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Biodiversity of Medicinal Plants in The Central Kalimantan Forest Indonesia: A Call for Conservation Programs

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Abstract: Medicinal plants are one of the essential ecosystem services provided by Indonesia's tropical forests. However, threats such as deforestation, forest degradation, climate change, and overharvesting jeopardize the existence of medicinal plants. This study aims to examine the diversity of medicinal plant species in three village forests in Central Kalimantan. The identification of medicinal plant species, including their local names, growth forms, and the number of individuals, was conducted using observation plots. Analysis was performed by calculating the Species Diversity Index, Species Richness Index, and Species Evenness Index. This research identified 69 species and 650 medicinal plant individuals. The study found that the diversity, species richness, and evenness of medicinal plant types varied across locations. Two villages exhibited medium diversity and richness index values (H'= 2.47 – 2.87; R= 3.82 – 4.48), while only one village was classified as having high values (H'=3.07; R=6.81). The species evenness index in all three locations showed a high category (E=6.69 – 11.54). The medicinal plants utilized by the community were predominantly climbers, herbs, and trees. High diversity of medicinal plant species was found in forest areas protected by customary regulations. This research conclude that di diversity of medicinal plant categorized as medium-high, and there are sign of declining biodiversity. Therefore, conservation program is urgently needed and encourage relevant stakeholders to participate.

Keywords: biodiversity. medicinal plant, conservation

Introduction

Indonesia's tropical forests are among the last remaining megabiodiversity hotspots in the world, facing the threats of deforestation and forest degradation (Assidiq et al., 2021; Indrajaya et al., 2022; Paoli et al., 2010). Indonesia ranks second only to Brazil, which has the largest tropical forest in the world. These forests are home to an exceptionally high level of biodiversity in plants and animals, encompassing genetic, species, and ecosystem diversity (Riswan & Yamada, 2006). Approximately 10% of the world's plant species are found in Indonesian forests. Additionally, these tropical forests host 16% of the world's bird species and 10% of the total mammal species (Dodo & Hidayat, 2020).

The environmental services provided by Indonesia's tropical forests are extensive, including the provision of various products, water management services, flood prevention, climate regulation, and cultural services (Nugroho et al., 2022; Yunus et al., 2024). In addition to serving as habitats for micellaneous flora and fauna, these forests supply food, fibre, and medicine for local communities (Alves & Rosa, 2007;

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Middleton et al., 2024). They have also inspired more than 300 ethnic groups to develop traditional ecological knowledge, including expertise in medicinal plants (Panjaitan et al., 2024; Riswan & Yamada, 2006).

Medicinal plants play a crucial function in maintaining the health and livelihoods of communities near forests. The loss of biodiversity and forest cover reduces nature's ability to provide essential environmental services for humans, including environmental maintenance (Pushpangadan & Behl, 2005). Villages in the interior of Central Kalimantan are remote from modern health services such as hospitals and pharmacies, leading residents to rely on medicinal plants for treatment. For the traditional Dayak people, these plants represent more than just remedies for diseases, they embody local knowledge and wisdom passed down through generations from their ancestors (Alves & Rosa, 2007; Hamilton, 2004; Rates, 2001; Sofowora et al., 2013). From an economic perspective, medicinal plants contribute approximately US$14.6 billion annually (Ministry of Environment of the Republic of Indonesia, 2013). Globally, public demand for medicinal plants is increasing due to their natural properties and low perceived risks (Motahhari et al., 2022; Srivastava, 2018).

Over 80% of the total medicinal plants in Southeast Asia are found in Indonesia, both in forests and in residential areas. The diversity of medicinal plant species is influenced by the introduction and cultivation of these plants in various regions of Indonesia. However, these efforts have not been sufficient to halt the decline in medicinal plant biodiversity, primarily due to limited funding and community capacity (Cahyaningsih et al., 2021; Shukla, 2023; Ssenku et al., 2022).

Deforestation, forest degradation, climate change, and overharvesting threaten the existence of medicinal plants in forests. Additionally, the decline of these plants is exacerbated by the loss of traditional knowledge regarding their uses. The diversity and survival of medicinal plant species depend on the interplay between ecological factors and human activities (Applequist et al., 2020; Chen et al., 2016).

Research on medicinal plants primarily emphasizes ethnobotanical studies and traditional ecological knowledge (TEK). For example, Ahmad & Husain (2008) conducted ethnobotany research on medicinal plants in Pakistan, while Idm'hand et al. (2020) explored the ethnobotany of medicinal plants in Tarfaya, Morocco. Additionally, the TEK of the Dayak community in West Kalimantan. Biodiversity research typically targets specific areas, such as the biodiversity of medicinal plants in tropical rainforests within national parks Sudarmono (2018); Susanti & Zuhud (2019) or in village forests (Farah et al., 2017). However, there has been no research identifying medicinal plant biodiversity in areas with varying management statuses. This study aims to address this research gap. This study aims to examine the diversity of medicinal plant species in various forests in Central Kalimantan. Information on the biodiversity of medicinal plants in forests and their conservation status is vital for developing effective conservation strategies, both in situ and ex situ. It is expected that this research will contribute to the conservation of natural resources in Indonesia, promote sustainable forest management, and preserve the wisdom and culture of indigenous peoples.

Method

Research Location

This research was conducted in three villages across three different districts in Central Kalimantan Province: Luwuk Kanan Village in Katingan Regency, Sei Gohong Village in Palangka Raya City, and Tuwung Village in Pulang Pisau Regency. The study conducted over four months, from April to July 2025. This research was conducted in the forests surrounding the villages of Luwuk Kanan, Sei Gohong, and Tuwung. The three study sites are lowland tropical forests dominated by the Dipterocarpaceae family. These forests are characterized by the prevalence of tree species such as Shorea, Hopea, and Dipterocarpus, which can reach heights of up to 70 meters. The layered tree canopy prevents most sunlight from reaching the forest floor, where various plant species thrive. The forest in Luwuk Kanan Village is situated within the village's administrative boundaries, and its use is regulated by local regulations. However, every villager, including those from neighboring areas, is generally permitted to collect various forest products, including medicinal plants. The research in Sei Gohong Village took place in a forest that is part of Sebangau National Park. The third research location was the customary forest of Tuwung Village.

Plot Observation Design and Analysis

Medicinal plants were identified using 2000 m^2 observation plot that systematically placed at the research site. In every village we set up two observation plots, in total there were six observation plots equivalent with 12,000 m^2. Local experts assisted in identifying the various types of medicinal plants found in the forest. The data collected included the names of the medicinal plants, their habitus, the number of individuals observed, and the frequency of encounters in each observation plot. Data analysis involved the use of the Shannon index, Margalef index, and Evenness index. Figure 1 depicts design of observation plot.

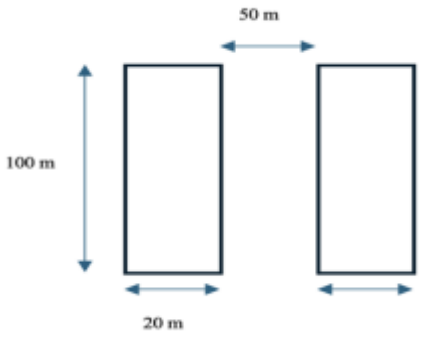

Figure 1. Measurement of observation plot

The species diversity index is used to determine the level of diversity of medicinal plant species found in the research site, which can be determined using the Shannon-Wiener Formula 1 (Odum, 1971).

$$H' = -\sum_{i=1}^{s} \left(\frac{\text{ni}}{\text{N}} \text{ X } ln\frac{\text{ni}}{\text{N}}\right) \quad (1)$$

Where: *H'* – Species Diversity Index, ni - number of individuals species i, N - total number of individuals of all species.

The criteria for the Shannon-Wiener (*H'*) species diversity index are as follows: *H'* <1 indicating the species diversity is low, *H'* 1-3 indicating the species diversity is moderate, *H'* >3 indicating the species diversity is high.

The species richness index is used to assess the richness of each species within the communities encountered. The species richness index is calculated using the Margalef Formula 2 (Odum, 1971).

$$R = (S - 1) \ln N \quad (2)$$

Where: R – Species Richness Index, S - Number of species, N - Total number of individuals of all species

The criteria for the value of species richness index are divided into 3 categories (Odum, 1971): R is < 2.5 indicating that the level of species richness is low, R is 2.5 - 4 indicates that the level of species richness is moderate, R is > 4 indicates that the level of species richness is high

The Evenness index is used to determine the equality of each type in each community found. The species Evenness index is calculated using the following Formula 3.

$$E = H' \ln S \quad (3)$$

Where: E - Species Evenness index, H' - Species diversity index, ln - natural logarithm, S - Number of species. According to Odum (1971) the criteria for the value of the species equality index are as follows: E is < 0.3 indicating that the level of species evenness is low, E is 0.3 – 0.6 indicating that the level of evenness of the species is moderate, E is > 0.6 indicating that the level of species evenness is high.

Result and Discussion

Biodiversity

This research identified 69 species and 650 medicinal plant individuals. In general the diversity of medicinal plant species in the three villages ranged from 15 to 43 species. Observations in the forest of Sei Gohong village identified a total of 23 species of medicinal plants, comprising 135 individual specimens. The medicinal plants predominantly included climbers and herbs. The climber species included *Arcangelisia flava*, *Uncaria spp.*, and *Ampelocissus rubiginosa*, while the herb species were represented by *Blumea balsamifera* and *Calophyllum spp*. Both climber types thrive well in the tropical forests of Central Kalimantan. However, logging and deforestation could cause the extinction of climber species. The abundant species in the forest included *Syzygium polyanthum*, *Palaquium spp.*, and *Ampelocissus rubiginosa*. The rarely found species included *Mischocarpus sp*p., *Hymenocallis caribaea*. Table 1 present detail information on species identified at Sei Gohong village

Table 1. Medicinal plant species found at Sei Gohong village forest

Local Name	Scientific Name	Amount
Tawas Pari	*Syzygium polyanthum*	20
Kantong Semar	*Nepenthes spp.*	7
Bajakah Putih	*Spatholobus littoralis*	8
Akar Kuning	*Arcangelisia flava*	5
Kalanis	*Calophyllum spp.*	4
Kalalawit	*Uncaria gambir*	5
Terong susu	*Solanum mammosum*	4
Nunang	*Palaquium spp.*	14
Tampung Penyang	*Blumea balsamifera*	5
Sintuk	*Cinnamomum sintoc*	10
Bajakah Merah	*Spatholobus littoralis*	5
Suli	*Erythrina variegata*	3
Rotan Ahas	*Calamus spp.*	2
Belawan	*Mangifera caesia*	4
Latak Manuk	*Mischocarpus sp.*	1
Kambasira	*Ilex cymosa*	10
Sawang Kelep	*Hymenocallis caribaea*	1
Tawas Ut	*Ampelocissus rubiginosa*	12
Saluang belum	*Luvunga sarmentosa*	3
Limau Nabi	*Citrus hystrix*	3
Ketiau	*Madhuca motleyana*	1
Kantong Semar	*Nepenthes spp.*	4
Karamunting	*Rhodomyrtus tomentosa*	4
Total		135

Fewer medicinal plants have been identified in the forest of Luwuk Kanan village compared to Sei Gohong village. A total of 39 individuals from 15 species of medicinal plants were found. The most commonly encountered species are *Uncaria* spp and *Calamus* spp. The medicinal plants in this location are primarily climbers, with 9 species, including *Arcangelisia flava*, *Calamus spp*, and *Piper aduncum*. In addition to being used as medicine for diarrhea, *Calamus* spp is also an important non-timber forest product utilized in various handicrafts and furniture. Detail species identified in the forest presented at Table 2.

Table 2. Medicinal plant species found at Luwuk Kanan village forest

Local Name	Scientific Name	Amount
Rotan Sigi	*Calamus spp*	5
Bajakah Darak Merah	*Spatholobus littoralis*	4
Karambuni Hutan	*Euodia spp.*	2
Bajakah Kalalawit	*Uncaria spp*	2
Kacang Ngaring	*Archidendron pauciflorum*	2
Batang Sulih	*Peperomia pellucida*	1
Manggis	*Garcinia mangostana*	1
Bajakah Darak	*Uncaria spp.*	7
Kalalawit	*Calamus spp.*	4
Rotan Irit	*Calamus spp*	1
Akar Kuning	*Arcangelisia flava*	2
Kambasira	*Ilex cymosa Blume*	1
Sirih Hutan	*Piper aduncum*	5
Saluang Belum	*Dracaena angustifolia*	1
Cempedak Hutan	*Artocarpus integer*	1
Total		39

The forest of Tuwung village has greater potential for medicinal plants than the previous two villages. At the observation location, 476 individual medicinal plants from 43 species were identified. The types of medicinal plants are predominantly shrubs and trees, including *Momordica charantia*, *Cordyline fruticosa*, *Macaranga hypoleuca*, and *Calliandra calothyrsus*. Notably, trees contributed to a higher diversity, with 15 species of medicinal plants found in this area. Table 3 provide detail medicinal plant species found in Luwuk Kanan village.

Table 3. Medicinal plant species found at Luwuk Kanan village forest

Local Name	Scientific Name	Amount
Kaja	*Macaranga hypoleuca*	13
Sangkuang	*Dioscorea spp*	5
Sawang Kelep	*Cordyline fruticosa*	12
Tantuwu	*Sterculia foetida*	12
Kalakai	*Stenochlaena palustris*	1
Kajunjung	*Alstonia scholaris.*	3
Tanggaring	*Zanthoxylum spp*	1
Bajungan	*Calamus trachycoleus*	62
Rotan Taman	*Calamus spp.*	94
Matahandau	*Phaleria macrocarpa*	7
Durian	*Durio zibethinus*	12
Kalang Pepek	*Acorus calamus*	2
Butun	*Barringtonia asiatica*	1
Kayu Palis	*Pterocarpus indicus*	12
Saga Rambat	*Abrus precatorius*	3
Ramunia	*Syzygium aqueum*	15
Gandaria	*Bouea macrophylla*	11
Bungur	*Lagerstroemia speciosa*	2
Sirih Hutan	*Piper aduncum*	10
Nyamu	*Palaquium spp.*	24
Bambu	*Bambusa spp.*	40
Rambai	*Baccaurea motleyana*	10
Daun Pandan	*Pandanus amaryllifolius*	10
Anggrek	*Orchidaceae*	10
Jamur	*Fungi spp.*	4
Raruju	*Hopea spp.*	1
Kaliandra	*Calliandra calothyrsus*	3
Kumis kucing	*Orthosiphon Aristatus*	1
Saluang Belum	*Dracaena angustifolia*	2
Langsat	*Lansium domesticum*	2
Bajakah	*Uncaria spp.*	4
Rotan Gita	*Calamus spp.*	4
Teken Pare	*Momordica charantia*	10
Batang Hara	*Palaquium spp.*	3
Karamunting	*Rhodomyrtus tomentosa*	2
Upak Langise	*Cananga odorata*	3
Suli	*Erythrina variegata*	2
Baramia	*Bouea macrophylla*	20
Karet	*Hevea brasiliensis*	22
Kajang	*Crinum asiaticum*	9
Latak Manuk	*Mischocarpus sp.*	2
Singkoh	*Zingiber zerumbet*	4
Bajakah Darak	*Uncaria spp.*	6
Total		476

Vegetation Analysis

Vegetation analysis revealed that medicinal plants in the three study sites exhibited varying levels of type diversity, species richness, and species evenness. The Shannon diversity index for Luwuk Kanan and Sei Gohong Villages is comparable, falling within the range of 1 to 3. This value indicates that the diversity of medicinal plant types in these two villages is categorized as medium. In contrast, the species richness index for Luwuk Kanan Village is medium, while Sei Gohong and Tuwung Villages are classified as high. The Evenness Index, which reflects the distribution of individual species, also varies across the three study sites. Although the Evenness Index value in all locations is classified as high, the value in Tuwung Village significantly differs from those in the other villages.

The potential of medicinal plants in Sei Gohong Village is relatively low due to the road accessibility of the forest where the community gathers these plants. This road access has facilitated easier collection of

medicinal plants by many people in the area. Some medicinal plant species that are becoming rare include *Dracaena angustifolia*, *Cananga odorata*, and *Mischocarpus* sp. Understanding which medicinal plants are becoming increasingly difficult to find is crucial for developing effective conservation programs (Hasyim et al., 2025).

In contrast to the medicinal plant biodiversity status in Luwuk Kanan and Sei Gohong villages, Tuwung village is categorized as having high biodiversity. The research site in Tuwung village is "Kaleka," a forest deemed sacred by the local community. The use and collection of medicinal plants in this area are still permitted but are strictly regulated by customary laws. This suggests that the presence of customary laws can positively contribute to the conservation of medicinal plants. These findings align with research conducted by Ogwu & Osawaru (2022); Yin (2022), which indicates that customary laws and traditional knowledge are effective in medicinal plant conservation efforts.

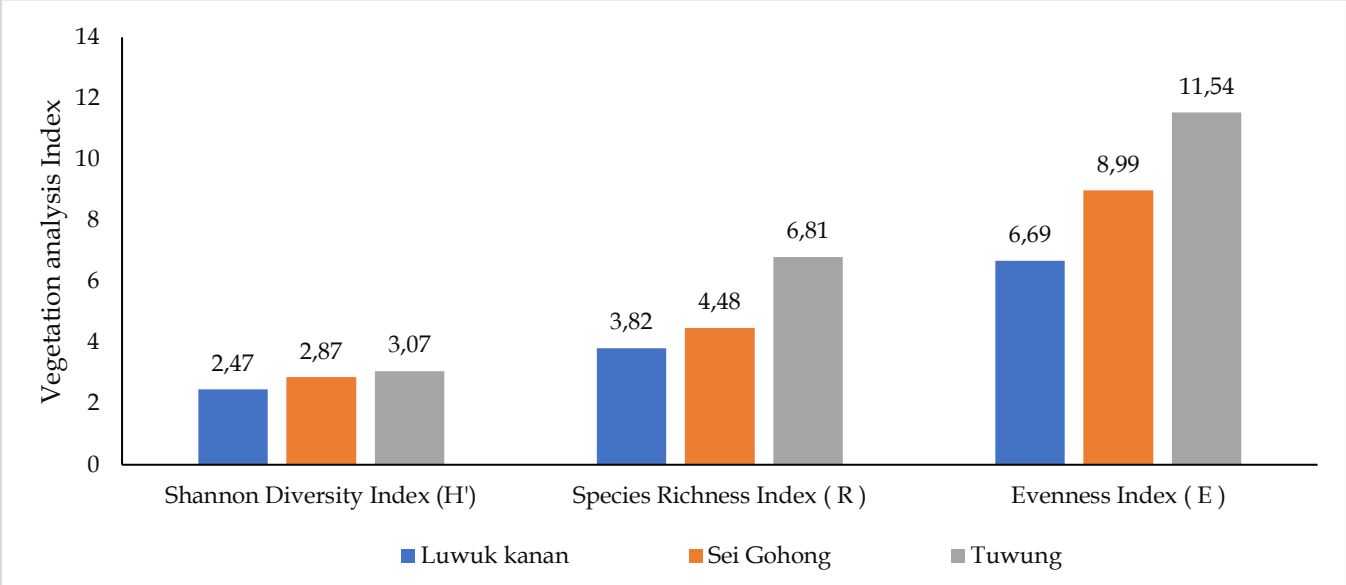

Figure 2. Biodiversity Index, Species Richness Index and Evenness Index at three location

The results of this study indicate that the diversity of medicinal plant species in Central Kalimantan is beginning to decline. This is evident from the vegetation analysis, which shows that two research locations exhibit medium diversity and richness of medicinal plant species, while only one location falls into the high criteria. According to community reports, the potential of medicinal plants is diminishing due to the conversion of forest land into plantations and excessive harvesting. Furthermore, there have been no efforts to cultivate medicinal plants, leading to continuous consumption from the forest, which ultimately threatens the biodiversity of these species. There are concerns that, at some point, certain medicinal plants may become extinct.

Conservation Program of Medicinal Plant

To address decreasing biodiversity of medicinal plant, it is essential to develop programs and strategies for the conservation of medicinal plants. One promising initiative is the Reduction of Emissions from Deforestation and Forest Degradation (REDD+). Currently, the provincial government of Central Kalimantan is receiving funding from the central government through the results-based payment (RBP) fund to establish the REDD+ framework and greenhouse gas (GHG) emission reduction programs. REDD+ aims to provide opportunities for countries with tropical forests rich in biodiversity to protect their ecosystems (Joppa & Pfaff, 2009). Biodiversity and carbon stock levels have a positive correlation, meaning that maintaining and enhancing biodiversity will contribute to increased carbon stocks. The conservation of medicinal plants is a key component of the REDD+ priority program for Central Kalimantan Province. The anticipated outcomes of this program include increased carbon trading, improved public health, and the establishment of a green economy.

The local community utilizes various parts of plants to treat diseases. The medicinal parts used include roots, stems, leaves, tips, and flowers. The most commonly used part is the root, with over 15 species being utilized, followed by stems, leaves, and, least frequently, flowers. The use of roots, stems, and bark can lead to the death of medicinal plants. Harvesting these parts affects the tree's physiological processes, such as water absorption and the distribution of photosynthesis products. In the future, it will be essential to find more

sustainable methods for harvesting medicinal plants. Gathering leaves, flowers, and shoots is considered less damaging by the community because medicinal plants can regenerate quickly. Herbs and shrubs are relatively easier to regenerate, with a regrowth process that typically takes 3 to 6 months. In contrast, trees and climbers require a longer time to mature, often taking decades. Therefore, caution is necessary when utilizing medicinal plants from tree and climber species. Figure 3 present number of species in every part of plant used in medication.

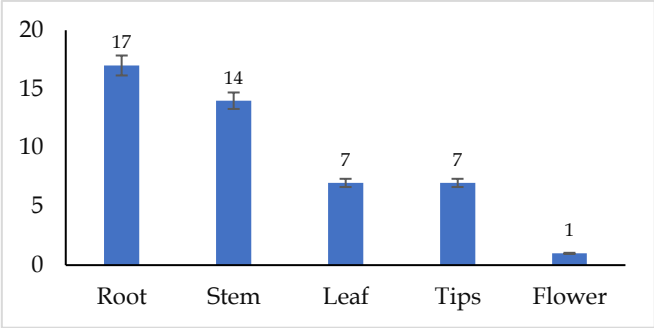

Figure 3. Part of plant used in medication

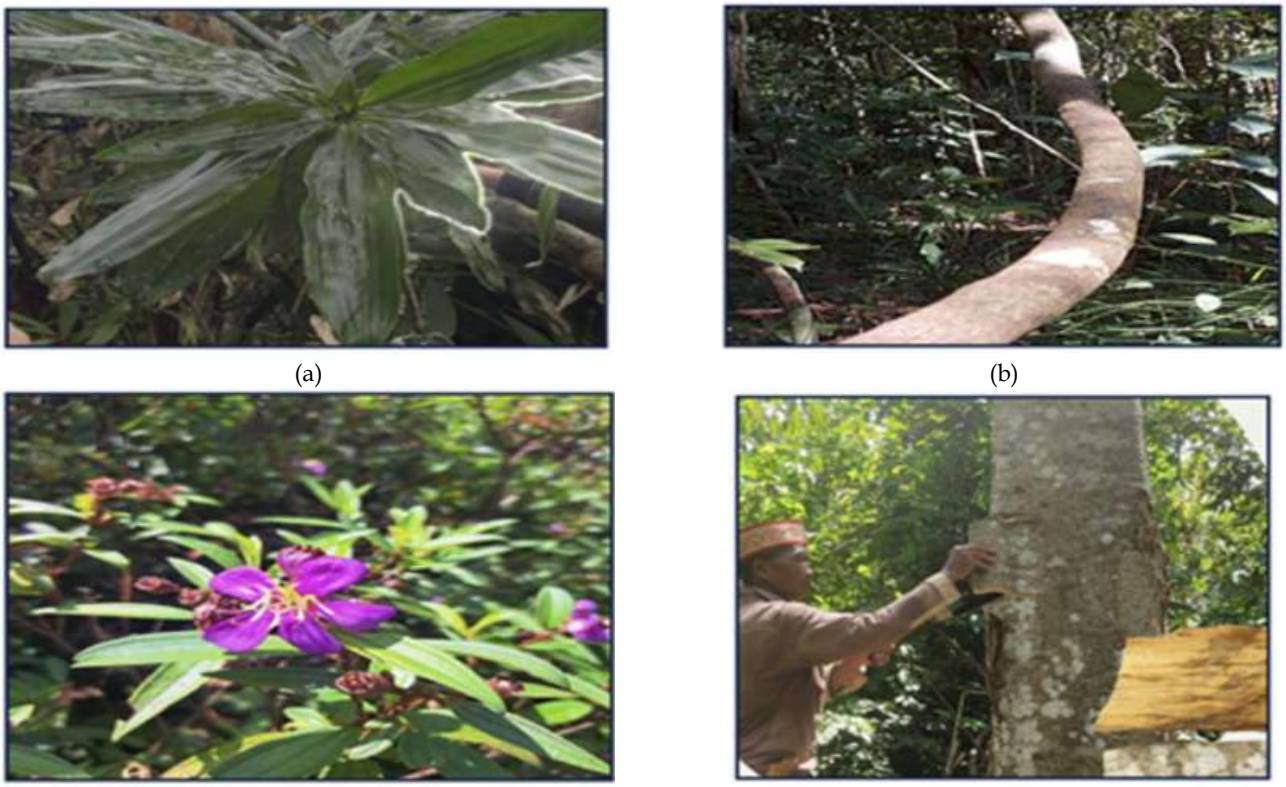

Figure 4. Some of medicinal plant identified in the forest: (a) *Cordyline fruticosa*, (b) *Spatholobus littoralis*, (c) *Rhodomyrtus tomentosa, (d)Cananga odorata*

Medicinal plants play a crucial role in maintaining community health (Alves & Rosa, 2007). For centuries, local communities have relied on these plants to treat various illnesses. They utilize the vegetation found in their villages and surrounding forests to address health issues such as skin problems, diarrhea, and to enhance their stamina. Given the importance of medicinal plants for both health and potential income, it is essential for local governments to implement policies that preserve the habitats of these plants and support local communities in developing small businesses enterprise around them. Some of example of medicinal plant present at Figure 3.

To be able using medicinal plants sustainably, conservation efforts are essential (Fanisah et al., 2023). The complexity of the issues at hand necessitates a comprehensive approach. Efforts to conserve medicinal plants require a comprehensive approach that includes policy, public awareness initiatives, strengthening customary regulations, and enhancing the cultivation of medicinal plants. The government can implement various policies to reduce deforestation rates, such as imposing a moratorium on clearing forests for monoculture plantations. Public awareness about the importance of conserving medicinal plants can be raised through campaigns in print and social media, as well as through formal education from elementary school to university level. Forest rehabilitation efforts should be

enriched by replanting rare medicinal plant species. For species in high demand, community-owned land should be used for medicinal plant cultivation programs, which is expected to decrease the harvesting of these plants from forests. Conservation must be pursued alongside economic improvement and public awareness initiatives. These efforts can be enhanced by adopting a participatory approach that actively involves the community from planning through program implementation. This collaboration aims to slow the decline in biodiversity of medicinal plants in the future.

Conclusion

This study concluded that the diversity of medicinal plant species varied among the three study sites. Two villages exhibited a medium diversity and species richness index, while only one village fell into the high category. The species Evenness index across the three locations indicated a high category. The medicinal plants utilized by the community were predominantly climbers, herbs, and trees. The highest diversity of medicinal plant species was found in forest areas protected by customary regulations, indicating that the decline in potential diversity is due to overharvesting and forest destruction.

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Author Contributions
Conceptualization, Writing, Formal Analysis, Afentina, Yanarita and Lies Indrayanti; Investigation, Methodology, Software, Resources, Grace Siska, Milad Madiyawati, Yusinta Tanduh; Validation, Patricia Putir; Writing-Original Draft Preparation; Writing-Review and Editing, Afentina and Chartina Pidjath.

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Conflicts of Interest
We declare that the manuscript titled "Biodiversity of Medicinal Plants in the Central Kalimantan Forest, Indonesia: A Call for Conservation Programs" is an original scientific work that has not been published in any form and is not currently under review by any other journals. We confirm that all data, analyses, and interpretations presented in this manuscript result from research conducted using valid methods and adhering to scientific standards. Proper credit has been given to all quotations, references, and contributions from other parties through appropriate citations. We also affirm that this manuscript contains no instances of plagiarism, either directly or indirectly. In the event of any future publication ethics violations, we are prepared to accept the consequences imposed by the journal. All authors involved in the preparation of this manuscript have made significant contributions to research design, data analysis, and the writing of the scientific article. No names have been included as authors without substantial scientific contributions.

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