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Botanical survey of ethnomedicines in Dayak sub-ethnic groups, Ot Danum and Tomum in Central Kalimantan, Indonesia

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Abstract. *Neneng L, Nawan, Naibaho FG, Rahman S, Septya L, Panjaitan D, Lestari RW, Irsyam ASD, Norwahyunie, Noraini. 2025. Botanical survey of ethnomedicines in Dayak sub-ethnic groups, Ot Danum and Tomum in Central Kalimantan, Indonesia. Biodiversitas 26: 458-469.* The rise of globalization, urbanization, and environmental changes has led to the emergence of new infectious diseases and increased Antimicrobial Resistance (AMR), posing significant public health threats. This study aims to document the traditional medicinal knowledge of the Dayak Ot Danum and Tomum subtribes in Central Kalimantan, Indonesia, particularly regarding their ethnobotanical remedies for treating infectious diseases. Field surveys were conducted in August 2024 across four villages, utilizing purposive and snowball sampling techniques to interview 12 key informants, including traditional healers. Semi-structured interviews, Focus Group Discussions (FGD), and field observations were employed to gather information on the local use of medicinal plants. A total of 62 plant species were identified, with the highest proportions targeting bacterial infections (24 species), followed by viral (21 species), fungal (11 species), and parasitic infections (4 species), with mixed efficacy as antibacterial and antifungal (10 species) and antibacterial and antiviral (3 species). The Zingiberaceae family was the most frequently documented, a testament to the diverse and rich ethnobotanical knowledge of these communities. The findings highlight the effective use of traditional medicine in combating infections, suggesting the potential for integrating ethnobiological practices into contemporary healthcare strategies to address AMR. As indigenous populations face increasing health risks, preserving and leveraging traditional medicinal knowledge is crucial for developing sustainable approaches to health and wellness.

Keywords: Dayak communities, ethnomedicine, infectious diseases, medicinal plants, Zingiberaceae

INTRODUCTION

The progression of globalization, urbanization, and environmental changes has driven the emergence of new infectious diseases. The global trend of infectious diseases shows a significant rise, with 335 new types of infectious diseases identified between 1940 and 2004 (Antabe and Ziegler 2020). Recent data also indicate the emergence of drug-resistant pathogens, including strains resistant to tuberculosis and malaria treatments, as well as antibiotic-resistant bacterial strains (Sreeja et al. 2017). The global spread of these resistant pathogens and their derivatives has had a profound impact on both health and the economy worldwide (Dhingra et al. 2020). The treatment of various infectious diseases, particularly those caused by bacteria and fungi, still largely depends on the use of antibiotics. However, the inappropriate use of antibiotics outside of proper protocols can lead to Antimicrobial Resistance (AMR) (Tang et al. 2023). Antibiotic-resistant pathogens make diseases much more challenging to treat, resulting in increased morbidity, mortality, and sharply rising healthcare costs. Over time, AMR has become one of the most critical public health threats of the 21st century (Ferri et al. 2017).

Ethnobiology, an interdisciplinary field that explores the cultural knowledge of nature, has significantly contributed to our understanding of traditional knowledge and medicinal practices. It plays a vital role in bridging biological, archaeological, and sociocultural perspectives within anthropology (Chebii et al. 2022). The emerging One Health framework, which emphasizes the interconnectedness of human, animal, and environmental health, can be seen as an extension of ethnobiology within the health domain (Quinlan and Quinlan 2016). Ethnobiology offers a valuable complement to biomonitoring research, helping to provide a more holistic understanding of how communities perceive and are impacted by environmental contamination. By integrating ethnobiological methodologies with biomonitoring, we can address critical knowledge gaps in environmental health and adopt more ethical and culturally sensitive research practices, particularly in indigenous populations facing health risks from infectious diseases (Caron-Beaudoin and Armstrong 2019).

Ethnobiology and traditional health practices offer promising strategies for addressing AMR. Traditional medicine, particularly ethnopharmacology, has been shown to effectively treat microbial infections in humans while reducing reliance on conventional antibiotics (Mickymaray 2019). The resurgence of botanical research in ethnomedicine provides a diverse array of chemical compounds that can help mitigate the growing dependence on synthetic antimicrobials (Elamaran 2020). Tackling AMR requires a holistic approach that incorporates cultural, social, and structural factors, with a strong emphasis on community engagement and the preservation of traditional medical practices (Jawad 2024). In certain indigenous populations, limited access to modern healthcare, combined with cultural preferences, drives the use of traditional remedies as alternatives to antibiotics, potentially reducing overall antimicrobial usage (González-Villoria et al. 2024).

The indigenous Dayak communities of Central Kalimantan have long relied on traditional medicine, utilizing various plants and mixtures of plant-based remedies to treat a wide range of ailments, including infectious diseases (Sukiada 2016). An example of the local knowledge from the Dayak Tomum tribe is the use of the plant *Hornstedtia conica* (locally known as *topah susu daro*), which has been empirically shown in laboratory studies to reduce breast tumors in mice (Neneng et al. 2020). Other studies have demonstrated the effectiveness of *Eleutherine bulbosa* (Dayak onion) in combating bacterial infections through in silico and in vitro approaches (Naibaho et al. 2023, et al. 2024). Furthermore, *Bajakah tampala* (*Spatholobus littoralis*: Fabaceae) has been found to inhibit infections caused by *Pseudomonas aeruginosa* (Hamzah et al. 2023). Despite these findings, it is evidenced that the majority of other medicinal plants used by the Dayak community to treat infectious diseases remain unexplored. The study on the traditional knowledge of the Dayak communities in Central Kalimantan regarding the use of various plants for medicinal purposes, particularly in treating infectious diseases, remains limited. In fact, certain Dayak sub-ethnic groups have not yet been studied in this regard. This study aimed to explore and document the traditional medicinal knowledge of the Dayak Ot Danum and Tomum subtribes, with a specific focus on their use of ethnobotanical remedies for the treatment of infectious diseases.

MATERIALS AND METHODS

Study area

The study was conducted in August 2024, involving a field survey across four localities in Central Kalimantan, Indonesia, representing the core distribution areas of two Dayak sub-ethnic groups: (i) Lamandau District, including the sub-districts of Sepoyu and Riam Tinggi, for the Dayak Tomun ethnic group; (ii) Katingan District, comprising the sub-districts of Baraoi and Penda Tenggaring, for the Dayak Ot Danum ethnic group. The survey was conducted to gather data on general village conditions, social backgrounds, and ethnographic aspects of the local communities. Geographic mapping and observational data were recorded at each location to contextualize the study findings (Figure 1).

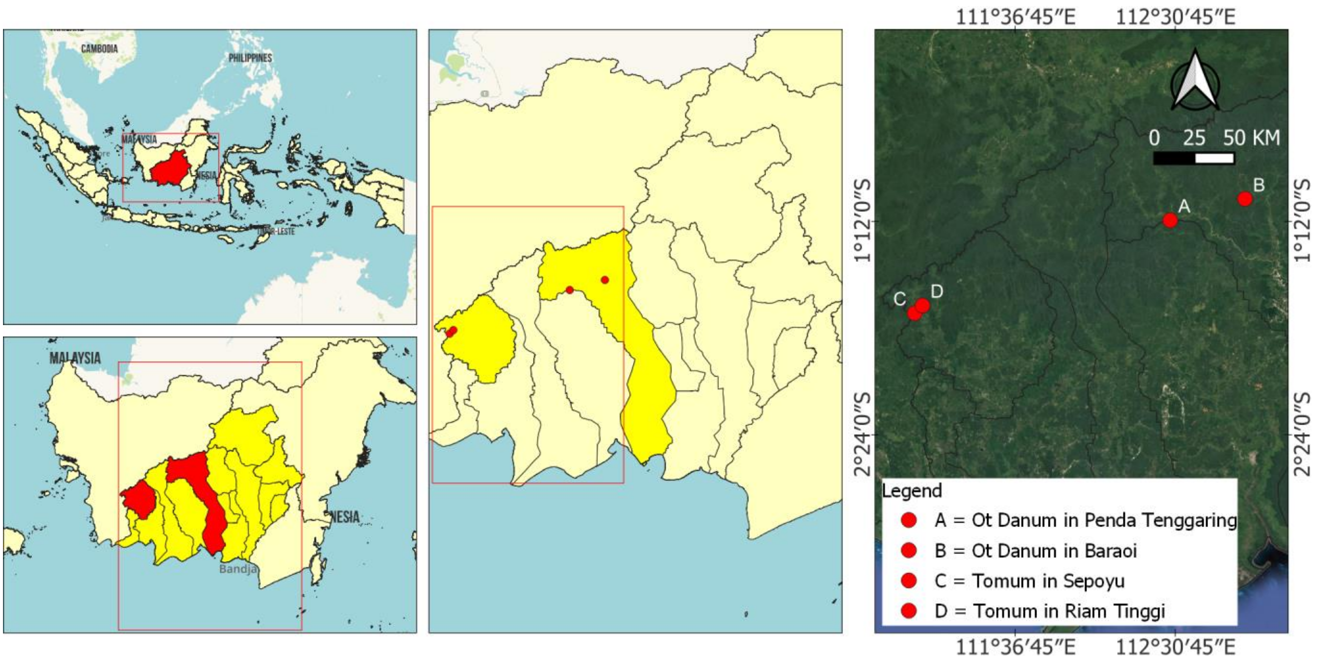

Figure 1. Location of ethnomedicinal survey sites by Dayak sub-ethnic groups, the Ot Danum (Baraoi and Penda Tenggaring Villages, Katingan District) and Tomum (Sepoyu and Riam Tinggi Villages, Lamandau District) in Central Kalimantan, Indonesia within four localities

Data collection

Informants were selected using purposive and snowball sampling techniques to include individuals with extensive ethnomedicinal knowledge. Initial interviews targeted key informants, such as traditional healers (*Batra*), who were recommended by local elders for their expertise in traditional medicine. These key informants then identified additional participants, ensuring a diverse representation of knowledge holders. To qualify, informants had to meet specific criteria: they were required to be of Dayak descent, have practical experience using traditional medicinal plants for disease treatment, possess ethnomedicinal knowledge passed down from parents or other traditional healers, and be willing to participate in the study. Three interview methods, following Alexiades' guidelines, were employed: semi-structured interviews to gather detailed information about medicinal plant use, the "walk-in-the-woods" approach where informants identified plants in their natural habitats, and Focus Group Discussions (FGDs) to validate and expand on individual interviews (Pirintsos et al. 2022). Interview questions explored local understanding of infectious diseases, traditional prevention and treatment methods, plant species, parts used, and preparation techniques, formulations, dosages, and application methods. Interviews were conducted in the Dayak language, with interpreters facilitating communication when necessary, ensuring both cultural sensitivity and linguistic accuracy while documenting traditional knowledge systems.

Plant sample collection was carried out in accordance with the traditional rituals of the Dayak people, if applicable. Medicinal plants were collected and prepared as herbarium specimens in triplicate, following the guidelines of Rugayah et al. (2004). The herbarium specimens comprised vegetative organs, including roots, stems, and leaves, as well as generative organs, such as flowers and fruits, which were essential for accurate identification. Specimen pressing and drying were conducted at the Laboratory of Biology, Faculty of Mathematics and Natural Sciences, Universitas Palangka Raya, Central Kalimantan, Indonesia. Herbarium specimens were used for plant identification. Identification was based on morphological characteristics and referenced plant identification guides and the "Plants of the World Online" database. Each herbarium collection was accompanied by detailed information, including scientific and local names, collection location and time, morphological description, collector details, and collection number. Herbarium specimens were stored at the Laboratory of Biology, Universitas Palangka Raya, Central Kalimantan, Indonesia.

Data analysis

Interview data were compiled and formulated descriptively into a list of plant species to identify the medicinal plants and their related use for treating infectious diseases in the Dayak Ot Danum and Tomum subtribes. Thematic analysis was also utilized to categorize plant usage according to treatment categories, such as antibacterial, antiviral, antifungal, or anti-inflammatory properties. The ethnobotanical data collected from the field were then cross-referenced or discussed descriptively with existing scientific literature to validate the reported uses of medicinal plants. This comparative analysis assessed the alignment between the traditional uses of these plants and their documented pharmacological properties. In this study, we assessed the significance of each species using three indices: use value (UV), index of cultural significance (ICS), and informant consensus factor (ICF). The UV represents the relative importance of each plant species recognized locally as an ethnomedicine. It was calculated using the formula provided by Phillips and Gentry (1993):

$$UV = \frac{\sum U}{n}$$

Where, *U* represents the number of use-reports cited by each informant, and *n* denotes the total number of informants interviewed for a given plant.

The ICS value quantifies how culturally significant a species is by considering multiple factors, calculated using Turner's (1988) formula:

$$ICS = \sum_{k=1}^{n} (q \times i \times e)\, n$$

ICS values range from 1 to *n*, where *n* denotes the total number of uses recorded for the species, and each use is assigned a subscript *k*, representing values from 1 to *n* in sequence. For each use, three core parameters are considered: (i) *q*, or quality value, which reflects the perceived efficacy and reliability of the ethnomedicine; (ii) *i*, or intensity value, indicating the frequency or intensity of the plant's use within the community; (iii) *e*, or exclusivity value, which measures how uniquely the plant is associated with specific uses within the cultural setting.

The ICF value represents the level of agreement among plant users in the study area regarding the use of plants across different ailment categories as calculated using the formula described by Heinrich et al. (1998):

$$ICF = \frac{Nur - Nt}{Nt - 1}$$

Where, *Nur* represents the total number of the use reports for a specific ailment category, and *Nt* denotes the number of distinct taxa utilized for that ailment category by all informants.

RESULTS AND DISCUSSION

The ethnomedicinal survey has been conducted in the study sites, followed by interviews and FGD with key informants, as presented in Figure 1. The demographic profiles of key informants from the Dayak Ot Danum and Tomum groups are presented in Table 1. The results showed a variation in the knowledge of traditional medicinal plants among the Dayak community that was derived from interviews with 12 residents across two regencies. The respondents included 7 individuals from the Dayak Ot Danum ethnic group and 5 from the Dayak Tomum ethnic group. Gender representation among both ethnic groups was balanced, with males and females each comprising 50% of the respondents. The majority of the participants were aged between 30 and 60 years (75%). The educational attainment of the respondents indicated that most had completed elementary school (41.67%), and all informants were engaged in farming as their primary occupation (100%). The results reveal an equal number of male and female respondents possessing knowledge about medicinal plants, with each gender represented by 6 individuals. Research into gender differences in knowledge of medicinal plants presents varied outcomes across different areas and contexts. Some studies indicate that there are no significant global differences in medicinal plant knowledge between men and women. In contrast, others highlighted that women tend to have a more comprehensive understanding of medicinal plants in specific areas (Torres-Avilez et al. 2016). For instance, in northeastern Brazil and Marrakech, Morocco, women exhibited greater knowledge of medicinal plants than their male counterparts (Voeks 2007; Teixidor-Toneu et al. 2021). This gender disparity is often linked to historical divisions of labor, with women taking on primary roles as healthcare providers and being more frequently engaged in cooking. In Jeddah, Saudi Arabia, women not only identified a greater number of medicinal plants but also relied on them more than men (Alqethami et al. 2020). The low educational level, specifically at the elementary school level, reflects a significant percentage (41.67%) in understanding traditional medicinal plants. Another study indicates that 52% of individuals with elementary education possess knowledge about medicinal plants.

Figure 1. Ethnomedicinal survey of medicinal plants utilized by Dayak Tomum (A-D) and Ot Danum (E-H) sub-ethnic groups in different localities of Central Kalimantan, Indonesia; A, E, F. Interviews with key informants; B, C, G. Field observation and plant collections; D, H. Documentation and preparation of herbarium specimens

Table 1. Demographic structure of key informants from Dayak Ot Danum and Tomum in Central Kalimantan, Indonesia

Parameter(s)	Informant group	Quantity	Percentage (%)
Sub-Ethnic	Ot Danum	7	58.33
	Tomum	5	41.67
Gender	Male	6	50.00
	Female	6	50.00
Age	Adult (30-60 years)	9	75.00
	Elderly (>60 years)	3	25.00
Education	No formal education	3	25.00
	Completed Elementary School	5	41.67
	Completed Junior High School	1	8.33
	Completed Senior High School	3	25.00
Occupation	Farmer	12	100.00
Residence	Paraoi Village, Petak Malai Sub-district, Katingan District	6	50.00
	Penda Tenggaring Village, Katingan Hulu Sub-district, Katingan District	1	8.33
	Riam Tinggi Village, Delang Sub-district, Lamandau District	4	33.33
	Sepoyu Village, Delang Sub-district, Lamandau District	1	8.33

Urbanization and modernization affect traditional knowledge. Individuals residing longer in rural areas typically possess greater knowledge of medicinal plants (Wayland and Walker 2014). Studies consistently show a positive correlation between age and medicinal plant knowledge, indicating that older individuals may retain more traditional information (Doyle et al. 2017; Wanjohi et al. 2020). Education significantly influences this dynamic; years spent in formal schooling often correlate negatively with knowledge of medicinal plants (Weckmüller et al. 2019).

Table 2 presents a comprehensive list of medicinal plants traditionally utilized by the Dayak Ot Danum and Tomum ethnic groups, categorized by their efficacy against infections caused by bacteria, fungi, parasites, and viruses. The findings reveal that a total of 62 plant species from 37 families have been reported as practically used by these communities. Notably, both sub-ethnic groups demonstrated the ability to identify and differentiate the medicinal properties of these plants, with the highest proportion targeting bacterial infections (24 species), followed by viral infections (21 species), fungal infections (11 species), and parasitic infections (4 species). Additionally, several plant species exhibited combinations of medicinal effects targeting multiple types of infections. The use of medicinal plants as antibacterial agents has been prominently documented across various studies. In Tamil Nadu, India, traditional healers employ a wide variety of plant species to treat multiple ailments with herbs most commonly utilized for their antibacterial properties (Sathyabama et al. 2013). Similarly, an extensive review conducted in Mexico identified the impressive antibacterial activity in vitro for 343 plant species against 72 bacterial species, particularly effective against some of the most challenging bacteria such as *Escherichia coli*, *P. aeruginosa*, *Mycobacterium tuberculosis*, and *Staphylococcus aureus*. The review further emphasized the importance of standardized experimental protocols and in vivo pharmacokinetic studies (Sharma et al. 2017). Indigenous communities have long exhibited an understanding of antibacterial properties through traditional practices and the use of ethnomedicinal plants. In a Mexican indigenous community, restricted access to healthcare and deep-rooted cultural traditions have encouraged the use of traditional antibacterial remedies as an alternative to conventional antibiotics (González-Villoria et al. 2024).

The use value (UV) ranged from 0.08 to 0.50, with a mean of 0.12 (SD: ±0.09) as presented in Table 2. *Piper betle* emerged as the species with the highest UV, indicating its importance to the Dayak sub-ethnic groups, as reflected by a high number of use reports. Additionally, *Orthosiphon aristatus* and *Oryza sativa* had notable UVs of 0.42 and 0.33, respectively, implying their significance as well. Respondents' knowledge of ethnomedicinal plant uses may be influenced by age, experience, and accessibility to these species in the wild (Wayland and Walker 2014; Sousa et al. 2022). However, we did not document which species might be cultivated or domesticated, representing a limitation in the scope of information gathered in this study. Notably, 74.6% of the recorded plants had more than one use report, though most exhibited UVs below 0.10. Species with high UVs are often linked to conservation concerns based on the principle that highly valued species are subject to greater harvesting pressures (Rosero-Toro et al. 2018). A high UV reflects numerous use reports for a species, implying its cultural and practical importance, while a low UV corresponds to fewer use reports (Ong and Kim 2014). In terms of plant's family representation, Zingiberaceae emerged as the most commonly utilized family, accounting for 7.88% of the species reported (Figure 2). This was followed by Rubiaceae, Poaceae, and Menispermaceae, each contributing 6.35% of the total. Additionally, families such as Sapindaceae, Rutaceae, Myrtaceae, Lamiaceae, and Fabaceae with each represented 4.76% of the species, while several minor families contributed less than 4%.

The Dayak communities throughout various regions of Kalimantan have introduced a rich tradition of utilizing medicinal plants. Research has identified the use of between 25 and 85 species across different Dayak sub-groups (Santoso and Utami 2019; Supiandi et al. 2019; Lestariningsih et al. 2023). Prominent plant families in these practices include Zingiberaceae, Piperaceae, Fabaceae, Rubiaceae, and Lamiaceae. Among the plant parts, leaves are frequently employed, often prepared through boiling and consumed as infusions. Certain plants, such as *Callicarpa longifolia* and *Colocasia esculenta*, hold significant value within these communities, as they are used to treat a range of ailments, including fever, ulcers, wounds, and gastrointestinal discomfort (Mariska et al. 2021).

However, this traditional knowledge faces the threat of erosion due to cultural shifts and environmental degradation. As such, documenting and preserving this ethnobotanical knowledge is essential for preserving local wisdom in traditional medicine practices. The Zingiberaceae family is of considerable importance in traditional medicine across diverse regions worldwide. In India, a notable study identified 13 species belonging to seven genera that are utilized within the Ayurvedic system of medicine (Saensouk et al. 2024). In the Northern Antique mountains of the Philippines, a study documented 23 species from eight genera, of which 16 species are recognized for their medicinal applications (Dalisay et al. 2018). Furthermore, the local community in district Rudraprayag, Western Himalayas, India, utilized 78 species across 72 genera to treat 15 ailments, with a focus on skin diseases and gastrointestinal disorders (Singh et al. 2017). In Northern Thailand, 33 native species from nine genera were utilized, primarily categorized as either food or medicinal resources (Inta et al. 2023). Based on these studies, rhizomes emerge as the most commonly utilized part of the plants, reflecting traditional practices that prioritize this plant morphology for its therapeutic properties. Among the most significant species identified are *Alpinia galanga*, *Curcuma longa*, *Zingiber purpureum*, and *Zingiber officinale* (Inta et al. 2023). A distinguishing feature of ginger species is their production of a distinctive aroma.

Table 2. List of traditional medicinal plants used by the Dayak Ot Danum and Tomum sub-ethnic groups in Central Kalimantan, Indonesia, for treating microbial-infection-related diseases by Bacteria (B), Fungi (F), Parasites (P), and Viruses (V) And Their Use Values (UV)

Scientific name	Family	Local name	Traditional knowledge of remedy						UV
			B	F	V	P	B+F	B+V	
Justicia gendarussa	Achantaceae	*Kakambat*	-	-	●	-	-	-	0.08
Acorus calamus	Acoraceae	*Jerangau putih*	-	-	-	-	-	●	0.08
Anisophyllea disticha	Anisophylleaceae	*Kayu busi*	-	-	-	-	●	-	0.08
Cananga odorata	Annonaceae	*Kenanga*	-	-	-	-	●	-	0.08
Centella asiatica	Apiaceae	*Akar ketidai*	-	-	-	-	●	-	0.08
Cocos nucifera	Arecaceae	*Kelapa*	-	-	●	-	-	-	0.17
Areca catechu	Arecaceae	*Pinang muda*	-	●	●	-	-	-	0.17
Blumea balsamifera	Asteraceae	*Sambung*	-	-	●	-	●	-	0.17
Ananas comosus	Bromeliaceae	*Daun nenas*	●	-	-	-	-	-	0.08
Carica papaya	Caricaceae	*Pepaya*	-	-	-	●	-	-	0.17
Decalobanthus peltatus	Convolvulaceae	*Akar labat*	●	-	-	-	-	-	0.08
Hellenia speciosa	Costaceae	*Totabai*	●	-	-	-	-	-	0.08
Kalanchoe pinnata	Crassulaceae	*Samamelum* or *Cocor bebek*	-	●	-	-	-	-	0.08
Momordica balsamina	Cucurbitaceae	*Teken pare*	●	-	-	-	-	-	0.08
Scleria sumatrensis	Cyperaceae	*Sapa hiring*	●	-	-	-	-	-	0.08
Spatholobus littoralis	Fabaceae	*Kayu dului* or *Duku*	-	-	-	●	-	-	0.08
Senna alata	Fabaceae	*Galinggang*	-	●	-	-	-	-	0.25
Flemingia macrophylla	Fabaceae	*Akar kuning*	-	-	●	-	-	-	0.08
Cratoxylum arborescens	Hyperiaceae	*Butun*	●	-	-	-	-	-	0.08
Orthosiphon aristatus	Lamiaceae	*Kumis kucing*	●	-	-	-	-	-	0.42
Vitex pinnata	Lamiaceae	*Sloban*	●	-	-	-	-	●	0.08
Coleus scutellarioides	Lamiaceae	*Kembang dirang*	-	●	-	-	-	-	0.08
Alium cepa	Liliaceae	*Bawang*	-	-	●	-	-	-	0.08
Durio zibethinus	Malvaceae	*Daun durian*	-	-	●	-	-	-	0.08
Melastoma malabathricum	Melastomataceae	*Kalamunting*	●	-	-	-	-	●	0.17
Lansium domesticum	Meliaceae	*Daun langsat*	-	-	●	-	●	-	0.08
Tinospora crispa	Menispermaceae	*Putarwali*	-	-	-	●	●	-	0.17
Fibraurea tinctoria	Menispermaceae	*Akar kuning*	-	-	●	-	-	-	0.17
Pericampylus glaucus	Menispermaceae	*Akar kuning*	-	-	●	-	-	-	0.08
Arcangelisia flava	Menispermaceae	*Akar kuning*	-	-	●	-	-	-	0.08
Musa acuminata	Musaceae	*Pisang raja merah*	●	-	-	-	-	-	0.08
Psidium guajava	Myrtaceae	*Daun jambu pasir*	●	-	-	-	-	-	0.25
Syzygium polyanthum	Myrtaceae	*Ubay/daun salam*	●	-	-	-	-	-	0.17
Syzygium aromaticum	Myrtaceae	*Cengkeh*	-	-	●	-	-	-	0.08
Jasminum sambac	Oleaceae	*Melati*	-	●	-	-	-	-	0.08
Phyllanthus niruri	Phyllanthaceae	*Meniran*	●	-	-	-	-	-	0.08
Glochidion littorale	Phyllanthaceae	*Kayu tigo*	●	-	-	-	-	-	0.08
Piper bettle	Piperaceae	*Kaun sirih*	●	●	-	-	-	-	0.5
Cymbopogon nardus	Poaceae	*Serai belanda*	-	●	-	-	-	-	0.08
Oryza sativa	Poaceae	*Beras*	●	●	-	-	-	-	0.33
Cymbopogon citratus	Poaceae	*Serai*	-	-	●	-	-	-	0.08
Bambusa vulgaris	Poaceae	*Bambu kuning*	-	-	-	-	●	-	0.08
Tarennoidea wallichii	Rubiaceae	*Koman*	-	-	-	●	-	-	0.08
Spermacoce alata	Rubiaceae	*Kayu rosu*	-	-	-	-	●	-	0.08
Psychotria winkleri	Rubiaceae	*Mato kucing*	●	-	-	-	-	-	0.08
Lasianthus attenuatus	Rubiaceae	*Bobaro*	●	-	-	-	-	-	0.08
Citrus × aurantiifolia	Rutaceae	*Limau*	-	●	-	-	-	-	0.25
Citrus hystrix	Rutaceae	*Jeruk purut*	-	●	-	-	-	-	0.08
Luvunga sarmentosa	Rutaceae	*Seluang belum*	-	-	●	-	-	-	0.08
Nephelium reticulatum	Sapindaceae	*Totubo*	-	-	●	-	-	-	0.08
Dimocarpus longan	Sapindaceae	*Mata Kucing/tangkuhis*	●	-	-	-	-	-	0.08
Nephelium lappaceum	Sapindaceae	*Rambutan*	-	-	-	-	●	-	0.08
Eurycoma longifolia	Simaroubaceae	*Pasak bumi*	-	-	●	-	-	-	0.08
Cucumis sativus	Solanaceae	*Daun timun*	-	-	●	-	-	-	0.08
Symplocos goodeniacea	Symplocaceae	-	●	-	-	-	-	-	0.08
Peronema canescens	Verbenaceae	*Sukai*	-	-	●	-	-	-	0.08
Ampelocissus thyrsiflora	Vitaceae	*Pangalit ut*	●	-	-	-	-	-	0.25
Hornstedtia havilandii	Zingiberaceae	*Tapah pokis*	●	-	●	-	-	-	0.08
Curcuma longa	Zingiberaceae	*Kunyit*	●	-	●	-	●	-	0.25
Boesenbergia rotunda	Zingiberaceae	*Temulawak/ Kunyit ntomu*	●	-	-	-	-	-	0.08
Zingiber officinale	Zingiberaceae	*Jahe*	-	-	●	-	-	-	0.08
Alpinia galanga	Zingiberaceae	*Lengkuas*	-	●	-	-	-	-	0.17
Total documentation(s)			24	11	21	4	10	3	N/A

Note: ●: Present, N/A: Not Applicable

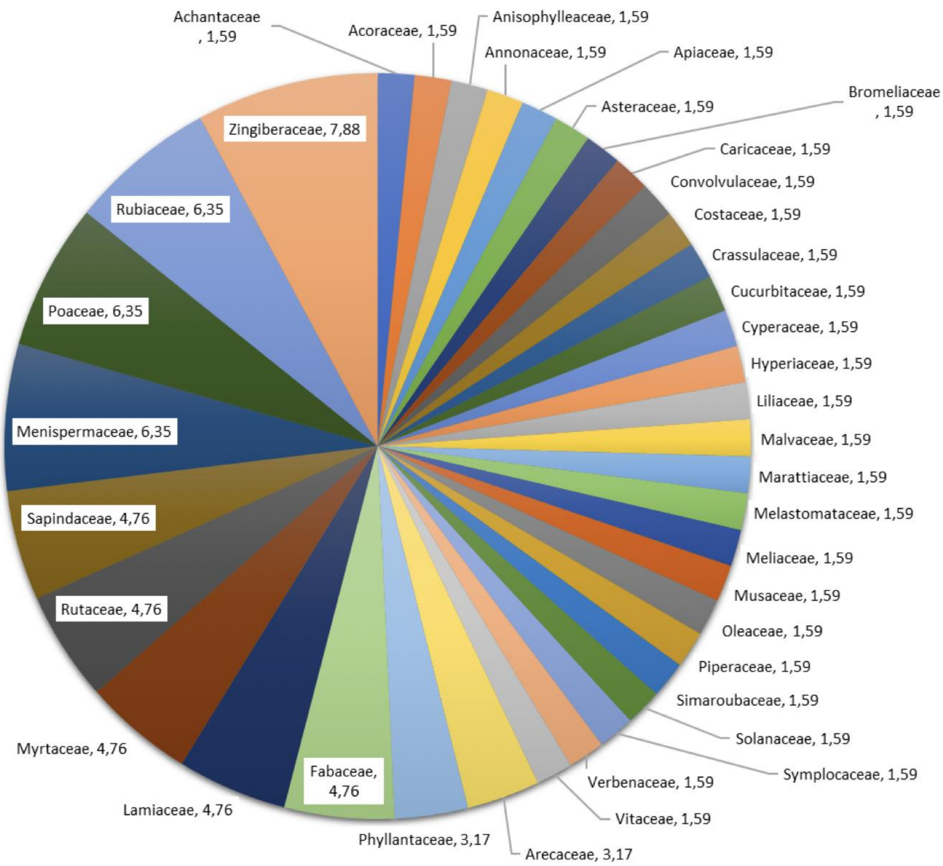

Figure 2. Plant families utilized as traditional remedies for infectious diseases by the Dayak Tomum and Ot Danum sub-ethnic groups in Central Kalimantan, Indonesia

This characteristic helps local communities recognize and differentiate among various ginger species. Such olfactory cues can assist even those with limited experience in recalling these valuable plants. This may contribute to the frequent mention of ginger species as one of the most significant families in ethnobotanical research. All of the documented species not only reflect the ethnomedicinal significance of the Zingiberaceae family by the Dayak communities but also suggest a rich potential for future pharmacological investigations that could be different from other local accessions.

Different parts of medicinal plants, each with specific healing properties, are used to make herbal remedies or ethnomedicines for various ailments (Table 3). For instance, the leaves of certain plants may have antibacterial properties, while the roots may be effective against fungal infections. This study revealed thirteen ethnomedicinal formulations were documented among the Dayak Ot Danum and Tomum communities, each targeting different ailments. These remedies address a variety of conditions caused by infectious agents, including bacterial infections (e.g. diarrhea, urinary tract infections), fungal infections (e.g. athlete's foot, dandruff, vaginal discharge), viral infections (e.g. COVID-19, seasonal flu, smallpox), parasitic infestations, and certain physiological disorders. Most ethnomedicines are formulated from leaves, followed by roots, fruits, and grains exclusively from rice (*O. sativa*). Rice is often mixed with other plants to create a paste, which is applied to the skin to treat disorders (Burlando and Cornara 2014).

In India, rice is typically boiled, drained, cooled, and then mashed into a paste. This paste can be molded into balls and applied to various skin issues, including blemishes, boils, sores, and swelling (Umadevi et al. 2012). Additionally, different landraces of rice grown in the Philippines are also known to help with skin problems, including pimples in human and even skin diseases in carabao or water buffaloes (Cabanting and Perez 2016). Plant leaves are widely used in ethnomedicines due to their medicinal properties, ease of traceability, and accessibility (Tariq et al. 2017). Their prominence in traditional medicine is linked to factors such as proven efficacy, availability, and the economic conditions of communities relying on these treatments (Nejad et al. 2018; Chaachouay et al. 2021; Balkrishna et al 2024). This dependence on leaf-based remedies highlights the practicalities of sourcing local plants based on the cultural and economic influences shaping unique traditional practices in each region. Certain conditions required in preparing ethnomedicines by Dayak sub-ethnic groups are evident in various plant species, notably *Arcangelisia flava*, *Melastoma malabathricum*, *Psidium guajava*, and *Scleria sumatrensis*. These preparations often involve traditional practices and mystical knowledge passed down through generations, which warrant further exploration through detailed ethnographic approaches (Tresca et al. 2020).

Table 3. List of ailments treated with concoctions from single or various plant species as ethnomedicines by Dayak sub-ethnics in Central Kalimantan, Indonesia

Ailments	Composition of plant species	Parts used	Preparation/conditions	Processing	Applications
Ot Danum					
Athlete's foot	*Curcuma longa*	Rhizomes		Rhizomes are grated and added with salt	Applied post-evening bath
COVID-19	*Allium cepa* *Curcuma longa* *Cymbopogon nardus* *Syzygium aromaticum* *Zingiber officinale*	Bulbs Leaves Leaves Fruits Leaves		Ingredients are boiled	Steam was inhaled and decoction was consumed orally
Dandruff and pubic lice	*Areca catechu* *Citrus × aurantiifolia*	Leaf shoots Fruits		Leaves are pounded and mixed with lime juice	Applied topically
Diarrhea	*Psidium guajava*	Leaf shoots	Leaves are collected and processed in odd quantity	Ingredients are boiled and mixed with commercial tamarind fruits	Consumed orally
Fever, seasonal flu, rashes	*Kalanchoe pinnata* *Oryza sativa*	Leaves Grains		Ingredients are pounded into a fine paste	Applied topically to the forehead
Goiter	*Allium cepa* *Oryza sativa*	Bulbs Grains		Ingredients are pounded into a fine paste	Applied from three to four times daily until healed
Jaundice	*Ampelocissus thyrsiflora* *Arcangelisia flava*	Roots Roots	Salt and nails are placed near the plant before harvesting	Ingredients are freshly boiled or dried under sunlight.	Consumed orally for three times daily
Shingles	*Pericampylus glaucus* *Oryza sativa*	Leaf shoots Grains		Ingredients are pounded into a fine paste	Applied topically on a frequent basis
Urinary tract infection	*Orthosiphon aristatus* *Phyllanthus niruri*	Roots Roots		Ingredients are soaked in drinking water	Consumed orally
Vaginal discharge	*Melastoma malabathricum* *Scleria sumatrensis*	Leaf shoots Leaf shoots	During healing practices, patients are instructed to consume all food provided without leaving any uneaten. The preparation of the remedy involved three stages of leaf collection: 21 leaf shoots were gathered during the first stage, 14 leaves during the second stage, and 7 leaves during the third stage.	The selected intact shoots are then either pounded or blended to create the remedy.	A quantity equivalent to the width of two fingers was measured and consumed orally. This process was repeated for three consecutive days.
	Coleus scutellarioides *Jasmimum sambac*	Roots Roots		Ingredients are soaked in drinking water	Consumed orally
Tomum					
Athlete's foot	*Blumea balsamifera* *Lansium domesticum* *Nephelium reticulatum* *Oryza sativa*	Leaves Leaves Leaves Grains		Ingredients are pounded into a fine paste	Applied topically
Smallpox	*Durio zibethinus* *Lansium domesticum*	Leaves Leaves		Ingredients are boiled	Steam was applied to body while warm

The Index of Cultural Significance (ICS) indicates that *C. longa* and *O. sativa* hold the highest importance among the community, with ICS values of 12.00 and 10.67, respectively (Table 4). *Curcuma longa* is the primary due to its anti-inflammatory and antimicrobial properties (Shi et al. 2021), while *O. sativa* is both nutritionally and topically valued for skin-related treatments, as previously discussed (Burlando and Cornara 2014). *Piper betle* (ICS 8.00) showed medicinal importance to the community due to its antibacterial properties, particularly in oral health and wound healing (Chowdhury and Baruah 2020). However, it was not listed among the specific ethnomedicinal formulations. This may be due to its simple, direct usage, as it is typically chewed or brewed directly by the Dayak communities. *Orthosiphon aristatus* (ICS 6.67), known for its diuretic properties, is used to manage kidney and urinary tract issues (Kusmala et al 2023). Plants like *Areca catechu* and *Tinospora crispa*, with ICS values of 5.33, are commonly utilized for digestive and immune-related ailments (Haque et al. 2017; Chen et al. 2024). Collectively, these top-ranking plants show the community's reliance on accessible and multifunctional plant species, highlighting the practicality and adaptability of their traditional medicinal practices. The remaining 49 species with an ICS below 2.67 represent plants with specific usages by the local community. These plants might be used as supplementary with lower prevalence and high variations in perceived cultural importance by the locals. This ICS hierarchy thus reveals the prioritization of plants in community health practices, reflecting both the efficacy attributed to specific plants and the cultural emphasis placed on their medicinal roles (Leonti 2022). However, based on Pieroni's (2001) ICS categorization, this study documented only plant species with low to no cultural significance (20<ICS<5). Despite this, the consistent presence of certain species with relatively high quantitative values still effectively highlights their importance within the Dayak community. An additional index examined in this study is the Informant Consensus Factor (ICF), as presented in Table 5.

Table 4. Categorization of medicinal plant species used by Dayak sub-ethnic groups in Central Kalimantan, Indonesia, based on their ICS values

Species	**N**	**Index of Cultural Significance (ICS)**
Curcuma longa	1	12.00
Oryza sativa	1	10.67
Piper betle	1	8.00
Orthosiphon aristatus	1	6.67
Areca catechu, Tinospora crispa	2	5.33
Citrus × aurantiifolia, Psidium guajava	2	4.00
Alpinia galanga, Carica papaya, Cocos nucifera, Lansium domesticum, Melastoma malabathricum, Syzygium polyanthum	6	2.67
Other species	49	<2.67

Table 5. Informant Consensus Factor (ICF) for different ethnomedicinal plant usages by Dayak sub-ethnic groups in Central Kalimantan, Indonesia

Ailment(s)	**Nur**	**Nt**	**ICF**	**Frequently used species**
Wound healing	3	1	1.00	*Ampelocissus thyrsiflora*
Dermatophytosis (*Tinea versicolor*)	5	2	0.75	*Senna alata*
Bromhidrosis	4	2	0.67	*Piper betle*
Malaria	3	2	0.50	*Carica papaya*
Respiratory tract infections	4	3	0.33	*Hornstedtia havilandii*
Skin infection	7	5	0.33	N/A
Urinary and genital tract infections	9	9	0	*Orthosiphon aristatus*
Gastrointestinal infections	7	7	0	*Psidium guajava*
Acne	3	3	0	N/A
Odontalgia	2	2	0	N/A
Helminthiasis	2	2	0	N/A
Hepatitis	6	6	0	N/A
Tonsillitis	2	2	0	N/A
Eye infection*	4	4	0	*Piper betle*
Dandruff*	3	4	0	*Citrus × aurantiifolia*
Smallpox*	3	5	0	*Cocos nucifera*
Athlete's foot*	3	7	0	N/A
Aphthous stomatitis*	1	1	0	N/A
Herpes simplex virus infection*	1	1	0	N/A
COVID-19*	1	6	0	N/A

Note: *CFI value of 0 (zero) indicates no similarity information between key informants related to the plant species used for ethnomedicines. N/A: Not Applicable

In analyzing the use of ethnomedicinal plants across various ailments, a trend emerges indicating a higher ICF value for conditions such as wound healing, dermatophytosis (e.g. *Tinea versicolor*), and bromhidrosis (body odor) compared to other ailments. For wound healing, *Ampelocissus thyrsiflora* holds an ICF of 1.00, signifying unanimous consensus among informants, possibly due to its perceived effectiveness and traditional reliance. Such high ICF values typically reflect the strong cultural integration and historical usage of these species in primary health care, implying a level of trust and observed efficacy that supports the plant's therapeutic application within the community. Conditions such as dermatophytosis and bromhidrosis show moderate ICF values of 0.75 and 0.67, respectively, indicating somewhat varied but still relatively consistent use of species like *P. betle* and *Senna alata*. Malaria treatment is marked by an ICF of 0.50, with *Carica papaya* frequently cited for its purported antimalarial effects. The lower ICF here may reflect the mixed efficacy reported in ethnomedicinal applications, which could be due to regional variations in malaria strains or variability in plant preparation and application methods. Respiratory tract infections, by contrast, hold an ICF of 0.33, with *Hornstedtia havilandii* being commonly used. The modest consensus here likely reflects the broad spectrum of respiratory ailments and the potential for multiple plant-based remedies to target different symptoms or infection stages, offering hope for future treatments.

Conversely, some ailments with zero ICF values, such as gastrointestinal infections, urinary and genital tract infections, and skin conditions, imply a greater diversity in treatment approaches without a clear consensus on plant use. For example, despite its lack of ICF value, *P. guajava* is still frequently chosen for gastrointestinal infections. Similarly, *O. aristatus*, as being used in urinary and genital tract infections, is traditionally regarded for its diuretic and urinary tract-cleansing effects. For conditions like COVID-19, which represent emerging health challenges, the community has turned to Zingiberaceae species, despite an ICF of zero. This reflects adaptive ethnomedicinal practices where familiar plants are repurposed to address new health issues, likely due to perceived antiviral properties and traditional uses in respiratory infections. The documentation of these plants and their applications shows the dynamic nature of ethnomedicinal knowledge, where both longstanding practices and evolving applications meet community health needs. A high ICF value reflects a strong agreement among informants regarding the selection of specific taxa, while a low ICF suggests a lack of consensus (Xavier et al. 2014; Balinado and Chan 2017). Therefore, the ICF can serve as a valuable tool for identifying species of particular interest in the exploration of bioactive lead compounds (Usman et al. 2021), particularly *A. thyrsiflora* or *Pangalit ut*. The species, *A. thyrsiflora* is documented as an essential and important ethnomedicinal plant based on our study. A further step is to promote its use as a raw material in medicines and drug development as well as to strengthen the unique ethnomedicinal practices by the Dayak Ot Danum and Tomum communities.

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