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Ethnomedicine and Knowledge Transmission among Dayak Communities in Central Kalimantan: An Ethnographic Inquiry

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ABSTRACT

Introduction: Traditional medicinal knowledge is central to cultural identity and community well-being among the Dayak communities of Central Kalimantan yet its continuity is increasingly threatened by modernization and declining youth engagement. This study aims to examine how ethnomedicinal knowledge is transmitted, practiced, and sustained through therapeutic traditions, eco-spiritual values, and intergenerational learning.

Methods: A qualitative ethnographic approach was conducted in four regions of Central Kalimantan involving twelve purposively and snowball-selected participants including traditional leaders, elders, and women healers. This design was chosen to capture culturally embedded meanings that cannot be accessed through quantitative techniques. Data were collected through participant observation in-depth interviews and documentation then transcribed verbatim and analyzed using thematic coding procedures.

Results: Three major findings emerged. First the transmission of medicinal plant knowledge is weakening as younger generations increasingly rely on biomedical services. Second ritual practices such as offerings prayers and ecological ethics remain central in legitimizing healing and guiding responsible plant harvesting. Third the perceived effectiveness of key plants including kalakai, pasak bumi, and bajakah is reinforced through lived experiences of vitality and longevity although sustainability is challenged by shifting health preferences and environmental change.

Conclusion: Dayak ethnomedicine reflects an integrated system combining therapeutic efficacy cultural identity and ecological stewardship. The findings highlight the importance of eco-spiritual practices and intergenerational dynamics in sustaining traditional healing. Strengthening documentation pharmacological validation and youth-focused digital revitalization initiatives is essential for ensuring the resilience of Dayak ethnomedicinal knowledge.

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INTRODUCTION

The use of traditional medicinal plants among indigenous communities remains a vital practice in maintaining health, particularly in regions with limited access to formal medical services. The Dayak people, for instance, have long utilized plants such as kalakai, pasak bumi, and bajakah for centuries to treat various illnesses and to support maternal health after childbirth. However, modernization and urbanization have increasingly led younger generations to abandon these practices in favor of modern medical services, which are perceived as faster and more practical (1)(2)(3). While global studies have widely documented the weakening of Indigenous medicinal knowledge under the pressures of modernization, the Dayak experience reflects a distinctive pattern shaped by Central Kalimantan's sociocultural transformations. Unlike many other Indigenous groups the Dayak are undergoing rapid shifts in religious orientation, formal education pathways, and urban-oriented economic aspirations which collectively reduce opportunities for young people to engage in forest based apprenticeship learning (4)(5). Furthermore land-use change and restricted access to customary forests alter the ecological settings in which medicinal knowledge is traditionally practiced. These Dayak-specific dynamics show that although international trends provide a useful comparative backdrop the mechanisms driving knowledge erosion in Central Kalimantan are shaped by a unique intersection of demographic cultural and environmental factors that remain insufficiently explored in the existing literature. This phenomenon signals the potential loss of traditional knowledge that is invaluable not only for cultural identity but also for biodiversity conservation. Similar conditions have been observed among other indigenous communities worldwide, where globalization has weakened intergenerational knowledge transmission (6)(7)(8). Therefore, research on Dayak traditional medicinal practices holds significant social relevance.

The theoretical framing of this study is anchored in Traditional Ecological Knowledge which conceptualizes indigenous medicinal practices as cumulative adaptive systems generated through long-term interactions between communities and their environments. Within the Dayak context, TEK provides a useful lens to understand how ritualized plant harvesting, ecological ethics, and spiritual reciprocity function not only as cultural expressions but also as mechanisms of environmental regulation. Moreover intergenerational transmission theory highlights that the continuity of such knowledge depends on structured pathways of learning embodied apprenticeship and socialization processes within families and customary institutions. Comparative studies from other Bornean groups including the Benuaq and Ga'ai as well as Indonesian communities such as the Baduy and Ammatoa Kajang show that the stability or erosion of ethnomedicinal systems is strongly shaped by these transmission pathways (9)(10). Integrating these theoretical perspectives allows this study to situate Dayak ethnomedicine within broader patterns of biocultural resilience while also identifying distinctive features that arise from Central Kalimantan's sociocultural transformations.

Previous studies have highlighted the importance of ethnobotany for both public health and conservation. Kola (2022) demonstrated that the Ammatoa Kajang community continues to maintain herbal practices through collective rituals (11), while Rinto et al. (2023) reported declining levels of ethnobotanical literacy among younger generations due to limited integration of indigenous knowledge into formal education (12). Similar findings have been documented globally. For example, Bussalleu et al. (2021), Aikman (2025), and Arjona-García et al. (2021) showed that modernization in Amazonian indigenous communities has weakened intergenerational knowledge transfer, leading to cultural erosion and declining conservation practices (13)(14)(1). These findings underscore that the sustainability of ethnobotanical knowledge depends not only on health-related practices but also on sociocultural mechanisms that enable intergenerational learning.

Equally important, traditional medicinal practices are deeply interwoven with rituals and ecological ethics. Among the Dayak, the harvesting of plants is often accompanied by offerings and prayers, reflecting a worldview that regards plants as living beings deserving respect. This resonates with research on the Suku Anak Dalam in Sumatra (15)(16) and with Canadian indigenous communities(17), which illustrates that rituals function both as spiritual legitimization and ecological regulation. Although modernization pressures have altered some ritual expressions (18)(19), the underlying value of respect for nature persists, confirming that rituals serve as socio-ecological systems vital for sustainability.

The perceived effectiveness of traditional medicinal plants further strengthens their cultural significance. Studies by Kopustinskiene et al. (2022) and Ullah et al. (2024) found high consensus values regarding herbal remedies for managing chronic illnesses (20)(21), while Chiș et al. (2023), Rai et al. (2025), and Ralte et al. (2022) revealed

pharmacological validation of bioactive compounds previously known only through traditional use (22)(23)(24). Yet, the sustainability of these practices faces challenges from environmental degradation (25)(26)(3) and the growing reliance on modern healthcare. These findings affirm that ethnomedicine is not only a matter of medical efficacy but also deeply intertwined with ecological and social sustainability.

The research also aligns with the global sustainable development agenda. The Dayak use of medicinal plants supports SDG 3 (Good Health and Well-being) by providing affordable and sustainable healthcare alternatives (27)(28). Rituals and ecological ethics correspond to SDG 12 (Responsible Consumption and Production) and SDG 15 (Life on Land), while the integration of digital innovation for knowledge revitalization links with SDG 17 (Partnerships for the Goals) (29)(30)(17). Thus, Dayak ethnomedicine exemplifies how local knowledge can contribute to broader global agendas on health, sustainability, and conservation.

Based on this background, the study addresses three guiding questions: (1) how knowledge of medicinal plants is transmitted among the Dayak and the challenges faced by younger generations, (2) how rituals, prayers, and ecological ethics function as both cultural and environmental conservation practices, and (3) to what extent the effectiveness and sustainability of medicinal plant use are reinforced through community-based experiences in the context of modernization. To answer these questions, the study advances three working hypotheses: first, that intergenerational transmission of ethnobotanical knowledge is weakening despite being upheld by elders; second, that rituals and ecological ethics serve dual roles of spiritual legitimacy and conservation mechanisms; and third, that perceived plant effectiveness remains strong, though sustainability is threatened by modernization and shifting health preferences.

METHOD

Research Type

This study employed a qualitative approach with an ethnographic design, as its primary aim was to understand the meanings, values, and practices associated with the use of medicinal plants in the daily lives of the Dayak community. Ethnography enables researchers to engage directly with community life and observe cultural practices in their natural context (31)(32)(33). As part of the reflexive orientation of this research, the primary researcher is not a member of the Dayak communities studied, but has longstanding academic engagement with Indigenous knowledge systems in Kalimantan. Access to the field was facilitated through customary leaders including mantir and damang, who served as cultural gatekeepers and verified the researcher's presence in ritual and domestic settings. Field immersion took place across multiple extended visits during a nine-month period, allowing the researcher to observe daily interactions, ritual practices, and plant-gathering activities. Throughout the study the researcher maintained an interpretive stance that balanced cultural sensitivity with analytical distance relying on continuous dialogue with community elders and member checking to validate emerging interpretations. This reflexive disclosure clarifies the researcher's positionality position in the field and enhances transparency regarding how authority trust and meaning were co-constructed during the ethnographic process.

This design was chosen to capture the deeper meanings underlying ritual practices, narratives of knowledge transmission, and empirical experiences of medicinal plant use—dimensions that cannot be adequately understood through quantitative data alone. Furthermore, ethnography is considered particularly relevant for ethnomedicine research because it allows for an in-depth exploration of the interactions among social, ecological, and spiritual dimensions. According to Gobbo (2025), Schulz and Binder (2023), and Ploder and Hamann (2021), ethnography is the most suitable approach for examining cultural phenomena embedded in everyday life (34)(35)(36). For this reason, ethnography was adopted as the principal conceptual framework to explore the dynamics of Dayak ethnomedicine.

Research Location

The research subjects included Dayak traditional leaders (damang and mantir), community elders, and individuals actively engaged in the use and transmission of medicinal plant knowledge. Informants were selected using purposive sampling, targeting those most knowledgeable about the research topic, and subsequently expanded through snowball sampling based on participant recommendations. A total of 12 primary informants, aged between 45 and 85, were interviewed across four sites in Central Kalimantan Province, Indonesia: Palangkaraya City, Kapuas

Regency, Seruyan Regency, and Pulang Pisau Regency. This geographic variation provided diverse perspectives, ranging from urban ethnomedicine practices to rural communities near forest areas. The informants included elders with extensive experience, traditional leaders versed in ritual practices, and women who regularly prepared herbal remedies for their families. This number of participants was deemed sufficient for ethnographic research, where the focus is on depth of data rather than statistical generalization. Interviews were concluded after the twelfth informant, when data saturation was reached—meaning information began to repeat and no new insights were emerging. This principle of saturation is consistent with qualitative research standards (37)(38)(39), affirming the descriptive validity of the study despite the limited sample size.

Table 1. Research Participants

Participant Code	Age	Gender	Role in Community	Location (Central Kalimantan)	Experience in Using Medicinal Plants
P1	72	Male	Mantir (traditional leader)	Kapuas	Ritual expert in plant harvesting; >40 years of experience
P2	65	Male	Damang (community chief)	Seruyan	Knowledge of customary rules and prayers for plant harvesting
P3	58	Female	Community elder	Pulang Pisau	Prepares herbal remedies for families, especially postpartum care
P4	80	Male	Elder	Palangkaraya	Active user of pasak bumi and bajakah for health
P5	45	Female	Housewife	Seruyan	Uses kalakai and cocor bebek for skin health
P6	70	Male	Community elder	Kapuas	Preserves ritual knowledge, still practices healing
P7	85	Male	Senior Mantir	Palangkaraya	Local healer, extensive knowledge of sangeh
P8	50	Female	Traditional practitioner	Pulang Pisau	Prepares bajakah decoctions for heart treatment
P9	60	Male	Young Damang	Seruyan	Combines modern and traditional healing practices
P10	68	Female	Senior elder	Kapuas	Herbal remedies for maternal health; >30 years' experience
P11	55	Female	Local herbal producer	Palangkaraya	Sells and educates about medicinal plants
P12	78	Male	Elder	Pulang Pisau	Regular user of pasak bumi; associated with vitality

Instrumentation or Tools and Data Collection Procedures

The research proceeded through three phases: pre-fieldwork, field data collection, and post-fieldwork. During the pre-fieldwork stage, the researcher conducted a literature review on Dayak ethnomedicine and global ethnobotany, designed semi-structured interview instruments, and obtained permission from local traditional leaders. In the fieldwork stage, data were gathered through participant observation of community activities, in-depth interviews with

informants, and documentation of narratives surrounding plant-harvesting rituals. Visual documentation was also collected to supplement field notes. In the post-fieldwork stage, the data were transcribed verbatim, categorized into preliminary themes, and validated through member checking, whereby informants confirmed the accuracy of transcriptions against their lived experiences. This process is consistent with ethnographic models described by Bieler et al. (2021), Günel & Watanabe (2024), and Folkes (2023), which emphasize researcher immersion and reflexivity (40)(41)(42).

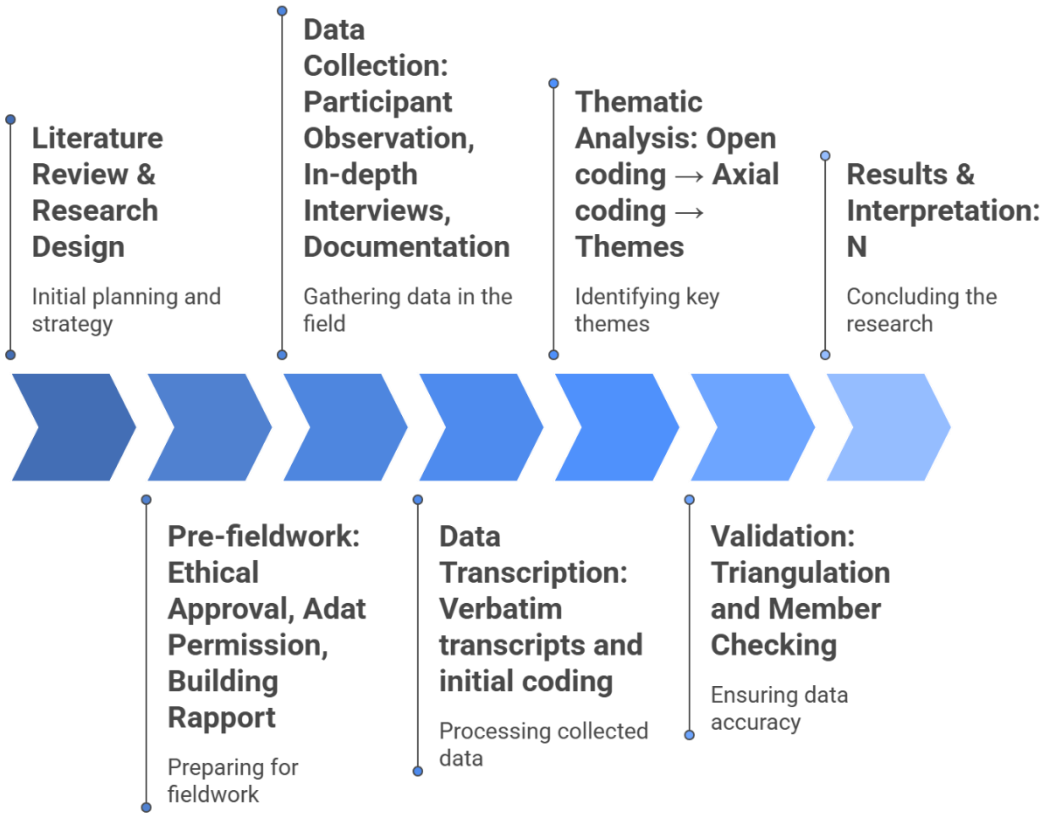

Figure 1. Research Flow Illustrating the Sequence of Pre-fieldwork Fieldwork and Post-fieldwork Stages in the Ethnographic Process

Data Analysis

Data were analyzed using thematic analysis to identify patterns of meaning in the informants' narratives. The thematic analysis followed a multi-stage coding process to ensure analytic depth and transparency. During the open coding phase transcripts and field notes were examined line by line to identify initial meaning units related to medicinal plant knowledge rituals and learning pathways. These codes were then grouped through axial coding to establish relationships among categories such as ecological ethics, ritual legitimacy, intergenerational learning, and perceived efficacy. In the selective coding phase overarching themes were refined by comparing categories across participants and field contexts to ensure conceptual coherence. To enhance reliability the analysis incorporated analyst triangulation with a second coder reviewing early code sets maintenance of an audit trail documenting coding decisions and ongoing member checking with community elders and key informants to validate interpretive accuracy. These steps strengthen the methodological rigor of the study and support the replicability of the analytic process (10).

The analysis began with open coding, marking keywords and phrases from interview transcripts. This was followed by axial coding to group codes into broader thematic categories, such as knowledge transmission, ritual-ecological practices, and medicinal plant effectiveness. From these categories, core themes were developed in

alignment with the study's objectives. The data were presented as descriptive narratives enriched with direct quotations from informants to strengthen empirical validity. Source triangulation was applied to compare the consistency of information across informants and with field observations. As noted by Cernasev & Axon (2023), Kiger & Varpio (2020), and O'Callaghan et al. (2024), thematic analysis is highly effective in qualitative research as it balances interpretive flexibility with structural clarity (43)(44)(45).

Interpretation of findings involved comparing field data with national and international literature, guided by three analytical dimensions: social (intergenerational knowledge transmission), ecological (conservation values in rituals), and spiritual (beliefs in the efficacy of medicinal plants). The results were presented thematically, linking empirical data to theoretical frameworks in ethnobotany. This approach allowed the study not only to present descriptive findings but also to contribute to global discussions on ethnomedicine. According to Gülpınar (2024), Birnbaum (2022), and Cena et al. (2024), interpretive approaches in qualitative research are essential for generating critical, reflective, and contextual analyses (46)(47)(48). While ethnobotanical studies often use quantitative indices such as Use Value (UV) or Informant Consensus Factor (ICF), this study deliberately emphasized an ethnographic qualitative approach. The focus was not on quantifying plant use frequency but on understanding the cultural meanings, spiritual values, and knowledge transmission dynamics underlying Dayak ethnomedicine. In doing so, the study captured the social-ecological depth often overlooked by quantitative approaches.

Ethical Approval

Ethical clearance for this research was granted by the Institute for Research and Community Service (LPPM) of Universitas Muhammadiyah Palangkaraya under letter number 464/PTM63.R7/LP2M/1/T/2025. This approval ensured that all research stages adhered to ethical standards, including respect for informants' dignity, confidentiality of personal data, and verbal informed consent prior to interviews. Furthermore, the researcher observed Dayak customary values by seeking permission from traditional leaders before conducting documentation or ritual observations. Such adherence ensured that the research was not only academically valid but also ethically sound from a local cultural perspective. Strict research ethics are especially critical in indigenous contexts to ensure that studies are not only beneficial to academia but also respectful of community rights (49)(50)(51).

RESULTS

Transmission of Medicinal Plant Knowledge and Challenges among Younger Generations

Interviews revealed that the practice of using medicinal plants within the Dayak community is a long-standing tradition that has been transmitted orally through families and embedded in daily activities. Elders described how plants such as kalakai are used to increase women's blood levels before and after childbirth and how pasak bumi is applied for conditions such as gout and loss of vitality. Informants explained that this knowledge is conveyed through direct involvement in gathering, preparing, and using the plants rather than through formal instruction or written documentation. Several participants expressed concern that younger generations rarely participate in these practices due to schooling schedules, urban migration, and increasing reliance on formal healthcare.

These accounts highlight that medicinal plant knowledge among the Dayak has historically depended on embodied apprenticeship, in which children learned through repeated observation and participation in forest-based tasks. The reduced engagement of younger generations suggests a structural shift from experiential learning toward more fragmented forms of cultural transmission. This transition appears closely linked to broader socioeconomic changes including increased mobility, schooling demands, and declining access to customary forests. These factors together weaken the intergenerational mechanisms that once ensured the continuity of ethnomedicinal practices.

As one informant stated: '*The Dayak people have used medicinal plants since long ago, relying on nature for healing. This practice has been passed down for generations. However young people today rarely use our traditional medicines anymore.'* Several elders echoed similar concerns noting that youth tend to prioritize modern healthcare services over customary practices. Participants described this decline as a threat to the continuity of medicinal plant knowledge which they regard as essential for cultural identity and community well-being.

The concerns expressed by elders suggest that the perceived decline in youth engagement is not only a matter of personal preference but reflects changes in cultural valuation and shifting health-seeking behaviors. The emphasis on modern medicine indicates a transformation in local health epistemologies while the erosion of ritual participation

points to weakening social mechanisms that historically reinforced medicinal plant knowledge. These patterns illustrate how globalization intersects with cultural identity shaping the conditions under which traditional knowledge persists or diminishes.

Rituals, Beliefs, and Ethics in Medicinal Plant Harvesting

The second finding highlights that the harvesting of medicinal plants among the Dayak is not merely a practical activity but one grounded in ecological ethics and spiritual beliefs. Informants described that each harvested plant must be reciprocated with offerings of rice, salt, and metals such as coins or needles. The ritual is accompanied by prayers invoking Nabi Adam Abu Basar and Nabi Ilyas as symbolic permission requests to the guardians of the land and trees. This customary procedure demonstrates a reciprocal relationship with nature, in which humans not only take but also give something back as an expression of respect. Such practices reinforce social legitimacy of medicinal efficacy while also reminding the community of the intrinsic value of nature.

Pic 1. A Dayak elder performing ritual steps before harvesting medicinal plants in Central Kalimantan, Indonesia

This is illustrated by a mantir (traditional leader) who stated: "*Whatever we take must be replaced, because plants are also living beings. We must ask permission from the guardian of the land. According to our ancestors, the land has a guardian, whose name is Nabi Adam Abu Basar."* Another elder emphasized the sacred technical rules: *"First, we must be mindful of our position; the plant we are about to take should not be in our shadow. Then we tap the ground three times and whisper Nabi Adam Abu Basar, asking permission to harvest the plant for healing."* These norms illustrate the integration of health, spirituality, and environmental ethics unique to the Dayak worldview.

Based on informant interviews, several types of plants were identified as commonly used for traditional healing. Table 2 summarizes the plants, their health functions, and the harvesting methods according to Dayak customary practices.

Table 2. Dayak Medicinal Plants, Their Functions, and Harvesting Practices

No.	Plant / Medicinal Material	Health Function	Harvesting Method (Dayak tradition)
1	Kalakai (fern vegetable)*	Increases blood levels, especially for women before and after childbirth	Leaves harvested respectfully after seeking permission from land guardians by tapping the ground three times and invoking Nabi Adam Abu Basar and Nabi Ilyas; offerings of rice, salt, and metals are provided
2	Pasak Bumi (Eurycoma longifolia)**	Treats gout, enhances stamina, maintains vitality	Roots taken from smaller plants for easier extraction; harvested while crouching at waist level and turning backwards; soil replaced with offerings of rice, salt, and metal/nails/coins

No.	Plant / Medicinal Material	Health Function	Harvesting Method (Dayak tradition)
3	Bajakah (red/white varieties)***	Cancer treatment, general health maintenance, boosts energy	Harvested in forests with ritual prayers; before extraction, the ground and wood are tapped while invoking Nabi Adam Abu Basar and Nabi Ilyas; offerings placed after roots or small stems are taken
4	Obat Tawar Ud (wood type)	Postpartum recovery, restoring energy for heavy labor	Wood harvested with ritual prayers and offerings of rice, salt, and metal; spiritual permission is believed necessary for efficacy
5	Cocor Bebek (Kalanchoe pinnata)	Skincare, reduces wrinkles, maintains youthfulness	Leaves harvested respectfully, often combined with rice and soaked overnight; always preceded by prayer and small offerings
6	Chinese Spinach	Household herbal remedy for general health	Uprooted with offerings of rice, salt, and coins, accompanied by prayers acknowledging the plant as a living being
7	Sangeh (leaves, stems, and roots)	Heart remedy; roots, stems, and leaves boiled and consumed	Harvested only on Fridays after prayer (around 1:00 PM); preceded by ritual prayers and offerings of rice, salt, and nails

Footnotes:
* Kalakai refers to a wild fern widely used for women's reproductive health and postpartum recovery.
** Pasak bumi is a well-known Bornean medicinal root believed to enhance stamina and treat gout.
*** Bajakah is a collective term for several medicinal vines associated with vitality-strengthening and restorative healing.

Table 2 demonstrates that Dayak traditional healing emphasizes not only the functional properties of plants but also the ritual and ecological ethics that reinforce community trust in their efficacy.

Effectiveness and Sustainability of Medicinal Plant Use

The third finding demonstrates that the Dayak community firmly believes in the effectiveness of medicinal plants for maintaining health, even in addressing serious illnesses. Informants attributed physical vitality and longevity among their relatives to the regular use of plants such as bajakah, cocor bebek, and sangeh. For instance, cocor bebek is used to maintain youthful skin, while sangeh is believed to support heart health. The perceived efficacy of these plants is reinforced by empirical experiences, with many elderly individuals reported to remain healthy, active, and rarely experiencing age-related decline—even beyond the age of 100. This underscores the tangible contribution of medicinal plants to community well-being.

One informant stated: *"My grandmother lived to 101 years old… her memory, hearing, and eyesight remained healthy, and she still used medicinal plants."* Another added: *"I am 72 years old but I have no wrinkles. Every day I use cocor bebek leaves mixed with rice and soaked for a day and a night. After one year, my wrinkles diminished, and people told me I look younger."* These accounts highlight that Dayak traditional medicine is regarded not only as cultural heritage but also as practical knowledge with proven health benefits. Nevertheless, the sustainability of these practices faces threats from modernization and declining generational uptake, pointing to the need for integration with contemporary healthcare approaches.

Pic 2. The harvested medicinal plant (Sangeh, Dayak ethnomedicine) widely used for traditional healing, particularly for heart-related health, in Central Kalimantan, Indonesia

To synthesize the qualitative findings, a thematic map was developed to illustrate the relationships between themes, subthemes, and representative quotes from informants. This visual representation complements the descriptive narrative and clarifies the analytical process underlying theme identification.

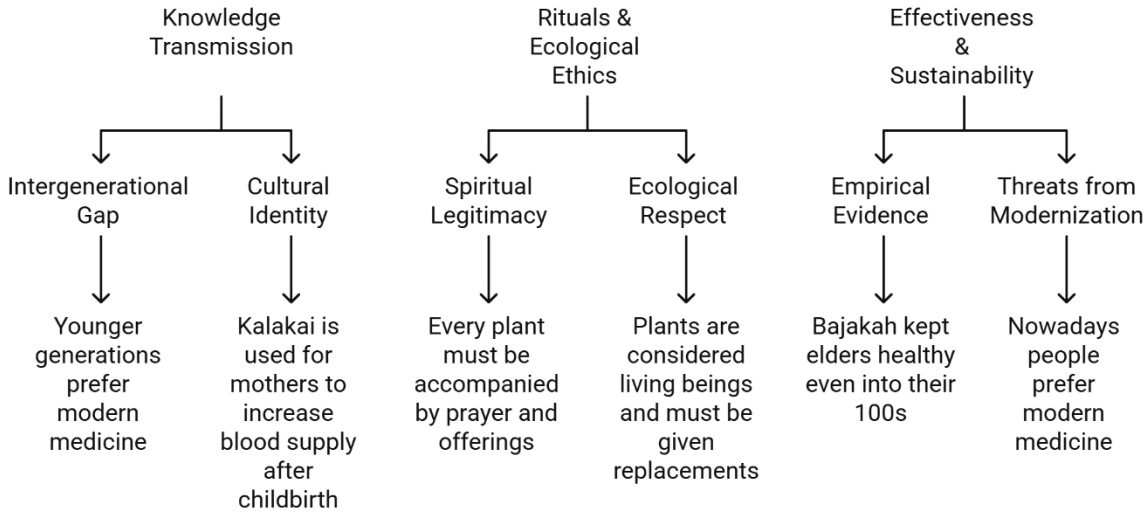

Figure 2. Thematic Map Depicting Relationships among Knowledge Transmission Ritual-Ecological Ethics and Perceived Effectiveness of Medicinal Plants

Table 3 summarizes the core themes, subthemes, and representative interview quotes that emerged from the thematic analysis. These themes capture the intergenerational transmission of medicinal plant knowledge, the ritual-ecological values embedded in harvesting practices, and the perceived effectiveness and sustainability of traditional remedies within the Dayak community.

Table 3. Main Themes Subthemes and Representative Quotations from Dayak Ethnomedicine Field Data

Main Theme	Subtheme	Interview Quotes
1. Transmission of Medicinal Plant Knowledge and Challenges among Youth	Intergenerational tradition	*"The Dayak people have used medicinal plants since long ago, relying on nature for healing. This practice has been passed down for generations."*
	Declining youth interest	*"Young people today rarely use our traditional medicines anymore."*
	Cultural identity	*"Kalakai leaves are often used for women before and after childbirth, believed to enrich the blood."**
2. Rituals, Beliefs, and Ethics in Plant Harvesting	Offerings and prayers	*"Whatever we take must be replaced, because plants are also living beings… the guardian of the land is Nabi Adam Abu Basar."***
	Customary technical norms	*"Pasak bumi should be harvested while crouching at waist height and turning backwards; smaller roots are easier to extract."****
	Eco-spiritual concepts	*"The plant must not be in our shadow. Tap the ground three times and whisper Nabi Adam Abu Basar."*
3. Effectiveness and Sustainability of Medicinal Plant Practices	Empirical health evidence	*"My grandmother lived to 101 years old… her memory, hearing, and eyesight remained healthy, and she still used medicinal plants."*
	Efficacy of traditional remedies	*"I am 72 years old but have no wrinkles. Every day I use cocor bebek leaves… after one year, my wrinkles diminished."*
	Sustainability threatened by modernization	*"Rice, salt, and nails were once offerings, but now people rarely perform these rituals and prefer modern medicine."*

Footnotes:
* Kalakai: a wild fern commonly used in Dayak ethnomedicine for postpartum recovery.
** Nabi Adam Abu Basar: an ancestral figure invoked in Dayak ritual permissions during plant harvesting.
*** Pasak bumi (Eurycoma longifolia): a well-known medicinal root used for stamina and treating gout in Bornean cultures.

As illustrated in Table 3, the voices of informants provide empirical depth to the analysis, demonstrating how Dayak ethnomedicine operates simultaneously as a therapeutic system, a cultural identity marker, and an eco-spiritual practice. These insights underscore the intertwined challenges of knowledge transmission, ritual continuity, and sustainability in the face of modernization.

DISCUSSION

Transmission of Medicinal Plant Knowledge and Youth Challenges

This study finds that the transmission of medicinal plant knowledge among the Dayak community remains primarily oral and family-based, yet its continuity is weakening. Informants emphasized that the use of kalakai for postpartum care and pasak bumi for gout has been handed down since ancestral times, but is increasingly infrequent among younger generations. This pattern aligns with Rinto et al. (2023), who reported declining ethnobotanical literacy among university students due to limited integration in formal education (12). These observations indicate that knowledge erosion stems not only from the external pressures of modernization, but also from the fragility of cultural transmission systems to the next generation (52)(53)(54). Accordingly, the findings underscore a tangible threat to the continuity of local wisdom that has long served as a pillar of cultural identity and community health.

Comparison with Previous Studies

Compared with the Ammatoa Kajang community, the Dayak case displays a different transmission pattern(11). While the Ammatoa Kajang model demonstrates a stable form of eco-spiritual knowledge sustained through tightly regulated communal rituals the Dayak case reveals a more fluid and personalized eco-spiritual system shaped by shifting religious orientations, ecological access, and demographic mobility. This variation extends existing models of Indigenous eco-spirituality which often emphasize collective ritual as the primary vehicle of environmental ethics. The Dayak example confirms aspects of these models such as the role of reciprocity and moral obligations toward forest beings yet it also disrupts them by showing that spiritual legitimacy can operate through individualized rituals conducted by household elders rather than through large scale communal rites. Furthermore the Dayak case expands theoretical understandings of eco-spiritual knowledge systems by demonstrating how hybridized beliefs drawing simultaneously from ancestral cosmology and newer religious interpretations coexist within medicinal plant

practices. This layered spiritual framework suggests that eco-spiritual knowledge is not static but adaptive evolving in response to socio environmental transformations unique to Central Kalimantan.

Empirically, youth in the Ammatoa Kajang community remain engaged in communal rituals as learning spaces, whereas among the Dayak there is almost no active regeneration. This suggests that the decline in Dayak youths' interest is exacerbated by the absence of structured formal or non formal mechanisms to revitalize traditional knowledge. The present study adds value by proposing the integration of digital media and virtual reality as educational tools, an approach rarely explored in ethnobotanical literature. Through these technologies, medicinal plant knowledge can be retransmitted in formats aligned with younger generations' learning preferences. Thus, this study not only identifies the problem but also advances a technology enabled strategy for revitalization.

Rituals, Beliefs, and Ecological Ethics

The second finding highlights the significance of ritual in medicinal plant harvesting as an expression of ecological ethics and religio-spirituality in Dayak society. Informants described how each harvest is accompanied by offerings of rice, salt, and metal, and by invoking the names Nabi Adam Abu Basar and Nabi Ilyas. Such practices reflect the belief that plants are living beings worthy of respect and that humans bear a moral obligation to maintain balance with nature. This is consistent with research on the Suku Anak Dalam (15)(16)(17), which demonstrates that traditional ecological knowledge (TEK) functions as an instrument of environmental sustainability through reciprocity with nature. This study further enriches the literature by detailing unique technical norms—such as the prohibition against allowing one's shadow to fall upon the plant during extraction—details that are seldom described in depth elsewhere. The Dayak case therefore illustrates the integration of technical practice, spiritual belief, and ecological ethics within a single cohesive system.

Comparison with Previous Studies

Whereas Alum (2025), Haq et al. (2024), and Petelka et al. (2022) found that collective social norms are the principal factor in forest and medicinal plant stewardship, this study shows that Dayak practice emphasizes a more personal spiritual dimension—direct communication with religious entities at the moment of harvest (55)(56)(57). This contrast reveals inter-community variation in approaches to ecological balance across indigenous groups in Indonesia. The present findings add a new nuance: ritual operates not only as social legitimation but also as a personal mechanism that reinforces belief in medicinal efficacy. More broadly, the results suggest that eco-spirituality can be an effective pathway for building conservation systems grounded in local values, thereby extending global discourse on religio-ecological roles in natural resource governance.

Effectiveness and Sustainability of Medicinal Plant Practices

The study reveals that the Dayak community's belief in medicinal plant effectiveness is rooted in intergenerational empirical experience. Informants linked relatives' longevity to routine consumption of bajakah, cocor bebek, and sangeh, emphasizing benefits for heart health and skin rejuvenation. These findings support Kopustinskiene et al. (2022) and Ullah et al. (2024), who reported high informant consensus factors among communities using traditional plants for elder health (20)(21). The contribution of this study lies in its narrative descriptions of users' life histories—elements rarely explored in quantitative research. Accounts of individuals living beyond 100 years in good health provide additional credibility to perceived plant efficacy. Thus, the study complements statistical evidence while affirming the qualitative value of community life experiences.

At the same time, the study acknowledges that this evidence reflects perceived efficacy rather than pharmacological validation. Global ethnobotanical research commonly begins with community narratives before moving to laboratory testing to identify bioactive compounds (58)(59)(60). Accordingly, Dayak ethnomedicine should be viewed as a valuable point of departure that invites collaboration with biomedicine to strengthen scientific validation.

Comparison with Previous Studies

Unlike other ethnobotanical studies that rely on quantitative indices such as Use Value (UV) or Informant Consensus Factor (ICF), this research foregrounds a qualitative ethnographic approach. The emphasis is not on

frequency counts but on cultural meanings, empirical narratives, and lived experiences through which the Dayak interpret medicinal efficacy. This methodological choice reveals dimensions often overlooked by quantitative designs—namely, the integration of spiritual values, ritual practice, and ecology within a unified therapeutic system (61)(62)(17). In doing so, the study contributes a complementary perspective that enriches global ethnomedicine discourse by foregrounding narrative and contextual depth.

Nevertheless, the sustainability of these practices faces serious threats from social and environmental change. De Meyer et al. (2025), Shaheen et al. (2023), and Dulal et al. (2022) identified environmental degradation as a key driver of declining traditional medicine practices (25)(3)(26). In contrast, this study finds that the shift toward modern medical services is the primary threat among the Dayak. This divergence underscores the contextual nature of sustainability challenges, contingent on each community's socio-ecological conditions. Preservation strategies must therefore be multidimensional—combining ecological conservation to secure plant availability with social and technological innovations to maintain the relevance of traditional practices. Such an approach can safeguard Dayak knowledge without diminishing its cultural meaning or health benefits.

The decline in ethnomedicinal knowledge among the Dayak is further contextualized by demographic and sociocultural changes occurring in Central Kalimantan. Census data indicate that younger Dayak generations increasingly migrate to urban centers for schooling and wage labor, resulting in reduced exposure to forest-based practices and diminished opportunities for apprenticeship with elders (63)(64). Prior ethnographies of Bornean groups such as the Dayak Ngaju, Kenyah and Pesaguan similarly document that mobility and changing livelihood strategies disrupt the embodied learning processes through which ritual and medicinal knowledge has traditionally been transmitted. In the Dayak context, additional sociocultural factors, including the expansion of formal schooling the adoption of biomedical health norms and shifts in religious orientation contribute to the fragmentation of customary learning pathways (65)(66)(67). By situating the observed decline within these demographic and ethnographic patterns this study contributes a more nuanced understanding of how biocultural knowledge erodes under conditions of rapid social transformation. The novelty of this research lies in demonstrating that the weakening of transmission is not merely generational but structurally rooted in broader socio ecological transitions unique to Central Kalimantan thereby advancing current debates on the vulnerability and resilience of Indigenous knowledge systems.

To further clarify the contribution of this study, Figure 5 illustrates a conceptual framework that links the empirical findings to the core discussion and their broader implications. This framework highlights the interrelation between knowledge transmission, rituals, and ecological ethics, and perceived effectiveness, and how these elements collectively contribute to global discourses on ethnomedicine and the Sustainable Development Goals (SDGs).

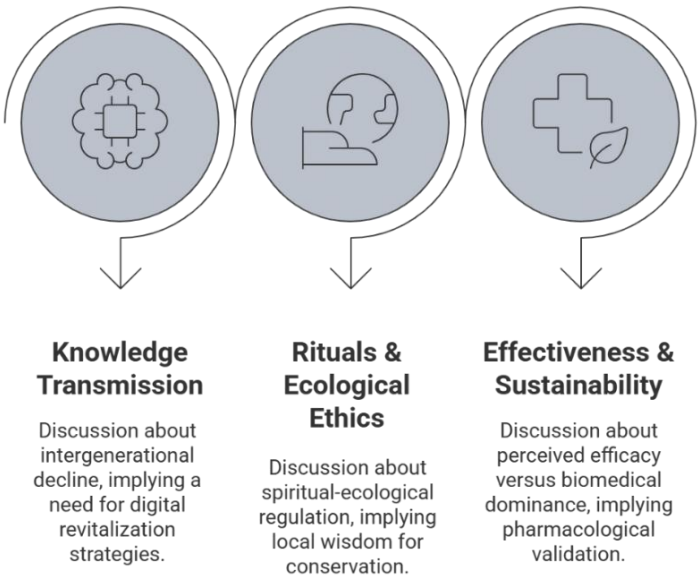

Figure 3. Conceptual Framework Linking Dayak Ethnomedicine with Intergenerational Transmission, Eco-spirituality, and Biocultural Sustainability

The conceptual framework demonstrates that Dayak ethnomedicine is not limited to therapeutic practices but also represents a cultural–ecological heritage of global value. This study contributes novelty by integrating three major dimensions rarely analyzed together: knowledge transmission, eco-spiritual practice, and perceived community-based efficacy within a single ethnographic framework. Unlike previous studies that generally focus either on the pharmacological potential of medicinal plants or the symbolic meaning of rituals, this research highlights the interconnectedness of social, spiritual, and ecological aspects in Dayak ethnomedicine. Thus, ethnomedicine is presented not only as a therapeutic practice but also as a cultural and ecological legacy relevant to global discourse. Moreover, by situating the findings within the framework of the SDGs, the study expands the contribution of ethnobotany from local practices to global agendas on health, sustainability, and conservation (61)(68)(17). The central novelty of this study lies in positioning Dayak ethnomedicine within a transdisciplinary framework that connects tradition, modernity, and sustainable development.

Contribution to the SDGs

This study aligns with several Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-being), SDG 12 (Responsible Consumption and Production), SDG 15 (Life on Land), and SDG 17 (Partnerships for the Goals). The preservation of Dayak ethnobotanical knowledge contributes to SDG 3 by providing a community-based, affordable, and sustainable healthcare alternative (27)(28). Ritual practices and respect for plants reflect SDG 12 and 15 by promoting sustainable consumption and ecosystem conservation (29)(69)(70)(71). Furthermore, the recommendation to integrate modern technologies for educational purposes indicates the potential for cross-sectoral partnerships (SDG 17) to strengthen local values (30)(17). Thus, the study demonstrates that traditional knowledge can directly contribute to global sustainable development agendas.

Limitations and Cautions

This study has several limitations that must be acknowledged. First, although data were collected from 12 informants across four Dayak regions in Central Kalimantan, Indonesia (Palangkaraya City, Kapuas Regency, Seruyan Regency, and Pulang Pisau Regency), the limited number of participants prevents generalization to the entire Dayak population or other indigenous communities in Indonesia. Second, the study employed a descriptive qualitative approach and did not incorporate quantitative ethnobotanical indices such as Use Value (UV) or Relative Frequency of Citation (RFC), which are commonly applied in ethnobotanical research. Third, the study did not conduct pharmacological testing to scientifically validate the efficacy of the medicinal plants. Consequently, the findings should be considered an initial contribution that opens avenues for further research. Future studies are recommended to combine qualitative and quantitative methods and adopt multidisciplinary approaches to produce more comprehensive and applicable results.

Recommendations for Future Research

At the global level, these findings offer a model of eco-spiritual ethnobotanical practice that may be applicable to other indigenous communities worldwide. The Dayak case demonstrates that the successful management of medicinal plants is shaped not only by pharmacological efficacy but also by cultural values and ritual practices. This insight enriches global discussions on the integration of local knowledge into health and conservation policies (55)(11)(72). Future research should focus on pharmacological validation of Dayak medicinal plants through bio-pharmaceutical testing, while simultaneously developing transdisciplinary, technology-based educational tools to revitalize knowledge transmission. Additionally, collaboration among academics, policymakers, and indigenous communities is essential to ensure the sustainability of practices. Such strategies would not only safeguard local knowledge but also position it as a contributor to global innovations in health and conservation.

CONCLUSION

This study highlights three key findings that reflect the distinctive characteristics of Dayak ethnomedicinal knowledge. First, the intergenerational transmission of medicinal plant knowledge has become increasingly fragile due to declining youth interest, despite its proven role in shaping cultural identity and community health. Second, rituals and ecological ethics remain central to the harvesting process, demonstrating how spirituality and respect for

nature are interwoven in maintaining environmental balance. Third, the effectiveness and sustainability of medicinal plant use are affirmed through strong empirical narratives—including accounts of longevity and elder health—yet these practices face growing threats from modernization and urbanization. Overall, this study enriches the literature not only by documenting ethnobotanical knowledge but also by offering critical detail on intergenerational dynamics, eco-spiritual practices, and forms of empirical validation that are rarely explored in depth in previous research.

The strength of this research lies in its ability to capture lived experiences and narratives of Dayak informants, providing a "thick description" of the cultural depth and ecological wisdom embedded in traditional medicine. Unlike many quantitative ethnobotanical studies, this research offers detailed accounts of ritual practices, ecological ethics, and personal testimonies that affirm the social and cultural value of medicinal plants. Nonetheless, several limitations must be acknowledged. Data were collected from a single Dayak community, limiting generalizability across broader indigenous populations. Furthermore, the study did not employ quantitative ethnobotanical indices such as Use Value (UV) or Informant Consensus Factor (ICF), and claims regarding plant efficacy remain at the level of perceived efficacy rather than pharmacological validation. Accordingly, the findings should be regarded as an initial contribution that opens avenues for further exploration.

Future research is encouraged to address these limitations by adopting mixed-methods approaches that combine qualitative narratives, quantitative measurement, and bio-pharmacological validation. Expanding the scope of inquiry across diverse Dayak subgroups or other indigenous communities is also crucial for strengthening comparison and generalizability. Collaboration among anthropologists, pharmacologists, ecologists, and educational technology experts will be essential to advance both the documentation and revitalization of ethnomedicinal knowledge. Moreover, leveraging digital technologies such as mobile applications or virtual reality may serve as innovative tools to retransmit knowledge to younger generations. Such strategies not only safeguard and strengthen cultural heritage but also position traditional knowledge as a valuable complement to modern healthcare systems and global biodiversity conservation efforts.

AUTHOR'S CONTRIBUTION STATEMENT

R.A. conceptualized the study, designed the methodology, collected and analyzed the data, and drafted the manuscript. M.F. contributed to validation, discussion, and manuscript refinement. G.S.P. and F.H. assisted with data curation, analysis, and writing review. I.G.A.R.P., S.L.W., S., and A.N.A.W. contributed to fieldwork, transcription, and thematic analysis. All authors reviewed and approved the final version of the manuscript.

CONFLICTS OF INTEREST

The authors confirm that there are no conflicts of interest that could have influenced the impartiality of this research.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The authors declare that ChatGPT was used during the preparation of this manuscript. Its role was limited to supporting language refinement, enhancing clarity, and improving the readability and structure of the text. ChatGPT was not used to generate primary data, perform analyses, or develop substantive scientific content. All authors carefully reviewed and verified the accuracy of the content to ensure that the final manuscript fully represents their intellectual contributions and scholarly integrity. This declaration is provided in accordance with ethical publication standards to maintain transparency and responsible authorship practices.

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