



Bridging culture and nature: An ethnobotanical exploration of the Dayak Ga'ai in Berau Regency, East Kalimantan

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Research

Abstract

Background: Dayak Ga'ai, who lived in Berau, East Kalimantan, has rich ethnobotanical knowledge reflecting their deep connection with nature. Ethnobotanical knowledge in Dayak Ga'ai communities does not exist in the form of comprehensive documentation; it is only passed down orally, so it is at high risk of being lost. Documenting and preserving this knowledge is crucial for cultural and environmental conservation.

Methods: This study employs interview methodologies utilizing purposive sampling. We conducted interviews with 70 respondents from five villages. The questions encompass respondent characteristics and ethnobotanical aspects of local wisdom knowledge. We additionally investigated and cataloged the plant. The Use Value (UV), Relative Frequency of Citation (RFC), and Cultural Significance Index (ICS) are ethnobotanical indexes employed for data analysis.

Results: The results show that 169 species belonging to 56 families are known and utilized in the live of Dayak Ga'ay community. Categorized into revealed that 13 species are used for cultural purposes, 15 species for handicrafts, 114 species for traditional medicine, 67 species for food, and 38 species for traditional tools and equipment. There are 7 species in each index, namely *Calamus* sp. (RFC = 0.61; UV = 2.46; ICS = 36), *Goniothalamus macrophyllus* (RFC = 0.56; UV = 2.78; ICS = 46), *Eusideroxylon zwageri* (RFC = 0.46; UV = 1.37; ICS = 15), *Vitex pinnata* (RFC = 0.41; UV = 0.83; ICS = 15), *Shorea* sp. (RFC = 0.37; UV = 1.48; ICS = 17), *Licuala spinosa* (RFC = 0.31; UV = 1.57; ICS = 40), and *Curcuma longa* (RFC = 0.30; UV = 0.60; ICS = 18). They found plants in forests, gardens, and yards.

Conclusions: The Ga'ai Dayak utilize diverse plants. Nevertheless, the ethnobotanical knowledge of these plants is decreasing due to modernization, migration, and deforestation. It is necessary to conserve natural resources and incorporate ancient knowledge into contemporary conservation and educational initiatives.

Keywords: Ethnobotany; Dayak Ga'ai; Traditional knowledge, Cultural heritage, Berau

Background

The Dayak tribe is one of Indonesia's indigenous tribes living on Borneo with a rich and diverse culture (Sillander 2016 & Sada *et al.* 2019). Etymologically, the term "Dayak" refers to the non-Malay and non-Muslim indigenous people who inhabit the interior of Borneo, with various sub-ethnicities spread across the region (Sillander 2016). One of the Dayak subtribes in the Dayak Apokayan group is the Dayak Ga'ai. The Dayak Ga'ai are a sub-tribe of the Dayak Kayan (Martvertnad 2016; Yanuarsyah 2018). The Dayak Ga'ai tribe lives along the main rivers, namely the Segah River and the Kelay River in Berau Regency, East Kalimantan Province, Indonesia. The Dayak Ga'ai people have a close relationship with nature, and their local wisdom in managing natural resources is the foundation of their culture in their daily lives (Martvertnad 2016; Yanuarsyah 2018).

The local wisdom of the Dayak Ga'ai community encompasses the sustainable use of natural resources, reflected in their philosophy of life that values nature and living things. One important aspect of this local wisdom is ethnobotanical knowledge, which encompasses the use of plants for various purposes such as food, traditional medicine, building materials, and traditional ceremonies (Satia *et al.* 2018; Sada *et al.* 2019, Salim *et al.* 2023). Ethnobotany is an integral part of bioculture, which is the knowledge of indigenous peoples in interacting with their surroundings (Andesmora *et al.* 2017). However, along with developments, changes in lifestyles, and increased human activity, the local wisdom of the Dayak Ga'ai community is increasingly threatened. The reduction in forest area and environmental degradation have resulted in reduced biodiversity, which also affects the ethnobotanical knowledge of the younger generation (Nartey 2025). Migration has also contributed to changing cultural structures and caused a decline in interest in traditions and natural knowledge, including the use of plants by the Dayak Ga'ai community. This observation is reinforced by the results of research by Yanuarsyah (2018), who stated that it is difficult to obtain information about traditional medicine in the Dayak Ga'ai tribe; this is due to the decreasing appeal of this knowledge among the younger generation. Other research results related to the Dayak Ga'ai include language and culture (traditional ceremonial rituals) (Martvertnad 2016; Yanuarsyah 2018; and Mackay *et al.* 2013) and the shifting cultivation system (Rusyanti & Heriyanto 2024), while research related to ethnobotany is still lacking.

As stipulated in the Minister of Environment and Forestry Regulation No. 34 of 2017, the importance of recognizing and protecting local wisdom must be maintained, not only for the sake of nature conservation, but also to recognize the culture of indigenous communities who have long interacted with their environment (Mulu *et al.* 2020). It is important to document the ethnobotanical knowledge of the Dayak Ga'ai community, considering that information regarding the use of plants in their lives is still limited. This study aims to examine and inventory the ethnobotanical knowledge possessed by the Dayak Ga'ai community, as well as its role in environmental and cultural preservation.

Materials and Methods

Study area

The research will be conducted in Berau Regency, East Kalimantan, precisely in Long Laay, Lesan Dayak, Tumbit Dayak, Long Ayan, and Long Lanuk Village (Figure 1). Long Laay and Long Ayan Village is situated in Segah District, along the upstream banks of the Segah River; Lesan Dayak Village is found in Kelay District, upstream of the Lesan River, which is a tributary of the Kelay River; and Tumbit Dayak and Long Lanuk Village is located in Sambaliung District. Tumbit Dayak and Long Lanuk Village is the closest village to the capital of Berau Regency, Tanjung Redeb. Tumbit Dayak and Long Lanuk Village is located on the banks of the Kelay River (CBS Berau Regency 2024).

Data Collection

Ethnobotanical data were gathered using emic and ethical methodologies. The emic technique was utilized to gather data regarding community knowledge of plants. The collection of community knowledge was conducted via interviews and observations. The methodology employed was purposive sampling and snowball sampling, including 70 respondents. The selected respondents were of Ga'ai ethnic origin and adults (over 20 years old), as it was expected that they still possessed relevant ethnobotanical knowledge (Gunawan *et al.* 2024). The methodology employed comprehensive semi-structured interviews with local populations and key informants (Jan *et al.* 2023; Zareef *et al.* 2023) and direct field observations (Due *et al.* 2013; Royyani & Efendy, 2015). Key informants are those possessing knowledge of local wisdom, such as village chiefs,

hamlet heads, traditional leaders, and community leaders. Data collection procedures pertaining to customs, culture, social activities, agriculture, and other areas are conducted via structured interviews (Rachmawati 2007). Utilization encompasses sources of sustenance, pharmaceuticals, traditional or cultural ceremonies, adornments, accessories, structures, implements, and materials. Plant identification is conducted by exploring residential yards and forested regions near settlements. Local nomenclature and additional terminology are likewise documented. We document the plant parts used, the subsequent processing, and the methods used to identify the species in the wild. The ethical methodology employed includes scientific nomenclature, which is based on citations from internet sources, specifically <https://powo.science.kew.org/>. Simultaneously, the conservation status was determined utilizing data from the International Union for Conservation of Nature (IUCN).

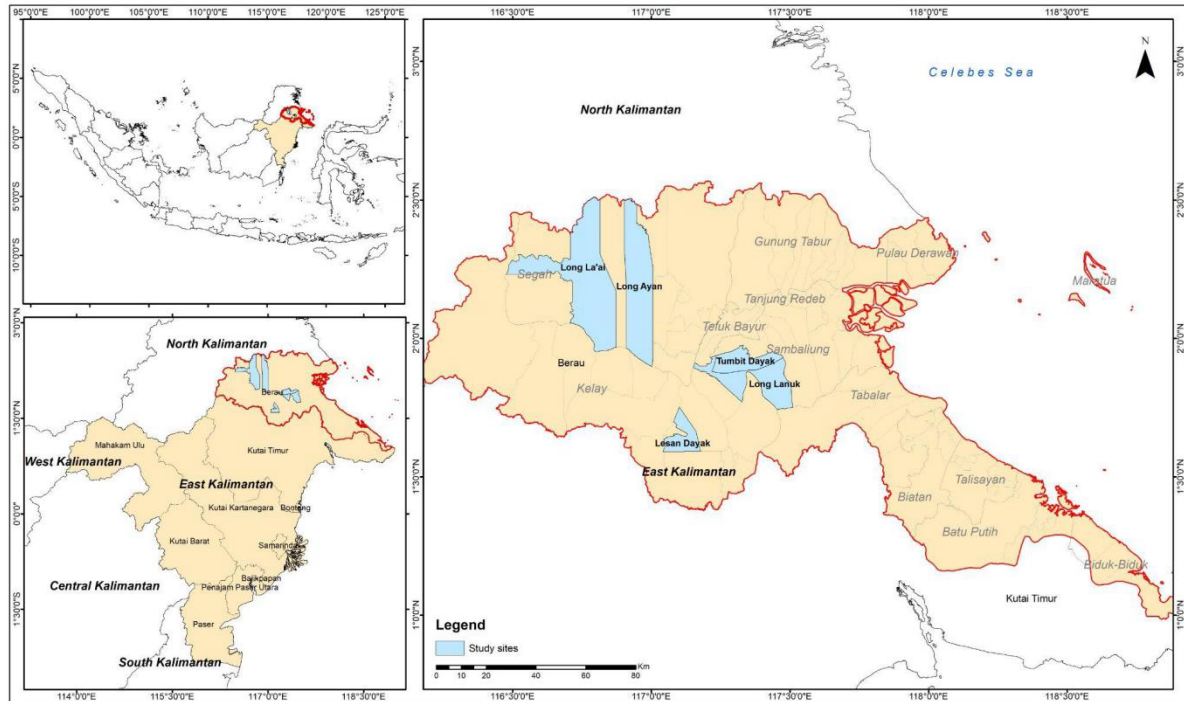


Figure 1. Map of study area, Long Laay, Lesan Dayak, Tumbit Dayak, Long Ayan and Long Lanuk, Berau Regency, East Kalimantan, Indonesia.

Table 1. Description of the selected study villages.

District	Name of Village	Area (km ²)	No. of population	No. of respondents
Segah	Long Laay	935,33	620	20
	Long Ayan	602,52	1.123	10
Kelay	Lesan Dayak	135,68	239	15
	Tumbit Dayak	81,19	3.532	10
Sambaliung	Long Lanuk	427,11	1.053	15
	Total		6.567	70

Data Analysis

The ethical approach was employed through analysis of the Index of Relative Frequency of Citation (RFC), Use Value (UV), and Cultural Significance (ICS). Ethnobotanical data were systematically organized utilizing Microsoft Excel spreadsheets. ICS is derived from quantitative ethnobotanical investigation that demonstrates the significance of each plant species. The significance of each species is assessed by the Relative Frequency of Citation (RFC). The computation employed the subsequent formula.

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

Where: q_i = the value of quality; i_i = intensity value; e_i = exclusivity value (Taram *et al.* 2020; Pratami *et al.* 2024)

$$UV = (\sum U_i s) / n_i s$$

Where: UV_{is} = the use values of the species s mentioned by the informants i ; $\sum UV_{is}$ = the number of uses of species s mentioned in each event by the informants i ; n_{is} = the number of events in which the informants i cited species s (Taram *et al.* 2020; Pratami *et al.* 2024)

$$RFC = FC/N \quad (0 < RFC < 1)$$

Where, FC is the frequency of citation; N is the total number of respondents participating in the study, without considering use categories into account (Andesmora *et al.* 2017; Taram *et al.* 2020; Pratami *et al.* 2024)

Results and Discussion

Sociodemographic Data and the Dayak Ga'ai Ethnobotanical Knowledge

The study comprised 70 participants, consisting of 37 males and 33 females, with respondents sourced from five villages: 20 from Long Laay, 15 from Lesan Dayak, 10 from Tumbit Dayak, 15 from Long Lanuk, and 10 from Long Ayan (Figure 2). The respondents' ages varied from 20 to over 60 years. This age group was deliberately chosen to assess whether younger participants retained knowledge of ethnobotany. The statistics indicated that even the younger participants had comprehension of ethnobotanical knowledge. The greater percentage of female responses corresponds with the increased prevalence of ethnobotanical applications associated with traditional medicine and food, which are predominantly utilized by women in the community (Ajiningrum *et al.* 2025).

The Dayak village of Tumbit and Long Lanuk, situated near the district capital Tanjung Redeb, has many citizens employed in the city or in adjacent mines. In contrast, the Dayak villages of Long Laay, Long Ayan and Lesan Dayak are situated further from the district headquarters, with their communities adjacent to forest and agricultural areas, leading to a higher number of responders. Moreover, this proximity to natural resources is evident in the data, indicating that most respondents in these villages are farmers reliant on their immediate environment for their sustenance (Ibrahim & Surya 2025; Neneng *et al.* 2025).

Figure 2(a) shows the distribution of respondents from five Dayak Ga'ai villages, with Long Laay and Long Lanuk having the highest number of respondents. Women slightly outnumber men in most villages, except in Tumbit Dayak Village. The relatively high representation of women supports the understanding that women's roles in Dayak communities are often more dominant in relation to medicinal plants, traditional foods, and household-based resource management (Ajiningrum *et al.* 2025; Anjeliana *et al.* 2024).

Based on the distribution by age group (Figure 2(b)), all villages show a balanced distribution of respondents across age groups, with a significant presence of younger respondents (21-40 years). This pattern confirms that ethnobotanical knowledge is still being passed down to the younger generation. The presence of older respondents (>61 years) in Long Laay and Long Lanuk indicates that traditional knowledge is still maintained in these villages.

Figure 2(c) shows that farming is the dominant profession in all villages, especially in Lesan Dayak and Long Lanuk. Only a small proportion of respondents worked as entrepreneurs, gold miners, or civil servants. This employment pattern confirms that this community remains heavily dependent on natural resources for its livelihoods, which is also why ethnobotanical knowledge is maintained and passed down. This reliance on local ecosystems reflects the research findings of Ibrahim & Surya (2025) and Neneng *et al.* (2025), which describe a close relationship between subsistence livelihoods and traditional plant knowledge among Dayak tribes.

Figure 2(d) shows that most respondents have lived in their villages for more than 30 years, particularly in Long Laay, Lesan Dayak, and Long Lanuk. This indicates a stable settlement pattern. Long-term residence patterns are closely associated with a richer understanding of ethnobotany. Meanwhile, minimal movement within the 0-20-year category suggests a strong cultural attachment to ancestral lands. This aligns with research by Hasanah *et al.* (2025) and Mirza (2025) that states that land and forests are sacred spaces tied to ancestors and spiritual obligations.

The sociodemographic structure of respondents in the four villages indicates a community deeply connected to its forest environment, with ethnobotanical knowledge widely distributed across gender, age, occupation, and length of residence. Women play a crucial role in traditional plant-based practices, younger generations continue to inherit traditional ecological knowledge, and long-term settlement fosters a strong connection to local biodiversity. These demographic dynamics collectively support the continued legacy of the Dayak Ga'ai's local wisdom despite increasing exposure to modernization.

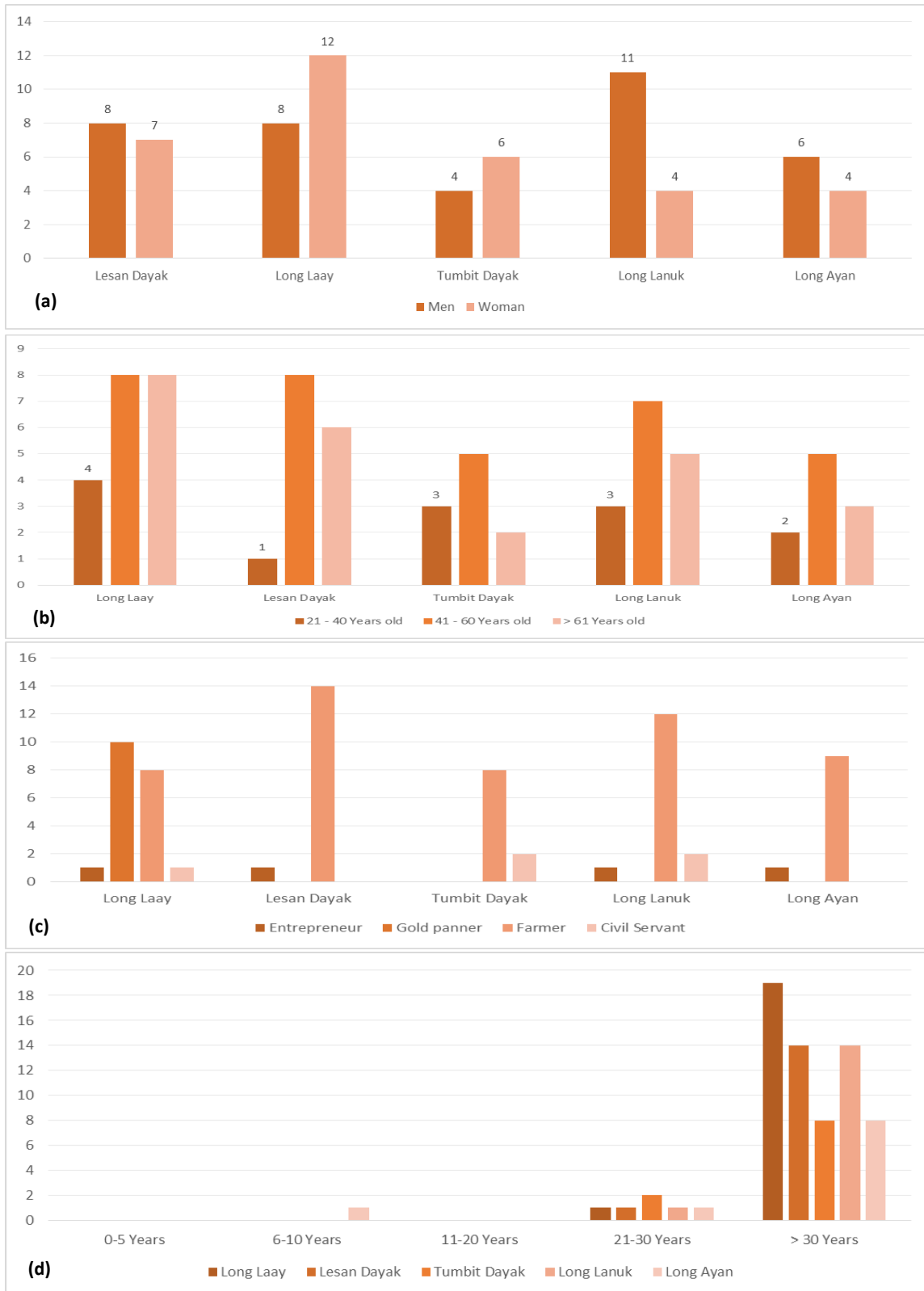


Figure 2. Graphs of sociodemographic Dayak Ga'ai community based on: (a) gender; (b) age class; (c) livelihood and (d) length of residence.

Categorized of ethnobotany

The Dayak Ga'ai community utilizes a diverse range of plant species, with a total of 169 species across 56 families. Notably, the *Arecaceae* family contributes 13 species, the *Zingiberaceae* family 10 species, the *Moraceae* family 8 species, the *Phyllanthaceae* family 7 species and the *Araceae* family 7 species. These plants are categorized into several uses, including

cultural, crafts, traditional medicine, food, and materials. Analysis revealed that 13 species are used for cultural purposes, 15 species for crafts, 114 species for traditional medicine, 67 species for food, and 38 species for traditional tools and equipment.

The majority of these plants are sourced from the forest, gardens, and yards. Dayak Ga'ai communities typically cultivate their gardens near the forest, allowing easy access to both forest resources and cultivated plants. This proximity to the forest enhances the community's ability to gather diverse plant species for various needs. Observations in the field also revealed that several food ingredients, including spices, as well as medicinal plants, are commonly planted in the homeyards further illustrating the community's integrated approach to using plants in everyday life.

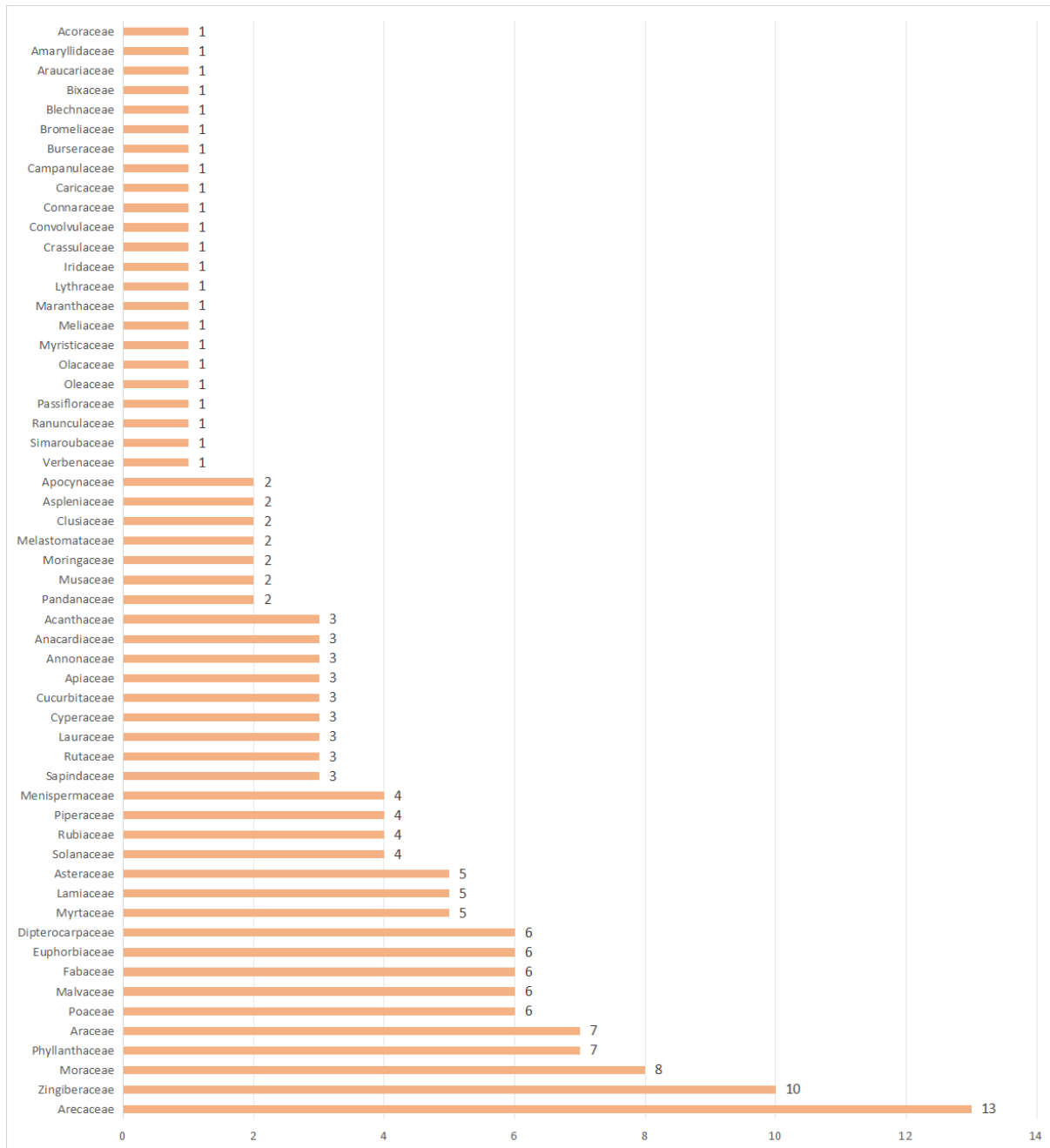


Figure 3. Species data number based on plant family used.

Culture

Ethnobotany examines the interrelationship between indigenous cultures and plants, encompassing various domains of cultural and practical significance (Sada *et al.* 2019). The cultural use of plants reflects their symbolic and spiritual

importance, often integrated into rituals, ceremonies, and traditional beliefs. Certain species are regarded as sacred, used to honor ancestors or mark significant life events, highlighting the close connection between nature and cultural identity (Salim *et al.* 2023). In the Dayak Ga'ai community, several traditional practices that incorporate plant use are still maintained, even if they are no longer fully relevant to modern life. For instance, Bejiak is a traditional welcoming dance still performed during ceremonies today, in which dancers wear traditional attire. Interestingly, the men's costumes are made from the bark of *Artocarpus elasticus*. Another enduring custom is *menyirih* (betle chewing), a daily habit among elders that involves chewing betel nuts (*Areca catechu*) and betel leaves (*Piper betle*). This practice is believed not only to be a social tradition but also to strengthen teeth and gums.

Other cultural events also highlight the close relationship between people, nature, and plants. *Bekudung* is a thanksgiving ritual held after the harvest, while Betiung marks the transition to adulthood. Historically, the Betiung ritual for boys involved bringing home a human head (locally named is *Ngayau*) as a symbol of bravery, while girls received traditional tattoos. In modern times, these elements have been replaced, and both ceremonies have been merged into a single event known as the Bekudung Betiung Festival, which preserves cultural meaning while removing practices incompatible with current religious values. In the traditional Betiung ceremony, young men carried weapons such as shields and machetes (*mandau*) made from durable Meranti wood and blowpipe darts coated with latex from *Antiaris toxicaria*, further demonstrating the deep integration of plants in Dayak Ga'ai cultural expression. Other plants also utilized in cultural (ritual) activities are Lujung (*Goniothalamus macrophyllus*) and Onlong (*Homalomena borneensis*). The Dayak Ga'ai indigenous community employs a combination of Lujung and Onlong (leaves dried and previously used in evil spirit expulsion rituals) to be hung in front of houses as a symbol of protection against malevolent spirits.



Figure 4. Leaves of *P. betle* and nut from *A. catechu* are often being used by elders for “menyirih” (betle chewing)



Figure 5. The Dayak Ga'ai indigenous community hangs dried Onlong (*H. borneensis*) and Lujung (*G. macrophyllus*) leaves that have been used in rituals to expel evil spirits in front of their houses as a form of family protection from evil spirits.

Traditional medicine

In traditional medicine, plants are essential for treating illnesses through knowledge transmitted across generations. Indigenous healers use plant parts such as roots, leaves, and barks to prepare remedies including teas, poultices, and infusions, forming the foundation of community health, particularly in areas with limited access to modern medicine (Pratami *et al.*, 2024). *Calamus* sp. is a multifunctional plant species utilized for several purposes. The young stems can halt bleeding in external wounds and serve as a toxin neutralizer. It is also thought to halt hemorrhaging during parturition when cooked and consumed. This phenomenon is the reason rattan possesses a significant value on the ethnobotanical index.



Figure 6. *Calamus* sp. (shoots part) (a), *Eleutherine bulbosa* or *bawang dayak* (bulb part) (b), *G. macrophyllus* or Lujung (wood part) (c), *H. borneensis* or Onlong (leaves part) (d), *Acorus calamus* locally known as Jeriangau (leaves) (e) and *Annona muricata* or Sirsak (leaves) are often utilize as medicine by Dayak Ga'ai indigenous community

Food

Plants also serve as a vital food source, contributing to food security and nutrition. Wild and cultivated species provide staple foods, roots, fruits, and seeds, while reflecting traditional ecological knowledge in sustainable harvesting and preparation methods (Andesmora *et al.* 2017). In addition to forest fruits belonging to the families Malvaceae, Meliaceae, Anacardiaceae, Sapindaceae, Moraceae, and Arecaceae, various types of vegetables are also collected from the forest and cultivated fields. Examples include the young shoots of green ferns (*Diplazium esculentum*) and small eggplants (*Solanum torvum*). Similar to other Dayak groups, the Dayak Ga'ai community maintains agricultural fields located near forest areas and often stays overnight in small field shelters. Consequently, many cooking ingredients are also sourced directly from the surrounding forest. As an alternative to garlic, the seeds of *Scorodocarpus borneensis*, referred to locally as Kulim or "forest garlic" is frequently utilized because of their potent and unique fragrance. Moreover, the desiccated leaves of *Albertisia papuana*, commonly referred to as Kanla, serve as a natural taste enhancer, illustrating the community's profound understanding of forest flora as both culinary and seasoning resources.

Handycrafts

The craft category includes the use of plant materials such as fibers, Bamboo, and wood for producing baskets, hats, mats, clothing, and tools. These crafts embody both functionality and cultural expression, representing the creativity and adaptability of indigenous artisans (Sillander 2016). In addition to Rattan, which possesses a significant ethnobotanical index, *L. spinosa* leaves serve as the primary material for the production of traditional hat or Seraung. *L. spinosa* is a plant species

of significant importance for culinary, traditional medicinal, craft, and tool-making purposes. Additionally, Long Lanuk village is home to traditional clothes artisans. These ancient garments are crafted from the inner bark layer. The production process is labor-intensive, resulting in a high market value. The bark is derived from the *A. elasticus* species.



Figure 7. *S. torvum* and *Passiflora foetida* fruits are regularly consumed as vegetables and fruits by the Dayak Ga'ai indigenous community (a & b), *D. esculentum* is also commonly incorporated into their diet as a vegetable (c), Plant-based natural seasonings frequently employed in their culinary practices include seeds of *S. borneensis* (d), leaves of *Eryngium foetidum* (e) dan *A. papuana* (f).



Figure 8. *L. spinosa* locally known as Yus (Yus leaves) being used as wrapping for P'toh (food served at cultural occasions such as Bekudung) and handycrafts known as Seraung (traditional hat used for cultural activities and tools).

Traditional tools or Utilization

Broader equipment involves plants with economic and environmental value, such as timber, resins, and fibers, managed through sustainable practices rooted in cultural ethics. This holistic approach demonstrates indigenous peoples' commitment to maintaining ecological balance and cultural continuity (Mulu *et al.* 2020). The selection of *Metroxylon sagu* for the fabrication of blowpipes is deliberate. If the wood is dense, the blowpipes will be challenging to use. The sap utilized in boat construction is derived from *Agathis damara*, but the sap employed for hunting is from *A. toxicaria* (Ipoh). Moreover, *V. pinnata* is utilized as firewood by the Ga'ai Dayak communities in several areas. This timber is typically stored beneath the home after being chopped to size. This wood is classified as energy wood (Sepsamli *et al.* 2025). Moreover, *E. zwageri* is the predominant wood species encountered in every Ga'ai Dayak villages. This timber serves as the primary material in residential building, particularly for house pole.



Figure 9. *A. elasticus* locally known as Kayu mut, the tree bark is one of the essentials materials for the traditional clothing of Dayak Ga'ai indigenous community, which they use for various ceremonies.



Figure 10. The people of Dayak Ga'a indigenous community frequently utilizes plants to create tools that support daily activities, such as fishing equipment (Bubu), house pole from *E. zwageri*, firewood from *V. pinnata*, blowpipe quivers, *Pestle* (*Lesung*) from *E. zwageri*, and small boat from *Shorea robusta*.

Ethnobotany indeces

The study revealed that *Calamus* sp. exhibited the highest RFC value of 0.61. That is indicating its significant and widespread utilization across the Dayak Ga'ai community. We collected data on 10 species with RFC highest values, including *G. macrophyllus* (0.56), *E. zwageri* (0.46), *V. pinnata* (0.41), *Shorea* sp. (0.37), *L. spinosa* (0.31), *C. longa* (0.30), *Spatholobus Littoralis* (0.28), *Tinospora cordifolia* (0.28), and *Eurycoma longifolia* (0.26) (Table 2). These high RFC values indicate that these species are widely used in daily life. This plant is extensively utilized and serves a crucial function in daily life. *Calamus* sp. serves as a fundamental resource for the production of bags and mats, utilized as rope, incorporated as a food component, and employed as a traditional medicinal substance. Additionally, other species such as *E. zwageri* (ironwood) despite their lower RFC values, also contribute substantially to the community's needs, particularly in construction, medicinal practices, and utilization. Despite being classified as vulnerable by the IUCN, the Dayak Ga'ai community still actively seeks *E. zwageri* in nearby forests due to its important role in their daily life and culture.

Table 2. The most popular species used in Dayak Ga'ai

Scientific Name	Family	IUCN	FC	RFC
<i>Calamus</i> sp.	Arecaceae	NA	43	0.61
<i>Goniothalamus macrophyllus</i>	Annonaceae	NA	39	0.56
<i>Eusideroxylon zwageri</i>	Lauraceae	Vu	32	0.46
<i>Vitex pinnata</i>	Lamiaceae	LC	29	0.41
<i>Shorea</i> sp	Dipterocarpaceae	NA	26	0,37
<i>Licuala spinosa</i>	Arecaceae	LC	22	0.31
<i>Curcuma longa</i>	Zingiberaceae	DD	21	0.30
<i>Spatholobus Littoralis</i>	Fabaceae	LC	20	0.28
<i>Tinospora cordifolia</i>	Menispermaceae	NA	20	0.28
<i>Eurycoma longifolia</i>	Simaroubaceae	LC	18	0.26

UV analysis provides an overview of the intensity and diversity of plant utilization (Ali et al., 2025). The UV values of plants in this study ranged from 0.05 to 2.78. *G. macrophyllus* (2.78) has an expansive range of uses, namely as a culture, craft materials, and medicinal plants. Rattan (2.46) is easily found in the forest and is one of the types of plants commonly used by the Dayak people in Kalimantan, not only by the Dayak Ga'ai. In addition *L. spinosa* (1.57) also showed high UV values (Table 3). Plants with high UV values are vital to the culture's sustainability and daily life. Meanwhile, plants with lower UV values, although less frequently used, still play an important role in certain aspects of the cultural and economic life of the community.

Table 3. Use value analysis of species in the Dayak Ga'ai Community

Local Name	Scientific Name	Family	IUCN	Used	UV
Lujung / Katmeang	<i>Goniothalamus macrophyllus</i>	Annonaceae	NA	Culture, Craft, Traditional medicine, Utilization	2.78
Samleh	<i>Calamus</i> sp.	Arecaceae	NA	Craft, Food, Traditional medicine, Utilization	2.46
Daun Yus	<i>Licuala spinosa</i>	Arecaceae	LC	Culture, Craft, Food, Traditional medicine, Utilization	1.57
Meranti	<i>Shorea</i> sp.	Dipterocarpaceae	NA	Culture, Craft, Utilization	1.48
Ulin	<i>Eusideroxylon zwageri</i>	Lauraceae	Vu	Craft, Traditional medicine and Utilization	1.37
Ukah Helat	<i>Vitex pinnata</i>	Lamiaceae	LC	Traditional and Utilization	0.83
Gui Ska	<i>Calamus caesius</i>	Arecaceae	NA	Craft, Traditional medicine Food, and Utilization	0.74
Awong Luk / Lo'ong	<i>Bambusa</i> sp.	Poaceae	LC	Craft, Food and Utilization	0.68
Kel Siau	<i>Curcuma longa</i>	Zingiberaceae	DD	Traditional medicine and Food	0.60
Mut / Kuwut	<i>Artocarpus elasticus</i>	Moraceae	LC	Culture, Craft, Traditional medicine, Utilization	0.57
Akar Mese'et	<i>Spatholobus Littoralis</i>	Fabaceae	LC	Traditional medicine and Food	0.57

On the table 4. summarizes the ten plant species, out of the total 169 documented, that exhibit the highest Index of Cultural Significance (ICS) values. The calculation of the Index of Cultural Significance (ICS) revealed that *G. macrophyllus*, locally known as Lujung (ICS = 46), held the highest cultural importance among the recorded species, followed by *L. spinosa* (40), *Calamus* sp. (36), *A. elasticus* (32), and *Calamus caesius* and *Calamus melanochaetes* (both 26). These species were used for multiple cultural and practical purposes, including medicine, food, cultural practices and traditional tools.

The high ICS value of *G. macrophyllus* indicates its multifunctional role and strong cultural attachment, particularly in conventional medicine and spiritual practices. This plant, belonging to the Annonaceae family, has long been utilized in traditional Southeast Asian medicine for treating fevers, infections, and a range of other health issues (Kurniawan *et al* 2023), highlighting its significant role in local healing practices. Similarly, *L. spinosa* plays a vital role in both cultural and craft contexts within rural livelihoods. These findings align with studies reporting that plant species with diverse utility values tend to hold high ethnobotanical importance within communities, reflecting both cultural symbolism and economic dependency (Pratami *et al.* 2024). The prominence of Arecaceae members represented by *L. spinosa*, *Calamus* sp., *C. caesius*, and *C. melanochaetes* further underscores the family's dominance in daily subsistence and ritual activities of the Dayak Ga'ai indigenous community, consistent with findings from other ethnobotanical studies in tropical regions (Dennehy & Cámara-Leret 2019; Macía *et al.* 2011), where palms are recognized as keystone resources and among the most culturally significant plant families.

Table 4. Index of Cultural Significance of species in the Dayak Ga'ai Community

Local Name	Scientific Name	Family	IUCN	Used	ICS
Lujung	<i>Goniothalamus macrophyllus</i>	Annonaceae	LC	Cultural, craft, medicine, tools	46
Daun Yus	<i>Licuala spinosa</i>	Arecaceae	LC	Cultural, medicine, craft, tools	40
Samleh	<i>Calamus</i> sp.	Arecaceae	NA/NE	Crafts, tools, medicine, food	36
Kayu Mut	<i>Artocarpus elasticus</i>	Moraceae	LC	Crafts, tools, cultural	32
Gui Ska	<i>Calamus caesius</i>	Arecaceae	NA/NE	Crafts, tools, medicine, food	26
Rotan Guyriyat /Gu Tap /Gui Eng	<i>Calamus melanochaetes</i>	Arecaceae	NA/NE	Crafts, tools medicine, food	26
Kunyit/Kel Siau	<i>Curcuma longa</i>	Zingiberaceae	DD	Medicine, food	18
Meranti	<i>Shorea</i> sp.	Dipterocarpaceae	NA/NE	Tools, cultural, medicine	17
Ulin	<i>Eusideroxylon zwageri</i>	Lauraceae	Vu	Medicine, tools, craft	15
Ukah Helat	<i>Vitex pinnata</i>	Lamiaceae	LC	Tools, Medicine	15

Challenges in Documenting and Preserving Ethnobotanical Knowledge

The study found that the Dayak Ga'ai exhibit extensive ethnobotanical knowledge, persistently employing an extensive variety of plant species. A large amount of their traditional knowledge concerning plant utilization, therapeutic practices, and environmental management has been transmitted orally. This is at significant risk of being lost due to insufficient documentation. In the absence of adequate documentation, a significant portion of this information may be lost to future generations, undermining the cultural identity and resource management practices that have supported the community for centuries (Pratami *et al.* 2024). This loss results from the effects of modernization, migration, and environmental degradation. This assertion is substantiated by interview findings, indicating that the majority of participants, particularly the youth, are increasingly losing their understanding of plant utilization.

The reduction in knowledge of medicinal plants is primarily attributed to the enhanced accessibility of healthcare services and the increasing number of alternative treatments. Modern pharmaceuticals are frequently favored for their convenience and efficacy. Comparable findings were reported by Arjona-García *et al.* (2021). The Ga'ai people have transitioned to acquiring more durable and reliable modern tools and equipment instead of depending on traditional materials. The increased challenge and distance associated with plant collection from forests contribute to the decline of botanical knowledge, necessitating considerable time, effort, and transportation expenses that frequently exceed the cost of acquiring plants from markets or stores. The decrease of forested regions utilized by the Ga'ai Dayak people for foraging is significantly influenced by the establishment of oil palm plantations and coal mines in surrounding regions. Several Ga'ai Dayak elders assert that the forest serves as a marketplace, providing them with food, shelter, and medicine at no charge. The lack of initiatives to cultivate flora near their settlements has led to the younger generation being progressively unfamiliar with the advantageous plants that were once common to their ancestors.

Considerable efforts are required to integrate indigenous knowledge with modern scientific studies. Although traditional ecological knowledge has developed over generations, it frequently contrasts with modern approaches in conservation and ethnobotany. A collaborative research approach that honors indigenous knowledge while using scientific methodologies is essential to bridge this divide. Collaboration with local people and governmental entities is essential for the documentation and preservation of ethnobotanical knowledge. Initiatives like the Bekudung Betiung festival in Tumbit Dayak village and the Hudoq/Hadoq ceremony held by the Dayak Ga'ai people, supported by the local government and coal companies through community development, have helped keep their culture alive. This tradition was started by a group of young people from the Dayak Gaai community. Nevertheless, many festivals require broader dissemination to achieve national or international prominence. Implementing effective techniques, such as generating innovative material on the official social media official channels of the Dayak Ga'ai community, is crucial for the promotion of this culture. Festivals can preserve cultural significance and draw a worldwide audience by disseminating narratives, rituals, and visuals, thereby reconciling local traditions with global participation (Wang, 2024).

Future Directions for Research and Preservation

The community of Dayak Ga'ai has a philosophy of sustainable utilization, taking only what is needed from the forest to avoid ecosystem harm. The Dayak Ga'ai's belief in the sacredness of nature reinforces their commitment to ethical resource use, treating the forest as a divine gift from the creator, fostering a strong sense of environmental management. Comparing traditional practices with modern conservation strategies, it becomes clear that both emphasize sustainable management, biodiversity conservation, and ecosystem health, with Dayak Ga'ai methods rooted in spiritual beliefs complementing contemporary ecological principles (Salim *et al.* 2023). This strong foundation of sustainable practices and spiritual values highlights the importance of preserving the Dayak Ga'ai's ethnobotanical knowledge for future generations. Therefore, further research and the integration of indigenous knowledge with modern conservation strategies are crucial for maintaining both the community's cultural heritage and the surrounding ecosystem.

To ensure the preservation of the Dayak Ga'ai community's ethnobotanical knowledge, several strategies can be implemented. First, documenting and digitally preserving this knowledge is crucial, as much of it is transmitted orally and is at risk of being lost over time. Currently, the young Dayak Gaai community has made records of events that have been shared on social media, like festivals and pictures of making crafts in Tumbit Dayak village and Long Lanuk village. Documentation methods that involve writing, like the ones used in Mandomai village, can safely pass on this information to future generations (Qamariah *et al.* 2020). Digital tools like mobile ethnographic apps will give people in the community the power to collect, organize, and share what they know so that it is correct and full (Chitakunye *et al.* 2024). Moreover, the integration of technologies such as artificial intelligence (AI)-based herbarium digitization and citizen science is also increasingly enabling rapid and accurate documentation of local species distribution and traditional uses (Echeverria *et al.* 2021). Adding ethnobotany to education through ethnobotanical walks and participatory workshops can also help intergenerational learning. This educational approach makes sure that traditional practices stay alive as elders pass their knowledge on to youth (Wardhani *et al.* 2023). For example, an ethnobotanical survey among the Dayak Kenyah highlights the role of Traditional Ecological Knowledge (TEK) in sustainable conservation while also noting a decline in youth engagement, thus advocating for culture-based education and modern integration (Ibrahim & Surya 2025).

Furthermore community-based conservation initiatives are essential for safeguarding both the ecosystem and the cultural traditions of the Dayak Ga'ai. Creating medicinal plant conservation zones or customary forests and offering training in sustainable harvesting techniques can safeguard both plant species and the related ethnobotanical knowledge (Ahirwar & Bhoi 2025). Integrating traditional ecological knowledge into comprehensive conservation plans will improve the sustainability of local ecosystems (Sari *et al.* 2022). Moreover, the incorporation of cultural and spiritual practices associated with cosmology and rituals establishes a framework for safeguarding ethnobotanical knowledge, as evidenced in the Dayak Benawan community (Niko, 2025). Research must persist in cataloging the complete spectrum of plant species utilized, emphasizing both prominent and obscure species, while investigating their contributions to sustainable land management and community well-being.

To ensure effective preservation, it is essential to integrate indigenous knowledge with modern conservation policies and educational initiatives. Collaborative frameworks that engage local people, governmental entities, and academics will reconcile traditional ecological knowledge with advanced scientific methodologies (Mulu *et al.* 2020). This aligns with international conservation initiatives, such as the Convention on Biological Diversity's post-2020 Global Biodiversity Framework, highlighting the significance of Indigenous and Local Knowledge (ILK). Community-based participatory research and inclusive data-sharing frameworks will guarantee equitable Access and Benefit-Sharing (ABS) while respecting cultural

intellectual property rights (Reyes-García *et al.* 2022). These innovations can significantly strengthen the Dayak Ga'ai community's efforts to maintain existing knowledge systems while aligning them with global conservation technologies.

Conclusion

The results of this study indicate that the Dayak Ga'ai people living in Berau Regency still utilize various types of plants in their daily lives, both for cultural purposes, food consumption, traditional medicine, crafts, and household utensils. The plants used are very diverse and have a significant role in the Dayak Ga'ai culture. These types of plants can be found in forests, gardens, and home yards. The result showed *Calamus* sp. is a multifunctional plant species utilized for several purposes. However, knowledge about the use of these plants is decreasing due to the impact of modernization, migration, and deforestation. As a conservation effort, the community has begun to cultivate these plants in their home gardens, although information on proper cultivation techniques is still limited. Furthermore, the reduced forest area makes it difficult for the community to obtain the plants they need. Therefore, it is important to maintain and preserve existing natural resources. This study provides comprehensive baseline information on the use of plants by the Dayak Ga'ai community, which is closely connected to their culture. Considering the wide diversity of plant species utilized and their ethnobotanical significance, it is strongly advised to integrate traditional knowledge with contemporary conservation strategies and educational programs within a framework of collaboration to preserve the cultural heritage of the Dayak Ga'ai community.

Declarations

List of abbreviations: UV - Use Value; RFC - Relative Frequency of Citation; ICS - Cultural Significance Index; BPS - *Badan Pusat Statistik*; IUCN - International Union for Conservation of Nature; AI - Artificial Intelligence; TEK - Traditional Ecological Knowledge; ILK - Indigenous and Local Knowledge; ABS - Access and Benefit-Sharing.

Ethics approval and consent to participate: This study followed the Ethical Clearance Approval guidelines for Social Studies and Humanities Research. This research was approved by the Ethics Committee on Social Studies and Humanities, National Research and Innovation Agency (NRIA), with the following number: No: 386/ KE.01/SK/04/2025, dated April 24, 2025. All the participants provided prior informed consent before the interviews. The participant shown in Figure 34 and 10 agreed to have her image published.

Consent for publication: All people shown in images agreed having their image published.

Availability of data and materials: Data is only stored by the authors under the knowledge of Indonesia Endowment Fund for Education Agency (Indonesian : *Lembaga Pengelola Dana Pendidikan* or LPDP) and NRIA (Indonesian: *Badan Riset dan Inovasi Nasional* or BRIN).

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