from the medicinal properties of plants. Zenebe et al. (2012) stated that leaf organs are the easiest to obtain for treatment without damaging the plant. The use of leaves for medicinal purposes has little negative effect on plant growth because leaves can grow again on the shoots, whereas if the root organs are removed, it can disrupt plant survival (Navia et al. 2021).

Continuous harvesting of root organs from forest plants without conservation efforts can lead to scarcity of a particular plant species if harvesting is through uprooting and logging techniques (Falah et al. 2013). This suggests that the use of leaves by the Sopotan Dayak tribe for traditional medicine indirectly supports plant sustainability and has distinct medicinal attributes. Individuals frequently resort to herbal plants for traditional medicine to treat various diseases. This aligns with Liu et al. (2021), who reported that the Miao people also use traditional medicines to cure diseases and prevent disease in daily life; their curing method for disease, most commonly back pain, may involve many plants. Furthermore, as previously stated, many plant species can cure diseases, and the most widely used species treat back pain (Figure 4).

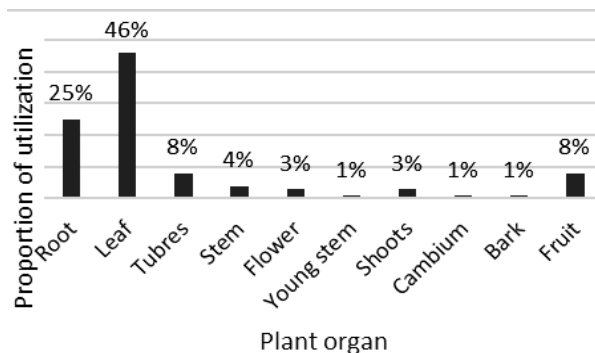


Figure 3. The proportion of plant organs used for traditional medicine

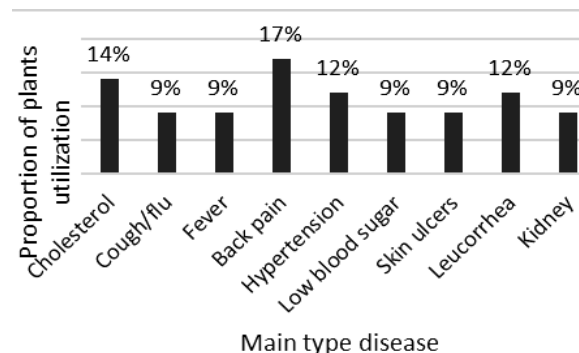


Figure 4. Percentage of medicinal plants used for treatment categorized by the primary type of disease

The economic value of medicinal plants

Plants have economic value because they have many benefits (Auliani et al. 2014; Hartanti et al. 2014; Elfrida et al. 2020). Ginting et al. (2018) found that the people in the Sentarum Lake National Park area of West Kalimantan valued medicinal plants as having a price and economic value. This is because, generally, when people are sick, they use medicinal plants before going to the doctor for medical treatment. The economically valued compounds in medicinal plants are accumulated in calculating the total economic value of environmental services, especially non-timber forest product components.

Many global projects have applied different methods or techniques for valuing assets and environmental impacts. Various approaches can be used to evaluate environmental services, including the market-price approach, the market-replacement approach (value of substitute or complementary goods), and survey techniques (Suparmoko 2014). Hasibuan (2014) and Kristiningrum et al. (2020) noted that economic valuation is an economic activity that provides a monetary assessment of goods and services generated by natural resources and the environment, encompassing both market and non-market valuations. Therefore, the economic appraisal of resources is a methodological approach that employs various valuation techniques to estimate the monetary

worth of goods and services derived from the environment and natural resources. In this case, the approach used is a market-substitute approach for medicinal plant products, where the actual market price of the product is not known but can be evaluated using the market price of the substitute for the commodity used, namely the price of synthetic drugs sold in pharmacies (Kaiser et al. 2019). Based on information obtained through interviews with 15 individuals from Long Penaneh III Village, the economic value of the substitute market for traditional medicinal plants can be seen in Table 2.

Table 2 shows the number of traditional medicinal plants obtained from 15 respondents (households) in the village of Long Penaneh III. The average economic value was IDR 2,445,667 per household per year or IDR 203,805 per month. In different communities in Sentarum Lake National Park, West Kalimantan, Indonesia Ginting et al. (2018) found that the economic value of medicinal plants obtained using the willingness-to-pay approach was only IDR 50,354 to IDR 72,312 per household per month. This indicates a significant contribution of traditional medicinal plants to support the household economy of the Sopotan Dayak tribe in the village of Long Penaneh III and for safeguarding against ailments and treating various diseases.



Figure 5. The economic value of ten traditional medicinal plants that are commonly used

Table 2. Market economic value of medicinal plant substitutes by species per year

Species	Estimated volume of plants utilization (Kg/type of organ)	Substitute market value (Price of synthetic drugs) (IDR)
<i>Aeschynanthus tricolor</i> Hook	3/leaf	1,818,000
<i>Ageratum conyzoides</i> L.	4/leaf	92,000
<i>Alpinia galanga</i> (L.) Willd	4/tubers	30,000
<i>Alternanthera brasiliana</i> (L.) Kuntz.	2/leaf	30,000
<i>Angiopteris evecta</i> (G. Forst.) Hoffm.	3/tubers	36,000
<i>Annona muricata</i> L.	4/leaf	269,000
<i>Anredera cordifolia</i> (Ten) Steenis	6/leaf	788,000
<i>Arcangelisia flava</i> (L.) Merr.	3/root	2,588,000
<i>Areca catechu</i> L.	3/fruit	30,000
<i>Aquilaria malaccensis</i> Lamk.	2/leaf	606,000
<i>Averrhoa bilimbi</i> L.	5/flower	182,000
<i>Breynia androgyna</i> (L.) Chakrab. & NP. Balakr	6/leaf	43,000
<i>Breynia disticha</i> J.R. Fosrt & G. Forst.	5/leaf	202,000
<i>Capsicum frutescens</i> L.	3/leaf	16,000
<i>Cassia alata</i> L.	4/leaf	576,000
<i>Catharanthus roseus</i> (L.) G. Don.	4/leaf and root	1,812,000
<i>Cheilocostus speciosus</i> (J.Konig) Sm.	4/stem	113,000
<i>Clerodendrum paniculatum</i> L.	3/leaf	522,000
<i>Cocos nucifera</i> L.	3/root and fruit	1,073,000
<i>Conostegia xalapensis</i> (Bonpl.) G. Don	3/leaf	92,000
<i>Cordyline fruticosa</i> A. Chev.	2/root	141,000
<i>Crinum asiaticum</i> L.	1/leaf	131,000
<i>Curcuma domestica</i> Val	3/tubers	21,000
<i>Curcuma zedoaria</i> (Christm) Roscoe	5/tubers	353,000
<i>Cyperus rotundus</i> L.	5/young stem	198,000
<i>Elephantopus tomentosus</i> L.	2/leaf	912,000
<i>Eleutherine bulbosa</i> (Mill) Urb.	3/tubers	1,303,000
<i>Episicia reptans</i> Mart.	2/leaf and shoots	76,000
<i>Euphorbia serpens</i> Kunth.	3/leaf	424,000
<i>Eurycoma longifolia</i> Jack	4/root	733,000
<i>Eusideroxylon zwageri</i> T. et B.	2/root	145,000
<i>Goniothalamus macrophyllus</i> (Blume) Zoll	3/root	848,000
<i>Gynura procumbens</i> (Lour) Merr.	4/leaf	1,591,000
<i>Helminthostachys zeylanica</i> (L.) Hook	5/root	37,000
<i>Hibiscus rosa sinensis</i> L.	1/leaf	19,000
<i>Hippobroma longiflora</i> (L.) G.Don.	1/leaf and flower	455,000
<i>Jatropha curcas</i> L.	2/leaf	202,000
<i>Kalanchoe pinnata</i> Pers.	3/leaf and root	163,000
<i>Lansium domesticum</i> Corr	1/cambium	170,000
<i>Lindernia crustacea</i> (L.) F. Muell	1/leaf	29,000
<i>Luvunga crassifolia</i> Tanaka	2/root	226,000
<i>Manihot esculenta</i> Crantz	4/leaf	43,000
<i>Morinda citrifolia</i> L.	2/fruit	162,000
<i>Myrmecodia pendens</i> Merr & L.M. Perry	8/tubers	755,000
<i>Orthosiphon aristatus</i> (Blume) Miq	3/root	2,410,000
<i>Orthosiphon stamineus</i> Benth	6/leaf	454,000
<i>Passiflora foetida</i> L.	1/leaf	107,000
<i>Peperomia pellucida</i> L.	2/leaf	85,000
<i>Piper betle</i> L.	5/leaf	91,000
<i>Piper crocatum</i> Ruiz and Pav	5/leaf	388,000
<i>Piper reticulatum</i> L.	8/leaf	303,000
<i>Plumbago zeylanica</i> L.	2/leaf	16,000
<i>Poikilospermum sp suaveolens</i> (Blume) Merr.	10/root	4,171,000
<i>Polyscias guilfoylei</i> (W. Bull) L.H. Bailey	5/leaf	435,000
<i>Psidium guajava</i> L.	6/leaf and root	425,000
<i>Pycnarrhena longifolia</i> Decne, Ex Miq	2/leaf and root	300,000
<i>Rellia simplex</i> C. Wright	5/leaf	1,363,000
<i>Rhodomirtus tomentosa</i> (Aiton) Hassk	3/fruit, root and shoots	550,000
<i>Saccharum officinarum</i> L.	4/steam and bark	202,000
<i>Sauropus androgynus</i> (L.) Merr.	8/leaf	65,000
<i>Solanum torvum</i> Sw.	1/fruit and root	757,000
<i>Spatholobus littoralis</i> Hassk	15/root	3,998,000
<i>Tinospora crispa</i> L.	2/stem	388,000
<i>Vitex trifolia</i> L.	3/leaf	122,000
Total Substitute Market Value (based on 15 respondents)		36,685,000
Average Value		2,445,667

Notes: US \$ 1.00 = IDR 15,760 (February 2024)

Examining the economic value of each type of medicinal plant showed different conditions even though the use volume was the same. This condition is determined by medicinal plants' properties, which can affect the price of synthetic drugs in the substitute market. Furthermore, the proportions of use of the various species of traditional medicinal plants have contributed to different economic values. Figure 5 shows the economic value of 10 species of traditional medicinal plants that are dominantly used.

The difference in the values shown is influenced by the number of properties of each plant species, its number of uses in one year, and its price value per property possessed. The more properties and uses of any plant species, the higher its price value. The medicinal plant species, i.e., *Uka Mohung* (*P. suaveolens*) and *Uka Tatok Konyu* (*S. littoralis*), have high and significant economic value compared to other plant species.

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REFERENCES

- Aftab F, Qureshi R, Munawar T, Waheed A, Rashid M, Rehman S. 2023. Quantitative analysis of ethnomedicinal plants of Tehsil Khairatta, Azad Jammu & Kashmir, Pakistan. *Ethnobot Res Appl* 25: 1-28. DOI: 10.32859/era.25.37.1-28.
- Andari D, Linda R, Rafdinal. 2020. Utilization of medicinal plants by the Dayak Kendawangan people in Rangkung Village, Marau District, Ketapang Regency. *J Bio Sci* 9 (1): 78-86. DOI: 10.26418/protobiont.v9i1.41609.
- Ani N, Sukenti K, Aryanti E, Rohyani IS. 2021. Ethnobotany study of medicinal plants by the Mbojo Tribe Community in Ndano Village at the Madapangga Nature Park, Bima, West Nusa Tenggara. *J BioTrop* 21 (2): 456-469. DOI: 10.29303/jbt.v21i2.2666.
- Aprillia FC, Anwari MS, Ardian H. 2020. Ethnozoology of the Mayan Dayak Tribe for medicines in Mensusai Village, Suhaid District, Kapuas Hulu Regency. *J Sustain For* 8 (3): 628-639. DOI: 10.26418/jhl.v8i3.42351.
- Auliani A, Fitmawati, Sofiyanti N. 2014. Studi etnobotani famili Zingiberaceae dalam kehidupan masyarakat lokal di Kecamatan Siak Hulu Kabupaten Kampar. [Dissertation]. Riau University, Riau. [Indonesian]
- Aziz M, Adnan M, Khan A, Shahat A, Al-Said M, Ullah R. 2018. Traditional uses of medicinal plants practiced by the indigenous communities at Mohmand agency, FATA, Pakistan. *J Ethnobiol Ethnomed* 14 (2): 2-16. DOI: 10.1186/s13002-017-0204-5.
- Bibi T, Ahmad M, Tareen RB, Tareen NM, Jabeen R, Rehman SU, Yaseen G. 2014. Ethnobotany of medicinal plants in district Mastung of Balochistan province-Pakistan. *J Ethnopharmacol* 157: 79-89. DOI: 10.1016/j.jep.2014.08.042.
- Casagrande A, Ritter MR, Kubo RR. 2023. Traditional knowledge in medicinal plants and intermedicallity in urban environments: A case study in a popular community in southern Brazil. *Ethnobot Res Appl* 25: 1-34. DOI: 10.32859/era.25.35.1-34.
- Deng JG, Hou XT, Zhang TJ, Bai G, Hao EW, Chu JJH, Wattanathorn J, Ard PS, Ee CS, Low H, Liu CX. 2020. Carry forward advantages of traditional medicines in prevention and control of outbreak of COVID-19 pandemic. *China Herb Med* 12: 207-213. DOI: 10.1016/j.chmed.2020.05.003.
- Efremila, Wardenaar E, Sisilia L. 2015. Ethnobotanical study of medicinal plants by the Dayak ethnic group in Kayu Tanam Village, Mandor District, Landak Regency. *J Sustain For* 3 (2): 234-246. DOI: 10.26418/jhl.v3i2.10310.
- Elfrida E, Tarigan NS, Suwardi AB. 2021. Ethnobotanical study of medicinal plants used by community in Jambur Labu Village, East Aceh, Indonesia. *Biodiversitas* 22 (7): 2893-2900. DOI: 10.13057/biodiv/d220741.
- Elfrida, Mubarak A, Suwardi AB. 2020. The fruit plant species diversity in the home gardens and their contribution to the livelihood of communities in rural area. *Biodiversitas* 21 (8): 3670-3675. DOI: 10.13057/biodiv/d210833.
- Falah F, Sayektiningsih T, Noorahyati. 2013. The diversity of species and use of medicinal plants by the community around the protected forest of Mount Beratus, East Kalimantan. *J For Res Nat Conserv* 10 (1): 1-18. DOI: 10.20886/jphka.2013.10.1.1-18.
- Ginting T, Ismail A, Simangunsong B. 2018. Economic value of medicinal plants in danau Sentarum National Park, West Kalimantan. Indonesia *J Eco Dev* 18 (1): 22 -34. DOI: 10.21002/jepi.2018.02.
- Hadijah S, Hendra M, Hariani N. 2016. Ethnobotany of traditional medicine by the people of Kutai in Muara Bengkal District, West Kutai Regency. *J Bio Sci* 11 (2): 19-24. DOI: 10.30872/bp.v11i2.
- Handayani R, Rusmita H. 2017. Inhibition test of the ethanol extract kelakai roots against *Escherichia coli* bacteria. *Sutya Medika J* 2 (2): 12-26. DOI: 10.33084/jsm.v2i2.356.
- Hartanti S, Fitmawati, Sofiyanti N. 2014. Ethnobotanical study of the Zingiberaceae family in local community life in Kuantan Singingi District, Riau. *J Bio Bio Edu* 6 (2): 122-132. DOI: 10.15294/biosaintifika.v6i2.3105.
- Haruna N, Syamsuri S, Alang H. 2022. Economic ethnobotanical study of sago plants (*Methroxylon sago*) in the Luwu indigenous community in Luwu Regency, South Sulawesi. *Bio-Lectura J Biol Edu* 9 (2): 179-185. DOI: 10.31849/bl.v9i2.10812.
- Haryadi NK. 2011. Kelor Herbal Multikhasiat Ampuh Melawan diabetes Mellitus, Kolesterol Tinggi dan Penyakit Lainnya. Delta Media, Surakarta. [Indonesian]
- Hasibuan B. 2014. Valuasi ekonomi lingkungan nilai guna langsung dan tidak langsung komoditas ekonomi. Signifikan: Jurnal Ilmu Ekonomi 3 (2): 113-123. DOI: 10.15408/sjie.v3i2.2055.
- Hu R, Lin C, Xu W, Liu Y, Long C. 2020. Ethnobotanical study on medicinal plants used by Mulam people in Guangxi, China. *J Ethnobiol Ethnomed* 16: 40. DOI: 10.1186/s13002-020-00387-z.
- Irwanta E, Hikmat A, Zuhud EAM. 2015. Diversity of vegetable simplicia and traditional medicine products traded in Pati District, Central Java. *Conserv Med* 20 (3): 197-204. DOI: 10.29244/medkon.20.3.%25p.
- Ismail A, Ahmad W. 2019. *Syzygium polyanthum* (Wight) Walp: A potential phytomedicine. *Pharmacogn J* 11: 429-438. DOI: 10.5530/pj.2019.11.67.
- Jamun R, Hendra M, Hariani N. 2020. Diversity of medicinal plants in the Manggarai Tribe, Ndisi District, West Manggarai Regency, West Nusa Tenggara. *J Math Sci Edu* 11 (2): 285-299. DOI: 10.26418/jpmipa.v11i2.40810.
- Kaiser AH, Hehman L, Forsberg BC, Simangolwa WM, Sundewall J. 2019. Availability, prices and affordability of essential medicines for treatment of diabetes and hypertension in private pharmacies in Zambia. *PLoS ONE* 14: e0226169. DOI: 10.1371/journal.pone.0226169.
- Karki S, Dhital AP, Uprety Y, Ghimire SK. 2023. Medicinal plants and their use by an ethnic minority Jirel in Dolakha district, Central Nepal. *Ethnobot Res Appl* 25: 18. DOI: 10.32859/era.25.18.1-29.
- Kassaye KD, Amberbir A, Getachew B, Mussema Y. 2006. A historical overview of traditional medicine practices and policy in Ethiopia. *Ethiop J Health Dev* 20: 127-134. DOI: 10.4314/ejhd.v20i2.10023.
- Khan SR, Rijjal DA, Piro A, Wheeler MB. 2021. Integration of AI and traditional medicine in drug discovery. *Drug Discovery Today* 26 (4): 982-992. DOI: 10.1016/j.drudis.2021.01.008.
- Khesht MA, Jafari H, Alizadeh K. 2021. The impact of cultivation of medicinal plants on the economic income of rural settlements case study of Kalat city villages. *Propósitos y Representaciones* 9 (SPE2): 957. DOI: 10.20511/pyr2021.v9nSPE2.957.
- Kidane L, Gebremedhin G, Beyene T. 2018. Ethnobotanical study of medicinal plants in Ganta Afeshum District, Eastern Zone of Tigray, Northern Ethiopia. *J Ethnobiol Ethnomed* 14: 64. DOI: 10.1186/s13002-018-0266-z.

- Kristiningrum R, Lahjie AM, Masjaya, Yusuf S, Ruslim Y, Ma'ruf A. 2020. Fauna diversity, production potential and total economic value of mangrove ecosystem in Mentawir Village, East Kalimantan, Indonesia. *Biodiversitas* 21: 1940-1953. DOI: 10.13057/biodiv/d210522.
- Liu S, Zhang B, Zhou J, Fang Q, Kennelly EJ, Long C. 2021. Herbal plants traded at the Kaili medicinal market, Guizhou, China. *J Ethnobi Ethnomed* 17: 67. DOI: 10.1186/s13002-021-00495-4.
- Malini DM, Madihah, Joko Kusmoro J, Kamilawati F, Iskandar J. 2017. Ethnobotanical study of medicinal plants in Karangwangi, District of Cianjur, West Java. *J Bio Bio Edu* 9 (2): 345-356. DOI: 10.15294/biosaintifika.v9i2.5756.
- Miraldi E, Baini G. 2018. Medicinal plants and health in human history: from empirical use to modern phytotherapy. *J Siena Acad Sci* 10: 1-6. DOI: 10.4081/jsas.2018.8529.
- Muktiningsih S, Muhammad HS, Harsana I, Budhi M, Panjaitan P. 2001. Review of medicinal plants used by traditional healers in North Sumatra, South Sumatra, Bali and South Sulawesi. *Health R&D Media* 11 (4): 25-36.
- Navia ZI, Suwardi AB, Baihaqi. 2021. Etnobotanical study of medicinal plants used by local communities in Sekerak Subdistrict, Aceh Tamiang, Indonesia. *Biodiversitas* 22 (10): 4273-4281. DOI: 10.1307/biodiv/d221019.
- Nomleni FT, Daud Y, Tae F. 2021. Ethnobotany of traditional medicinal plants in Huilelot Village and Villages Uiasa Semau District, Kupang Regency. *Bio Edu* 6 (1): 60-73. DOI: 10.32938/jbe.v6i1.993.
- Noorahyati. 2012. Tumbuhan Berkhasiat Obat Etnis Asli Kalimantan. Balai Penelitian Teknologi Konservasi Sumber Daya Alam, Balikpapan. [Indonesian]
- Nugroho AS, Anis T, Ulfah M. 2015. Analisis keanekaragaman jenis tumbuhan berbuah di hutan lindung Surokonto, Kendal, Jawa Tengah dan potensinya sebagai kawasan konservasi burung. *Prosiding Seminar Nasional Masyarakat Biodiversitas Indonesia* 1 (3): 472-476. DOI: 10.13057/psnmbi/m010316. [Indonesian]
- Nurhidayah DZ, Saprin, Walukou, Raban AI. 2023. Ethnobotanical study of medicinal plants in local communities in Sabulakoa District, South Konawe Regency. *Bio Edu* 8 (1): 1-7. DOI: 10.36709/ampibi.v8i1.1.
- Pathy KK, Flavien NB, Honoré BK, Vanhove W, Van Damme P. 2021. Ethnobotanical characterization of medicinal plants used in Kisantu and Mbanza-Ngungu territories, Kongo-Central Province in DR Congo. *J Ethnobi Ethnomed* 17: 5. DOI: 10.1186/s13002-020-00428-7.
- Prasetyo B. 2021. The community perception in the Tobelo Dalam Tribe against plants as traditional medicine. *Intl J Sci Basic Appl Res* 58 (1): 131-146. DOI: 10.04394/ijbsar.v52.131-146.
- Qomariah N, Handayani R, Novaryantin. 2020. Empirical and ethnopharmacological study of efficacious medicinal forest plants from Tumbang Rungan Village, Pahandut Regency, Palangkaraya City, Central Kalimantan. *Anterior J* 18 (1): 98-106. DOI: 10.33084/anterior. v18i1.424.
- Qureshi R, Ghazanfar SA, Obied H, Vasileva, Tariq MA. 2016. Ethnobotany: A living science for alleviating human suffering. *Evid-Based Complement Altern Med* 2016: 9641692. DOI: 10.1155/2016/9641692.
- Rehman S, Iqbal Z, Qureshi R, Shah GM. 2023. Quantitative ethnobotanical study of medicinal plants used by the indigenous communities of Shawal Valley, District North Waziristan, Pakistan. *Ethnobot Res Appl* 25: 48. DOI: 10.32859/era.248.5.1-24.
- Rivera D, Obon C, Inocencio C, Heinrich M, Verde A, Fajardo J, Llorach R. 2005. The ethnobotanical study of local Mediterranean food plants as medicinal resources in Southern Spain. *J Physiol Pharm* 56: 97-114.
- Rujehan, Matus P. 2018. Potential and management strategy of floral biodiversity in coastal areas in East Kalimantan, Indonesia. *Biodiversitas* 19 (3): 1130-1137. DOI: 10.13057/biodiv/d190348.
- Sari A, Linda R, Lovadi I. 2015. Utilization of medicinal plants in the Dayak people of the Jangkang Tanjung in Ribau Village, Kapuas District, Sanggau Regency. *J Bio Sci* 4 (2): 1-8. DOI: 10.26418/protobiont. v4i2.10841.
- Sharma A, Khanna S, Kaur G, Singh I. 2021. Medicinal plants and their components for wound healing applications. *Futur J Pharm Sci* 7: 53. DOI: 10.1186/s43094-021-00202-w.
- Siahaan N, Triskapriya D, Angga M, Trisna A, Larasati D, Rahayu SE, Siburian J. 2022. Ethnobotanical study of medicinal plants used to treat human diseases in The Urban Forest Area of Sangga Buana Cilandak Jakarta Selatan. *J Trop Biodivers* 2 (3): 117-132.
- Siregar RS, Tanjung AF, Siregar AF, Salsabila, Bangun IH, Mulya MO. 2020. Studi literatur tentang pemanfaatan tanaman obat tradisional. *Scenario Seminar of Social Sciences Engineering and Humaniora* 385-391. [Indonesia]
- Suparmoko. 2014. *Valuasi Ekonomi Sumber Daya Alam dan Lingkungan*. Bhakti Profesindo, Yogyakarta. [Indonesian]
- Sutrisno IH, Suwardi AB, Navia ZI, Baihaqi B, Fadhillah MA. 2021. Documentation of the traditional Alas food in Southeast Aceh District, Indonesia. *Biodiversitas* 22: 3243-3249. DOI: 10.13057/biodiv/d220818.
- Suwardi AB, Navia ZI, Harmawan T, Syamsuardi, Mukhtar E. 2020. Wild edible fruits generate substantial income for local people of the Gunung Leuser National Park, Aceh Tamiang region. *Ethnobot Res Appl* 20: 1-13. DOI: 10.32859/era.20.11.1-13.
- Tantengco OA, Condes MA, Estadilla HH, Ragragio EM. 2018. Ethnobotanical survey of medicinal plants used by Ayta communities in Dinalupihan, Bataan, Philippines. *Pharmacog J* 10 (5): 859-870. DOI: 10.5530/pj.2018.5.145.
- Tugume P, Nyakoojo C. 2019. Ethno-pharmacological survey of herbal remedies used in the treatment of paediatric diseases in Buhunga parish, Rukungiri District, Uganda. *BMC Complement Altern Med* 19: 353. DOI: 10.1186/s12906-019-2763-6.
- Ullah R, Alqahtani AS, Noman OMA, Alqahtani AM, Ibenmoussa S, Bourhia M. 2020. A review on ethno-medicinal plants used in traditional medicine in the Kingdom of Saudi Arabia. *Saudi J Bio Sci* 27 (10): 2706-2718. DOI: 10.1016/j.sjbs.2020.06.020.
- Witjoro A, Sulisetijono, Setiowati FK. 2016. Utilization of medicinal plants in Kayukebek Village, Tutar Regency, Pasuruan Regency. *Nat B J Health Environ Sci* 3 (4): 303-310. DOI: 10.21776/ub.natural-b.2016.003.04.6.
- Zahra W, Rai SN, Birla H, Singh SS, Rathore AS, Dilnashin H, Keswani C, Singh SP. 2019. Economic importance of medicinal plants in Asian Countries. In: Keswani C (eds). *Bioeconomy for Sustainable Development*. Springer, Singapore. DOI: 10.1007/978-981-13-9431-7_19.
- Zaman W, Ye J, Saqib S, Liu Y, Shan Z, Hao D, Chen Z, Xiao P. 2021. Predicting potential medicinal plants with phylogenetic topology: Inspiration from the research of traditional Chinese medicine. *J Ethnopharmacol* 281: 114515. DOI: 10.1016/j.jep.2021.114515.
- Zenebe GM, Zerihun, Solomon Z. 2012. An Ethnobotanical study of medicinal plants in Asgede Tsimbila District, Northwestern Tigray, Northern Ethiopia. *Ethnobot Res Appl* 10: 305-320. DOI: 10.17348/era.10.0.305-320.