Ethnomedicinal study of medicinal plants used by the Melanau Igan Community of Sarawak

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Research

Abstract

Background: The Melanau Igan community is a distinctive subgroup of the larger Melanau ethnic group. What sets the Melanau Igan apart from other Melanau communities is their unique dialect and cultural characteristics. The present study was conducted to document the herbal medicinal plants used by this community, and the cultural, geographical, and historical dimensions that shape this ethnomedicinal system.

Methods: A total of 71 respondents from five Melanau Igan villages were interviewed in this study. The results were evaluated based on the plant's total use-reports, number of respondents citing the plant, and use-reports by ailment category. Moreover, the similarity with other neighboring ethnic groups were calculated.

Results: The 71 respondents in this study cited 72 plant species with a total of 596 use reports. Fever, headaches, skin issues, diabetes, and hypertension are the most common ailments treated with traditional medicine in the Melanau Igan community. *Hibiscus rosa-sinensis*, *Citrus aurantifolia*, *Psidium guajava*, *Ageratum conyzoides* and *Citrus limon* play prominent roles in the traditional medicine of the community, being the top five plants with the most respondent citations.

Conclusions: A distinctive feature of the Melanau Igan community's ethnomedicine is the significant role of women in traditional healing due to their household and caregiving responsibilities. The uniqueness of the community's traditional medicine is influenced by historical and cultural factors, while geographical proximity does not guarantee similarity. Their coastal lifestyle, historical associations, and cultural ties with Malays shape their ethnomedicinal practices, underscoring the importance of considering these contexts when studying traditional medicine in Borneo.

Keywords: Ethnobotany; Tropical forest herbs; Borneo; Southeast Asia; Traditional medicine

Background

Sarawak's population of nearly three million is characterized by diversity, comprising over 30 sub-ethnic groups, each with its own unique culture, language, and way of life. The major ethnic groups in Sarawak include the Iban, Malay, Bidayuh, Chinese, Melanau, Orang Ulu, and several smaller groups collectively referred to as "others." The Melanau are the fifth-largest ethnic group in Sarawak, with a population of over 120000 (Inai et al. 2020). They primarily reside along the southwest coastal areas of Sarawak, namely Rejang, Paloh, Belawai, Daro, Matu, Igan, Oya, Mukah, Bintulu, Dalat, Medong, Kut, Narub, Balingian, Kanowit, and Tatau (Inai et al. 2020). Historically, the Melanau people practiced their own indigenous believes, but today they are predominantly Muslims, and a small minority are Christians (Long & Chik, 2020).

The Melanau people have traditionally been involved in a variety of economic activities, including fishing, sago palm planting, boat making, carpentry, and blacksmithing (Long & Chik, 2020). As a coastal community, they are closely connected to the river and sea, which are their pillars of economy and culture (Inai et al. 2020). The Melanau are culturally very similar to the Malays, especially Melanau Muslims. This is due to Malay traders marrying Melanau women in the 19th century, which led to the Islamization of the Melanau people (Morris, 1978). Alongside conversion, Melanau communities began adopting Malay culture, including food, clothing, and traditions. Even their houses gradually changed from longhouses, which is common in Sarawak, to kampung-style Malay houses. However, the Melanau are distinct from Malays. They have a unique and rich cultural heritage, including traditional religious practices such as Bebayuh and Kaul Festival that are still practiced by some Melanau communities, as well as a unique dialect that differs from other ethnic groups in Sarawak, including Malays (Inai et al. 2020).

In fact, the different dialects spoken by the Melanau is not only different from the Malays, but it even differs within the Melanau community itself. Melanau dialects differ in every region and every district (Long & Chik, 2020). The Melanau dialects can be grouped into 5 different classifications, largely depending on their geographic location. These differences sometimes even go beyond dialects, as there can sometimes be minor differences in culture and traditions. Thus, when studying the culture of Melanau, like ethnomedicinal practices, it is important to consider the regional variation within specific Melanau groups and not to group the entire ethnicity as a whole. Some of these groups are Melanau Matu-Daro, Melanau Bruit, Melanau Seduan, Melanau Dalat, Melanau Oya, and Melanau Igan. The Melanau Igan are a unique Melanau subgroup, as they consist of two intertwined groups: Muslims and those who still adhere to traditional Melanau indigenous believes.

Like most Sarawakian communities, Melanau communities rely on herbs for their traditional medicine. Even though modern medicine is widely available nowadays, traditional medicine is still performed in some Sarawakian villages (Ripen & Noweg, 2016). However, like most parts of the world, this knowledge is at risk of going extinct due to rapid modernization (Christensen, 2002). Sarawak's high biodiversity (Rajoo et al., 2021) and diverse population have led to a variety of unique ethnomedicinal systems. Though, there is limited ethnomedicinal research in Sarawak and Borneo as a whole. The few studies that have been conducted focused on major ethnicities like the Iban and Bidayuh (Christensen, 2002), or were conducted almost a century ago (Nieuwenhiuis, 1929; Burkill & Haniff, 1930).

Despite the rich cultural heritage of the Melanau, there are very few ethnomedicinal studies focusing on this ethnic group. The few studies that have been conducted fail to distinguish between the different Melanau sub-ethnic groups (Omar & Latip, 2022; Arshad et al. 2023), and do not attempt to understand the cultural and historical dimensions of Melanau traditional medicinal customs. Furthermore, considering the cultural affinities shared by the Melanau people with the Malays, it is imperative to undertake research aimed at comprehending these influences, as well as to ascertain the extent to which they have shaped the Melanau ethnomedicinal practices.

Therefore, this study was conducted to document the ethnomedicinal knowledge of the Melanau, or more precisely, the Melanau Igan community. The main objectives of this study are: 1) To identify and document the medicinal flora used by the Melanau Igan community, and 2) To determine the cultural, geographical and historical influences of the Melanau Igan's traditional medicine.

Materials and Methods

Melanau Igan Community

The Melanau are traditionally a seafaring people (Figure 1), and they mainly reside in coastal villages and depend on the sea or rivers for their livelihoods (Long & Chik, 2020). They are skilled fishermen, boat builders, and sago processors. The Melanau

are also known for their beautiful handicrafts, such as their woven baskets and mats. They may share a cultural affinity with the Malays, but they have their own unique traditions, cultural identity and language which is different with that of Sarawak Malays (Morris, 1978; Long & Chik, 2020).

Figure 1. A Melanau fishing jetty at Kampung Baru Dagang

The Melanau have a strong sense of community and are known for their hospitality and their love of festivals. The Kaul festival is the most important Melanau festival, and it is celebrated annually as a form of "cleansing" to rid of uninvited spirits and other bad omens by escorting them out of the village via a flotilla of boats (Morris, 1978). The festival also includes ceremonial offerings of food, cigarettes, and betel nut, which is set on the Seraheng at the river mouth. The Seraheng is an intricately decorated pole (Arshad et al. 2023).

The Melanau consists of several distinctive subgroups, each with their own unique dialects. These variations are found in different regions and districts and can be grouped into five classifications, primarily based on geographical location (Long & Chik, 2020). These differences extend beyond just language, often encompassing variations in culture and traditions. Although predominantly Muslims, there are some Melanau communities who are Christians and a small minority who still practice traditional animistic believes. This further increases the variation between the different Melanau groups. In this regard, the Melanau Igan are a unique Melanau subgroup as they consist of both Muslims and members who still adhere to the traditional Melanau believes.

The Melanau Igan community is a distinctive subgroup of the larger Melanau ethnic group. As of the year 2020, the estimated population of Melanau Igan is less than 3000, mainly residing at Kampung Igan. What sets the Melanau Igan apart from other Melanau communities is their unique dialect and cultural characteristics.

The Melanau Igan are distinguished from other Melanau groups by their unique dialect, which is divided into two sub-dialects: Melanau Igan and Keling. The key difference between these two groups is their origin. The Keling dialect is similar to Sarawak Malay but has "evolved" over time. The Melanau who speak Keling were originally from Kuching and migrated to Kampung Igan centuries ago. They embraced certain beliefs and customs of Sarawak Malays, some of which are still

practiced to this day. In contrast, the Melanau who do not speak Keling still retain some knowledge of traditional Melanau beliefs and practices, such as the Kaul festival. Their believe system is more animistic, including believing in spirits residing in nature. Most non-Keling Melanau in Kampung Igan originated from Kampung Mudan, which no longer exists but is still home to their ancestral burial grounds.

Regardless, both groups identify as “Melanau Igan”, and the combination of Sarawak Malay and Keling culture has provided a unique cultural identity to the Melanau Igan community, making them a distinctive subgroup of the larger Melanau ethnic group.

Study Area

The research was conducted in Kampung Igan, situated in Mukah, Sarawak, Malaysia (latitude 2°49'18.7" N, longitude 111°42'34.3" E). Kampung Igan is predominantly inhabited by the Melanau Igan community and comprises five distinct villages: Kampung Baru Dagang, Kampung Baru Ismail, Kampung Pulau, Kampung Tengah, and Kampung Sekerang (Figure 2).

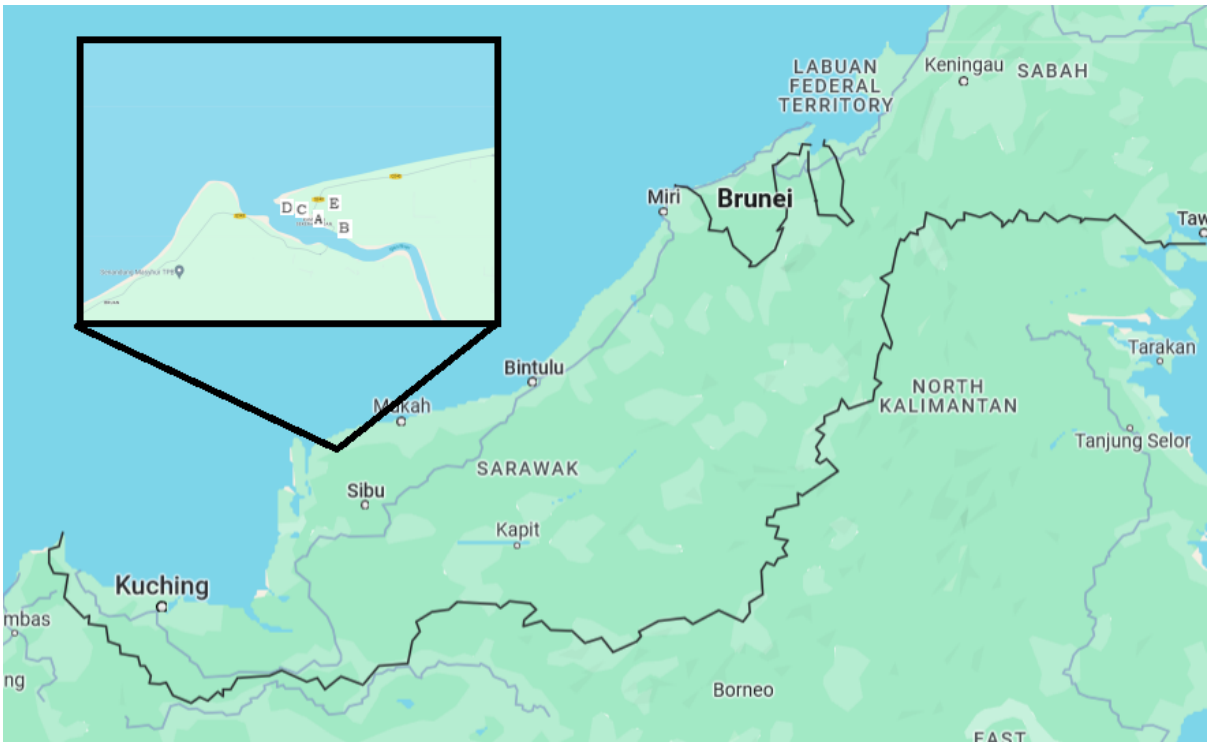

Figure 2. Location of the study sites. (A: Kampung Baru Dagang, B: Kampung Baru Ismail, C: Kampung Pulau, D: Kampung Tengah, and E: Kampung Sekerang).

Each of these villages consists of approximately 100 households, in Malay styled kampung houses (Figure 3). All five villages were included in the study to ensure an adequate number of respondents. The primary demographic in these villages is Melanau Igan, with a minority population of Iban (approximately 5%). Kampung Igan is strategically located along the Sungai Batang Igan riverbank, which connects to the South China Sea, and is surrounded by forested landscapes and small-scale oil palm plantations.

Figure 3. Malay style village houses at Kampung Igan

Data Collection

The study used face-to-face ethnobotanical surveys (Figure 4) to collect data from practitioners with extensive traditional medicinal knowledge. Structured and semi-structured interviews were used, following Rigat et al. (2007). The selection of respondents was based on practitioners of traditional medicine. Potential respondents were identified through preliminary interviews and word-of-mouth recommendations within the community. The five villages in Kampung Igan (Kampung Baru Dagang, Kampung Baru Ismail, Kampung Pulau, Kampung Tengah, and Kampung Sekerang) were chosen as they are predominantly inhabited by the Melanau Igan community, ensuring a representative sample of the target population. All participants were informed of the purpose of the study and consent was obtained prior to conducting the interviews and surveys. Since most of the men were fishermen, they were visited at home after their workdays. Whereas for housewives, there were usually visited in late mornings or early evenings since these were the periods they had completed most household chores and were available. Translators were employed to ensure accurate communication. The demographic characteristics of the interviewees (education, age, and gender) and the plants they used for medicinal treatments (including their local (common) and scientific names, treatments, preparation methods (Figure 5), utilized parts, knowledge transfer, and opinions on traditional medicine) were also recorded.

Species identification

Dendrologist Mr. Philip Lepun assisted with the botanical identification of plants based on samples, common names, field identification (Figure 6) and existing literature. Voucher specimens of the identified plant species can be found at the Herbarium of Universiti Putra Malaysia (UPM) and Universiti Putra Malaysia Bintulu Sarawak Campus (UPMKB). Scientific names were verified using the Medicinal Plant Names Services (https://mpns.science.kew.org) and WFO Plant List (https://wfoplantlist.org/plant-list/). Respondents listed a total of 72 plants, with their common and scientific names provided in Table 1.

Figure 4. Interview with herbal medicine practitioner.

Figure 5. A respondent demonstrating how traditional medicine is applied.

Table 1. List of species mentioned by respondents

Species/Specimen code	Common name	Wild/Cultivated/Exotic
Acanthus arboreus Forssk. / UPMM0001	Daun geligei	Wild
Acorus calamus L. / UPMK0033	Daun Jerangu	Wild
Ageratum conyzoides (L.) L. / UPMM0002	Sengit Asew	Wild
Allium sativum L. / UPMM0003	Bawang Putih	Cultivated & Exotic
Allium cepa L. / UPMM0004	Bawang merah	Cultivated & Exotic
Aloe vera (L.) Burm.f. / UPMK0007	*Aloe vera*	Cultivated & Exotic
Alpinia galanga (L.) Willd. / UPMM0005	Lengkuas	Cultivated
Andrographis paniculata (Burm.f.) *Nees* / UPMM0006	Hempedu Bumi	Cultivated & Exotic
Annona muricata L. / UPMK0019	Durian Belanda	Cultivated & Exotic
Areca catechu L. / UPMM0007	Pinang	Cultivated & Exotic
Bridelia stipularis (L.) Blume / UPMM0008	Bridelia	Wild
Carica papaya L. / UPMK0016	Pucuk Betik	Cultivated & Exotic
Centella asiatica (L.) Urb. / UPMM0009	Daun pegaga	Cultivated
Cerbera odollam Gaertn. / UPMM0010	Buah Bi	Wild
Citrus aurantifolia (Christm.) Swingle / UPMM0011	Limau Nipis	Cultivated
Citrus hystrix DC. / UPMM0012	Limau Purut	Cultivated
Citrus limon (L.) Osbeck / UPMM0013	Lemon	Cultivated
Clinacanthus nutans (Burm.f.) *Lindau* / UPMK0010	Belalai Gajah	Cultivated
Cocos nucifera L. / UPMK0061	Kelapa	Cultivated & Exotic
Colocasia esculenta (L.) Schott / UPMM0014	Keladi	Cultivated
Colocasia gigantea (Blume) Hook.*f.* / UPMM0015	Keladi Penawar	Wild
Coriandrum sativum L. / UPMM0016	Ketumbar	Cultivated
Cosmos caudatus Kunth / UPMM0017	Ulam Raja	Cultivated
Curcuma xanthorrhiza Roxb. / UPMM0018	Bengeli	Wild & Cultivated
Curcuma domestica Valeton /UPMK0057	Kunyit	Cultivated
Curcuma zedoaria (Christm.) Roscoe / UPMM0019	Kunyit Putih	Wild & Cultivated
Daemonorops hallieriana Becc. / UPMM0020	Wai Luto	Wild
Euphorbia hirta L. / UPMM0021	Ara Tanah	Wild
Euphorbia ingens E.Mey. ex Boiss. / UPMM0022	Kaktus	Cultivated & Exotic
Falcataria spp / UPMM0023	Pa'u	Cultivated & Exotic
Garcinia atroviridis Griff. ex T.Anderson / UPMM0024	Asam gelugor	Cultivated & Exotic
Gynura procumbens (Lour.) Merr. / UPMM0025	Daun Lidah Tedong	Cultivated & Exotic
Helminthostachys zeylanica (L.) Hook. / UPMM0026	Tunjuk Langit	Wild
Hibiscus rosa-sinensis L / UPMM0027	Bunga Raya	Cultivated
Kaempferia galanga L. / UPMM0028	Cekor biasa	Cultivated
Kaempferia parviflora WalL. ex Baker / UPMM0029	Cekor brunei	Cultivated & Exotic
Kalanchoe pinnata (Lam.) Pers. / UPMM0030	Daun tumbuh di daun	Cultivated & Exotic
Lawsonia inermis L. / UPMM0031	Daun Inai	Cultivated & Exotic

Lygodium flexuosum (L.) Sw. / UPMM0032	Telaat	Wild
Melastoma malabathricum L. /UPMK0043	Bunga Senduduk	Wild
Mimosa pudica L. /UPMK0050	Rumput Semalu	Wild
Mitragyna speciosa (Korth.) HaviL. / UPMM0033	Daun Ketum	Cultivated & Exotic
Momordica charantia L. / UPMK0024	Peria Katak	Cultivated & Exotic
Morinda citrifolia L. / UPMM0034	Daun mengkudu	Wild & Cultivated
Myristica fragrans Houtt. / UPMM0035	Buah Pahala	Cultivated & Exotic
Nicotiana tabacum L. /UPMK0054	Daun Tembakau	Cultivated & Exotic
Nigella sativa L. / UPMM0036	Habbatus Sauda	Cultivated & Exotic
Nypa fruticans Wurmb / UPMM0037	Pucuk Nipah	Wild
Orthosiphon aristatus (Blume) Miq. / UPMM0038	Misai Kucing	Wild & Cultivated
Pandanus amaryllifolius Roxb. / UPMM0039	Pandan	Wild
Pangium edule Reinw.	Buah Ngah	Cultivated
Pedilanthus tithymaloides (L.) Poit. / UPMM0040	Pokok Lipan	Cultivated & Exotic
Phaleria macrocarpa (Scheff.) BoerL. / UPMK0045	Mahkota Dewa	Cultivated & Exotic
Physalis angulata L. / UPMM0041	Ketup-Ketup	
Piper nigrum L. /UPMK0011	Lada Hitam	Cultivated & Exotic
Piper betle L. /UPMK0028	Daun sireh	Cultivated
Plumeria rubra L. / UPMM0042	Bunga kemboja	Cultivated & Exotic
Portulaca grandiflora Hook. / UPMM0043	Bunga cantik manis	Cultivated & Exotic
Premna cordifolia Roxb. / UPMM0044	Daun Tebawan	Wild
Psidium guajava L. /UPMK0021	Pokok Jambu Batu	Cultivated & Exotic
Quercus infectoria G.Olivier / UPMM0045	Buah manjakani	Cultivated & Exotic
Senna alata (L.) Roxb. /UPMK0020	Daun Tarum	Wild
Shorea laevis Ridl. / UPMM0046	Balau	Wild
Smilax myosotiflora A.DC. / UPMM0047	Ubi Jaga	Wild
Spondias dulcis Parkinson / UPMM0048	Buah kedondong	Cultivated
Syzygium aromaticum (L.) Merr. & L.M.Perry / UPMM0049	Cengkih	Cultivated & Exotic
Tamarindus indica L. / UPMM0050	Asam Jawa	Cultivated
Usnea misaminensis (Vain.) Motyka / UPMM0051	Akar Tahi Angin	Wild
Vitis diffusa Miq. / UPMM0052	Buah Lakum	Wild
Wedelia biflora (L.) DC. / UPMM0053	Daun serunai	Wild
Zingiber officinale Roscoe /UPMK0030	Halia merah	Cultivated & Exotic
Ziziphus mauritiana Lam. / UPMM0054	Daun Bidara	Cultivated

Figure 6. A respondent showing a tree for field identification.

Ethnobotanical values and calculations

All data was analyzed using Microsoft Excel and SPSS version 23. The data was quantified following Weckerle et al. (2022) and Leonti's (2022) recommendations for ethnopharmacological field studies. The results were evaluated based on the total use-reports and the number of respondents citing each plant. We also evaluated the data based on use-reports by ailment category. To ensure standardization, the ailments were categorized using the International Classification of Primary Care (ICPC), recognized by the World Health Organization (Weckerle et al. 2022).

Comparative analysis

To contextualize the findings of this study within the broader ethnobotanical literature, a comparative analysis was conducted with other relevant studies from neighboring regions. The selection criteria for comparative studies included geographical proximity, cultural similarities, and the availability of ethnobotanical data on medicinal plant use.

The Jaccard Similarity Index was used to quantify the similarity between the medicinal flora reported in this study and those documented in other selected ethnobotanical studies. The Jaccard Similarity Index is calculated as follows:

Similarity = (Number of similar plants / Total number of different plants) X 100%

A higher index value indicates greater similarity in the medicinal plant species used between the compared studies.

Results and Discussion

Demographic

This study involved 71 participants from 5 villages in the Igan River basin, Sarawak, Malaysia (Table 2). The distribution of the respondents from the 5 villages were quite similar, ranging from 13 (Pulau Village) to 16 (Baru Ismail Village). An interesting demographic trend that can be observed is that the majority of the participants were female (67.6%). This distribution reflects a significant gender imbalance ($p < 0.05$), which suggests that women in the Melanau Igan community are more actively involved in the practice of traditional medicine. This gender-based disparity is due to women traditionally

being responsible of managing household affairs in Melanau Igan communities, including caring for sick family members. Female participants also expressed that traditional medicine was their preferred approach in treating illnesses while their husbands were away due to work. The lack of easy access to hospitals or clinics without transportation and their dependency on their spouses might contribute to this reliance on traditional medicinal plants by the women folk.

Table 2. Demographic of respondents (N = 71).

Factor	Categories	Number of respondents	Percentage of respondents
Gender	Male	23	32.4%
	Female	48	67.6%
Age	20 – 40 years old	13	18.3%
	41 – 60 years old	30	42.3%
	61 – 80 years old	27	38.0%
	81 years old and above	1	1.4%
Education	No formal education	15	21.1%
	Primary education	33	46.5%
	Secondary education	13	18.3%
	Tertiary education	10	14.1%
Village	Baru Dagang	14	19.7%
	Baru Ismail	16	22.5%
	Tengah	14	19.7%
	Pulau	13	18.3%
	Sekerang	14	19.7%
Knowledge passed on	Yes	65	91.5%
	No	6	8.5%

The age distribution of the participants shows that a substantial percentage of individuals (81.7%) were above 40 years old. This group exhibited a strong eagerness to share their traditional medicinal knowledge, underlining their role as repositories of ethnobotanical wisdom. Younger participants (20-40 years old) expressed limited knowledge about traditional medicine, as they predominantly relied on modern medicine, which they found more accessible. Many participants, regardless of age, voiced challenges in locating certain plant sources and the time-consuming process of preparing traditional remedies compared to the instant availability of modern medicines.

Despite, the majority of the younger members of the Melanau Igan community admitting that they had limited knowledge of traditional medicine practices, a significant majority of participants (91.5%) reported passing on their traditional medicinal knowledge to others. This was mainly among other housewives, since they were responsible for treating unwell members of their households. However, the respondents indicated that they usually shared their knowledge with their daughters once they got married. This practice reflects the passing down of traditional medicinal knowledge from one generation to the next, reinforcing the intergenerational continuity of these practices. Therefore, despite the majority of traditional medicine practitioners being above 40, the preservation of this knowledge within the community is somewhat secure.

The primary mode of knowledge transmission was oral, with individuals passing down their expertise through spoken communication. This mode of knowledge dissemination is in line with the traditional and cultural nature of the practices. It highlights the importance of direct communication, allowing for the sharing of nuances, context, and experiential insights that might be lost in written records. It also emphasizes the deeply rooted oral traditions that have been instrumental in preserving the ethnobotanical knowledge of the Melanau Igan community over generations.

When compared to the ethnomedicinal system of the Kenyah, a neighbouring Sarawakian community, there are a few key differences in demographics. First, the Kenyah participants were predominantly male (71%), while the Melanau Igan participants were predominantly female (67.6%) (Rajoo et al. 2023). This is due to the different cultural roles of men and women in the two communities. In the Kenyah community, men are traditionally responsible for hunting and gathering, which often takes them away from the village for extended periods of time. As a result, they are more likely to have knowledge of traditional medicine, as they may need to treat themselves for minor ailments while they are away. As mentioned previously, in the Melanau Igan community, women are traditionally responsible for household duties and

childcare. This means that they are more likely to have knowledge of traditional medicine, as they are the ones who are typically responsible for treating the health problems of their families.

Another key difference is that the Melanau Igan participants were more likely to have passed on their knowledge of traditional medicine to others (91.5%) than the Kenyah participants (25%) (Rajoo et al. 2023). This is likely due to the fact that the Melanau Igan community is more matrilineal, meaning that property and knowledge are passed down through the female line. This is in contrast to the Kenyah community, which is more patrilineal, meaning that property and knowledge are passed down through the male line. And since the majority of the younger male members of the Kenyah community have migrated to the cities, there is no longer a need for them to use herbal medicine (Rajoo et al. 2023). In this regard, the traditional medicinal knowledge of the Melanau Igan community is better preserved.

It is important to note that the higher involvement of women in traditional medicine practices of the Melanau Igan is not unique to this region. Similar patterns have been reported in various parts of the world, where women have traditionally played a significant role as repositories of ethnobotanical knowledge, including South America (Voeks, 2007), North America (Camou-Guerrero et al., 2008) and Africa (Howard, 2003). This trend is often attributed to the traditional division of labour, where women are responsible for managing household affairs, including caring for sick family members. Additionally, in many cultures, women have been the primary gatherers and cultivators of food and medicinal plants, further contributing to their extensive knowledge of plant species and their applications (Howard, 2003). While the specific cultural contexts may vary, the significant role of women in preserving and transmitting ethnobotanical knowledge is a global phenomenon deserving of recognition and further exploration.

Methods of usage

The methods of usage for the 72 cited plant species were diverse and reflected a profound understanding of the local flora and its medicinal properties by the Melanau Igan community (Table 3). Tukey's HSD test were conducted to explore specific pairwise differences between plant parts. The results, as determined by ANOVA, revealed that leaves were significantly more frequently used than fruits, roots, and flowers ($p<0.05$). A total of 44 plant species utilized leaves for medicinal purposes, for both internal and external treatments. This is followed by fruits (23 plant species), roots (5 plant species) and flowers (3 plant species). Most plant species (34) were utilized for external treatments, however, it was not significantly higher ($p<0.05$). External usage mainly involved the application of plant extracts on affected areas, especially for skin ailments. Some plants were crushed and applied to the skin or used as a bath. A total of 28 plant species were used internally. The most common way this was practiced was by boiling the plant parts and consuming the resulting infusion. Ten plant species were employed for both internal and external treatments.

It is also important to note that the Melanau Igan traditional medicine system incorporates both native and exotic plant species (Table 1), a pattern observed in several traditional knowledge systems around the world (Medeiros et al., 2012; Kunwar et al., 2013). The inclusion of exotic species, such as *Ageratum conyzoides* (native to Brazil) and *Syzygium aromaticum* (native to the Maluku Islands), highlights the dynamic nature of ethnobotanical knowledge and the influence of cultural exchange and globalization on traditional practices. While some communities may resist the adoption of introduced species, others have embraced and integrated them into their medicinal repertoire, recognizing their potential benefits (Medeiros et al., 2012; Rajoo et al., 2013). This adaptability and openness to new knowledge sources have contributed to the resilience and evolution of traditional medicine systems, allowing them to adapt to changing environmental conditions and cultural influences, and this is reflective of the Melanau Igan community.

Total use-reports

The 71 respondents in this study cited a total of 596 use reports for the 72 cited plants (Table 4). Each use-report signifies a specific application of a plant for treating a particular ailment or health concern. Seventeen plants were cited only once, while nine plants were cited twice. There was an interesting observation with two plant species, *Centella asiatica* (L.) Urb. and *Lawsonia inermis* L. Urb. *Centella asiatica* had 9 use reports but was only cited by two respondents; one respondent cited it 5 times while the other cited it 4 times. Similarly, *Lawsonia inermis* had 20 use reports and cited by 10 respondents, however, one respondent cited the plant six times. This could be due to a similar believe shared by the Orang Ulu communities of Sarawak. In these communities, people believe that all traditional medicinal practices are valid, but their effectiveness varies from person to person (Rajoo et al. 2023). Therefore, the question is not if a treatment is effective, but rather if it works for them. As a result, individuals in these communities may believe that a particular plant species is the best treatment for them and use it for various ailments.

Table 3. Method of preparation and use of cited medicinal plants.

Plant species	Parts used	Preparation method	Application	Practical uses
Acanthus arboreus Forssk.	Leaves and seeds	1) Boiled and water consumed[2] 2) Squeezed and applied on affected area[2]	Internal & external	Traditional medicine
Acorus calamus L.	Leaves	1) Rolled and blown through at affected eye	External	Flavoring, traditional medicine
Ageratum conyzoides (L.) L.	Leaves and flowers	1) Crushed and applied on affected area[25]	External	Traditional medicine
Allium sativum L.	Fruits	1) Blown through hole at affected eye	External	Culinary herb, traditional medicine
Allium cepa L.	Fruits	1) Crushed and applied on forehead[10] 2) Crushed and applied on affected area[1]	External	Culinary vegetable, traditional medicine
Aloe vera (L.) Burm.f.	Leaves	1) Crushed and applied on affected area[19]	External	Traditional medicine
Alpinia galanga (L.) Willd.	Fruits	1) Crushed and applied on affected area[5]	External	Culinary spice, traditional medicine
Andrographis paniculata (Burm.f.) *Nees*	Leaves	1) Boiled and water consumed[11]	Internal	Traditional medicine
Annona muricata L.	Leaves	1) Boiled and water consumed[4]	Internal	Food, traditional medicine
Areca catechu L.	Leaves and fruits	1) Fruits consumed[6] 2) Leaves crushed and applied on affected area[2]	Internal & external	Stimulant, traditional medicine
Bridelia stipularis (L.) Blume	Leaves	1) Crushed and applied on affected area[3]	External	Traditional medicine
Carica papaya L.	Leaves	1) Boiled and water consumed[6]	Internal	Food, traditional medicine
Centella asiatica (L.) Urb.	Leaves and roots	1) Boiled and water consumed[9]	Internal	Traditional medicine
Cerbera odollam Gaertn.	Fruits	1) Crushed and applied on abdomen[15]	External	Traditional medicine
Citrus aurantifolia (Christm.) Swingle	Fruits	1) Squeezed and consumed as beverage[26] 2) Squeezed and applied on affected area[52]	Internal & external	Culinary, traditional medicine
Citrus hystrix DC.	Fruits	1) Squeezed and water is bathed with[3]	External	Culinary, traditional medicine
Citrus limon (L.) Osbeck	Fruits	1) Boiled and water consumed[19]	Internal	Culinary, traditional medicine
Clinacanthus nutans (Burm.f.) *Lindau*	Leaves	1) Boiled and water consumed[12]	Internal	Traditional medicine
Cocos nucifera L.	Fruits	1) Consumed[6] 2) Virgin coconut oil applied on affected areas[14]	Internal & external	Food, traditional medicine, handicrafts
Colocasia esculenta (L.) Schott	Leaves	1) Latex applied on skin[1]	External	Food, traditional medicine
Colocasia gigantea (Blume) Hook.*f.*	Leaves	1) Lie on leaves[2]	External	Food, traditional medicine
Coriandrum sativum L.	Seeds	1) Crushed and consumed[1]	Internal	Culinary herb, traditional medicine
Cosmos caudatus Kunth	Leaves	1) Boiled and water consumed[1]	Internal	Food, traditional medicine

Curcuma xanthorrhiza Roxb.	Fruits	1) Boiled and water consumed[4] 2) Crushed and applied on affected area[5]	Internal & external	Culinary spice, traditional medicine
Curcuma domestica Valeton	Fruits	1) Boiled and water consumed[1]	Internal	Culinary spice, traditional medicine
Curcuma zedoaria (Christm.) Roscoe	Fruits	1) Boiled and water consumed[1]	Internal	Culinary spice, traditional medicine
Daemonorops hallieriana Becc.	Bark	1) Warmed and wrapped at affected areas[1]	External	Handicrafts, traditional medicine
Euphorbia hirta L.	Leaves and roots	1) Boiled and water bathed with[1]	External	Traditional medicine
Euphorbia ingens E.Mey. ex Boiss.	Leaves	1) Latex applied on skin[4]	External	Traditional medicine
Falcataria spp	Leaves	1) Crushed and applied on affected area[2]	External	Construction, furniture, traditional medicine
Garcinia atroviridis Griff. ex T.Anderson	Fruits	1) Boiled and water consumed[12]	Internal	Food, traditional medicine
Gynura procumbens (Lour.) Merr.	Leaves	1) Boiled and water consumed[11]	Internal	Traditional medicine
Helminthostachys zeylanica (L.) Hook.	Leaves	1) Boiled and water consumed[2]	Internal	Traditional medicine
Hibiscus rosa-sinensis L	Flowers and leaves	1) Squeezed and water is bathed with[57]	External	Ornamental, traditional medicine
Kaempferia galanga L.	Fruits	2) Crushed and applied on affected area[3]	External	Culinary spice, traditional medicine
Kaempferia parviflora WalL. ex Baker	Fruits	2) Crushed and applied on affected area[3]	External	Culinary spice, traditional medicine
Kalanchoe pinnata (Lam.) Pers.	Leaves	1) Crushed and applied on forehead[9]	External	Traditional medicine
Lawsonia inermis L.	Leaves	1) Boiled and water consumed[9] 2) Crushed and applied on affected area[11]	Internal & external	Hair dye, traditional medicine
Lygodium flexuosum (L.) Sw.	Leaves and roots	1) Boiled and water consumed[1]	Internal	Handicrafts, traditional medicine
Melastoma malabathricum L.	Flowers	1) Crushed and applied on affected area[16]	External	Traditional medicine
Mimosa pudica L.	Leaves	1) Boiled and applied on affected area[1]	External	Traditional medicine
Mitragyna speciosa (Korth.) HaviL.	Leaves	1) Boiled and water consumed[3]	Internal	Stimulant, traditional medicine
Momordica charantia L.	Leaves	1) Boiled and water consumed[13]	Internal	Food, traditional medicine
Morinda citrifolia L.	Leaves	1) Warmed and wrapped at affected areas[23]	External	Traditional medicine, health supplement
Myristica fragrans Houtt.	Fruits	1) Crushed and applied on affected area[5]	External	Culinary spice, traditional medicine
Nicotiana tabacum L.	Leaves	1) Crushed and applied on abdomen[4]	External	Smoking, traditional medicine
Nigella sativa L.	Seeds	1) Crushed and consumed[8]	Internal	Culinary spice, traditional medicine
Nypa fruticans Wurmb	Leaves and bark	1) Boiled and water consumed[4] 2) Boiled and water bathed with[3]	Internal & external	Handicrafts, traditional medicine

Orthosiphon aristatus (Blume) Miq.	Leaves	1) Boiled and water consumed[8]	Internal	Traditional medicine
Pandanus amaryllifolius Roxb.	Leaves	1) Boiled and water consumed[4]	Internal	Handicrafts, traditional medicine
Pangium edule Reinw.	Fruits	1) Crushed and applied on affected area[2]	External	Food, traditional medicine
Pedilanthus tithymaloides (L.) Poit.	Leaves	1) Latex applied on skin[8]	External	Traditional medicine
Phaleria macrocarpa (Scheff.) BoerL.	Leaves	1) Boiled and water consumed[3]	Internal	Traditional medicine
Physalis angulata L.	Roots	1) Boiled and water consumed[2]	Internal	Food, traditional medicine
Piper nigrum L.	Seeds	1) Crushed and wrapped at affected areas	External	Culinary spice, traditional medicine
Piper betle L.	Leaves	1) Boiled and water consumed[6] 2) Boiled and applied on affected area[19]	Internal & external	Stimulant, traditional medicine
Plumeria rubra L.	Leaves	1) Latex applied on skin[1]	External	Ornamental, traditional medicine
Portulaca grandiflora Hook.	Leaves	1) Boiled and water consumed[1]	Internal	Traditional medicine
Premna cordifolia Roxb.	Leaves	1) Warmed and wrapped at abdomen[1]	External	Traditional medicine
Psidium guajava L.	Leaves and bark	1) Boiled and water consumed[16] 2) Crushed and applied on affected area[11]	Internal & external	Food, traditional medicine
Quercus infectoria G.Olivier	Fruits	1) Boiled and water bathed with[1]	External	Traditional medicine
Senna alata (L.) Roxb.	Leaves	1) Boiled and water consumed[3] 2) Crushed and applied on affected area[3]	Internal & external	Traditional medicine
Shorea laevis Ridl.	Leaves	1) Lie on leaves[1]	External	Construction, traditional medicine
Smilax myosotiflora A.DC.	Leaves	1) Boiled and water consumed[1]	Internal	Traditional medicine
Spondias dulcis Parkinson	Fruits	1) Consumed[3]	Internal	Food, traditional medicine
Syzygium aromaticum (L.) Merr. & L.M.Perry	Fruits	1) Crushed and consumed[1]	Internal	Culinary spice, traditional medicine
Tamarindus indica L.	Fruits	1) Warmed and wrapped at affected areas[5]	External	Food, traditional medicine
Usnea misaminensis (Vain.) Motyka	Roots	1) Crushed and consumed[1]	Internal	Traditional medicine
Vitis diffusa Miq.	Leaves	1) Lie on leaves[3]	External	Traditional medicine
Wedelia biflora (L.) DC.	Leaves	1) Warmed and wrapped at affected areas[5]	External	Traditional medicine
Zingiber officinale Roscoe	Fruits	1) Boiled and water consumed[3]	Internal	Culinary spice, traditional medicine
Ziziphus mauritiana Lam.	Leaves	1) Boiled and water consumed[2]	Internal	Food, traditional medicine

Table 4. Total use-reports and use-reports by ailment categories for plant species.

Plant species	Number of respondents citing plant	Total use-reports	Use-reports by ailment categories
Citrus aurantifolia (Christm.) Swingle	47	78	A(26), N(32), S(6), Y(3), W(3), D(6), R(2)
Hibiscus rosa-sinensis L.	52	57	A(49), N(3), R(3), S(2)
Garcinia atroviridis Griff. ex T.Anderson	6	12	T(6), K(6)
Cocos nucifera L.	16	20	A(9), H(3), S(4), L(4)
Citrus limon (L.) Osbeck	17	19	A(3), T(6), K(7), R(3)
Acanthus arboreus Forssk.	3	4	K(1), T(1), S(2)
Mimosa pudica L.	1	1	W(1)
Piper betle L.	14	25	A(1), D(1), K(2), S(16), L(3), T(2)
Lawsonia inermis L.	10	20	A(2), D(1), S(11), N(2), K(2), T(2)
Allium cepa L.	7	11	A(10), S(1)
Ageratum conyzoides (L.) L.	18	25	S(25)
Melastoma malabathricum L.	13	16	S(16)
Aloe vera (L.) Burm.f.	15	19	S(19)
Senna alata (L.) Roxb.	6	6	A(3), S(3)
Spondias dulcis Parkinson	3	3	K(3)
Kalanchoe pinnata (Lam.) Pers.	9	9	A(5), N(4)
Pedilanthus tithymaloides (L.) Poit.	8	8	S(8)
Curcuma domestica Valeton	1	1	A(1)
Portulaca grandiflora Hook.	1	1	A(1)
Psidium guajava L.	21	27	D(14), S(11), T(2)
Nypa fruticans Wurmb	5	7	D(4), W(3)
Andrographis paniculata (Burm.f.) Nees	6	11	A(2), K(4), T(5)
Nicotiana tabacum L.	3	4	D(4)
Clinacanthus nutans (Burm.f.) *Lindau*	5	12	A(4), K(5), T(3)
Momordica charantia L.	5	13	K(5), T(8)
Morinda citrifolia L.	14	23	A(11), S(1), L(3), K(4), T(3)
Kaempferia galanga L.	3	3	S(3)
Kaempferia parviflora WalL. ex Baker	3	3	S(3)
Quercus infectoria G.Olivier	1	1	W(1)
Zingiber officinale Roscoe	3	3	A(2), D(1)
Coriandrum sativum L.	1	1	A(1)
Centella asiatica (L.) Urb.	2	9	D(2), R(2), U(2), T(1), K(1), W(1)

Wedelia biflora (L.) DC.	5	5	S(5)
Curcuma xanthorrhiza Roxb.	9	11	A(5), L(2), W(2), T(2)
Orthosiphon aristatus (Blume) Miq.	6	8	T(5), U(2), K(1)
Nigella sativa L.	8	8	A(8)
Cerbera odollam Gaertn.	15	15	D(13), Y(2)
Euphorbia hirta L.	1	1	S(1)
Myristica fragrans Houtt.	5	5	L(3), S(2)
Areca catechu L.	7	8	A(1), D(2), T(3), H(1), S(1)
Tamarindus indica L.	4	4	A(1), S(1), R(2)
Gynura procumbens (Lour.) Merr.	11	11	A(11)
Citrus hystrix DC.	3	3	A(3)
Curcuma zedoaria (Christm.) Roscoe	1	1	Y(1)
Mitragyna speciosa (Korth.) HaviL.	3	3	A(3)
Alpinia galanga (L.) Willd.	5	5	4(S), L(1)
Vitis diffusa Miq.	3	3	A(2), T(1)
Premna cordifolia Roxb.	1	1	D(1)
Carica papaya L.	5	6	A(3), W(3)
Euphorbia ingens E.Mey. ex Boiss.	4	4	S(4)
Colocasia esculenta (L.) Schott	1	1	S(1)
Colocasia gigantea (Blume) Hook.f.	2	2	A(2)
Ziziphus mauritiana Lam.	2	2	T(2)
Falcataria spp	2	2	S(2)
Annona muricata L.	2	4	K(2), T(2)
Shorea laevis Ridl.	1	1	A(1)
Usnea misaminensis (Vain.) Motyka	1	1	D(1)
Daemonorops hallieriana Becc	1	1	A(1)
Pangium edule Reinw.	2	2	N(2)
Helminthostachys zeylanica (L.) Hook.	2	2	K(2)
Acorus calamus L.	2	2	F(2)
Allium sativum L.	2	2	F(2)
Piper nigrum L.	1	2	A(1), S(1)
Smilax myosotiflora A.DC.	1	1	K(1)
Cosmos caudatus Kunth	1	1	K(1)

Bridelia stipularis (L.) Blume	3	3	A(3)
Physalis angulata L.	2	2	A(2)
Pandanus amaryllifolius Roxb.	4	4	A(4)
Phaleria macrocarpa (Scheff.) BoerL.	3	3	A(3)
Lygodium flexuosum (L.) Sw.	1	1	K(1)
Plumeria rubra L.	1	1	S(1)
Syzygium aromaticum (L.) Merr. & L.M.Perry	1	1	A(1)

Therefore, to identify plant species that played a significant role in the ethnomedicinal system of the Melanau Igan community, the top ten plants that were cited by the greatest number of respondents were identified (Figure 7). This would provide a more accurate picture of the plants that are most widely used and valued by the community. On the other hand, listing plants by total use-reports might provide skewed data since it might include plants that are only used by a small number of people, but are cited multiple times by those people, such as *Centella asiatica* (L.) Urb. and *Lawsonia inermis* L. The top ten plants that were cited by the greatest number of respondents is shown in Figure 7.

Figure 7. Selected prominent plant species used in Melanau Igan traditional medicine. A: *Hibiscus rosa-sinensis*, B: *Citrus aurantifolia*, C: *Ageratum conyzoides*, D: *Citrus limon*, E: *Aloe vera*, F: *Piper betle*, G: *Morinda citrifolia*.

Hibiscus rosa-sinensis L (Figure 7A) recorded the highest number of respondents citing it, cited by a total of 52 respondents or 73.34% of the study respondents. It is also the plant species with the second highest total use-reports (57). In the Melanau Igan community, the plant species is primarily used to treat fever. The flower is squeezed in water, and the resulting infusion is used for bathing. *Hibiscus rosa-sinensis* L is a flowering plant species of tropical hibiscus, widely cultivated as an ornamental plant in the tropics. The flower plays a major role in the culture and tradition of Malaysia, being the national flower since 1960. The flower in imprinted on the notes and coins of the Malaysian Ringgit. Locally it is known as “Bunga Raya”, which can be best translated as “flower of celebration”. The plant has been widely used in Asian traditional medicine to treat an array of ailments, including inflammation, open wounds, coughs, and even diabetes (Missoum, 2018). Chemical analysis of *Hibiscus rosa-sinensis* has shown that it contains a variety of bioactive compounds, such as flavonoids, tannins, terpenoids,

saponins, and alkaloids, which are responsible for its medicinal effects. Recent studies have shown that extracts from all parts of the plant have a wide range of beneficial effects, including lowering blood pressure, reducing fever, reducing inflammation, fighting cancer, and protecting against free radical damage (Missoum, 2018). Studies on the toxicity of *Hibiscus rosa-sinensis* have shown that it is generally safe, with no signs of toxicity at higher doses. In Malaysia, *Hibiscus rosa-sinensis* L is widely used to treat fever in traditional Malay medicine. It is used in a variety of ways, including boiling the flowers and using it for a bath, similar to that of the Melanau Igan community (Haron and Yacob, 2023). This could be attributed to the similarity that is shared between the Malay and Melanau communities in terms of traditions and culture, thus there is a likelihood that this trend is also present in their traditional medicinal practices.

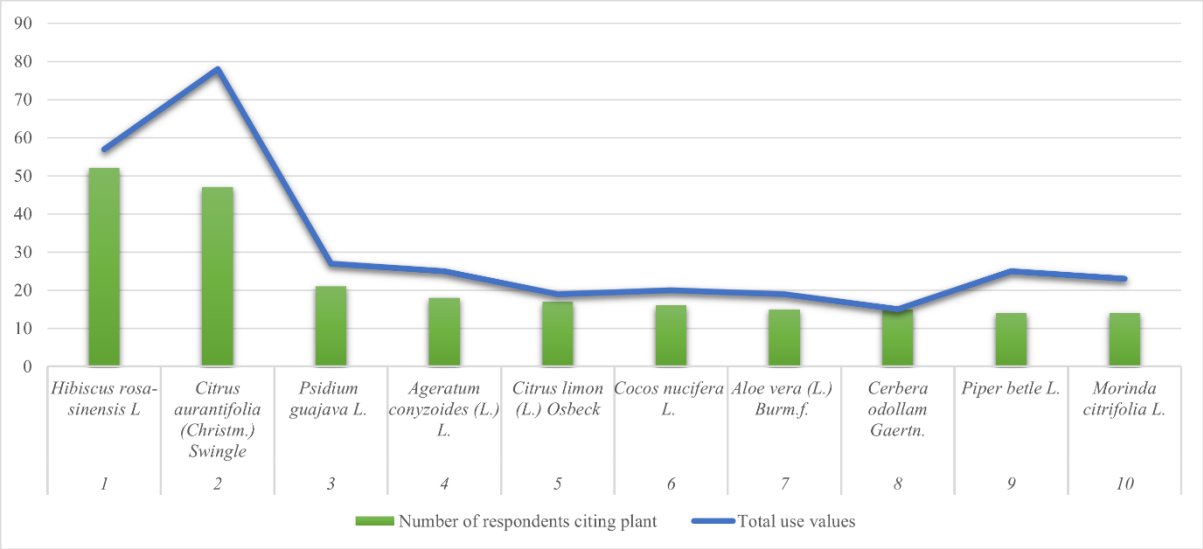

Figure 8. Number of citations for top ten plant species used in Melanau Igan traditional medicine.

The plant species with the second highest number of respondents citing it (47 respondents), with the highest total use-reports (78 use-reports) was *Citrus aurantifolia* (Christm.) Swingle (Figure 7B). Locally known as "Limau Nipis", it is a perennial shrub with sharp thorns. The main stem rarely grows straight, and the plant can grow up to 5 meters tall without proper pruning. It is widely cultivated in the tropics including Malaysia, where the fruits are used in cooking. The young fruits are green and turn yellow as they ripen. They are spherical, with smooth skin, and measure about 4 centimeters in diameter. When crushed, the fruits produce plenty of sour juice. The fruit exudate has been found to be nutrient-rich and is beneficial as an antibacterial, anticancer, antioxidant, anti-inflammatory, and insecticide (Indriyani, et al. 2023). In Malaysia, the juice is used to "flavor" food, to provide a distinctive sourish taste. It is also used to make beverages, in the same manner as lemonades. The fruit juice is also extensively used in Malay traditional medicine, such as in herbal baths after childbirth and to treat sinuses, headaches, sore throats, coughs, dysentery, dandruff, fever, and stomachache (Mat-Salleh and Latiff, 2002). Similarly, the Melanau Igan community uses the fruit juice for treating an array of ailments, namely fever and headaches. Thus, this is another similarity shared between the Malay and Melanau communities' traditional medicinal practices.

Widely grown in subtropical and tropical regions, *Psidium guajava* L. (commonly known as guava), is also a common feature of Melanau Igan traditional medicine. The plant species was the third highest cited plant by respondents (21 respondents), with a total of 27 use-reports. The plant species is commonly cultivated for its fruits, but other parts of the tree can also be utilized. The fruit can be eaten raw or cooked, while the leaves can be used as animal feed. In some regions, the wood is used for the smoking of meat. The plant is also widely used in traditional medicine across the world, from Central America, Africa to Asia. It is used for an array of ailments, including lung diseases, hypertension, open wounds, diabetes, diarrhea, and fever (Gutiérrez et al. 2008). However, despite it being widely consumed in Malaysia, there has been limited documentation of the plant being used in traditional medicinal practices. Even in the Melanau Igan community, the fruit is not used in traditional medicine, only the leaves and the tree bark are utilized. According to the respondents, is used to primarily address digestive issues (12 citations) and itching (11 citations). To treat diarrhea, the leaves and bark are boiled, and the water is consumed directly or as a tea. For itching, the leaves and bark are crushed and applied directly on the affected area. Preliminary laboratory investigations and clinical trials have discovered that guava is efficacious against several ailments (Daswani et al. 2017). However, more studies need to be conducted to determine its effectiveness in treating digestive issues and itching. Beyond its medicinal applications, *Psidium guajava* is also widely valued for its culinary uses in the Melanau

Igan community and throughout Malaysia. The fruit can be consumed fresh or used in various preparations, such as jams, jellies, and juices. The leaves are also commonly used to infuse tea, providing a unique flavor. Guava is sometimes also incorporated into local dishes, to add a distinctive tangy taste. The versatility of this plant in both medicinal and culinary contexts highlights its significance in the local culture and traditions.

Ageratum conyzoides (L.) L., locally called Sengit Asew (Figure 7C), is an invasive weed in Malaysia. Native to Brazil, it is an herb that grows up to 1m high and has small white flowers. A. conyzoides plays an important role in the Melanau Igan traditional medicine practice, having the fourth highest citations both in terms of total use-reports (25 use-reports) and number of respondents citing it (18 respondents). However, the plant is not viewed favorably both in Sarawak and Southeast Asia, as can be seen by its common names. The term "Sengit Asew" means "smells like urine" in the Melanau Igan language. In Peninsular Malaysia, it is called "Bunga Tahi Ayam" which translates to "chicken feces flower", while in Vietnam it is called "cứt lợn" or "pig feces". This notoriety is due to the weed being considered a nuisance, especially in rice cultivation (Caton, 2004). Moreover, it also grows in areas that are considered dirty, such as in drains and dumps, further strengthening its negative stigma. Despite this reputation, the plant is quite widely used in the traditional medicine of many cultures (Panda and Luyten, 2018). In South America and Africa, it is used to treat colds, fever, urinary tract infections, rheumatism, diarrhea, and other diseases (Okunade, 2002). In the Melanau Igan community, the plant is used to treat skin issues, namely boils. This is done by crushing leaves and flowers of A. conyzoides and applying it directly on the skin. The plant has been extensively studied and has shown several pharmacological properties, including promising anti-inflammatory effects in rats, particularly in reducing granulomatous tissue and mitigating edema without causing gastric damage (Moura et al. 2005). It also demonstrates wound healing potential, namely in managing septic wounds (Chah et al. 2006). These multifaceted pharmacological characteristics make A. conyzoides a subject of continued research for potential therapeutic applications, however, there are also safety concerns. A study discovered the presence of pyrrolizidine alkaloids, which are known to be hepatotoxic and can cause a variety of health issues including lung cancer (Moura et al. 2005).

Lemon (*Citrus limon* (L.) Osbeck) was cited by 17 respondents for 19 use-reports (Figure 7D). Lemon juice is consumed widely across the globe, and it is also widely used in the traditional medicine of native communities. The juice is commonly used to relieve coughs, reduce phlegm, treat sore throats, and coughs. It is also used in Chinese traditional medicine as an anti-diabetic treatment (Bekkouch et al. 2023). This is similar to the Melanau Igan community, whereby the juice is used to address diabetes (6 use-reports), throat symptoms (3 use-reports) and fever (3 use-reports). However, the main use of lemon juice cited by the respondents was to treat hypertension (7 use-reports). It has been reported that certain communities in Turkey also consumed lemon juice as an alternative therapy to treat hypertension (Adibelli et al. 2009), however, other such documentation is limited. Moreover, clinical studies in this aspect are almost non-existent (Adibelli et al. 2009). Laboratory analyses has shown that lemon juice contains valuable biological activity, such as high content of phenolic compounds, mainly flavonoids and phenolic acids (Marta et al. 2020). Moreover, studies have shown that it has potential to lower blood glucose levels in streptozotocin-induced diabetic rats, meaning that it has the potential to be an anti-diabetic alternative treatment (Bekkouch et al. 2023). However, more clinical trials need to be done to determine its true potential on diabetic patients. Besides that, there also needs to be more research on its potential in addressing hypertension.

Unsurprisingly, coconuts (*Cocos nucifera* L.) were also highly cited by the study respondents, cited by 16 respondents (22.53% or respondents) for 20 use-reports. A common feature of coastal tropical regions, the coconut tree provides food, fuel, cosmetics, traditional medicine resource and building materials, among many other uses. Thus, it is no surprise that the tree plays a major cultural role in certain societies, namely Austronesian societies, and South Asian cultures (Nayar, 2017). It is widely used in the traditional medicine of numerous communities, for treating diarrhea, venereal diseases, asthma, diabetes, renal diseases and even for HIV-AIDS infections (Lima et al. 2015). Studies on the coconut tree's phytochemical and pharmacological properties discovered that the tree has several beneficial biological effects, such as anti-inflammatory, antimicrobial, antioxidant, antiarthritic, antibacterial, antipyretic, anthelminthic, antidiarrheal, and hypoglycemic activities (Lima et al. 2015). Coconut water and coconut kernel were found to also contain microminerals and nutrients that were essential to human wellbeing (DebMandal & Mandal, 2011). In the Melanau Igan community, coconut flesh and water are used to treat fever (6 use-reports), while virgin coconut oil is used to address ankle sprain (4 use-reports) and ear-pain (3 use-reports).

Similar to coconuts, *Aloe vera* (L.) Burm.f. (Figure 7E) is also a common feature of traditional medicinal systems worldwide, and it was also highly cited by the study respondents (19 use-reports by 15 respondents). Despite growing wildly in tropical to arid regions of the world, it is also cultivated to produce commercial skin care products, such as lotions, cosmetics, and gels for minor burns (Lie et al. 2019). The Melanau Igan community also utilizes *Aloe vera* for the same purposes, to treat an

array of skin issues such as pruritus, scalding, sunburns, and skin injuries. This plant is also a common feature in the traditional medicine practice of other Malaysian communities (Saniasiaya et al. 2017; Rajoo et al. 2023).

Cerbera odollam Gaertn was also a highly cited plant species (15 use-reports by 15 respondents). Locally known as Buah Bi, it was mainly used to address flatulence or belching (13 citations). The tree species is native to South Asia, Southeast Asia, and parts of Australia, and is sometimes referred to as the "suicide tree". This is due to tree bearing a fruit that contains a strong poison that has been used for suicides and homicides (Kaplan, 2021). In the Melanau Igan community, the poisonous fruit is used in their traditional medicine, but externally. The fruit is crushed and applied directly on the abdomen. It has been used as folk medicine by some Asian communities, and laboratory analyses has found that the plant does have pharmaceutical properties such as auspicious anticancer properties and antioxidant activities (Saxena et al. 2023). However, since the plant is highly toxic, care must be taken when using it as a treatment.

Similar to coconut trees and *Aloe vera*, betel pepper is a common feature of folk medicine. The plant species was also widely used in the Melanau Igan community, *Piper betle* L., (Figure 7F) locally called daun sireh, recorded 25 use-reports by 14 respondents. *Piper betle* has a long history of use in Southeast Asian traditional medicine and India (Naliha & Rahim, 2007; Krishna & Amirthalingam, 2014). It was also widely used by the Kenyah community of Sarawak (Rajoo et al. 2023). However, in Kenyah traditional medicine, it is commonly used to treat fever, which was not seen in the Melanau Igan community. The Melanau Igan used the plant to namely treat skin ailments (17 use-reports), such as pruritus, scabies, and skin infections. The plant leaves were boiled and then applied directly at the affected areas. It was also used for sprained ankles (3 use-reports), hypertension (2 use-reports), and diabetes (2 use-reports). For hypertension and diabetes, the leaves were boiled, and the water consumed. Pharmacology studies have found that the plant species has anti-inflammatory and anti-bacterial activity, meaning that it does have potential to be a treatment for skin issues (Nalina and Rahim, 2007).

Morinda citrifolia L. (Figure 7G), locally known as mengkudu, had the tenth highest respondent citations (23 use-reports by 14 respondents). The tree is native to Southeast Asia but is now cultivated throughout tropical regions. The fruit of the tree can be consumed raw or cooked, and is a staple food in some Pacific Islands, while also consumed in parts of Asia and Australia (Krauss, 1993). It is also widely used in the traditional medicine of Polynesian communities, where it is used to treat a wild array of ailments including tumors, diabetes, bacterial infections, and high blood pressure (Su et al. 2005). In the Melanau Igan community, it was mainly used for swelling (11 use-reports), followed by hypertension (4 use-reports), sprained ankle (3 use-reports), and diabetes (3 use-reports). The plant parts have been extensively studied for pharmacological activities, and the results have been favorable (Chan-Blanco et al. 2006). However, the plant has also exhibited several negative effects and concerns, for instance the overconsumption of the fruit juice resulted in nausea, vomiting, anorexia, hypersensitivity, and hyperkalemia (Stadbauer et al. 2005). Moreover, it has been found to interact with medications, affecting the efficacy of certain drugs including insulin (Lee et al. 2012). Thus, this is especially dangerous for individuals with chronic diseases, namely diabetes. Despite the potential risks, *Morinda citrifolia* L. is a widely used medicinal plant in both Sarawak and other regions. Since the plant demonstrates positive pharmacological potential, it is vital to conduct more extensive research and clinical trials on this plant to better understand its safety and efficacy.

Use-reports by ailment categories

The 71 respondents in this study cited a total of 596 use reports for 13 ailment categories. Table 5 shows the use-reports for individual plant species according to ailment categories. Plant species with 2 or fewer citations were excluded, except for the eye and urological ailment categories, which only had plants with two or fewer citations. The general and unspecified ailment category recorded the highest number of total use-reports (170 use-reports), followed by the skin ailment category (163 use-reports), endocrine/metabolic and nutritional ailment category (55 use-reports), digestive ailment category (49 use-reports), cardiovascular ailment category (48 use-reports) and neurological ailment category (43 use-reports). The remaining ailment categories had 20 or less total use-reports.

Table 5. Species use-reports based on ailment category.

Ailment (Total use-reports)	Species (Use-reports)
General and unspecified ailment category	
Fever (111)	*Hibiscus rosa-sinensis L (49)*
	Gynura procumbens (Lour.) Merr.*(9)*
	Senna alata (L.) Roxb*. (3)*
	Kalanchoe pinnata (Lam.) Pers. *(5)*
	Cocos nucifera L. *(6)*

	Citrus aurantifolia (Christm.) Swingle *(25)*
Weakness/tiredness general (10)	Campuran mandian *(3)*
	Mitragyna speciosa (Korth.) HaviL. *(3)*
Swelling (21)	*Curcuma xanthorrhiza* Roxb*. (5)*
	Morinda citrifolia L. *(11)*
Health maintenance/prevention (6)	*Phaleria macrocarpa* (Scheff.) BoerL. *(3)*
General diseases (17)	*Clinacanthus nutans* (Burm.f.) *Lindau (4)*
	Acanthus arboreus Forssk*. (3)*
	Bridelia stipularis (L.) Blume *(3)*
	Pandanus amaryllifolius Roxb*. (4)*
Digestive ailment category	
Abdominal pain (10)	*Psidium guajava* L. *(6)*
Flatulence/gas/belching (18)	*Cerbera odollam* Gaertn.*(13)*
	Kaempferia galanga L. *(3)*
Diarrhoea (10)	*Psidium guajava* L. *(6)*
	Nypa fruticans Wurmb *(4)*
Eye ailment category	
Eye infection/inflammation other (4)	*Allium sativum* L. *(2)*
	Acorus calamus L. *(2)*
Ear ailment category	
Ear pain/earache (4)	*Cocos nucifera* L. *(3)*
Cardiovascular ailment category.	
Hypertension (48)	*Garcinia atroviridis* Griff. ex T.Anderson *(6)*
	Clinacanthus nutans (Burm.f.) *Lindau (5)*
	Spondias dulcis Parkinson *(3)*
	Morinda citrifolia L. *(4)*
	Andrographis paniculata (Burm.f.) *Nees (4)*
	Citrus limon (L.) Osbeck *(7)*
	Momordica charantia L. *(5)*
Musculoskeletal ailment category	
Sprain/strain of ankle (11)	*Myristica fragrans* Houtt*. (3)*
	Morinda citrifolia L. *(3)*
	Cocos nucifera L. *& Piper betle* L. *(3)*
Neurological ailment category	
Headache (42)	*Hibiscus rosa-sinensis L (3)*
	Kalanchoe pinnata (Lam.) Pers. *(4)*
	Citrus aurantifolia (Christm.) Swingle *(32)*
Respiratory ailment category	
Cough (4)	*Hibiscus rosa-sinensis L (3)*
Throat symptom/complaint (8)	*Citrus limon* (L.) Osbeck *(3)*
Skin ailment category	
Pruritus (Itching) (35)	*Aloe vera* (L.) Burm.f. *(7)*
	Psidium guajava L. *(13)*
	Piper betle L. *(6)*
	Mimosa pudica L (7)
Boil/carbuncle (25)	*Ageratum conyzoides* (L.) L. *(18)*
Insect bite/sting (13)	*Euphorbia ingens* E.Mey. ex Boiss*. (4)*
	Pedilanthus tithymaloides (L.) Poit*. (8)*
Burn/scald (7)	*Aloe vera* (L.) Burm.f. *(14)*
Bruise/contusion (7)	*Wedelia biflora* (L.) DC*. (5)*
Laceration/cut (7)	*Ageratum conyzoides* (L.) L. *(5)*
Skin texture symptom/complaint (13)	*Melastoma malabathricum* L. *(13)*
Nail symptom/complaint (9)	*Lawsonia inermis* L. *(6)*
Hair/scalp symptom/complain (11)	*Lawsonia inermis* L. *(5)*

Skin symptom/complaint other (5)	*Alpinia galanga* (L.) Willd. *(3)*
Scabies/other acariasis (8)	*Piper betle* L. *(5)*
Skin infection other (6)	*Piper betle* L. *(5)*
Acne (11)	*Melastoma malabathricum* L. *(3)*
	Kaempferia galanga L. *biasa (3)*
	Kaempferia parviflora WalL. ex Baker *(3)*
Endocrine/Metabolic and Nutritional ailment category.	
Diabetes (44)	*Garcinia atroviridis* Griff. ex T.Anderson *(6)*
	Clinacanthus nutans (Burm.f.) *Lindau (3)*
	Areca catechu L. *(3)*
	Morinda citrifolia L. *(4)*
	Citrus limon (L.) Osbeck *(6)*
	Orthosiphon aristatus (Blume) Miq. *(5)*
	Momordica charantia L. *(4)*
Lipid disorders (8)	*Andrographis paniculata* (Burm.f.) *Nees (4)*
	Momordica charantia L. *(4)*
Urological ailment category	
Urine symptom/complaint other (2)	*Centella asiatica* (L.) Urb. *(2)*
Kidney symptom/complaint (2)	*Orthosiphon aristatus* (Blume) Miq. *(2)*
Pregnancy, Childbearing, Family Planning ailment category	
Contraception oral (3)	*Carica papaya* L. *(3)*
Post-partum symptom/complaint others (15)	Jamu *(4)*
	Citrus aurantifolia (Christm.) Swingle mixed with Limestone chalk *(3)*
	Nypa fruticans Wurmb *(3)*
Male genetical ailment category	
Penis symptom/complaint other (7)	*Citrus aurantifolia* (Christm.) Swingle mixed with Limestone chalk *(3)*

Note: Jamu is concoction made from *Zingiber officinale, Coriandrum sativum, Nypa fruticans, Piper betle* and *Centella asiatica*.

For the general and unspecified ailment category, most treatments were for fever (111 use-reports), followed by swelling (21 use-reports) and general diseases (17 use-reports). Fever also had the highest number of citations for an individual ailment. *Hibiscus rosa-sinensis* (49 citations) and *Citrus aurantifolia* (25 citations) recorded the highest number of citations for treating fever. As mentioned previously, traditional medicine was primarily used by housewives of the Melanau Igan community to treat illnesses while their husbands were away due to work, thus fever was a common ailment treated with traditional medicine. The high number of citations for *Hibiscus rosa-sinensis* and *Citrus aurantifolia* to treat fever is likely due to the plants being easily accessible, often grown in individual households. This also explains the high number of use reports for the skin ailment category, since skin issues is a common health problem in tropical countries especially for children. The majority of citations in the skin ailment category were for itching (35 use-reports), followed by boils (25 use-reports), insect bite/sting (13 use complaints) and skin texture symptom/complaint (13 use-reports). The most cited plants in this category were *Ageratum conyzoides* (23 use-reports), *Aloe vera* (21 use-reports) and *Piper betle* (16 use-reports). These plants were also among the top ten most cited plants by the respondents, indicating that there was a consensus for treatments in this category.

The main health issue addressed in the endocrine/metabolic and nutritional ailment category (55 use-reports) was diabetes (44 use reports). There were ten plant species cited for addressing diabetes, ranging from 6 use-reports (*Garcinia atroviridis*) to 1 use-report (*Centella asiatica*). Diabetes is a major health concern in Malaysia, with a prevalence rate of 18.3% in 2019, up from 13.4% in 2015 (Ministry of Health Malaysia, 2019). Worryingly, some Malaysians believe that traditional treatments can cure diabetes, as evident by a survey conducted by the Ministry of Health Malaysia (Ministry of Health Malaysia, 2019). This was also witnessed in the Kenyah community of Sarawak, whereby the majority of respondents cited resorting to traditional treatments to address diabetes because modern medicine was unable to "cure" the ailment. This lack of awareness and understanding of diabetes is concerning and requires urgent attention from the relevant authorities.

For the digestive ailment category (49 use-reports), the most common treatments were for flatulence/gas/belching (18 use-reports), abdominal pain (10 use-reports) and diarrhoea (10 use-reports). In Malaysia, stomach discomfort is commonly referred to as “angin”, or “bloating”, which explains the high number of citations for addressing flatulence/gas/belching. The Melanau Igan community believe that reducing abdominal gasses is vital in addressing digestive issues. *Cerbera odollam* was the most cited plant to address this issue (13 citations). Since the treatment involves applying crushed *Cerbera odollam* fruit directly on the abdomen, there needs to be laboratory studies on whether the fruit possesses antispasmodic activities. This is due to external treatments to reduce bloating usually involves antispasmodic agents to suppress muscle spasms. *Psidium guajava* was mainly cited to address abdominal pain (6 citations) and diarrhoea (6 citations). As mentioned previously, preliminary laboratory investigations and clinical trials have discovered that *Psidium guajava* is efficacious against several ailments, but more studies need to be conducted to determine its effectiveness in treating digestive issues (Daswani et al. 2017).

Interestingly, for the cardiovascular ailment category (48 use-reports), only hypertension was addressed. Fifteen plant species were cited to treat hypertension, the highest cited plants being *Citrus limon* (7 citations), *Garcinia atroviridis* (6 citations), *Clinacanthus nutans* (5 citations), *Momordica charantia* (5 citations), *Andrographis paniculata* (4 citations), *Morinda citrifolia* L. (4 citations), and *Spondias dulcis* Parkinson (3 citations). The remaining eight species were cited twice or less. As mentioned previously, despite *Citrus limon* being widely used in traditional medicine, it is rarely cited as a treatment for hypertension (Adibelli et al. 2009). This is a unique feature of the Melanau Igan ethnomedicinal system. However, most of the other cited plants are common treatments for hypertension in the traditional medicine of different communities. *Clinacanthus nutans*, commonly known as snake grass or belalai gajah, is widely used in Asian herbal medicine. Chinese herbal medicine lists it as a treatment for hypertension (Alam et al. 2016). The plant has exhibited pharmacological benefits, such as anti-inflammatory, antiviral, antioxidant, and anti-diabetic activities (Alam et al. 2016). Similarly, *Momordica charantia* is also widely used as a traditional medicine, whereby native communities in Panama, Nicaragua and Trinidad have used the plant to address hypertension (Kumar and Bhowmik, 2010). However, studies have been conflicting regarding the effectiveness of this plant species in addressing hypertension (Jandari et al. 2020).

For the neurological ailment category (43 use-reports), almost all citations were for addressing headache (42 citations), while the remaining one citation was for injury to nervous system. This main plant species cited for this ailment category was *Citrus aurantifolia* (32 citations). The species is widely used in Malay traditional medicine to address fever and headaches (Mat-Salleh and Latiff, 2002); which is a trait that is shared by the Melanau Igan community.

Besides the documented plants with high use reports, *Nypa fruticans*, locally known as Pokok Nipah, deserves special attention due to its cultural significance and versatile uses within the Melanau Igan community. This coastal palm species is native to the mangrove forests of Southeast Asia, including the region inhabited by the Melanau Igan. The utilization of *Nypa fruticans* by indigenous communities in the region is multifaceted, encompassing food, thatching, handicrafts, and traditional medicine (Giesen et al., 2007). Within the Melanau Igan community, *Nypa fruticans* holds a prominent position, deeply ingrained in their cultural identity and practices. In addition to using the leaves and bark for treating diarrhea (4 use-reports) and post-partum issues (3 use-reports), the Melanau Igan have traditionally harvested the sap from the palm's stem to produce palm sugar. This sugar is a staple ingredient in Melanau cuisine and has been a significant trading commodity for the community for centuries, particularly with the Brunei Sultanate. The preservation of traditional knowledge associated with *Nypa fruticans* is crucial for maintaining the cultural heritage and practices of the Melanau Igan community. Such efforts not only safeguard biodiversity but also protect the rich traditional knowledge and cultural identity of indigenous communities like the Melanau Igan, which have coexisted harmoniously with these plant resources for generations.

It can be concluded that the most common ailments addressed with traditional medicine in the Melanau Igan community are fever, headaches, skin issues, diabetes, and hypertension. Fever, headaches, and skin issues are common health concerns especially in tropical regions; therefore, housewives are more focused on addressing these common household ailments. It is also worth noting that the use of traditional medicine to treat diabetes and hypertension is significant, given the high prevalence of these diseases in Malaysia (Ministry of Health Malaysia, 2019). However, treating chronic conditions with traditional medicine can be dangerous, especially without consulting medical professionals. Therefore, awareness campaigns are needed to disseminate awareness pertaining to this issue.

Comparison with other ethnomedicinal systems in the region

Table 6 shows the comparison between the Melanau Igan traditional medicinal system with other ethnicities in the region (Figure 9). Similarity between these traditional medicinal systems were calculated using the Jaccard Similarity Index. The similarity ranged between 3.77% (Iban in Sarawak) to 35.14% (Malay in Peninsular Malaysia).

Despite their geographic proximity, the Melanau Igan community displays varying degrees of similarity with neighboring ethnic groups. For instance, the similarity with the Kenyah in Sarawak is 27.18%, indicating a moderate level of shared knowledge, whereas similarity was only 3.77% with the Iban community. Thus, geographically proximity does not influence ethnomedicinal system of Sarawakian communities. Other factors, namely historical and cultural influences, have resulted in their diverse approaches to traditional medicine.

As observed in the case of the Iban, historical factors, such as their close association with the Brooke administration during the colonial era, have influenced their ethnomedicinal practices (Kaga et al. 2008). For instance, the Iban historically have engage in economic activities with the Brooke administration, namely by trading crops that had economic incentives such as cash crops and commercial trees. These crops eventually affected the Iban ethnomedicinal system, whereby commercial vegetables and Dipterocarpus trees are prominent components in their herbal medicine. Although the Melanau also engaged in trading, their focus was on Sago production and fishing, which had less of an impact on their ethnomedicinal system.

The Melanau are coastal societies, residing close to rivers and the sea, thus forming their pillars of economy and even culturally identity. For instance, the Melanau people had even developed their own calendar system based on the sea (Morris, 1978). The first month in this calendar was known as “pengejin” and coincided with March in the Gregorian calendar. This is because March is when the monsoon season is over, thus the sea is calm and the Melanau are able to resume their economic activities like fishing and planting new crops. This proximity to sea and rivers has also resulted in the incorporation of coastal plants such as *Nypa fruticans*, *vitis diffusa*, *acorus calamus* and *Centella asiatica* in their ethnomedicinal system. It is important to note that none of these plants were recorded in the herbal medicine of the Iban although they too often reside close to rivers (Chai, 2000), further demonstrating that historical and cultural factors played a bigger role in the development of ethnomedicinal systems.

It is also important to note that the Melanau and Malays share similar cultural identities. As mentioned previously, this was mainly due to Islamization of the Melanau people by the Malay traders in the 19th century (Morris, 1978). The Malay traders married local Melanau women and gradually Islamized the Melanau tribe. As a result, many Melanaus converted to Islam and adopted Malay culture, including food, clothing, traditions, and religious practices. Moreover, as mentioned previously, part of the Melanau Igan community consist of the Keling sub-group who shares a cultural affinity with Sarawak Malays; Some of these traditions and culture and still practiced by the Melanau Igan. Based on the findings of this study, this similarity also extended to traditional medicine. The Melanau Igan communitity, who are largely Muslims, recorded the highest similarity index value with Malays of Peninsular Malaysia (35.14%). Prominent plants in Malay herbal medicine such as *Hibiscus rosa-sinensis*, *Citrus aurantifolia*, and *Garcinia atroviridis* were also widely used by the Melanau Igan community. The similarity of the Melanau Igan with Sarawak Malays needs to also be studied, considering their geographic proximity and also the Keling sub-group’s origin. This is an area that is worth exploring in future studies.

There are also reports that the Melanau has historically have a positive relationship with the Kayan and Kenyah, often engaging in trading (Shin, 2020). This is due to both communities often residing along the same rivers. Orang Ulu communities usually reside downstream while Melanau communities were mostly located upstream, thus trade could easily be done by river. This could explain the high similarity of the Melanau Igan herbal plants with the Kenyah (27.18%). It is also important to note that the Kenyah have low ethnomedicinal similarity with the Malays of Peninsular Malaysia (6.4%) (Rajoo et al. 2023), unlike the Melanau Igan. Overall, it can be concluded that geographically proximity did not significantly influence the ethnomedicinal system of Sarawakian communities, but it is rather their distinct historical and cultural developments that influences their approaches to traditional medicine.

Figure 9. Map showing the geographical locations of the neighboring regions included in the comparative analysis of ethnomedicinal systems.

Table 6. Similarity of Melanau Igan herbal plants with ethnicities in neighboring region

Ethnicity and area	**Studies**	**Total plants cited**	**Total identical plants**	**Similarity Index**
Kenyah in Sarawak	Rajoo *et al.* 2023	61	14	27.18%
Dusun in Sabah	Ahmad and Ismail, 2003	83	15	32.61%
Murut in Sabah	Kulip, 2003	95	4	6.35%
Dayak in West Borneo	Adi *et al.* 2022	102	5	9.09%
Malay in Peninsular Malaysia	Adnan and Othman, 2012	78	13	35.14%
Dusun in Sabah	Ahmad and Holdsworth, 2003	82	15	32.96%
Kulisus in Indonesia	Royyani and Rahay, 2010	96	15	32.26%
Iban in Sarawak	Chai, 2000	136	3	3.77%

Global Comparison

While the Melanau Igan community's traditional medicinal system exhibits similarities with neighboring regions, as discussed in the previous section, it is also instructive to draw comparisons with ethnobotanical studies from other parts of the world. Such global comparisons can shed light on the universality or uniqueness of certain practices and reveal broader patterns in the utilization of medicinal plants across diverse cultures.

One of the notable similarities between the Melanau Igan community and traditional medicine systems worldwide is the widespread use of plant species like *Aloe vera* and *Cocos nucifera*. *Aloe vera*, in particular, is a common feature in the ethnobotanical repertoires of various cultures, ranging from South America to Africa and Asia (Salehi et al., 2018). Its use for treating skin ailments, such as burns, wounds, and dermatitis, is well-documented across multiple regions, reflecting a shared recognition of its therapeutic properties. Similarly, the coconut palm (*Cocos nucifera*) holds immense cultural and medicinal significance in many tropical and subtropical regions, including Southeast Asia, the Pacific Islands, and South America (Lim, 2012). Its versatility as a source of food, fiber, and traditional remedies has made it an integral part of the lives and traditions of numerous indigenous communities worldwide.

Interestingly, certain plant species that are prominent in the Melanau Igan traditional medicine system, such as *Hibiscus rosa-sinensis* and *Citrus aurantifolia*, also find applications in other distant regions. For example, *Hibiscus rosa-sinensis* has been used in traditional Mexican medicine for treating various ailments, including fever, respiratory disorders, and skin conditions (Alvarez-Gayou et al., 2021). Similarly, *Citrus aurantifolia* (lime) has been extensively utilized in traditional Ayurvedic medicine in India for its therapeutic properties, particularly in treating digestive and respiratory issues (Yadav et al., 2022).

On the other hand, some aspects of the Melanau Igan traditional medicine system appear to be more distinctive and localized. For instance, the use of coastal plants like *Nypa fruticans* (a mangrove palm) and *Vitis diffusa* (a coastal vine) in treating ailments is likely a reflection of the Melanau Igan community's close association with coastal and riverine environments. Additionally, the application of the highly toxic *Cerbera odollam* (the suicide tree) in treating flatulence and belching is a unique practice that may not be widely observed in other traditional medicine systems, highlighting the need for caution and further research into the safety and efficacy of such practices.

These global comparisons underscore both the shared foundations and the unique adaptations of traditional medicine systems across different cultures. While certain plant species and therapeutic applications may be universally recognized, local environmental conditions, cultural beliefs, and historical influences shape the distinctive aspects of each community's ethnobotanical knowledge. Exploring these similarities and differences can not only deepen our understanding of the rich tapestry of traditional medicine but also potentially uncover novel therapeutic agents or approaches that could contribute to modern healthcare practices.

Conclusion

The most notable aspect of the ethnomedicine of the Melanau Igan community is the predominant role of women in traditional medicine practices due to their responsibilities in managing households and caring for family members. Moreover, the passing down of this knowledge is secured through oral transmission, maintaining the continuity of traditional medicine practices within the community. This is not evident in other Sarawakian communities like the Kenyah, whereby shifting reliance towards modern medicine has resulted in the traditional medicinal knowledge not being passed on to future generations.

Fever, headaches, skin issues, diabetes, and hypertension are the most common ailments treated with traditional medicine in the Melanau Igan community. Fever, headaches, and skin issues are expected since they are common ailments especially in tropical regions. It is also worth noting that the prevalence of diabetes and hypertension in Malaysia is high, which explains why traditional medicine is used to treat these chronic diseases. However, this can be dangerous especially if the community is not consulting healthcare professionals, thus this issue needs to be further explored. *Hibiscus rosa-sinensis*, *Citrus aurantifolia*, *Psidium guajava*, *Ageratum conyzoides* and *Citrus limon* play prominent roles in the traditional medicine of the Melanau Igan community, being the top five plants with the most respondent citations. These plants were primarily used to treat fever, headaches, skin issues and digestive ailments.

The comparison with neighboring ethnic groups underscores the influence of historical and cultural factors on the Melanau Igan's unique traditional medicine system. Geographical proximity does not determine similarity, as demonstrated by the varying degrees of shared knowledge with neighboring communities, such as the Iban and Kenyah. Historical associations, the Melanau's coastal lifestyle and cultural affinity with Malays, are pivotal in shaping their ethnomedicinal practice. This emphasizes the necessity of considering cultural and historical context when studying traditional medicine practices in Borneo.

In conclusion, this study provides valuable insights into the Melanau Igan's traditional medicinal system, emphasizing the roles of gender, oral knowledge transmission, and the impact of historical and cultural factors. There needs to be a continuous statewide study to not only document the traditional medicinal knowledge of the 40 plus sub-ethnic groups in Sarawak, but also the safety and efficacy of these traditional medicines, especially for chronic diseases.

Declarations

List of abbreviations: UPM - Universiti Putra Malaysia

Ethics approval and consent to participate: The ethical guidelines for the survey of rural and indigenous communities provided by the International Society of Ethnobiology (available online: www.ethnobiology.net/whatwe-

do/coreprograms/iseethics-program/code-of-ethics) were carefully adhered to. Before interviews, formal verbal consent (regarding data collection and publication) of each participant was taken. All participants provided informed consent. This study was approved by The Sarawak Biodiversity Centre (Ref: SBC/700-1/1/RES/K/1/10). Based on this approval and alignment with the university's JKEUPM-134 Bil regulations, UPM's ethical committee deemed additional written approval unnecessary.

Consent for publication: All participants shown in images gave their prior informed consent to have their images published.

Availability of data and materials: Not applicable

Competing interests: We the authors have no conflict of interest to declare.

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