Ethnobotany of ritual plants in Malay culture: A case study of the Sintang community, Indonesia

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Research

Abstract

Background: The Malay community in Sintang, West Kalimantan, possesses a long-standing tradition of plant use in ceremonial and spiritual contexts. However, this knowledge is increasingly threatened by modernization and ecological degradation. This study aims to document the diversity of ritual plants used by the Malay communities of Sintang, evaluate their cultural significance, and assess the transmission of related knowledge.

Methods: The study was conducted in Sintang Regency between December 2024 and January 2025. A total of 390 respondents were randomly selected for ethnobotanical surveys involving semi-structured interviews, participant observation, and plant identification. Quantitative indices, including Relative Frequency of Citation (RFC), Cultural Importance Index (CI), and Fidelity Level (FL), were applied.

Results: A total of 68 ritual plant species from 43 botanical families were documented across 24 traditional rituals. The most cited species were *Areca catechu* (RFC = 0.928, CI = 6.02), *Piper betle* (RFC = 0.900, CI = 7.77), and *Cocos nucifera* (RFC = 0.779, CI = 3.37). Leaves (29.6%) and fruits (26.8%) were the most commonly used parts. The most diverse rituals were *Sengkelan Kanong* (25 species), *Pesta Pernikahan* (20 species), and *Betangas* (19 species). Two unique Sintang-specific rituals were identified: *Nopen* and *Bepentik*. A significant decline in knowledge was observed among younger generations ($p = 0.0001$).

Conclusions: The ritual plant knowledge of the Sintang Malays reflects strong biocultural relationships. However, intergenerational erosion of this knowledge threatens cultural continuity. Community-based conservation and digital documentation are urgently needed to preserve this valuable heritage.

Keywords: Ethnobotany, ritual plants, biodiversity, indigenous knowledge, West Kalimantan

Abstrak

Latar Belakang: Masyarakat Melayu di Sintang, Kalimantan Barat, memiliki tradisi panjang dalam pemanfaatan tumbuhan dalam konteks seremonial dan spiritual. Meskipun demikian, modernisasi dan degradasi lingkungan mengancam kelangsungan pewarisan pengetahuan ini. Penelitian ini bertujuan untuk mendokumentasikan keanekaragaman tumbuhan ritual yang digunakan oleh komunitas Melayu Sintang, mengevaluasi signifikansi budayanya, serta menilai proses pewarisan pengetahuan terkait antar generasi.

Metode: Penelitian ini dilakukan di Kabupaten Sintang pada Desember 2024 hingga Januari 2025. Sebanyak 390 responden dipilih secara acak untuk mengikuti survei etnobotani melalui wawancara semi-terstruktur, observasi partisipatif, dan identifikasi spesimen tumbuhan. Indeks kuantitatif seperti *Relative Frequency of Citation (RFC), Cultural Importance Index (CI)*, dan *Fidelity Level (FL)* digunakan dalam analisis.

Hasil: Sebanyak 68 spesies tumbuhan ritual dari 43 famili botani terdokumentasi dalam 24 jenis ritual tradisional. Spesies yang paling sering disebut adalah *Areca catechu* (RFC = 0,928; CI = 6,02), *Piper betle* (RFC = 0,900; CI = 7,77), dan *Cocos nucifera* (RFC = 0,779; CI = 3,37). Bagian tumbuhan yang paling sering digunakan adalah daun (29,6%) dan buah (26,8%). Ritual dengan keanekaragaman spesies tertinggi adalah *Sengkelan Kanong* (25 spesies), *Pesta Pernikahan* (20 spesies), dan *Betangas* (19 spesies). Dua ritual khas Sintang yang berhasil diidentifikasi adalah *Nopen* dan *Bepentik*. Terdapat penurunan signifikan dalam pengetahuan generasi muda (p = 0,0001).

Kesimpulan: Pengetahuan tumbuhan ritual masyarakat Melayu Sintang mencerminkan keterkaitan biokultural yang kuat. Namun, erosi pengetahuan antar generasi mengancam kesinambungan budaya tersebut. Diperlukan upaya konservasi berbasis komunitas dan dokumentasi digital untuk menjaga warisan berharga.

Background

Indigenous communities across the world have long maintained intricate relationships with plant species, integrating them into rituals, healing practices, and cultural identity. These ethnobotanical traditions reflect deep ecological knowledge, sustainable resource management, and spiritual beliefs that have been passed down through generations (Gandasari *et al*. 2023; Mahalwal & Kabra 2023; Nepal 2023). Across diverse regions, such as the Amazon (Argentim *et al*. 2023), Africa (Baaweh *et al*. 2022), and Asia (Negi *et al*. 2021), traditional ecological knowledge (TEK) has played a fundamental role in biodiversity conservation and ecosystem sustainability. However, modernization, rapid deforestation, socioeconomic transitions, and generational shifts are increasingly threatening these traditions (Dari & Khubalkar 2023; Lan Anh *et al*. 2023; Sinthumule 2023). While indigenous knowledge is gaining greater global recognition, research has primarily focused on well-documented communities, such as Amazonian tribes and African pastoralists (Malapane *et al*. 2022), whereas inland indigenous groups in maritime Southeast Asia—particularly the inland Malays—remain critically underrepresented (Yati & Niko 2022). Recognizing this gap, institutions such as the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and the Convention on Biological Diversity (CBD) emphasize the urgency of safeguarding indigenous knowledge as a crucial component of sustainable development, environmental conservation, and cultural resilience.

Among Indonesia's many indigenous communities, the Malay ethnic groups of West Kalimantan represent a unique intersection between cultural heritage and biodiversity conservation. Unlike the Malays of Sumatra and the Malay Peninsula, who primarily descend from the Deutero-Malay migration wave, the Malays of West Kalimantan embody a blend of Proto-Malay and Deutero-Malay ancestry, resulting in a rich and dynamic cultural identity (Collins 1995; Adelaar 2005). Linguistic research suggests that West Kalimantan is the original homeland of the ancient Malay language (Collins 2005), based on the principle that regions with the highest linguistic diversity within a language family are often its place of origin. Proto-Malay speakers are believed to have inhabited West Kalimantan for approximately two millennia, settling in river deltas and coastal areas, where they developed advanced maritime navigation skills. This strategic location facilitated the exchange of material and spiritual knowledge between Austronesian inland populations and maritime communities beyond Borneo. By approximately 100 CE, segments of these Malay-speaking populations began migrating across the South China Sea via the Tambelan Islands and Riau Archipelago, eventually reaching Sumatra and the Malay Peninsula (Collins 2005). Subsequent migrations followed a clockwise diffusion pattern along the northern coast of Borneo, expanding southward and westward, establishing Malay-speaking settlements in key trade networks. Similarly, Nothofer (1996) supports this theory, suggesting that early Malay migration originated from West Kalimantan before spreading to Bangka, Sumatra, and the western tip of Java (Jakarta). The linguistic diversity of Malay dialects in West Kalimantan extends to ethnobotanical knowledge, with many ritual plants identified by unique local names rarely documented in scientific literature.

Ritual plants have long played a fundamental role in the spiritual and cultural practices of the Malay community in Sintang. These plants are deeply embedded in religious observances and are believed to possess symbolic, medicinal, and ancestral significance (Suroyo *et al*. 2022; Bahari & Ismiyani 2023). Throughout various ceremonies, specific plants are selected based on their perceived spiritual properties, historical importance, and traditional narratives passed down through generations. However, despite the central role of ritual plants in cultural identity and spirituality, there has been no comprehensive ethnobotanical study documenting the specific species used, their local names, or their ritual applications. This gap highlights the need for systematic research to understand how these plants function within Sintang Malay traditions and how their meanings and uses have evolved. The increasing influence of modernization, urbanization, and socio-economic changes has led to a gradual shift away from traditional practices (Ouma 2022; Shaheen *et al*. 2023). As younger generations adopt new lifestyles, the transmission of local plant knowledge from elders to younger community members has weakened (Sutrisno *et al*. 2020; Blue *et al*. 2023; Khan *et al*. 2023). In many indigenous communities, including those in maritime Southeast Asia, the loss of such knowledge has broader implications for cultural continuity and identity. Ethnobotanical research is therefore essential to preserving the intricate relationship between plants and rituals before valuable knowledge is lost. This study aims, therefore, to document the diversity of ritual plants used by the Malay communities of Sintang, evaluate their cultural significance, and assess the transmission of related knowledge.

Materials and Methods

Study area

Sintang Regency, located in West Kalimantan, Indonesia, spans approximately 21,638 km², making it one of the largest regencies in the province. Geographically, it lies between 0°40' - 1°30' N latitude and 110°40' - 112°30' E longitude, sharing borders with Kapuas Hulu, Melawi, Sekadau, Sanggau, and Sarawak (Malaysia). The region's diverse topography, ranging from lowland plains and rolling hills to the Schwaner Mountain Range, supports extensive tropical forests and river systems, with the Kapuas and Melawi Rivers serving as vital lifelines for transportation, livelihoods, and cultural practices. Sintang experiences a tropical rainforest climate (Af) under the Köppen classification, characterized by high humidity (70-90%), an average temperature of 25-27°C, and annual rainfall ranging from 2,500 to 4,000 mm. The region has two main seasons: the wet season (October-April) and the drier season (May-September), though significant rainfall occurs year-round (BPS Kabupaten Sintang 2024), fostering rich biodiversity that supports traditional plant use.

The Regency is home to approximately 438,022 people (BPS Kabupaten Sintang 2024), with Malay and Dayak communities as the dominant ethnic groups. The Sintang Malay (*Melayu Sintang*) primarily inhabit riverbank settlements, engaging in trade, fishing, and agriculture. Their culture, heavily influenced by Islamic traditions, retains strong oral traditions, customary laws, and botanical rituals, particularly in weddings (*Pesta Pernikahan*), purification rites (*Tepung Tawar*), and *Robo-Robo* ceremonies. Despite the influence of Islamization, pre-Islamic animistic elements persist, blending with Islamic beliefs in ritual healing, herbal medicine, and spiritual cleansing. The Dayak ethnic subgroups, including Iban, Taman, Uud Danum, and Seberuang, predominantly inhabit the interior regions, relying on subsistence farming, weaving, and traditional ecological knowledge. Meanwhile, the Chinese and Javanese communities contribute to trade and culinary traditions, further enriching Sintang's multicultural landscape.

Administratively, Sintang Regency consists of 14 sub-districts, 16 urban villages, and 390 rural villages. The Regency with the highest number of villages includes Kayan Hilir (43 villages), Ambalau (33 villages), and Dedai (31 villages), while Sintang Regency serves as the economic and administrative center. This study was conducted in three sub-districts, i.e., Kelam Permai, Sintang, and Sungai Tebelian, selected for their significant Malay populations and diversity of ritual plant use (Figure 1).

Ethnobotanical survey

The ethnobotanical survey was conducted from December 2024 to January 2025. The sample size was determined using the Cochran formula (Bartlett *et al*. 2001), resulting in a total of 390 respondents (Table 1).

In this study, a clear distinction was made between informants and respondents based on their roles and the nature of data collection. Respondents (n=390), selected through random sampling, participated in the structured questionnaire survey aimed at documenting general community knowledge on ritual plant use. In contrast, informants (n=15), such as traditional healers, ritual specialists, elders, and community leaders, were selected purposively due to their in-depth knowledge of ritual practices. These informants provided qualitative insights into the meaning, symbolism, and spiritual-ecological values of rituals through in-depth interviews and informal conversations. Their perspectives helped contextualize and interpret the ethnobotanical data obtained from respondents.

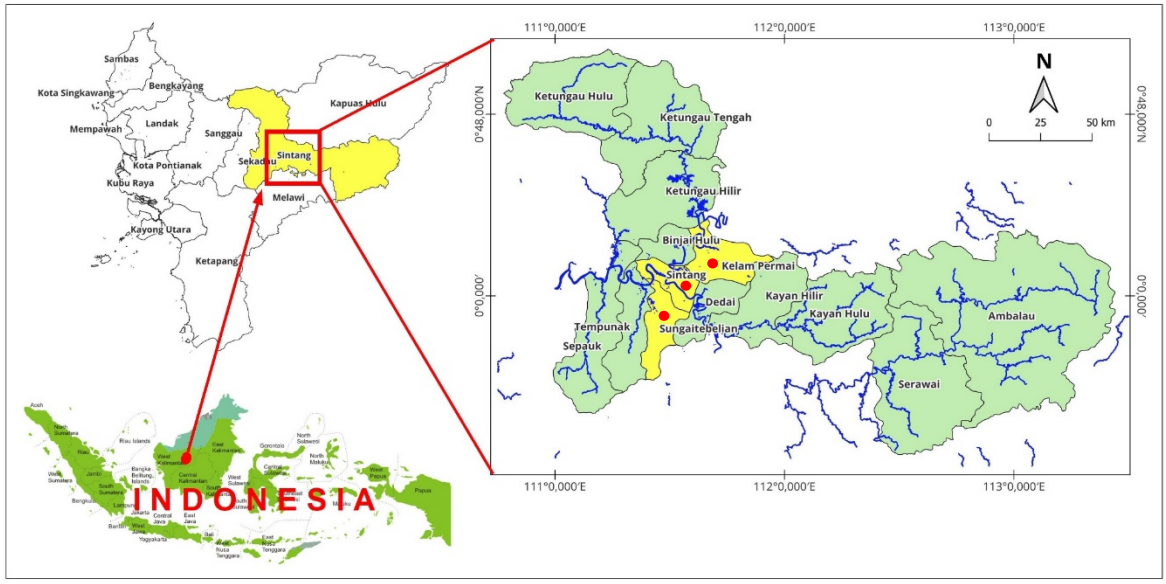


Figure 1. Map of Sintang Regency, West Kalimantan, Indonesia, showing the study area

Table 1. The sample size of respondents from the selected sub-district

Regency	Sub-district	Villages	No. of population	Number of respondents involved in the study
Sintang	Sintang	Sengkuang	4,880	127
		Rawa Mambok	2,799	73
		Kapuas Kiri Hilir	597	16
	Sungai Tebelian	Balai Agung	3,156	82
		Sungai Ukoi	2,858	74
	Kelam Permai	Kelam Sejahtera	700	18
				390

Data on traditional knowledge of ritual plants were collected through semi-structured questionnaires, which included information on local plant names, plant parts used, preparation methods, modes of administration, ritual applications, and knowledge transmission. Prior to the interviews, the objectives of the study were clearly explained to each participant, and informed consent was obtained. During the survey, plant specimens were collected and subsequently identified at the Laboratory of Biology, Universitas Samudra, Aceh, Indonesia. The botanical nomenclature was verified and updated using Plants of the World Online (*https://powo.science.kew.org/*), ensuring taxonomic accuracy and alignment with current scientific classifications.

Data Analysis

The collected ethnobotanical data were analyzed using descriptive statistics, *Relative Frequency Citation (RFC), Cultural Importance Index (CI)*, and *Fidelity Level (FL)* to assess the significance of ritual plants within the Malay community of Sintang. The data were organized using Microsoft Excel, and statistical analyses were conducted using IBM-SPSS version 21.

Relative frequency citation (RFC)

The RFC index was calculated to measure the cultural significance of each plant based on its frequency of mention by respondents, following the formula (Tardío & Pardo de Santayana 2008):

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

where, FC is the frequency of citation (number of respondents who mentioned the species) and N is the total number of respondents in the study

RFC values range from 0 to 1, with higher values indicating greater ethnobotanical relevance and widespread recognition of a species within the community.

Cultural importance index (CI)

The CI index, following the method of Tardío & Pardo de Santayana (2008), was used to assess the overall cultural significance of each species based on its versatility in various ritual contexts.

$$CI = \sum_{u=u_i}^{U_{NC}} \sum_{i=i_1}^{i_N} \frac{UR_{ui}}{N}$$

where, U is the total number of use reports for a given species and N is the total number of respondents.
A higher CI value signifies that a species is widely used across multiple rituals, reflecting its cultural versatility and significance.

Fidelity Level (FL)

The Fidelity Level (FL), following the formula by Hoffman & Gallaher (2007), was determined to assess the specificity of plant use in particular rituals.

$$FL(\%) = \frac{Np}{N}\ x\ 100\%$$

where, N_P is the number of respondents who reported using a species for a specific ritual and N is the total number of respondents who mentioned the species for any ritual.
FL values range from 0 to 100%, with higher values indicating strong cultural associations of a plant with a specific ritual.

Results

Characteristics of respondents

A total of 390 respondents participated in the ethnobotanical survey (Table 2). Women represented 47.9% of the sample, while men made up 52.1%. This slight men dominance may reflect local cultural norms where men are more frequently involved in public and community-level ritual activities, including the gathering and preparation of ritual plants. However, women play a vital role in domestic rituals and knowledge transmission, ensuring their perspectives are also well-represented.

Table 2. Socio-demographic characteristics of the respondents

Characteristics	Total respondent	Percentage
Gender		
Men	187	47.9
Women	203	52.1
Age		
15-25	135	34.6
26-35	62	15.9
36-45	68	17.4
46-55	46	11.8
56-65	52	13.3
66-75	19	4.9
75-85	8	2.1
Latest education		
Elementary School	33	8.5
Junior High School	71	18.2
Senior High School	191	49.0
Higher Education	95	24.4

In terms of age distribution, the largest group of respondents (34.6%) was aged between 15-25 years, followed by those in the 26-35 age range. The relatively lower representation of respondents over 50 years of age is due to limited availability or preference for engaging older individuals as key informants rather than general respondents. In this study, informants were

selected based on their deep knowledge of local ritual practices, often including village elders, traditional healers, or ritual leaders, whereas respondents represented a broader demographic of community members who could share knowledge of ritual plant use. This respondent profile provides insights into the generational dynamics of ritual knowledge, indicating a potential shift in how knowledge is accessed and shared across age groups.

Diversity of ritual plant species

A total of 68 ritual plant species, representing 61 genera and 43 botanical families, were documented in the study area. These plants serve essential roles in the traditional rituals of the Malay communities in Sintang, West Kalimantan (Table 3). The majority of the species were trees (38.03%), followed by herbs (32.39%), shrubs (11.27%), climbers (8.45%), grasses (7.04%), and ferns (1.41%). Cultivated species accounted for 77.9% of the total, while the remaining 22.1% were wild. Among botanical families, Poaceae was the most dominant, with six species, followed by Fabaceae (5 species), while Arecaceae, Myrtaceae, and Zingiberaceae were each represented by four species. The remaining 36 families contained one or two species each.

Plant Parts utilized and processing methods in ritual practices

The use of plant parts in ritual practices within the Malay community of Sintang reflects a profound integration of ethnobotanical knowledge with spiritual and cultural traditions (Figure 2). Among the various plant parts utilized, leaves (29.6%) and fruits (26.8%) emerge as the most frequently employed, highlighting their significance in purification rites, symbolic offerings, and fertility ceremonies. Leaves are commonly associated with cleansing rituals, believed to dispel negative energies and provide spiritual protection. Meanwhile, fruits, prominently featured in offerings and communal feasting traditions, symbolize abundance, renewal, and prosperity. Flowers (12.7%) serve not only for their aesthetic and aromatic qualities but also as integral components in transition rites, ancestral reverence, and symbolic purification. Seeds (8.5%) hold vital importance in ritual contexts due to their association with fertility and continuity, making them central to rites of passage and prosperity-related ceremonies. Stems (9.9%) are primarily used in crafting ceremonial structures and ritual objects, representing resilience, continuity, and the interconnectedness of nature and cultural traditions. Less frequently utilized plant parts, such as tubers and rhizomes (4.2% each), play a crucial role in healing and protective ceremonies, reinforcing the fusion of medicinal plant knowledge with spiritual beliefs. Meanwhile, the selective use of bark (2.8%) and sap (1.4%) in sacred anointing and blessing rituals highlights their specialized role in transformative ceremonies, preserving their exclusivity for high-sacredness events.

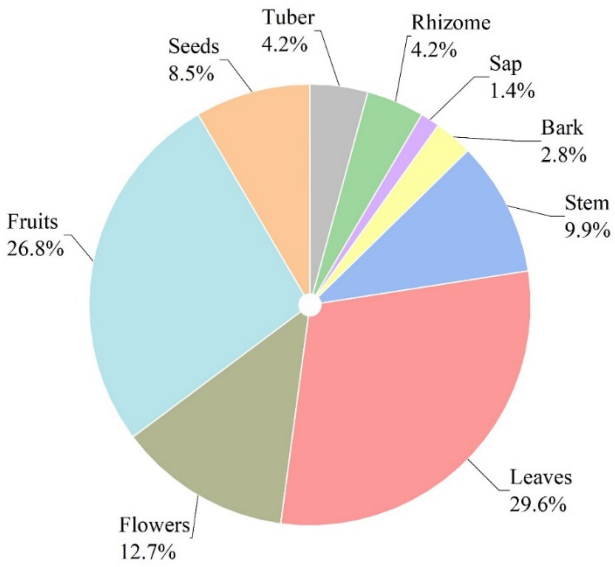


Figure 2. Distribution of plant parts used in ritual practices

The diverse methods of plant preparation further illustrate the interplay between symbolic meaning and functional application in ritual contexts (Figure 3). The dominance of fresh plant materials (25.3%) suggests a cultural emphasis on the vitality and purity of unprocessed botanicals in cleansing rituals, offerings, and symbolic acts of renewal. The high frequency of decoction (15.7%) and fumigation (15.7%) underscores the spiritual and medicinal significance of heat and aroma in purification and healing rituals, particularly in steam baths (*Betangas*) and ancestral ceremonies. Slicing (15.7%) is closely

linked to fruit-based rituals, where plants are prepared for offerings, fertility-related ceremonies, or consumption in *rujak*, a dish believed to enhance vitality and balance bodily energies. Boiling (9.6%) remains a significant preparation technique for rhizomes and seeds, reinforcing their role in spiritual fortification and medicinal applications. The practice of chewing (2.4%), primarily associated with *Piper betle* and *Areca catechu*, reflects deep-rooted betel quid traditions that facilitate social bonding, fertility rites, and purification practices. The techniques of carving (3.6%) and weaving (2.4%) highlight the enduring craftsmanship involved in ritual plant use, where species like *Bambusa vulgaris* and *Eusideroxylon zwageri* are transformed into ceremonial structures and decorative objects that reinforce communal identity and spiritual continuity. Crushing (3.6%) and powdering (1.2%) are primarily utilized in body adornment and purification rites, while raw consumption (2.4%) of select fruits in fertility and blessing ceremonies signifies their direct spiritual potency. The limited occurrence of rolling (1.2%) for *Nicotiana tabacum* in traditional smoking rituals and grinding (1.2%) for *Curcuma longa* in cleansing ceremonies suggests their highly specialized functions within ritual frameworks.

Beyond the technical aspects of plant processing, the ritual applications of plants provide deeper insight into their embedded meanings in social and spiritual life. Food-based rituals, including fruit offerings (2.94%), *rujak*-based mixtures (4.41%), and traditional cakes (1.47%), symbolize communal sharing, fertility, and blessings, reinforcing the connection between nourishment and spiritual fulfillment. Cleansing rituals, such as *tepung tawar* purification, herbal steam baths, and ritual bathing, represent a significant portion of plant use. Mixing in cleansing water (2.94%) and preparing fragrant herbal infusions (2.94%) serve as common practices to purify the body, mind, and spirit. Additionally, plants utilized in crafting ceremonial objects not only uphold ancestral traditions but also preserve the aesthetic and symbolic dimensions of ritual practices. These findings illustrate how the selection, preparation, and application of ritual plants transcend mere functionality, embodying a sophisticated cultural framework that intertwines ethnobotanical wisdom with spiritual beliefs.

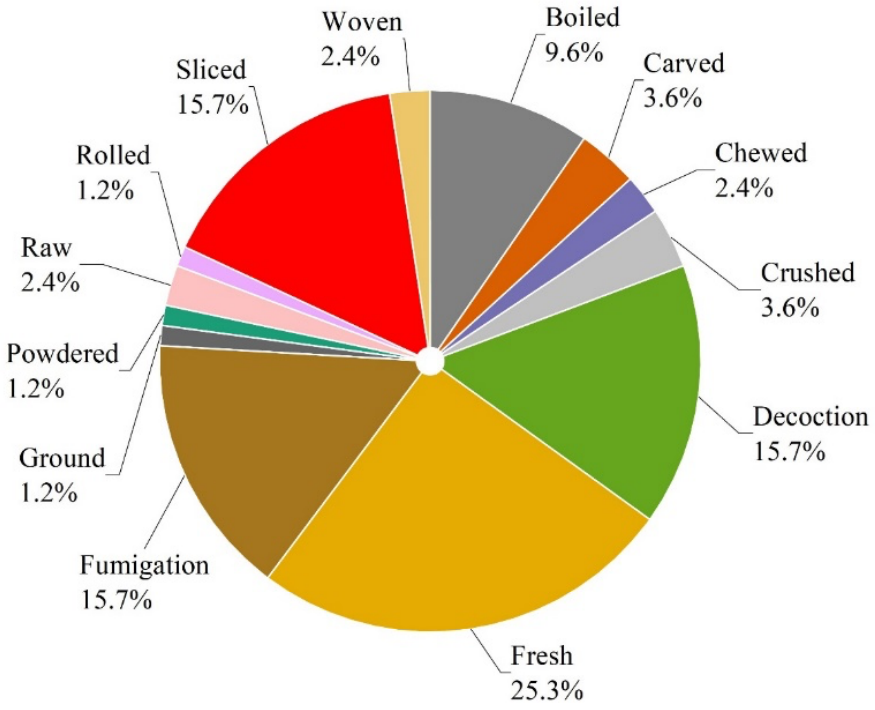
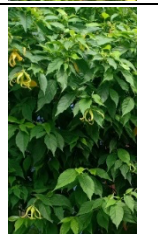
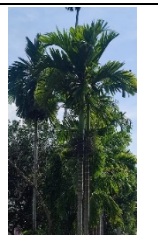
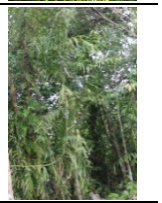
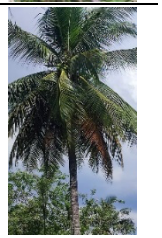


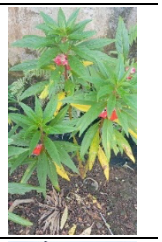
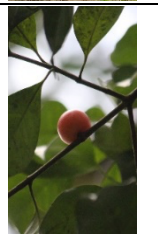
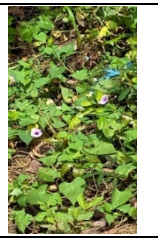
Figure 3. Common processing methods of ritual plants in Malay traditions

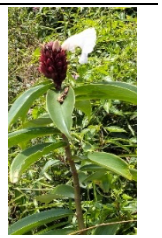
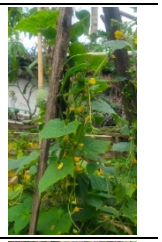
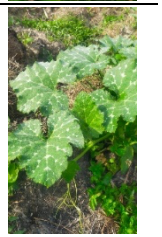
Table 3. Plants with essential roles in the traditional rituals of the Malay communities in Sintang, West Kalimantan .

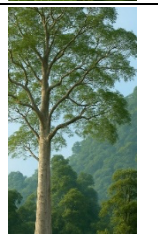
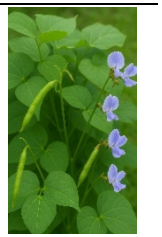
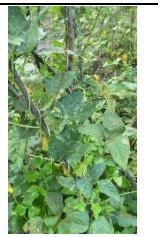
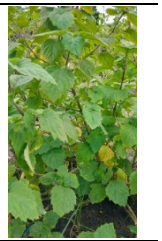
Family	Scientific name	Vernacular name	Habit	Status	Plant part used	Mode of preparation	Mode of administration	Ritual Name	RFC	CI	Conservation status (IUCN)	Plant image
Anacardiaceae	*Mangifera indica* L.	Mangga	Tree	Cultivated	Fruit	Sliced	Used in fruit offerings, prepared in *rujak Culet*	*Sengkelan Kanong*	0.046	0.05	Data Deficient (DD)	
Annonaceae	*Cananga odorata* (Lam.) Hook.f. & Thomson	Kenanga	Tree	Cultivated	Flowers	Fresh	Used in bathing and cleansing rituals	*Pesta pernikahan, Mandi-Mandi, Akikah*	0.210	0.27	Least Concern (LC)	
Apiaceae	*Oreocome striata* (DC.) Pimenov & Kljuykov	Geganti	Herb	Wild	Leaves	Decoction, fumigation	Used in bathing and cleansing rituals	*Betangas*	0.190	0.19	Not Evaluated (NE)	
	Pimpinella aromatica M.Bieb.	Adas	Herb	Cultivated	Seeds	Decoction, fumigation	Used in bathing and cleansing rituals	*Betangas*	0.226	0.23	Not Evaluated (NE)	

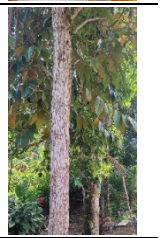
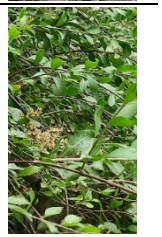
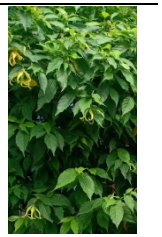
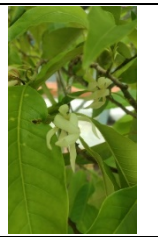
Arecaceae	*Areca catechu* L.	Pinang	Tree	Cultivated	Seeds	Chewed	Included in betel preparation for ritual offerings	*Meminang, Mensurong, Akad Nikah, Pesta pernikahan, Nopen, Sengkelan Kanong, Akikah, Mandi Bayi, Robo-robo, Berumpan, Bebuang, Selamatan*	0.928	6.02	Least Concern (LC)	
	Arenga pinnata (Wurmb) Merr.	Enau	Tree	Cultivated	Sap	Fresh	Used in ritual drink, offering	*Lepas tali pusar, Akad Nikah, Pesta pernikahan*	0.179	0.44	Least Concern (LC)	
	Calamus javensis Blume	Rotan	Climber	Wild	Stem	Woven	Used in symbolic objects, decorations	*Khitanan*	0.108	0.11	Not Evaluated (NE)	
	Cocos nucifera L.	Kelapa	Tree	Cultivated	Fruit, Leaves	Fresh	Used in cleansing, offerings, decorations, and symbolic objects	*Akad Nikah, Arak-arak, Pesta pernikahan, Nopen, Mandi-Mandi, Sengkelan Kanong,*	0.779	3.37	Not Evaluated (NE)	

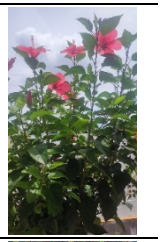
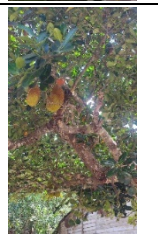
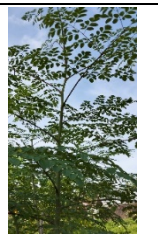
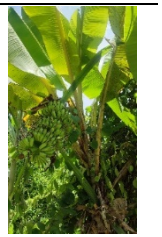
								Mengemas ari-ari, Lepas tali pusar, Akikah, Mandi Bayi, Mutus tali ayun, Khitanan, Robo-robo				
Asparagaceae	*Cordyline fruticosa* (L.) A.Chev.	Sabang Merah	Shrub	Cultivated	Leaves	Fresh	Used for *tepung tawar* purification	*Betangas, Mandi Berias, Pesta pernikahan, Mandi-Mandi, Sengkelan Kanong, Akikah, Khitanan, Selamatan*	0.723	2.27	Least Concern (LC)	
Aspleniaceae	*Asplenium nidus* L.	Paku serikan	Fern	Wild	Leaves	Fresh	Used for *tepung tawar* purification	*Betangas, Mandi Berias, Khitanan*	0.067	0.16	Not Evaluated (NE)	
Asteraceae	*Blumea balsamifera* (L.) DC.	Sembung	Shrub	Wild	Leaves	Decoction, fumigation	Used in cleansing rituals	*Betangas*	0.264	0.26	Least Concern (LC)	

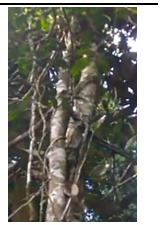
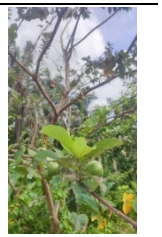
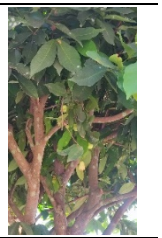
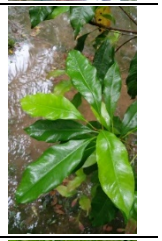
Balsaminaceae	*Impatiens balsamina* L.	Pacar Air	Herb	Cultivated	Flowers	Fresh	Sprinkled in bathing rituals	*Mandi-Mandi*	0.079	0.08	Not Evaluated (NE)	
Bromeliaceae	*Ananas comosus* (L.) Merr.	Nanas	Herb	Cultivated	Fruit	Sliced	Used in ritual food offerings	*Pesta pernikahan, Mandi Bayi*	0.228	0.44	Not Evaluated (NE)	
Caricaceae	*Carica papaya* L.	Terong Kayu	Tree	Cultivated	Fruit	Sliced	Used in ritual food, used in *rujak Culet*	*Sengkelan Kanong, Mandi Bayi*	0.518	0.62	Data Deficient (DD)	
Clusiaceae	*Garcinia parvifolia* (Miq.) Miq.	Kandis	Tree	Wild	Fruit	Crushed	Sprinkled on the placenta before burial	*Mengemas ari-ari, Mandi Bayi*	0.077	0.11	Least Concern (LC)	
Convolvulaceae	*Ipomoea batatas* (L.) Lam.	Ubi Jalar	Herb	Cultivated	Tuber	Sliced	Used in *rujak Semparik*	*Sengkelan Kanong*	0.126	0.10	Data Deficient (DD)	

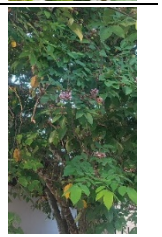
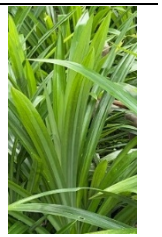
Costaceae	*Hellenia speciosa* (J.Koenig) S.R.Dutta	Ketabar, Sentabar, Mentaba	Herb	Wild	Leaves	Fresh	Used for purification	*Betangas, Sengkelan Kanong, Akikah, Khitanan, Selamatan, Mandi Berias, Mandi-Mandi*	0.779	2.40	Least Concern (LC)	
Cucurbitaceae	*Cucumis sativus* L.	Mentimun	Climber	Cultivated	Fruit	Sliced	Used in *rujak Culet*	*Sengkelan Kanong*	0.600	0.60	Not Evaluated (NE)	
	Cucurbita pepo L.	Perenggi	Climber	Cultivated	Fruit	Boiled	Used in offerings	*Pesta pernikahan*	0.331	0.33	Least Concern (LC)	
Euphorbiaceae	*Manihot esculenta* Crantz	Ubi Kayu	Shrub	Cultivated	Tuber	Sliced	Used in *rujak Semparik*	*Sengkelan Kanong*	0.082	0.08	Not Evaluated (NE)	
Fabaceae	*Albizia saponaria* (Lour.) Blume ex Miq.	Langir	Tree	Wild	Bark	Fresh	Used in purification rituals	*Mandi Berias*	0.236	0.45	Least Concern (LC)	

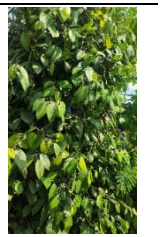
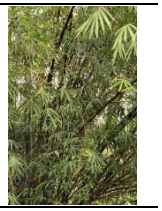
	Biancaea sappan (L.) Tod.	Sepang	Tree	Wild	Stem	Boiled	Boiled into a traditional drink (*serbat*)	*Akad Nikah*	0.113	0.11	Least Concern (LC)	
	Koompassia excelsa (Becc.) Taub.	Tapang	Tree	Wild	Wood	Carved	Used in ceremonial pillars	*Mandi Bayi*	0.110	0.11	Lower Risk (LR)	
	Pachyrhizus erosus (L.) Urb.	Bengkoang	Herb	Cultivated	Tuber	Sliced	Used in *rujak Culet*	*Sengkelan Kanong*	0.113	0.11	Not Evaluated (NE)	
	Vigna unguiculata subsp. unguiculata	Kacang Panjang	Climber	Cultivated	Fruits	Boiled	Used in offerings	*Pesta pernikahan*	0.264	0.26	Not Evaluated (NE)	
Lamiaceae	*Pogostemon cablin* (Blanco) Benth.	Nilam	Herb	Cultivated	Leaves	Decoction, fumigation	Used in aromatic cleansing rituals	*Betangas, Pesta pernikahan*	0.221	0.30	Not Evaluated (NE)	

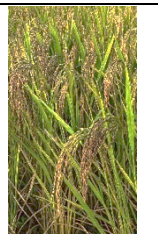
Lauraceae	*Cinnamomum verum* J.Presl	Kayu Manis	Tree	Cultivated	Bark	Boiled	Boiled with other herbs for a steam bath	*Betangas*	0.585	0.58	Vulnerable (VU)	
	Eusideroxylon zwageri Teijsm. & Binn.	Belian	Tree	Wild	Stem	Carved	Used in crafting ceremonial objects	*Mandi Bayi, Bepentik*	0.236	0.35	Vulnerable (VU)	
Lythraceae	*Lawsonia inermis* L.	Inai	Shrub	Cultivated	Leaves	Crushed	Used for body decoration	*Berpacar*	0.882	0.88	Least Concern (LC)	
Magnoliaceae	*Magnolia × alba* (DC.) Figlar	Kembang Kantil	Tree	Cultivated	Flowers	Fresh	Used in offerings	*Akikah*	0.082	0.08	Not Evaluated (NE)	
Magnoliaceae	*Michelia champaca* L.	Cempaka	Tree	Cultivated	Flowers	Fresh	Used in ritual bathing, ceremonial	*Akikah, Robo-robo*	0.174	0.25	Least Concern (LC)	

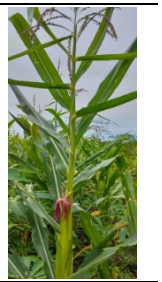
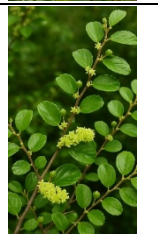
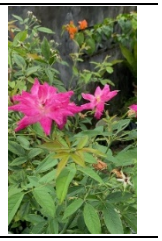
Malvaceae	*Hibiscus × rosa-sinensis* L.	Kembang sepatu	Shrub	Cultivated	Flowers	Fresh	Used in offerings	*Akikah*	0.072	0.07	Not Evaluated (NE)	
Moraceae	*Artocarpus heterophyllus* Lam.	Nangka	Tree	Cultivated	Fruit	Sliced	Used in *rujak Semparik*	*Sengkelan Kanong*	0.228	0.23	Not Evaluated (NE)	
Moringaceae	*Moringa oleifera* Lam.	Kelor	Tree	Cultivated	Leaves	Decoction, fumigation	Boiled with other herbs for a steam bath	*Betangas*	0.126	0.13	Least Concern (LC)	
Musaceae	*Musa x paradisiaca* L.	Pisang	Herb	Cultivated	Fruit, Leaves	Fresh	Used in offerings, cleansing, and symbolic elements	*Pesta pernikahan, Sengkelan Kanong, Mandi Bayi, Mandi jenazah, Berumpan, Bebuang*	0.474	1.36	Not Evaluated (NE)	

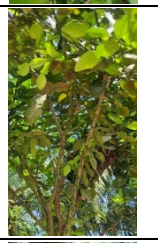
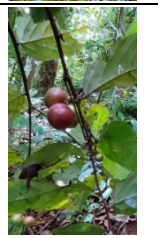
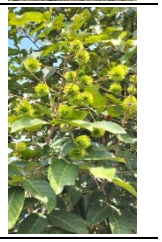
Myristaceae	*Horsfieldia crassifolia* (Hook.F. & Thomson) Warb.	Kumpang	Tree	Wild	Stem	Carved	Used in crafting ritual objects	*Bepentik*	0.226	0.23	Least Concern (LC)	
Myrtaceae	*Psidium guajava* L.	Jambu Biji	Tree	Cultivated	Fruit	Sliced	Used in *rujak Semparik*	*Sengkelan Kanong*	0.095	0.09	Least Concern (LC)	
	Syzygium aqueum (Burm.f.) Alston	Jambu air	Tree	Cultivated	Fruit	Sliced	Used in *rujak Culet*	*Sengkelan Kanong*	0.113	0.11	Least Concern (LC)	
	Syzygium aromaticum (L.) Merr. & L.M.Perry	Cengkeh	Tree	Cultivated	Flowers	Decoction, fumigation	Boiled with other herbs for a steam bath	*Betangas*	0.533	0.53	Not Evaluated (NE)	
	Syzygium polyanthum (Wight) Walp.	Salam	Tree	Wild	Leaves	Fresh	Used in purification rituals	*Robo-robo*	0.087	0.09	Not Evaluated (NE)	

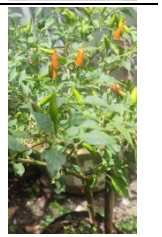
Oleaceae	*Jasminum sambac* (L.) Aiton	Melati	Shrub	Cultivated	Flowers	Fresh	Soaked in fragrant water, mixed with cleansing water	*Pesta pernikahan, Mandi-Mandi, Akikah, Robo-robo, Berumpan*	0.141	0.45	Not Evaluated (NE)	
Oxalidaceae	*Averrhoa carambola* L.	Belimbing	Tree	Cultivated	Fruit	Sliced	Used in *rujak Culet*	*Sengkelan Kanong*	0.136	0.14	Data Deficient (DD)	
Pandanaceae	*Pandanus amaryllifolius* Roxb. ex Lindl.	Pandan	Herb	Cultivated	Leaves	Fresh, decoction, fumigation	Used in cleansing, bathing water, offerings, decorations, or woven into mats	*Arak-arak, Mandi-Mandi, Lepas tali pusar, Akikah, Mandi jenazah, Robo-robo, Berumpan, Mandi Kemben, Betangas, Pesta pernikahan*	0.536	2.71	Data Deficient (DD)	
	Pandanus tectorius Parkinson	Perupuk	Tree	Wild	Leaves	Fresh, decoction, fumigation	Used in decorations	*Mandi Bayi, Betangas*	0.536	0.78	Least Concern (LC)	

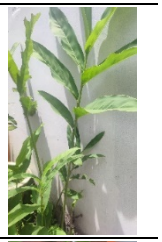
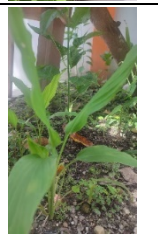
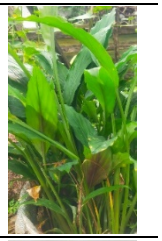
Piperaceae	*Piper betle* L.	Sirih	Climber	Cultivated	Leaves	Chewed	Chewed and offered, mixed in cleansing water, sprinkled, or included in offerings	*Meminang, Mensurong, Akad Nikah, Arak-arak, Nopen, Sengkelan Kanong, Akikah, Mandi Bayi, Khitanan, Robo-robo, Berumpan, Bebuang, Selamatan, Mandi Kemben*	0.900	7.77	Not Evaluated (NE)	
	Piper nigrum L.	Lada	Climber	Cultivated	Fruits	Powdered	Used in ritual food	*Sengkelan Kanong*	0.169	0.17	Not Evaluated (NE)	
Poaceae	*Bambusa vulgaris* Schrad. ex J.C.Wendl.	Bambu	Grass	Wild	Stem	Woven	Used for making ceremonial structures, woven elements	*Arak-arak, Berumpan*	0.108	0.16	Not Evaluated (NE)	

Cymbopogon citratus (DC.) Stapf	Serai	Herb	Cultivated	Leaves	Boiled, decoction, fumigation	Boiled for fragrant water, mixed in cleansing water	*Akikah, Betangas*	0.774	1.31	Not Evaluated (NE)	
Cymbopogon nardus (L.) Rendle	Serai Wangi	Herb	Cultivated	Leaves	Fresh, decoction, fumigation	Boiled for fragrant water, mixed in cleansing water	*Pesta pernikahan, Mandi-Mandi, Sengkelan Kanong, Khitanan*	0.136	0.43	Not Evaluated (NE)	
Oryza sativa L.	Padi	Grass	Cultivated	Seeds	Boiled	Cooked into yellow rice, mixed with turmeric, and scattered as blessings	*Akad Nikah, Pesta pernikahan, Mandi Bayi, Robo-robo*	0.785	4.48	Not Evaluated (NE)	
Oryza sativa L. f. *glutinosa*	Padi Pulut	Grass	Cultivated	Seeds	Boiled	Used in ritual cakes	*Pesta pernikahan, Nopen, Sengkelan Kanong, Lepas tali pusar, Akikah, Mandi Bayi, Khitanan, Robo-robo, Bebuang*	0.231	0.67	Not Evaluated (NE)	

	Saccharum officinarum L.	Tebu	Grass	Cultivated	Stem	Fresh	Used in offerings, a wedding procession	*Arak-arak, Pesta pernikahan, Nopen, Sengkelan Kanong, Akikah, Mandi Bayi, Robo-robo, Bebuang*	0.656	1.97	Not Evaluated (NE)	
	Zea mays L.	Jagung	Grass	Cultivated	Seeds	Boiled	Used in ritual food, shared with children	*Mandi Bayi*	0.038	0.04	Least Concern (LC)	
Rhamnaceae	*Ziziphus mauritiana* Lam.	Bidara	Tree	Wild	Leaves	Crushed	Mixed with water for cleansing and purification	*Mandi jenazah*	0.541	0.54	Least Concern (LC)	
Rosaceae	*Rosa chinensis* Jacq.	Mawar	Shrub	Cultivated	Flowers	Fresh	Sprinkled in ritual baths, used in offerings	*Bebuang*	0.787	0.79	Not Evaluated (NE)	

Rubiaceae	*Uncaria gambir* (Hunter) Roxb.	Gambir	Shrub	Cultivated	Latex	Fresh	Included in betel preparation for ritual offerings	*Bebuang*	0.741	0.74	Not Evaluated (NE)	
Rutaceae	*Citrus hystrix* DC.	Jerok Purut	Tree	Cultivated	Leaves, Fruits	Decoction, fumigation	Boiled with other herbs for a steam bath	*Betangas*	0.774	0.77	Least Concern (LC)	
Salicaceae	*Flacourtia rukam* Zoll. & Moritzi	Rukam	Tree	Wild	Fruit	Raw	Shared with children, used in ritual food	*Mandi Bayi*	0.054	0.05	Least Concern (LC)	
Santalaceae	*Nicotiana tabacum* L.	Tembakau	Herb	Cultivated	Leaves	Rolled	Rolled with areca leaves to make cigarettes	*Bebuang*	0.733	0.73	Not Evaluated (NE)	
Sapindaceae	*Nephelium lappaceum* L.	Rambutan	Tree	Cultivated	Fruit	Raw	Shared with children, used in ritual food	*Mandi Bayi*	0.172	0.17	Not Evaluated (NE)	

Schisandraceae	*Illicium verum* Hook.f.	Kembang cerancak/ perancak	Tree	Cultivated	Flowers	Decoction, fumigation	Boiled with other herbs for a steam bath	*Betangas*	0.797	0.80	Not Evaluated (NE)	
Solanaceae	*Capsicum frutescens* L.	Rangki	Herb	Cultivated	Fruit	Sliced	Used as a ritual food element, used in rujak for pregnancy blessings	*Pesta pernikahan, Sengkelan Kanong*	0.882	1.65	Least Concern (LC)	
	Solanum melongena L.	Terong ungu	Herb	Cultivated	Fruit	Sliced	Used as a ritual food element	*Pesta pernikahan*	0.528	0.53	Not Evaluated (NE)	
Vitaceae	*Leea indica* (Burm.f.) Merr.	Mali-Mali	Shrub	Wild	Leaves	Fresh	Used for purification rituals and *tepung tawar*	*Betangas, Mandi Berias, Pesta pernikahan, Mandi-Mandi, Sengkelan Kanong, Khitanan, Selamatan*	0.826	5.41	Least Concern (LC)	

Zingiberaceae	*Alpinia galanga* (L.) Willd.	Laos	Herb	Cultivated	Rhizome	Boiled	Included in ritual offerings	*Sengkelan Kanong*	0.290	0.29	Not Evaluated (NE)	
	Curcuma longa L.	Kunyit	Herb	Cultivated	Rhizome	Ground	Mixed in cleansing water, scattered for blessings, used in body scrubs	*Pesta pernikahan, Sengkelan Kanong, Akikah, Mandi Bayi, Khitanan, Robo-robo, Berumpan, Selamatan, Mandi Kemben*	0.538	3.48	Data Deficient (DD)	
	Curcuma zanthorrhiza Roxb.	Temulawak	Herb	Cultivated	Rhizome	Decoction, fumigation	Boiled with other herbs for a steam bath	*Betangas*	0.354	0.35	Data Deficient (DD)	
	Elettaria cardamomum (L.) Maton	Kapulaga	Herb	Cultivated	Seeds	Decoction, fumigation	Boiled with other herbs for a steam bath	*Betangas*	0.562	0.56	Not Evaluated (NE)	

Types of rituals and the role of plants in the cultural context

The Malay community of Sintang practices 24 distinct customary rituals in which plants play integral symbolic, medicinal, and spiritual roles—particularly in ceremonies related to birth, marriage, purification, protection, and communal harmony (Table 3). These rituals can be grouped into seven categories based on their functions and cultural significance: (1) Life cycle rituals, such as *Akad nikah, Arak-arak, Berpacar, Betangas, Lepas tali pusar, Mandi bayi, Mandi berias, Mandi kemben, Mandi-mandi, Meminang, Mensurung, Mutus tali ayun*, and *Pesta pernikahan*; (2) Healing rituals, represented by *Bepentik*; (3) Rituals related to respect for ancestors, including *Mengemas ari-ari*; (4) Religious rituals, such as *Akikah, Khitanan, Mandi jenazah*, and *Sengkelan kanong*; (5) Social and communal rituals, including *Robo-robo* and *Selamatan*; (6) Rituals related to the spirit world (*Apotropaic Rituals*), such as *Berumpan* and *Bebuang*; and (7) Rituals of art and traditional performance, exemplified by *Nompen*. These classifications reflect the multifaceted roles that rituals play in maintaining the spiritual, social, and ecological balance within the Sintang Malay cultural landscape.

Each ritual category is associated with specific plant species that carry symbolic and functional meanings. Life transition rituals such as *Sengkelan Kanong*, *Akikah*, and *Mandi Bayi* incorporate *Cocos nucifera*, *Curcuma longa*, and *Oryza sativa* for purification, protection, and prosperity. Marriage ceremonies, including *Akad Nikah* and *Betangas*, utilize *Piper betle*, *Areca catechu*, and *Lawsonia inermis*, reinforcing fertility rites, social bonding, and personal purification before marriage. Rituals related to the spirit world, such as *Berumpan* and *Bebuang* feature *Jasminum sambac* and *Nicotiana tabacum*, which are believed to dispel negative energies and fortify spiritual resilience. Meanwhile, community-wide ceremonies such as *Robo-robo* and *Nopen* emphasize ancestral reverence and social unity, often involving food offerings made from *Oryza sativa*, *Saccharum officinarum*, and *Cocos nucifera*, reinforcing cultural identity and gratitude toward ancestors. These practices demonstrate the essential role of plants not only as ritual tools but also as mediators of social meaning and cosmological balance.

Ethnobotanical analysis highlights *Sengkelan Kanong* (25 species), *Pesta Pernikahan* (20 species), and *Betangas* (19 species) as the most botanically diverse rituals, reflecting their complex ceremonial functions (Figure 4). In contrast, specialized rituals like *Berpacar* and *Bepentik* involve fewer plant species, indicating localized cultural significance. The frequent use of *Piper betle* (14 rituals), *Cocos nucifera* (13 rituals), and *Areca catechu* (11 rituals) underscores their central role in fertility, purification, and communal traditions. These findings reveal a highly structured ritual plant system, demonstrating the interwoven relationship between ethnobotanical knowledge and cultural identity, reinforcing the importance of preserving ritual plant use as a key component of Malay heritage in West Kalimantan.

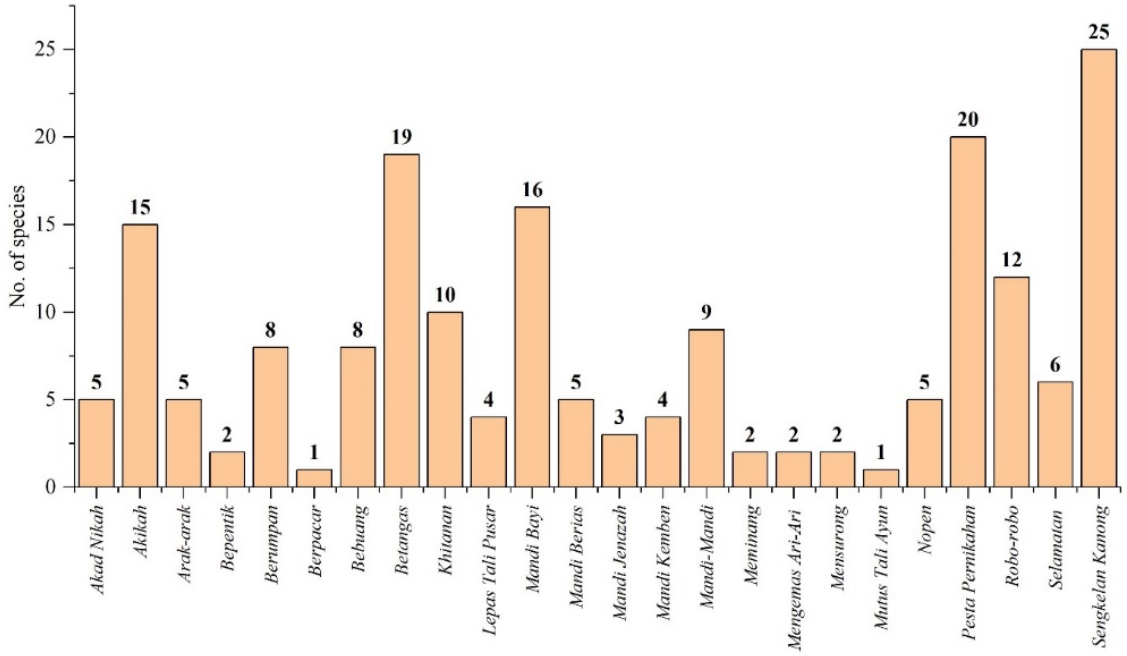


Figure 4. Rituals and their associated plant species in the Malay community of Sintang

Certain plant species play prominent roles across multiple rituals, with *Piper betle* (14 rituals, UR = 3029), *Cocos nucifera* (13 rituals, UR = 2347), and *Areca catechu* (11 rituals, UR = 1748) emerging as the most frequently utilized species (Figure 5). Their high usage frequency highlights their importance in social bonding, fertility rites, and purification practices. Fidelity Level (FL) analysis further reveals species with high ritual specificity, such as *Mangifera indica*, *Cucumis sativus*, *Cucurbita pepo*, and *Manihot esculenta* (FL = 100%), which are strongly associated with postnatal blessings and infant bathing due to their protective and revitalizing properties (Figure 6). Similarly, *Biancaea sappan* (FL = 100%) is central to *Akad Nikah*, symbolizing purity and the transition into married life. Purification rituals such as *Betangas* prominently feature *Cinnamomum verum* and *Syzygium aromaticum* (FL = 100%), reinforcing their cleansing and therapeutic functions in traditional steam baths.

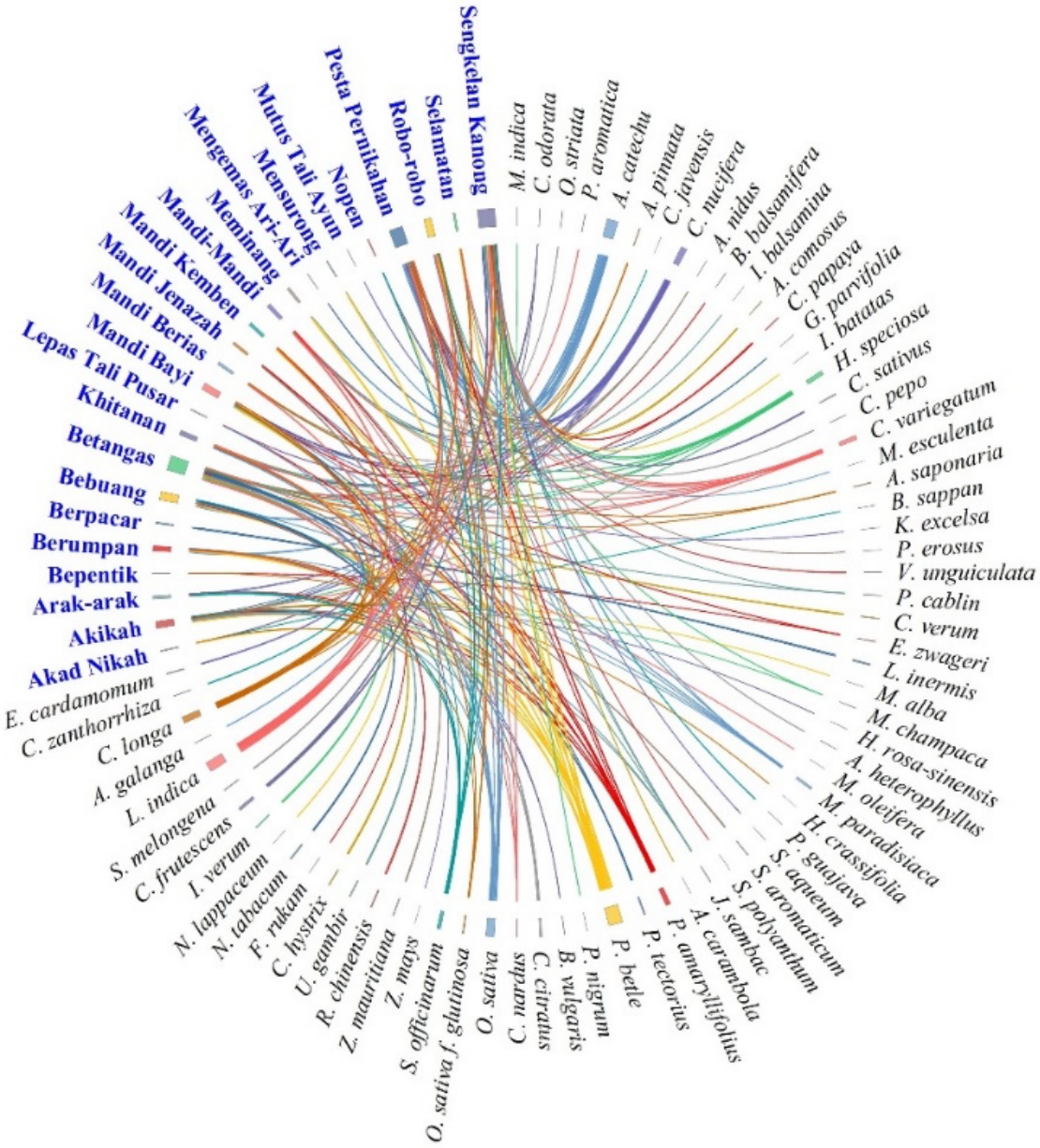


Figure 5**.** Distribution of 24,357 use reports across 68 plant species and 24 different ritual categories

Beyond these widely recognized Malay rituals, *Nopen* and *Bepentik* stand out as unique ceremonial traditions of the Sintang Malay community, reflecting localized cultural adaptations and interethnic exchanges. *Nopen*, a matrimonial ritual where close family members of the bride and groom cover their faces, fosters festivity and kinship bonding, with *Areca catechu* and *Piper betle* playing key symbolic roles in marital unity, fertility, and social cohesion (Figure 7). Meanwhile, *Bepentik*, originally a Dayak ritual, has been preserved among the Sintang Malays in the Sungai Tebelian sub-district, showcasing cultural

syncretism between Dayak and Malay traditions. This ritual integrates both indigenous animistic elements and Islamic spiritual beliefs, utilizing *Eusideroxylon zwageri* and *Horsfieldia crassifolia* for protection (Figure 8).

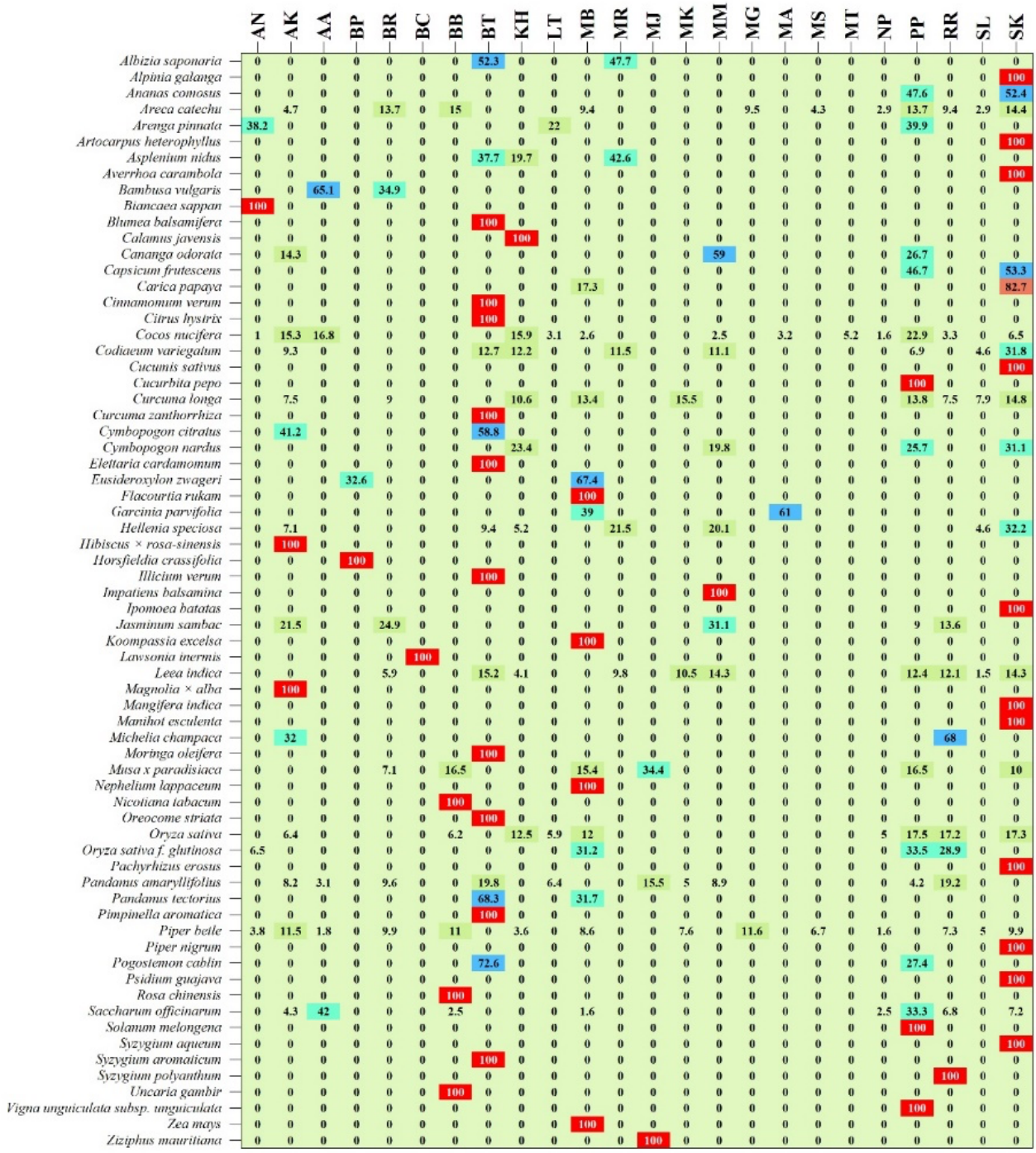


Figure 6**.** Fidelity Level (FL) of plants used in rituals*.* AN = *Akad Nikah*; AK = *Akikah*; AA = *Arak-arak*; BP = *Bepentik*; BR = *Berumpan*; BC = *Berpacar*; BB = *Bebuang*; BT = *Betangas*; KH = *Khitanan*; LT = *Lepas Tali Pusar*; MB = *Mandi Bayi*; MR = *Mandi Berias*; MJ = *Mandi Jenazah*; MK = *Mandi Kemben*; MM = *Mandi-Mandi*; MG = *Meminang*; MA = *Mengemas Ari-Ari*; MS = *Mensurong*; MT = *Mutus Tali Ayun*; NP = *Nopen*; PP = *Pesta Pernikahan*; RR = *Robo-robo*; SL = *Selamatan*; SK = *Sengkelan Kanong*

Figure 7. Ethnographic illustration of the *Nopen* matrimonial ritual among the Sintang Malay, featuring symbolic plants and performative disguise

Figure 8. Ethnographic illustration of the *Bepentik* (*Tolak Bala*) ritual among the Sintang Malay, highlighting protective stakes and Islamic supplication

Ethnobotanical importance of ritual plants

The Relative Frequency Citation (RFC) and Cultural Importance Index (CI) analyses provide a comprehensive understanding of the most culturally significant ritual plants within the Malay community of Sintang, emphasizing their ritualistic, symbolic, and medicinal functions (Figure 9). These indices highlight the plants that hold the highest cultural relevance and frequency of use in traditional ceremonies, reflecting their deep-rooted spiritual significance and social utility.

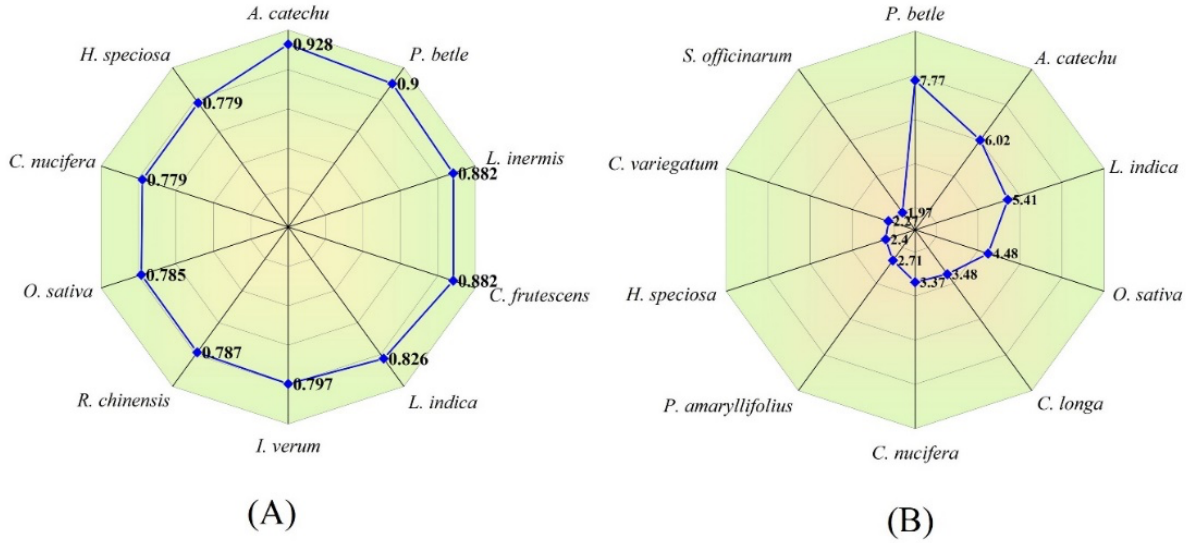


Figure 9. Relative Frequency Citation (RFC) (A) and Cultural Importance Index (CI) (B) of ritual plants

Among the most culturally significant species, *Areca catechu* (RFC = 0.928, CI = 6.02) and *Piper betle* (RFC = 0.900, CI = 7.77) emerge as the most frequently cited and symbolically embedded plants. Their high usage underscores their pivotal role in social, marital, and purification ceremonies, particularly in betel quid preparation, fertility rites, and ritual offerings. These plants play a crucial role in reinforcing kinship bonds, protection, and prosperity across various ceremonial contexts. Other notable species include *Lawsonia inermis* (RFC = 0.882, CI = 0.88) and *Capsicum frutescens* (RFC = 0.882; CI = 1.65), which hold significant importance in ritual body adornment and postnatal rites, symbolizing protection, renewal, and transitional blessings. *Leea indica* (RFC = 0.826, CI = 5.41) and *Illicium verum* (RFC = 0.797) are commonly utilized in cleansing and aromatic purification rituals, reflecting their perceived ability to ward off negative energies and enhance spiritual well-being.

Several staple plants are integral to blessing ceremonies and prosperity-related traditions, such as *Oryza sativa* (RFC = 0.785, CI = 4.48) and *Rosa chinensis* (RFC = 0.787, CI = 0.79), which symbolize abundance, fertility, and purity. *Cocos nucifera* (RFC = 0.779, CI = 3.37) and *Hellenia speciosa* (RFC = 0.779, CI = 2.40) are frequently associated with purification and postnatal rituals, emphasizing their protective and healing properties in traditional Malay healing practices. Moreover, *Pandanus amaryllifolius* (RFC = 0.536, CI = 2.71) is strongly linked to aromatic cleansing rituals and ancestral reverence, playing a central role in maintaining spiritual harmony. *Codiaeum variegatum* (RFC = 0.723, CI = 2.27) is an essential component in *tepung tawar* purification ceremonies, reinforcing spiritual protection and renewal. The presence of *Saccharum officinarum* (RFC = 0.656, CI = 1.97) in offerings and communal feasts signifies sweetness, unity, and fertility, symbolizing harmony and blessings during traditional ceremonies.

Transmission of indigenous knowledge on ritual plants

The transmission of ritual plant knowledge in the Sintang Malay community is primarily sustained through intergenerational oral traditions, with elders and parents serving as the primary custodians (26.6%) (Figure 10). This underscores the pivotal role of familial inheritance in preserving ethnobotanical knowledge, where traditional plant use is deeply embedded within household practices and ceremonial customs. In addition, social networks, including friends (18.7%) and neighbors or the broader community (18.1%), contribute significantly to knowledge exchange, reinforcing the communal nature of knowledge transmission. Despite the dominance of oral traditions, formal education (8.7%), books and printed materials (4.5%), and cultural or religious leaders (3.7%) play only a minimal role in perpetuating ritual plant knowledge. This suggests that while indigenous knowledge remains integral to community life, its limited presence in structured educational and religious frameworks poses a challenge to long-term conservation. Notably, digital media (10.2%) is emerging as an alternative knowledge source, indicating a shift in transmission pathways, particularly among younger generations who increasingly rely on online platforms to learn about traditional practices.

Statistical analysis reveals significant variations in ritual plant knowledge based on age and education level, whereas gender differences appear negligible. The chi-square test (χ^2 = 58.132, p = 0.078) indicates that gender does not significantly influence knowledge levels, although female respondents (58.11 ± 2.11) demonstrated a slightly higher mean number of

plants identified than males (52.18 ± 1.22) (Table 4). This aligns with broader ethnobotanical trends where women play a central role in cultural transmission, particularly in household-based rituals and healing practices. Age emerges as a critical determinant of ritual plant knowledge retention. The Kruskal-Wallis test (W = 53.249, p = 0.0001) confirms that older respondents possess significantly greater ritual plant knowledge. Individuals aged 75-85 exhibited the highest mean knowledge (59.03 ± 1.41), followed by those aged 66-75 (58.29 ± 2.10) and 46-55 (52.18 ± 3.22), while the youngest respondents (15-25 years) reported the lowest levels (32.48 ± 3.22). This trend suggests an ongoing decline in intergenerational knowledge transmission, likely driven by modernization, urbanization, and changing cultural practices. Education level also plays a significant role in knowledge retention, as evidenced by the Kruskal-Wallis test (W = 37.416, p = 0.0001). Respondents with only elementary education exhibited the highest mean knowledge (53.11 ± 1.02), whereas those with higher education had the lowest (41.16 ± 0.32). This inverse correlation suggests that formal education, which prioritizes standardized curricula over indigenous knowledge systems, may inadvertently contribute to the erosion of ethnobotanical wisdom.

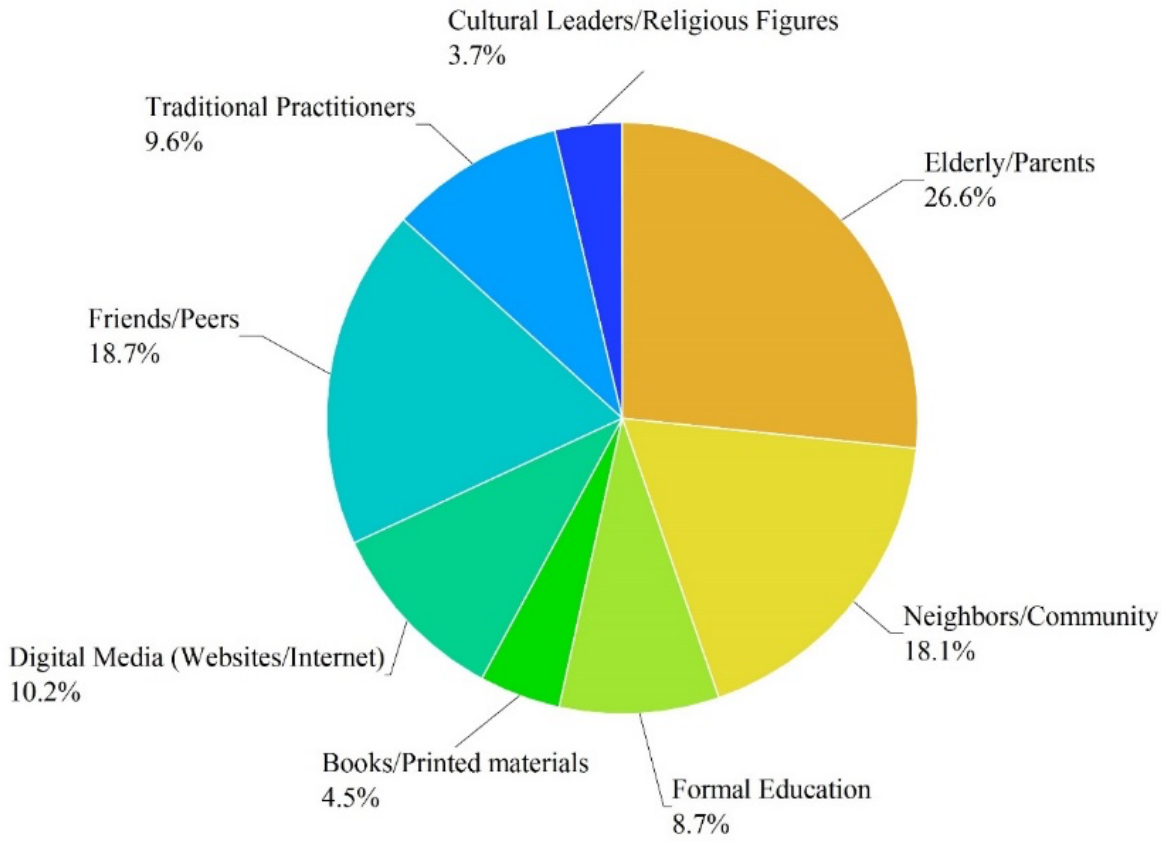


Figure 10. Sources of knowledge transmission of ritual plants in the Malay communities of Sintang

Discussion

The ethnobotanical knowledge and ritualistic use of plants within the Malay community of Sintang illustrate a deeply rooted connection between culture, spirituality, and ecology. Biodiversity plays a central role in ceremonial expressions, as demonstrated by the documentation of 68 ritual plant species used across 24 distinct traditional ceremonies. The predominance of tree species (38.03%) and herbs (32.39%) suggests that ritual plants are not only widely accessible but also integrated into the local agroecosystem. Additionally, the high proportion of cultivated species (77.9%) compared to wild species (22.1%) reflects a sustainable agroforestry-based management strategy, ensuring a steady supply of culturally significant flora. These findings align with broader ethnobotanical trends in Southeast Asia, where species from the Poaceae, Fabaceae, and Arecaceae families play significant ecological, medicinal, and ritualistic roles (Bidin 2017; Cordero *et al*. 2022; Sutjaritjai *et al*. 2022). The widespread utilization of these plant families in various ceremonies mirrors other cultural traditions, such as the Manobo tribe's reliance on Arecaceae and Poaceae for ritual practices (Jamera *et al*. 2020) and Bali's *Ngusaba* ceremonies, where Poaceae species are extensively used (Ratnani *et al*. 2021). Comparable use of cultivated and wild plants for ritual purposes is observed among the Serampas people of Sumatra, where 32 ritual plant species—many of

them food crops—are integrated into ceremonial cycles such as *Selamatan ruso* and *Kenduri pusako***,** signifying a long-standing syncretism of ecological practice and spiritual cosmology (Hariyadi & Ticktin 2012)**.** Similarly, in Gokwe South district, Zimbabwe, ritual and sacred uses are among seven primary ethnobotanical categories, with 89 plant species—mainly from Fabaceae and Euphorbiaceae—being central to community rites and ecological functions (Shopo *et al*. 2022). Even in diaspora settings, such as the Afro-Caribbean *botánicas* of Miami-Dade County, Florida, ritual plant selection emphasizes accessible and potent species, often exotic or invasive, underscoring the flexibility and adaptability of religious ethnobotany in urban environments (Herrera *et al*. 2021). The documentation of these traditions not only underscores their cultural significance but also serves as a crucial step toward preserving traditional knowledge and heritage.

Table 4. Comparison of respondent subgroups based on indigenous knowledge of ritual plants in the Malay community

Variable	Total respondents	The average number of ritual plants identified	Statistical test	*p*-value
Gender			$\chi 2$ = 58.132	0.078
Male	187	52.18 ± 1.22		
Female	203	58.11 ± 2.11		
Age			*W* = 53.249	**0.0001**
15-25	135	32.48 ± 3.22		
26-35	62	41.33 ± 2.32		
36-45	68	49.62 ± 2.30		
46-55	46	52.18 ± 3.22		
56-65	52	41.35 ± 2.22		
66-75	19	58.29 ± 2.10		
75-85	8	59.03 ± 1.41		
Level Education			*W* = 37.416	**0.0001**
Elementary School	33	53.11 ± 1.02		
Junior High School	71	42.44 ± 0.36		
Senior High School	191	43.28 ± 1.12		
Higher Education	95	41.16 ± 0.32		

Beyond species diversity, the selection of plant parts used in rituals reveals the deep symbolic meanings attached to different botanical components. Leaves (29.6%) and fruits (26.8%) emerge as the most frequently utilized plant parts, primarily associated with purification, fertility, and ceremonial offerings. Leaves are widely incorporated into cleansing rituals, believed to dispel negative energies, while fruits, commonly used in offerings and feasting traditions, symbolize abundance and renewal. The ritual use of tubers and rhizomes (4.2% each) corresponds with similar traditions in African and Amazonian communities, where underground plant parts are often linked to spiritual fortification and ancestral reverence (Batista *et al*. 2020; Nicosia *et al*. 2022). By contrast, in Vietnamese and Filipino ritual practices, bark and resin are extensively used for healing and divination (Jamera *et al*. 2020), whereas in the Malay Sintang community, these plant parts (bark 2.8%, sap 1.4%) are reserved for sacred anointing and high-status ceremonies, reinforcing their unique cultural significance. Among the Osage people in Oklahoma, USA, ritual firewood selection—emphasizing slow-burning, low-spark woods like *Quercus shumardii*—represents both symbolic and functional dimensions of plant part selection in a religious ceremony, echoing similar care in the use of leaves and fruits for symbolic efficacy (Swan & Simons 2014). Likewise, in the sub-Himalayan tract of Uttarakhand, herbs (59%) dominate magico-religious practices, with whole plants and fruits used for sacred offerings and spiritual protection, reflecting cultural equivalencies in symbolic plant part use (Sharma *et al*. 2022).

However, environmental pressures threaten the continued availability of certain key species. The population decline of ritual plants such as *Horsfieldia crassifolia* and *Eusideroxylon zwageri*, driven by deforestation and habitat loss, poses a challenge to the continuity of these traditions. While other indigenous groups, such as the Karen community in Thailand, have implemented conservation policies to protect sacred groves (Duker & Klanarongchao 2022; Pongsermpol & Chukaew 2022), the Malay Sintang community lacks formal mechanisms for safeguarding its ritual plant sites. The absence of such protections has already led to declining plant availability, habitat degradation, and shifts in ritual practices. Without dedicated conservation efforts, key ritual plant species are becoming increasingly scarce due to deforestation, agricultural expansion, and logging activities. This decline causes societies to either substitute alternate species, which may alter the symbolic and spiritual values of rituals or abandon particular traditions entirely. Furthermore, the loss of ritual plant habitats contributes to the erosion of indigenous knowledge, particularly among younger generations, who are experiencing reduced exposure to traditional practices due to modernization and urbanization.

The unique ceremonial traditions of *Nopen* and *Bepentik* further illustrate the cultural complexity and adaptive nature of ritual practices in Sintang. Unlike other Malay societies in Indonesia and Malaysia, which have experienced significant Islamic homogenization in their traditional ceremonies, the Malay Sintang community has maintained a distinctive blend of indigenous and Islamic practices. *Nopen*, a matrimonial ritual, is typically performed during wedding receptions and involves close relatives of the bride and groom concealing their identities with theatrical costumes, exaggerated makeup, or masks. These performances, often initiated by the kitchen committee after completing their culinary responsibilities, create a festive environment of humor and interaction that reinforces kinship bonds and communal cohesion. Though comedic in appearance, *Nopen* is rooted in collective memory and traditional ecological knowledge. The ritual incorporates several plant species with symbolic roles, such as *Piper betle* and *Areca catechu*, chewed together as emblems of marital union and fertility; *Cocos nucifera*, used decoratively and functionally as containers; and *Saccharum officinarum* and *Oryza sativa f. glutinosa*, representing sweetness, abundance, and prosperity. Their selection reflects an orthopraxic ritual structure, where material precision outweighs textual doctrine—a pattern consistent with ritual systems across Southeast Asia (Sujarwo *et al*. 2020; Jeniver *et al*. 2024). In this way, *Nopen* functions not only as performative art but also as a medium for transmitting intergenerational cultural values and ecological literacy.

Bepentik, while originally rooted in Dayak tradition, has been reinterpreted within the Islamic framework of the Sintang Malays, particularly in the Sungai Tebelian sub-district. Among the Malay Sintang community, this ritual is also widely known as *Tolak Bala*—meaning "to repel misfortune"—reflecting its central function as a spiritual mechanism to ward off collective calamity. The Dayak version involves carved ritual stakes, chants, and offerings to ancestral spirits, whereas the Malay adaptation employs uncarved stakes made from *Eusideroxylon zwageri* and *Horsfieldia crassifolia*, which are strategically placed at village boundaries. These species are chosen for their strength and spiritual potency and serve as protective boundary markers. The ritual sequence begins with the symbolic staking of *Eusideroxylon zwageri* and *Horsfieldia crassifolia* wood in designated locations, followed by the recitation of *zikir* (Islamic remembrance) and selected Qur'anic verses by religious leaders. This marks a cultural transition from earlier animistic offerings of material substances to verbal Islamic supplications, while retaining botanical elements and spatial symbolism from pre-Islamic traditions. Ethnographic insights indicate that *Bepentik* is conducted only in response to extraordinary disruptions, such as disease outbreaks or environmental crises. Its rare enactment and solemnity position it as a high-threshold communal ritual deployed during times of cosmological imbalance. This mirrors patterns in other Southeast Asian ritual systems, where plant symbolism, sacred space, and prayer converge in context-specific spiritual responses (Sujarwo *et al*. 2020; Jeniver *et al*. 2024).

Unlike other Malay communities, where state-driven religious standardization has led to the replacement of pre-Islamic botanical traditions with Islamic healing practices (Abdullah & Nasir 2017; Kamarudin *et al*. 2020; Moiden & Liaw 2021), the geographical isolation of Sintang has facilitated the preservation of animistic and indigenous ritual elements. Additionally, the long history of interethnic coexistence with Dayak groups has reinforced syncretic traditions, as evidenced in *Bepentik*, where animistic purification rites persist alongside Islamic prayers. This interethnic exchange has not only shaped ceremonial practices but also preserved a distinct ethnobotanical knowledge system, reflected in the continued use of species such as *Cocos nucifera* and *Curcuma longa* in purification and transitional rites. The persistence of these practices underscores the importance of safeguarding them as components of intangible cultural heritage (Radzuan *et al*. 2024; Wang & Zaibon 2024). Moreover, these findings enrich wider discourses on religious pluralism and cultural sustainability, offering insight into how marginalized communities negotiate evolving spiritual identities while maintaining ancestral traditions amid the pressures of globalization and socio-religious transformation.

The transmission of ritual plant knowledge within the Malay Sintang community is primarily influenced by age and education level, whereas gender differences appear to have a negligible impact. Women exhibit slightly higher levels of ritual plant knowledge, a pattern observed globally where women serve as primary custodians of cultural traditions (De Vera & Fajardo 2018; Da Costa *et al*. 2021; Teixidor-Toneu *et al*. 2021). However, modernization, changing lifestyles, and reduced intergenerational interactions pose significant threats to the continuity of this knowledge. The increasing preference for formal education over indigenous knowledge further accelerates this decline, as modern curricula often fail to integrate ethnobotanical traditions, reducing opportunities for younger generations to engage with cultural and ecological heritage. Moreover, shifting family structures from extended to nuclear households weakens direct knowledge transmission, limiting immersion-based learning essential for preserving traditional practices (Hau 2015; Putra 2020). Environmental degradation exacerbates this issue, as the expansion of palm oil plantations, mining, and infrastructure projects continues to reduce natural habitats for ritual plants, restricting accessibility and diminishing their cultural relevance (Meyer & Wallace 2017; Sibhatu 2023). The economic commercialization of ritual plants further complicates conservation efforts, as economic

incentives often overshadow traditional values, leading to unsustainable harvesting practices. Addressing these challenges requires a multifaceted approach that includes integrating ethnobotanical knowledge into formal education, developing digital documentation initiatives, and fostering community-based learning programs. Strengthening intergenerational knowledge-sharing through cultural workshops led by elders is particularly crucial for ensuring the sustainability of ritual plant traditions.

While this study primarily focuses on documenting the diversity of plant species and their functional roles in ritual practices, deeper community perceptions and meanings behind these rituals—particularly their spiritual, ecological, and socio-cultural benefits—remain areas for further exploration. Preliminary findings from informal interviews with key informants indicate that these rituals are not merely symbolic performances but are perceived as essential acts of maintaining cosmic balance, ancestral connection, and environmental harmony. Spiritually, rituals are viewed as means of cleansing the body and soul, offering protection from unseen forces, and honoring ancestral spirits believed to influence daily life. Socially, ritual events such as *Robo-robo* and *Selamatan* reinforce communal cohesion, intergenerational knowledge transfer, and cultural identity. For instance, *Robo-robo*, which commemorates the arrival of Malay nobility and their blessings, serves as a platform for unifying community members across generations and religious backgrounds (Azizah *et al*. 2023). Ecologically, many ritual practices reflect an embedded environmental ethic, evident in the selective use of plants that follow seasonal cycles, support sustainable harvesting, and recognize sacred landscapes. This is consistent with patterns observed in other indigenous traditions, where plant use in rituals is guided by customary ecological knowledge that integrates spiritual meaning with biodiversity conservation (Geng *et al*. 2017; Panda *et al*. 2024). Such traditions favor cultivated over wild species to minimize ecological impact, highlighting the community's adaptive strategies for preserving both cultural heritage and useful biodiversity.

Overall, this study underscores the critical role of ritual plants in Malay Sintang cultural practices, demonstrating their symbolic, medicinal, and ecological significance. The findings contribute to the broader ethnobotanical discourse by examining the interplay between religious adaptation, cultural transmission, and environmental sustainability. To safeguard these traditions, it is essential to integrate ritual plant knowledge into conservation policies, formal education curricula, and digital knowledge archives. Future research should explore how globalization influences the meaning and use of ritual plants while also assessing the effectiveness of conservation strategies, including community-led initiatives and government-supported biodiversity protection programs. By addressing these challenges, this study provides a foundation for sustaining the ethnobotanical traditions of the Malay Sintang community, ensuring their resilience amid socio-environmental transformations.

Conclusion

This study demonstrates a strong interrelation between ritual plant use, cultural identity, and ecological knowledge in the Malay community of Sintang. Addressing the initial objectives, the research successfully documented the diversity of 68 ritual plant species across 24 ceremonies, identified their cultural importance through ethnobotanical indices, and revealed significant generational gaps in knowledge transmission. These findings underscore the urgency of strengthening intergenerational education and cultural preservation. Moving forward, the results offer a foundation for the development of local biocultural conservation strategies, including community-based initiatives, policy integration, and digital archiving. Future research should explore participatory conservation models and the role of ritual plants in adaptive resilience to environmental change. This ethnobotanical documentation contributes to global efforts in safeguarding biocultural heritage and supports the integration of traditional ecological knowledge into sustainable development policies.

Declarations

Ethics approval and consent to participate: The study obtained ethical clearance from the Ethics Committee on Social Studies and Humanities of the National Research and Innovation Agency (NRIA), with approval number 697/KE.01/SK/08/2024. Permission was taken from the head of the sub-district of Sintang, Kelam Permai, and Sungai Tebelian before data collection. Oral agreements were obtained from local respondents, and all field data were collected through their oral approval.

Consent for publication: Not applicable

Availability of data and materials: Not applicable

Competing interests: Not applicable

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Author contributions: ABS, ZIN, IHS, E, and HE carried out fieldwork and data analysis. ABS configured the research project. ABS and ZIN drafted the manuscript. All authors read, reviewed, and approved the final version of the manuscript.

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