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Ethnomedicinal and Ethnopharmacology Value of Plants Used by Kenyah in Borneo: A Review

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ABSTRACT

Numerous societies across the globe rely on medicinal plants as a primary therapeutic resource. These plants have a long history of use in traditional medicine among several indigenous communities in Borneo. Among these communities is the Kenyah, who have an extensive heritage of relying on plants for medicinal purposes. The purpose of this review is to examine and compile the ethnomedicinal utilisation of plants by the Kenyah people of Borneo. This review included and documented different plants used by the locals of Borneo particularly Kenyah of Kalimantan and Sarawak for various medicinal purposes. The plants are grouped into family name, scientific name, and local name. Tabulation of each plant's specific treatment remedy after the method of administration, which may involve crushing and drinking an infusion, applying a poultice externally, grinding the plant into a paste, or inhaling smoke were done. The documentation identified 61 plant families, and several traditional treatment groups. Selected plants are scrutinized for their existing data on traditional usage to determine further potential and research gaps for research of the plants relating with the Kenyah ethnomedicinal knowledge.

Keywords: Ethnomedicinal; Ethnopharmacology; Kenyah; Sarawak; Kalimantan

INTRODUCTION

Traditional medical practices and their application across many cultural and geographical settings are the primarily the ethnomedicinal study (Quinlan, 2022). In traditional ethnomedicine, knowledge is passed down orally from one generation to the next by means other than written documents (Y. Zhang et al., 2014). Despite the availability of basic and supplementary healthcare, traditional medicines are still commonly utilised to treat minor diseases such as colds, fevers, stomach issues, and headaches to major diseases such as cancer, broken bone and reproductive issues (Aziz et al., 2020). The society's traditional remedies ought to solely be administered by skilled traditional healers or elders.

The preference for the traditional ethnomedical system for some illnesses is probably due to its availability, efficacy, and particularly affordability compared to biomedicine, and conventional treatment is culturally more acceptable (Bakar et al., 2023). This demonstrates how local traditional knowledge may help alleviate a wide range of healthcare issues in rural and urban communities by supplementing technological therapy with conventional remedies (Gomes et al., 2023). Worldwide, medical usage trends and practices are influenced by many cultures and lifestyles. According to Süntar (2020), traditional understandings and the geographical distribution of plant species can impact the methods used to manufacture medications and plant sections. Understanding the variety of medicinal plants requires research on these factors. Furthermore, many trends, most notably urbanization and globalization, have had a detrimental impact on traditional wisdom.

For a long time in Borneo, people of indigenous descent have relied on herbal remedies to treat and prevent a wide range of diseases. The Kenyah Dayak tribe is a Dayak tribe that includes the Kenyah, Kayan, and Bahau group that originates from Baram district, Sarawak (Sagala et al., 2020). From that region the Kenyah tribe entered Malinau Regency, East Kalimantan through the river in Iwan Sarawak, split into two parts towards the Apau Kayan area which was previously occupied by the Kayan tribe and the other part towards Bahau. They are also a native Malaysian ethnic group well-known for their extensive knowledge of and practice with a wide range of herbal remedies (Khan et al., 2023). Research on the ingredients and methods of preparation of these medicinal plants is crucial for understanding the Kenyah people's long-standing usage of these plants in healing, as well as their traditional therapies.

Traditional medicine among Malaysia's Kenyah community dates back thousands of years (Sundara Rajoo et al., 2023a). In order to cure injuries including wounds, burns, and infections, the Kenyah folks use a wide range of medicinal herbs, according to a recent study (Khan et al., 2023). These herbal remedies are also used by the Kenyah folks to alleviate gastrointestinal issues, lower fevers, and promote healthy skin, according to the study. There is potentially a strong connection between the spirituality and cultural traditions of the Kenyah community and the utilization of medicinal plants in traditional medical procedures. An analysis also revealed that studies are conducted in a few districts of Sarawak, primarily focusing on Iban, Kedayan, Melanau, Bidayuh, Orang Ulu (Kenyah and Kayan), and Jagoi communities suggesting that the utilization of herbal plants by other communities and regions are yet to be recognized, published or the data is not presented online (Bakar et al., 2023).

Research into the Kenyah's ethnomedicinal plants, including their chemical make-up and their therapeutic uses, is crucial for understanding their traditional medicine and the plants' effects on human health. In addition to protecting the Kenyah people's rich cultural heritage and body of knowledge, this data may lead to the discovery of novel medicinal and therapeutic agents. Therefore, for the benefit of rural communities and for the advancement of medicine, it is critical to record traditional knowledge in order to preserve it. In general, the development of novel medications relies heavily on traditional ethnobotany knowledge (Süntar, 2020). Yet, there are a number of drawbacks to relying on plants for traditional medicine. These include issues with efficacy, dosage uncertainty, diagnostic difficulties, and the availability of plant species, which can change over time. The goal in conducting this review was to elucidate the diversity of medicinal plant utilization by the Kenyah indigenous community for health care reasons in the study area. As a result, there is ample potential for additional research into the fields of ethnobiology, ethnopharmacology, and ethnobotany of these plants through investigating the connection between human cognition and communication of Kenyah people’s history.

METHOD AND APPROACHES

Data Sources and Search Strategy

This study followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methods to the extent in order to reach the objective of the systematic study (Page et al., 2021). Due to its widespread use and acceptance in systematic reviews, this procedure was chosen to provide a systematic and comprehensive approach to data collection, analysis, and presentation. The study was supplemented by a systematic review-specific evaluation criteria checklist to further ensure high quality, transparency, and reproducibility (Duche-pérez et al., 2024). To guarantee that the review was carried out in a thorough and rigorous manner, these criteria were essential.

Google Scholar, Web of Science, Scopus, Springer, and PubMed were among the more specific databases that were thoroughly searched throughout the process. We selected these databases because of the wealth of internationally recognised scientific articles they include and the breadth of their coverage. To ensure that the included studies were up-to-date and pertinent to the research issue, the search concentrated on finding publications published in high-impact scientific journals. Despite extensive searching, no previous systematic evaluations were located that dealt with the documentation and therapeutic applications of Kenyah ethnomedicinal knowledge. Thus, relevant information was collected through a literature survey of the published Kenyah ethnobotanical papers on herbal medicines found in the Kalimantan and Sarawak regions of Borneo. The significance of this discovery in addressing this gap in the existing scientific literature highlights the uniqueness and necessity of the current review.

This study is based on a research topic that asks: What is the health-related theories, knowledge, therapeutic value of medicinal plants documented the Kenyah, and how have their ethnopharmacological applications been evaluated in the scientific literature? The following terms and their related concepts were used in the search process: ethnomedicine (Kenyah medicine, cultural medicine, folk medicine, indigenous medicine, natural medicine, traditional herbal medicine, traditional medicine) and medicinal plants (curative plants, healing herbs, healing plants, herbal medicine plants, herbal remedies, medicinal botanicals, medicinal flora, medicinal herbs). The lookup was completed in both English and Malay. Here, the search equation included both predefined terms and free-form ones: (Kenyah OR ethno OR ancestral OR culture OR folk OR indigen OR natural OR tradition) + (plant OR herb OR flora OR botanic).

Inclusion and Exclusion Criteria

Articles published in peer-reviewed scientific journals between 2014 and 2024 and indexed in databases such as PubMed, Springer, Scopus, and Google Scholar (Core Collection) were the only ones included for the systematic review. In the context of ethnomedicine, ethnobotanical surveys were carried out in Borneo, Sarawak, and Kalimantan pertaining to Kenyah, and these studies were published in English and Malay and dealt with subjects including documentation, evaluation, and pharmacology of the medicinal plants. In order to ensure that the articles were relevant to the review objectives, they were additionally selected based on whether they included terms related to "ethnomedicine" (such as Kenyah medicine, cultural medicine, folk medicine) or "ethnopharmacology" (such as chemical constituent, antioxidant, pharmacology, clinical studies) in their abstracts or descriptors. In the ethnopharmacology table, only the chemical constituent from the utilized part of the plant by Kenyah people are cited such as Hibiscus rosa-sinensis is mainly reviewed for the data of its flower but the leaves are the applied part to treat pus urine according to a Kenyah ethnomedicinal studies so only the chemical constituent of the leaves are tabulated. The pharmacological studies row in the table is included for studies generally done *in vitro, in silico* and *in vivo* relating to the traditional use of Kenyah yet for plants with limited data or studies, the available pharmacology is added. The clinical trial part is inserted with any available data related to the utilization of the plant as a whole in the study. Notably, some of the evaluated studies omitted vital ethnobotanical facts on plant folk names,

informants, research site selection criteria, remedy preparations, ICPC-2 categories and administrations, among other things.

Studies were also excluded if they did not fulfil the aforementioned criteria. Papers such as this fall under this category, as do conference abstracts, initial research, editorials, and letters to the editor. Excluded from the search were studies authored in languages other than English and Malay, as well as those published between 2014 and 2024. Furthermore, publications published in platforms or forums other than scholarly journals were also not included, nor were research that did not centre on ethnomedicine or ethnopharmacological applications of the linked medicinal plants. This includes ethnoveterinary use in particular. For the ethnopharmacology table, the chemical components are excluded with quercetin, gallic acid and kaempferol as an additional row is added for antioxidant DPPH test proven the existence of the aforementioned chemical constituent. Therefore, the focus is more on detailed chemical compound that is isolated from the plant that may contribute not only to antioxidants but other pharmacological and biological activities.

Finally, to ensure that only high-quality and relevant research was included in the review, studies that were duplicated or overlapped were excluded, as were studies that did not give adequate detail on the evaluation, documentation, or conservation of ethnomedicinal knowledge.

Document Selection Procedure

Before settling on a final set of publications, the researchers underwent a multi-step process. The initial step in selecting articles was for four separate writers to manually review the titles and abstracts of relevant journal publications. Other writers looked over all of the papers that might have qualified. In the event of disagreement, the view of a third author was taken into account. In Figure 1 we can see the steps used to choose the data. Out of the 136 papers that were retrieved using various search engines, 41 did not provide enough detail. From this pool, 95 documents were chosen for this review's design, and all of them met the inclusion and exclusion criteria.

Data Analysis

It was considered crucial to create a table that compiled important data as this review requires a higher degree of specificity. There were three figures and two tables that summarised the data: one for ethnomedicine and another for ethnopharmacology. The tables for ethnopharmacology also included the phytochemistry of the plants that were described. There is information on the plant's name, family, vernacular name, traditional usage, parts used, extraction methods, indication, and survey area in the ethnomedicinal table (Aziz et al., 2020; Jarić et al., 2024). The ethnopharmacology table contains information about the plant's common or regional name, its primary chemical component, its antioxidant capacity, its pharmacology, its clinical trials, and its claimed traditional usage. In addition, a comparison analysis was carried out among the chosen studies to enhance the analysis. The data was tabulated, sorted, and organised in MS Excel for cross-regional study of medicinal taxa and their usage. Then, Venn diagrams and charts were used to present the results. This allowed for the identification of noteworthy parallels and differences in the techniques and conclusions reported in the literature review. A greater grasp of patterns and trends in Kenyah ethnomedicinal research is made possible by this all-encompassing method, which also helps with data organisation and analysis.

SCOPE AND LIMITATION

Traditional Medicines of Borneo

A total of 95 documents were chosen for inclusion in the sample once the search was finished and the results were reviewed using the defined technique. Table 2 lists the ethnopharmacology, pharmacology, chemical constituents, and clinical research conducted on ethnomedicinal plants from Kenyah in Borneo, and Table 1 lists the ethnomedicinal plants of Kenyah in Borneo. Furthermore, it was sought out 30 medicinal plant species to study their phytopharmacological profiles. Table 2 is provided with the main chemical components of selected plants with significant to Kenyah ethnomedicine such as cross cited in previous literature or highly cited by respondent in articles. These tables were used to organise and categorise the objects being studied.

The Kayan and Kenyah

Located in the inner highland woods of Kalimantan (Indonesian) and Sarawak (Malaysian) both in Borneo, the Kenyah are agrarian community (Leaman et al., 1995). On the plateau that connects the Kayan and Mahakam rivers, known as the Apo Kayan, about 8,000 Kenyah people live in longhouse populations. They grow rice by shifting cultivation and depend heavily on forest resources for subsistence hunting, fishing, and gathering. In furtherance of their own understanding of local resources, the Kenyah have limited access to medicines, as do many groups in comparatively far and inaccessible regions.

In Sarawak Bintulu, the upper Tubau River, which is a tributary of the Kemena River, is home to the Kenyah people. Numerous Kenyah settlements can be found downstream the Kakus, a tributary of the Tatau River. Statistics showed that there were 230,000 people living in Bintulu Division in 2010 (石川登, 2013). Of the total population, just 5% are Orang Ulu, which includes the inland Kayan and Kenyah peoples.

Kenyah Kalimantan Ethnomedicine

In Kalimantan, the types of infectious diseases that has been recorded for example Malaria, panu or water lice, infectious wounds (purulent), diarrhoea, toothache, urinary tract infections, worms, eye pain and more are noted in Table 1. Diarrhoea occupies the first position of the infectious disease most often experienced by the Kenyah Dayak Tribe community (Setiawan & Hazyrul, 2022). This may be due to the condition of the community which is still lacking in paying attention to the cleanliness of the environment where they live. There are still many people who live with dogs and there are people who keep pigs, where the pigsty is very close to their homes.

Six ways of processing medicinal plants that are commonly done by the Kenyah Dayak tribe, namely, boiling with a percentage of 46%, pounded with a percentage of 18.18%, dripped with a percentage of 13.63%, burned and brewed with a percentage of 9% (Setiawan & Hazyrul, 2022). Then there are 2 main sources of income for the Dayak Kenyah community in obtaining medicinal plants used for the treatment of infectious diseases, namely, the cultivation (farm) of medicinal plants amounting to 9.10% while medicinal plants obtained from wild habitats (forests) amount to 90.90% (Imang et al., 2008).

The traditional medicine of the Kenyah Dayak Sub-tribe of Umaq Bekuai Village, Tabang, Kutai Kartanegara, Kalimantan that are most commonly used in the families of Acanthaceae, Compositae, and Euphorbiaceae. (Acanthaceae (49%), followed by Compositae (30%), Euphorbiaceae dan Poaceae masingmasing (10%) and others (1%)) (Az-Zahra et al., 2021). Native Kenyak Dayaks make Pupur, a medicinal plant paste, by boiling, crushing, drinking, and applying it to sore spots. *Graptophyllum pictum* (Kemba) and *Justicia gendarussa* (Kembat) are members of the Acanthaceae family; Tumbuh Daging is a

member of the same family and is used to treat bloody faeces (Sagala et al., 2020). The decocted leaf water of V*ernonia amygdalina* (Udo Lepek) can be used to cure diabetes, while the hormonal menstruation can be alleviated by *Ageratum conyzoides* (Tambora). *Tagetes erecta* (Bunga Saret Batak) can be used to treat coughs that are full of phlegm. Using the decocted leaf water, fractures can be treated with *Euphorbia tithymaloides* (Patah Tulang), while rheumatic disorders can be treated with *Excoecaria cochinchinensis* (serat merah) (Sagala et al., 2020). Accordingly, it was found that there is a potential anti-cancer plant, namely Bekai (*Pycnarrhena cauliflora* Diels), which needs to be further researched on the chemical content found in the plant (Sagala et al., 2020). Interestingly, *Pycnarrhena tumefacta* Miers was also reported to be called bekai locally but used for eye sore instead of cancer with a different indication (Setiawan & Hazyrul, 2022). The Kenyah of the Apo Kayan, a remote forested plateau in Indonesian Borneo, use 17 malaria remedies derived from natural sources (Leaman et al., 1995). A study reported with results that confirm the selection and use of traditional remedies for malaria by the Kenyah.

Furthermore, it can be known that members or species of plants from the Family Zingiberacea have the most amount utilized by the Dayak community in Long Nawang Village (Ingan & Jaya, 2023). In addition to plants from the Family Zingiberaceae, more than one species of plants from the Family Poaceae, Piperaceae, and Liliaceae are used by the Dayak Kenyah tribe for medicines and spices. For the rest, each of the recorded families has only one species of plant that is used either for medicine only, for spices only, or for both. One of the interesting information from the results of this research is that the family Zingiberaceae has members of the species that are used the most by the Dayak Kenyah tribe compared to members of other families as is also done by the Dayak tribes in other regions, both fellow Dayak Kenyah tribes as well as the Dayak Lundayeh tribe (Ingan & Jaya, 2023; Listiani & Abrori, 2019; S. A. Maharani et al., 2021; Setiawan & Hazyrul, 2022). Plants from the Family Zingiberaceae are widely used as medicines and spices by people in Indonesia because they contain chemical compounds that are beneficial for the body as a general essential oils, saponins, flavonoids, and polyphenols (Ingan & Jaya, 2023).

Family Poaceae and Piperaceae also have quite a role for the Dayak Kenyah tribal community as also found in the Tidung tribal community (Listiani & Abrori, 2019). This plant from the Family Poaceae and Piperaceae has benefits as a medicinal ingredient as well as a spice ingredient. Bambusa vulgaris is one of the plants from the Poaceae family that is used as a medicine by the Dayak Kenyah, Dayak Mahap, and Malay tribes (S. A. Maharani et al., 2021). It is known that the medicinal plant that is often used by the Kenyah Dayak tribe for the treatment of infectious diseases namely bekai with a percentage of use of 12%, then soursop (Dian kapen) of 8%. The bekai plant is used by the Kenyah Dayak tribe to treat red eyes and often remove eye dirt (Sepsamli et al., 2019). Research shows that general flavonoid compounds, alkaloids, tannins, and phenols can inhibit bacterial growth by interfering with cell wall components, metabolism, and DNA-RNA synthesis (Ulfa et al., 2021). As the leaves containing the flavonoid chemicals, alkaloids, tannins, and phenolics, bekai leaves used to treat eye pain may limit bacteria development.

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TABLE 1: Kenyah Ethnomedicinal Plants in Borneo

Family name	Name of herb	Local name	Disease specified or use categories (ICPC-2)	Plant part	Extraction methods and indication	Reference
Lamiaceae	*Orthosiphon aristatus* (Blume) Miq.	Misai Kucing/ Kumis Kucing	Diabetes stomach-ache Kidney stones	Leaves	Boiled and water is consumed twice a day.	(Ingan & Jaya, 2023; Khan et al., 2023; Sagala et al., 2020; Sundara Rajoo et al., 2023a)
	Leuconotis eugeniifolia	Senudung	Bloated stomach (baby only)	-	-	(Khan et al., 2023)
	Vitex pinnata L.	-	Eye	Leaves	Boiled and water is applied on affected area	(Sundara Rajoo et al., 2023a)
	Vitex pubescens	-	Eye	Leaves	Boiled and water is applied on affected area	(Sundara Rajoo et al., 2023a)
	Callicarpa longifolia Lam.	-	Skin	Leaves	Pounded and applied on affected area	(Sundara Rajoo et al., 2023a)
Zingiberaceae	*Curcuma longa*	Kunyit/Lia mit/ Le berung	Diarrhoea Malaria	Roots, Fruit added with honey	Powdered, boiled with tea/water, and consumed. Take enough turmeric, wash it clean and then grate it, add water, and drink it. When added honey can treat malaria.	(Ingan & Jaya, 2023; Setiawan & Hazyrul, 2022; Sundara Rajoo et al., 2023b)
	Kaempferia galanga	Kencur/Lia sanit	Digestive, Cardiovascular, Respiratory	Root	Boiled and water is consumed	(Ingan & Jaya, 2023; Sundara Rajoo et al., 2023a)

	Zingiber officinale	Jahe/Lia buke/Liasa lok	Diarrhoea Malaria	Fruit added with honey	Take enough turmeric, wash it clean and then grate it, add water and drink it. When added honey can treat malaria. To be taken 3 times per day	(Ingan & Jaya, 2023)
			Skin	Root	Pounded and applied on affected area	(Sundara Rajoo et al., 2023a)
	Alpinia galanga L.	Lengkuas/ Bukek/ Burak	Skin panu/water lice	Fruit	Take enough fruit, wash it clean, then mash it until smooth and apply it on the skin.	(Setiawan & Hazyrul, 2022)
Caricaceae	*Carica papaya*	Pepaya/Manjan	Diarrhoea, Skin	Leaves	Take 4-5 leaves, wash them clean, then boil them, filter and drink. Honey can be added to reduce the bitter taste. Drink three times a day	(Ingan & Jaya, 2023; Setiawan & Hazyrul, 2022; Sundara Rajoo et al., 2023a)
Piperaceae	*Piper betle*	Sirih/ Kudu Sepak	Sore throat Toothache Eye, Neurological, Respiratory	Leaves	Take 4-5 kudu sepak leaves, wash them clean, then boil the kudu sepak leaves until they change color, let it cool down, add	(Ingan & Jaya, 2023; Sagala et al., 2020; Setiawan & Hazyrul, 2022; Sundara Rajoo et al., 2023a)

					salt and rinse using the kudu sepak water. Gargled 3 times a day or drink 2 times a day. Boiled water is also used for bath.	
	Piper nigrum L.	-	General and Unspecified	Fruit/ Seed	Boiled and water is consumed or bathed with.	(Sundara Rajoo et al., 2023a)
Aristoloceae	*Aristolochia foveolata*	Taban aka	-	-	-	(Ingan & Jaya, 2023)
Annonaceae	*Annona muricata*	Sirsak/Dian Kapen	Digestive, Cardiovascular, Respiratory, Endocrine/Metabolic and Nutritional Worms	Leaves	Pounded and applied on affected area. Take 7-8 leaves, wash clean and then boil until the boiled water turns greenish. Drink 3 times a day	(Ingan & Jaya, 2023; Setiawan & Hazyrul, 2022; Sundara Rajoo et al., 2023a)
	Goniothalamus macrophyllus (Blume) Zoll.	-	Skin	Stem and roots	Burned like incense and applied on body	(Sundara Rajoo et al., 2023a)
	Phaeanthus sp.	-	Skin	Kebin (other)	Pounded and applied on affected area	(Sundara Rajoo et al., 2023a)
	Polyalthia spp.		Skin	Leaves	Pounded and applied on affected area	(Sundara Rajoo et al., 2023a)
Arecaceae	*Cocos nucifera*	Kelapa	Respiratory and skin	Fruit	Pressed to produce oil,	(Ingan & Jaya, 2023; Sundara Rajoo et al., 2023a)

					applied on affected area	
Poaceae	*Bambusa vulgaris*	Bambu	-	-	-	(Ingan & Jaya, 2023)
	Cymbopogon citratus	Serai	-	-	-	(Ingan & Jaya, 2023)
	Panicum sp.	Rumput Jalar	For back pain	Leaves	First cleaned and then boiled. Drink once a day	(Sagala et al., 2020)
	Imperata cylindrica (L.) Raeusch.	Alang-alang	For bone pain, Neurological	Root	Boiled in four glasses of water make two glasses. Then drink it twice a day	(Sagala et al., 2020; Sundara Rajoo et al., 2023a)
	Giganthochloa spp.	-	Skin	Leaves	Leaves are used to wrap around affected area	(Sundara Rajoo et al., 2023a)
	Pennisetum purpureum (Schumach.) Morrone	-	Skin	Leaves	Squeezed and applied on affected area	(Sundara Rajoo et al., 2023a)
	Cymbopogon nardus (L.) Rendle	-	Musculoskeletal, Neurological, Urological	Stem and leaves	Pounded and boiled, water is consumed or bathed with	(Sundara Rajoo et al., 2023a)
	Saccharum officinarum L.	-	Respiratory, Urological	Leaves	Pounded and applied on affected area	(Sundara Rajoo et al., 2023a)
Asphodelaceae	*Aloe vera*	Lidah buaya	Skin	Leaves	Leave extract is applied on affected area	(Ingan & Jaya, 2023; Sundara Rajoo et al., 2023a)
Rutaceae	*Citrus* sp.	Bunyau/Jeruk purut	-	-	-	(Ingan & Jaya, 2023)
	Citrus aurantifolia L.	Jeruk nipis/Meo	Panu/Kutu Air Respiratory, skin	Fruit	Take enough lime fruit, then burn it and wash	(Setiawan & Hazyrul, 2022;

					it until it is clean. Mash it finely and apply it on the skin that has panu/water lice. Fruit can consumed directly	Sundara Rajoo et al., 2023a)
Liliaceae	*Allium cepa*	Bawang merah	-	-	-	(Ingan & Jaya, 2023)
	Lilium longiflorum Thunb	Bunga Paskah/Bakong	A suppurating wound	Leaves	Take 7-8 leaves, wash clean, mash until smooth and apply to the infected skin.	(Setiawan & Hazyrul, 2022)
Iridaceae	*Eleutherine bulbosa*	Udo Lembak (Bawang Dayak)	Amandel/Tonsils	Rhizome	Clean the rhizome then grate and filter. Drink 2 times a day	(Ingan & Jaya, 2023; Sagala et al., 2020)
Myrtaceae	*Psidium guajava*	Daun Jambu/ Jambu/Nyi bun	Diarrhoea	Leaves	Cleaned first then grated and drink once a day/Take 10 sheets of nyibun leaves, wash them clean, then boil the nyibun leaves until they turn greenish, then strain and drink. Drink three times a day.	(Ingan & Jaya, 2023; Sagala et al., 2020; Setiawan & Hazyrul, 2022; Sundara Rajoo et al., 2023a)
	Syzygium fergusonii (Trimen) Gamble		Skin	Leaves	Leaves are used to wrap around affected area	(Sundara Rajoo et al., 2023a)

Menispermaceae	*Pycnarrhena cauliflora* Diels	Bekai	For Cancer and Flavoring	Leaves	Boiled and then drink 3 times a day/put into cooking as a flavoring agent	(Sagala et al., 2020)
	Pycnarrhena tumefacta Miers	Mekai/Bekai	Eye sore	Leaves	Take 1 young bekai leaf that rolls up, pull out the water and drop it on the sore eye.	(Setiawan & Hazyrul, 2022)
	Fibraurea chloroleuca Miers	Akar Kuning/Aka Kuning	Eye sore	Root	Taken 1 drop of water that comes out of the root to a red or sore eye.	(Setiawan & Hazyrul, 2022)
	Coscinium fenestratum (Gaertn.) Colebr.	-	Respiratory, Digestive	Root	Chewed directly or boiled with water	(Sundara Rajoo et al., 2023a)
Amaranthaceae	*Amaranthus tricolor* L.	Bayam Merah	Poisonous animal bites	Leaves	Mashed or grated paste on the wound, enough	(Sagala et al., 2020)
Acanthaceae	*Graptophyllum pictum* (L.) Griff.	Kemba/ Kembat Hitam	To bathe the baby's lender and itch	Leaves	Wash it clean, grate it and rub it on your body then wash it clean. 2 times a day	(Sagala et al., 2020)
	Justicia gendarussa Burm.f.	Kembat (Pue Bule)	For bathing babies and itching	Leaves	Wash it clean, grate it and rub it on your body then wash it clean. 2 times a day	(Sagala et al., 2020)
	Hemigraphis bicolor Boerl.	Tumbuh Daging	Bleeding	Leaves	Boiled with three glasses of water until it boils to	(Sagala et al., 2020)

					one glass, then drunk three times a day	
	Hemigraphis sp.	Sugi Gajah	Internal infection	Leaves	The leaves are cleaned first and then grated. Drink twice a day	(Sagala et al., 2020)
	Clinacanthus nutans (Burm.f.) Lindau		Skin	Leaves	Pounded and applied on affected area	(Sundara Rajoo et al., 2023a)
Euphorbiaceae	*Excoecaria cochinchinensis* Lour.	Serat Merah	Rheumatism	Leaves	Boiled in 3 glasses of water until 2 glasses remain. Drink 3 times a day	(Sagala et al., 2020)
	Euphorbia tithymaloides L. Syn.Pedilanthus tithymaloides (L.) L.	Patah Tulang	For broken bones	Leaves	Boil it until it boils and drink it twice a day	(Sagala et al., 2020)
	Endospermum diadenum (Miq.) Airy Shaw	-	Digestive and skin	Leaves	Pounded and applied on affected area	(Sundara Rajoo et al., 2023a)
Polypodiaceae	*Pyrrosia piloselloides* (L.) M. G. Price	Letek	Tumour	Leaves	Washed clean and boiled until boiling. Drink 3 times a day	(Sagala et al., 2020)
Orchidaceae	*Acriopsis liliifolia* (J. Koenig) Seidenf.	Bawang Kayu (Paku Jet)	For bleeding	Rhizome	Wash clean then mash and boil 2 glasses of water until 1 glass is left. Drink 3 times a day	(Sagala et al., 2020)
Nephrolepidaceae	*Nephrolepis cordifolia* (L.) C. Presl	Julut	Vagina complications	Root	Wash it clean and then boil it, the boiled water is	(Sagala et al., 2020)

					washed on the vagina	
Amaryllidaceae	*Crinum* sp.	Bakung	Broken bones	Leaves	The leaves are roasted and then wrapped or tied to the painful part	(Sagala et al., 2020)
Compositae	*Veronia amygdalina* Delile	Udo Lepek	Diabetes	Leaves	Wash clean and boil until boiling. Drink twice a day	(Sagala et al., 2020)
	Ageratum conyzoides (L.)	Tambora	Blood bleach	Leaves	Boiled in two glasses of water make one glass and drink once a day	(Sagala et al., 2020)
	Tagates erecta L.	Bunga Saret Batak	Coughing up phlegm	Root	Boiled in three glasses of water until the remaining two glasses of chilled water. Drink three times a day	(Sagala et al., 2020)
Malvaceae	*Hibiscus rosa-sinensis* L.	Kembang Sepatu	Pus urine	Leaves	Wash clean, boil in four glasses of water until one glass is left, filter and drink once a day	(Sagala et al., 2020)
Malvacea	*Abelmoschus manihot* L.	Gedi/Ludo kayu	Urinary Tract Infection	Leaves	Take 7-8 leaves, wash them clean, then boil them until the boiled water changes colour, filter and drink. Drink 3 times a day.	(Setiawan & Hazyrul, 2022)

	Abelmoschus esculentus L.	Okra/Ludu Buak	Urinary Tract Infection	Leaves	Take 7-8 pieces of leaves, wash clean, then boil until the boiled water changes colour, filter and drink. Drink 3 times a day.	(Setiawan & Hazyrul, 2022)
	Abelmoschus moschatus Medik.	-	Skin, Endocrine/Metabolic and Nutritional	Fruit/ Seed	Directly consumed or added to cooking as a spice	(Sundara Rajoo et al., 2023a)
Lythraceae	*Lawsonia inermis* L.	Pacar	For wounds/swelling	Leaves	Wash it clean and mash and paste it on the sore part	(Sagala et al., 2020)
Cyperaceae	*Rhynchospora colorata* (L.) H. Pfeiff. Syn. Cyperus kyllingia Endl.	Kaput Burit	For vaginal cleansing	Leaves	Wash it clean and then boil it, the boiled water is washed on the vagina	(Sagala et al., 2020)
Phyllanthaceae	*Phyllanthus niruri* L.	Nyiur Hongo (Udo Anggok)	Scabies and wounds	Leaves and roots	Washed, mashed and then applied to the sore part/boiled, drink twice a day	(Sagala et al., 2020)
	Sauropus androgynus (L.) Breynia androgyna (L.) Chakrab. & N. P.Balakr	-	General and Unspecified, Respiratory, fever, Influenza	Leaves	Boiled and water is consumed or bathed with	(Sundara Rajoo et al., 2023a)
Fabaceae	*Spatholobus littoralis* Hassk	Bajakah/A kar gelang	Diarrhoea	Root	Take a sufficient amount of root, then wash it clean, boil it and filter the water and drink it.	(Setiawan & Hazyrul, 2022)

					Drink 3 times a day.	
	Spatholobus ferrugineus (Zoll. & Moritzi) Benth.	-	Digestive and skin	Root	Boiled and water is consumed	(Sundara Rajoo et al., 2023a)
	Senna alata (L.) Roxb.	-	Digestive and skin	Leaves	Pounded and applied on affected area	(Sundara Rajoo et al., 2023a)
	Parkia speciosa Hassk.	-	Musculoskeletal	Skin of fruit	Fruit skin is used to wrap around affected area	(Sundara Rajoo et al., 2023a)
	Mimosa pudica L.	-	Musculoskeletal	Stem	Boiled and water is consumed	(Sundara Rajoo et al., 2023a)
	Derris elliptica (Wall.) Benth.	-	Respiratory and Skin	Roots	Burned like incense and inhaled	(Sundara Rajoo et al., 2023a)
Solanaceae	*Nicotiana tabacum* L.	Tembakau/ Sugi	Diarrhoea	Leaves	Take enough leaves, wash them clean, then add hot water until it changes colour, then the water and drink. Drink 3 times a day.	(Setiawan & Hazyrul, 2022)
			Skin	Stem	Chewed and applied on affected area	(Sundara Rajoo et al., 2023a)
	Solanum lycopersicum L.	-	Endocrine/Metabolic and Nutritional	Fruit	Grinded and consumed	(Sundara Rajoo et al., 2023a)
	Capsicum annuum L.	-	Skin	Fruit	Pounded and applied on affected area	(Sundara Rajoo et al., 2023a)
Lauraceae	*Eusideroxylon zwageri*	Ulin/Buluan	Diarrhoea	Bark	Take enough wood that has been cut and	(Setiawan & Hazyrul, 2022)

					washed clean then burn it until it becomes charcoal and add water and drink it. Drink 3 times a day. Take enough wood, wash it clean, then boil it until the boiled water changes colour and drink it. Drink 3 times a day.	
	Litsea cubeba (Lour.) Pers.	-	Musculoskeletal, Respiratory	Fruit/ Seed	Pounded and boiled, water is consumed and bathed with	(Sundara Rajoo et al., 2023a)
Basellaceae	*Anredera cordifolia* Ten	Binahong/ Ludu Aka	Panu/Water fleas	Leaves	Take a sufficient amount of leaves, mash until smooth and apply to the area of the skin that has panu or water lice.	(Setiawan & Hazyrul, 2022)
Passifloraceae	*Passiflora foetida* L.	-	Cardiovascular, Endocrine/Metabolic and Nutritional	Root	Boiled and water is consumed	(Sundara Rajoo et al., 2023a)
Araceae	*Homalomena cordata* Schott	-	Digestive and skin	Root	Dried, cut, and boiled. Water is consumed	(Sundara Rajoo et al., 2023a)
Cunoniaceae	*Pterophylla fraxinea* D.Don	-	General and Unspecified	Root	Boiled and water is consumed	(Sundara Rajoo et al., 2023a)

Asteraceae	*Blumea balsamifera* (L.) DC.	-	Digestive, Pregnancy and skin	Leaves	Boiled and water is consumed. Boiled and water is bathed with	(Sundara Rajoo et al., 2023a)
	Vernonia amygdalina (Delile) Sch.Bip.	-	General and Unspecified	Leaves	Boiled and water is consumed	(Sundara Rajoo et al., 2023a)
Rubiaceae	*Uncaria acida* (W. Hunter) Roxb.	-	Digestive, Endocrine/Metabolic and Nutritional	Roots	Water in roots is consumed	(Sundara Rajoo et al., 2023a)
Oxalidaceae	*Averrhoa carambola* L.	-	Cardiovascular	Leaves	Boiled and water is consumed	(Sundara Rajoo et al., 2023a)
Melastomataceae	*Memecylon garcinioides* Blume	-	Eye	Leaves	Squeezed and applied on affected area	(Sundara Rajoo et al., 2023a)
	Melastoma sanguineum Sims	-	Digestive	Leaves	Boiled and water is consumed	(Sundara Rajoo et al., 2023a)
	Melastoma malabatricum	-	Digestive	Leaves	Boiled and water is consumed	(Sundara Rajoo et al., 2023a)
Meliaceae	*Lansium domesticum* Correa	-	Digestive	Leaves	Boiled and water is consumed	(Sundara Rajoo et al., 2023a)
Cucurbitaceae	*Momordica charantia* L.	-	Endocrine/Metabolic and Nutritional	Fruit	Cut and applied on affected area	(Sundara Rajoo et al., 2023a)
Euphorbiaceous	*Plukenetia volubilis* L.	-	Endocrine/Metabolic and Nutritional	Leaves	Boiled and water is consumed	(Sundara Rajoo et al., 2023a)
Aristolochiaceae	*Apama tomentosa* (Blume) Ding Hou	-	Skin	Leaves	Pounded and applied on affected area	(Sundara Rajoo et al., 2023a)
Orobanchaceae	*Striga asiatica* (L.) Kuntze	-	Musculoskeletal	Leaves	Dried then boiled, and water is consumed	(Sundara Rajoo et al., 2023a)
Acoraceae	*Acorus calamus* L.	-	Digestive	Root	Boiled and water is consumed	(Sundara Rajoo et al., 2023a)
Thymelaeaceae	*Aquilaria malaccensis* Lam.	-	Endocrine/Metabolic and Nutritional	Root	Boiled and water is consumed	(Sundara Rajoo et al., 2023a)
	Phaleria macrocarpa (Scheff.) Boerl.	-	Cardiovascular	Fruit	Fruit skin is boiled, water is consumed	(Sundara Rajoo et al., 2023a)

Convolvulaceae	*Ipomoea batatas* (L.) Lam	-	Skin	Leaves	Pounded and applied on affected area	(Sundara Rajoo et al., 2023a)
Tetramelaceae	*Octomeles sumatrana* Miq.	-	Digestive	Stem	Boiled and water is consumed	(Sundara Rajoo et al., 2023a)
Dipterocarpaceae	*Shorea bracteolata* Dyer.	-	Digestive	Stem	Boiled and water is consumed	(Sundara Rajoo et al., 2023a)
Blechnaceae	*Blechnum orientale* L.	-	Skin	Leaves and Stem	Pounded and applied on affected area	(Sundara Rajoo et al., 2023a)
Athyriaceae	*Diplazium esculentum* (Retz.) Sw.	-	Skin	New shoots	Boiled and water is consumed	(Sundara Rajoo et al., 2023a)
Simaroubaceae	*Eurycoma longifolia* Jack	-	Musculoskeletal	Roots	Boiled and water is consumed	(Sundara Rajoo et al., 2023a)
Moraceae	*Artocarpus heterophyllus* Lam.	-	Endocrine/Metabolic and Nutritional	Fruit	Fruit consumed directly	(Sundara Rajoo et al., 2023a)

Kenyah Sarawak Ethnomedicine

In Sarawak, traditional healers primarily employ the plant species in the treatment of digestive and heart conditions among indigenous communities as recorded in Table 1. Researchers cited that Zingiberaceae, Annonaceae, Rubiaceae, Piperaceae, Leguminosae, and Lamiaceae are the most common families of therapeutic plants. (Bakar et al., 2023; Sundara Rajoo et al., 2023a).

The five most commonly used medicinal plants among Kenyahs in general are Senudung (*Leuconotis eugeniifolia*), Misai Kucing (*Orthosiphon Aristatus*), Logan and burung kerokop (Khan et al., 2023). Another study in Bintulu area (Sarawak), the twenty-four people who took the survey named sixty-one different types of plants with total of seven plants namely *Blumea balsamifera, Coscinium fenestratum, Derris elliptica, Homalomena cordata, Piper betle, Annona muricata, and Senna alata* were mentioned by more than 20% of the participants in the Uma Kulit, Lebu Kulit, Uma Badeng, Uma Baha (Sundara Rajoo et al., 2023a).

Such ethnobotanical plants are utilized for medicinal purposes for treating diabetes, urinary tract infections, lugol, biting pain, bloated stomach, and broken bones complication (Khan et al., 2023). The leaves, next the roots, and finally the bark, were the most utilized portions of plants. According to Bakar et al. (2023) the herbs were used in a number of preparations and administration methods, such as decoction, infusion, and poultice. Given the present climate and biodiversity problems, the preference for leaves over other plant parts could be a sustainable and beneficial trend. In particular, *Phyllanthus niruri, Orthosiphon stamineus,* and *Eurycoma longifolia* were among the ethnomedicinal plants identified in the literature study as being utilized by the Kenyah people. Nevertheless, these plants are used to cure a wide range of diseases, such as fever, hypertension, and renal issues (Khan et al., 2023).

Another indigenous community in Malaysia, the Orang Asli, had their medicinal plant practices studied elsewhere, which is in line with the findings from this study (Abdullah et al., 2021). Similar to the Kenyah people, the Orang Asli utilize a diverse range of plant species for medicinal purposes, according to Abdullah et al. (2021). This includes *P. niruri, O. stamineus*, and *E. longifolia.* Another indigenous Malaysian community, the Jakun Orang Asli, also used ethnomedical plants for medicinal purposes; researchers in Pahang, Malaysia, found a similar trend (Ismail, 2017; Ramli et al., 2021). While the Kenyah people make extensive use of *P. niruri* for medicinal purposes, the Jakun Orang Asli people use a far broader range of plant species. Similar to the Kenyah people, the Jakun Orang Asli use a number of preparation methods. These methods include poultice, decoction, infusion.

Furthermore, Ayurvedic, Chinese herbal, Malay traditional, and other Asian ethnomedicinal systems have pioneered the use of the majority of the plants enlist. Kenyah used four species otherwise *Sauropus andrognus, P. betle, D. elliptica*, and *C. fenestratum* to treat fever, influenza, and nonmedical medication toxicity (Sundara Rajoo et al., 2023a). These remedies are rarely discussed in any literature. On the other hand, four varieties of wild peppers namely *Piper rueckeri, Piper borneense, Piper umbellatum*, and *Piper auritifolium* have been identified as leafy green vegetables eaten by the Orang Ulu people of Belaga, Sarawak (Alan et al., 2022). Not only were these pepper species eaten by the Orang Ulu people as a source of sustenance, but they also had medicinal uses, including the alleviation of constipation, heat and toxins, and the prevention of malaria which is noteworthy to be further researched.

Diplazium esculentum and *Pycnarrhena tumefacta* were also cited in a study by (Yusli et al., 2021) regarding consumption of indigenous leafy vegetables that is a common practice among local people in Bintulu, Sarawak included with 5.80% of their respondent as Kenyah. *D. esculentum* and *P. tumefacta* has local name of paku and tubu, respectively while *P. tumefacta* is called Mekai or Bekai in Kenyah language. These two plants are not cultivated according to the locals. The leaves and stem of *D. esculentum* are

chopped and fried together with anchovies and shrimp paste while the *P. tumefacta* leaves are added in the preparation of meat and fish dishes. These two plants both are reported in Table 1 to carry the ethnomedicinal use for skin and eye sore respectively.

In short, Kenyah indigenous medicine draws on both local plant life and the herbal remedies practiced by other communities. As indicated before, this is probably because the Kenyah culturally think that all therapies in various traditional medicinal practices are acceptable, but their efficiency varies from person to person. So, people look for an individual approach that helps them the most. The result is a medicinal flora that is distinctive to the Kenyah, one that incorporates both traditional herbal practices and modern scientific knowledge.

Comparative Analysis of Kenyah Ethnomedicine in Borneo

By comparing the recorded data across regions, it can be evaluated the potential impact of geographical and ecological factors on indigenous activities. Using Venn diagrams, the separated ethnomedicinal data was named into two groups: those from Kalimantan and those from Sarawak who employ plants in traditional medicine. Figure 1 shows Kenyah Sarawak overlap of the overall recorded traditional plants which refer only to those species that were reported by both groups.

Of the 100 plants species, only 13 were shared between the two groups indicated before. Therefore, the image implies that even plants documented in both groups likely have highly varied traditional applications within each cluster, which are likely based on local circumstances. According to these results, there are significant differences in actual plant uses, and the plants utilized in Kalimantan and Sarawak Kenyah from one another, even if they are located in very similar ecological zones providing a big gap for future studies. In short, folk medicinal herbal knowledge in Borneo has been greatly influenced by both geography/ecology and ethnicity/cultural customs accordingly to this pattern.

According to ethnobotanical table summary conducted in the Borneo region, 53 families including 100 species were found to have practical uses in the traditional medicine of the Kenyah people. The richest families in terms of species were Poaceae (8), Zingiberaceae (6), and Fabaceae (6), which accounted for 37.7% of the total number of species. The dominant species otherwise species existed at least twice were Poaceae, Zingiberaceae, Fabaceae, Acanthaceae, Annonaceae, Lamiaceae, Menispermaceae, Euphorbiaceae, Compositae, Malvacea, Solanaceae, Piperaceae, Rutaceae, Liliaceae, Myrtaceae, Phyllanthaceae, Lauraceae, Asteraceae, Melastomataceae, and Thymelaeaceae are found in Figure 2.

On the other hand, Table 1 and Figure 3 include botanical details as well as information about the plants' ethnomedical uses, including the following: plant part/product, preparation method, application mode, diseases treated/respondent count (ICPC-2). The plant parts most commonly used to make a variety of herbal preparations were the leafy parts (49 citations), followed by roots (19 citations), fruits or seed (10 citations), other plant parts (6 citations), stem (4 citations), combination of plant parts (4 citations), and rhizome (2 citations) (Figure 4). Other plant parts were namely new shoots, bark, and fruit skin while combination usage can be stem and roots, leaves and roots, leaves and stem or fruit added with honey. It is worth mentioning that none cited flowers as there ethnomedicinal usage part which may be a study gap for further field research.

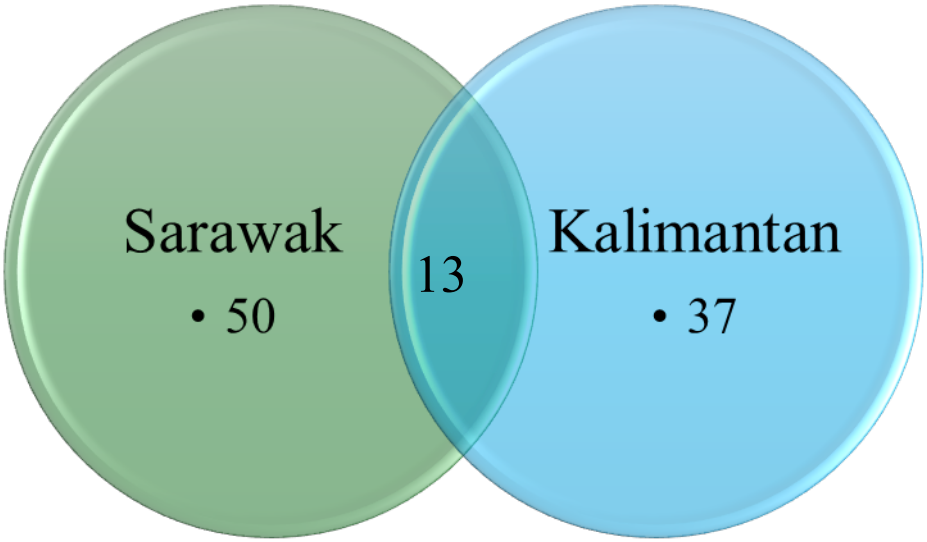

FIGURE 1: Venn diagrams showing the comparison of ethnomedicinal plants used by Sarawak and Kalimantan Kenyah

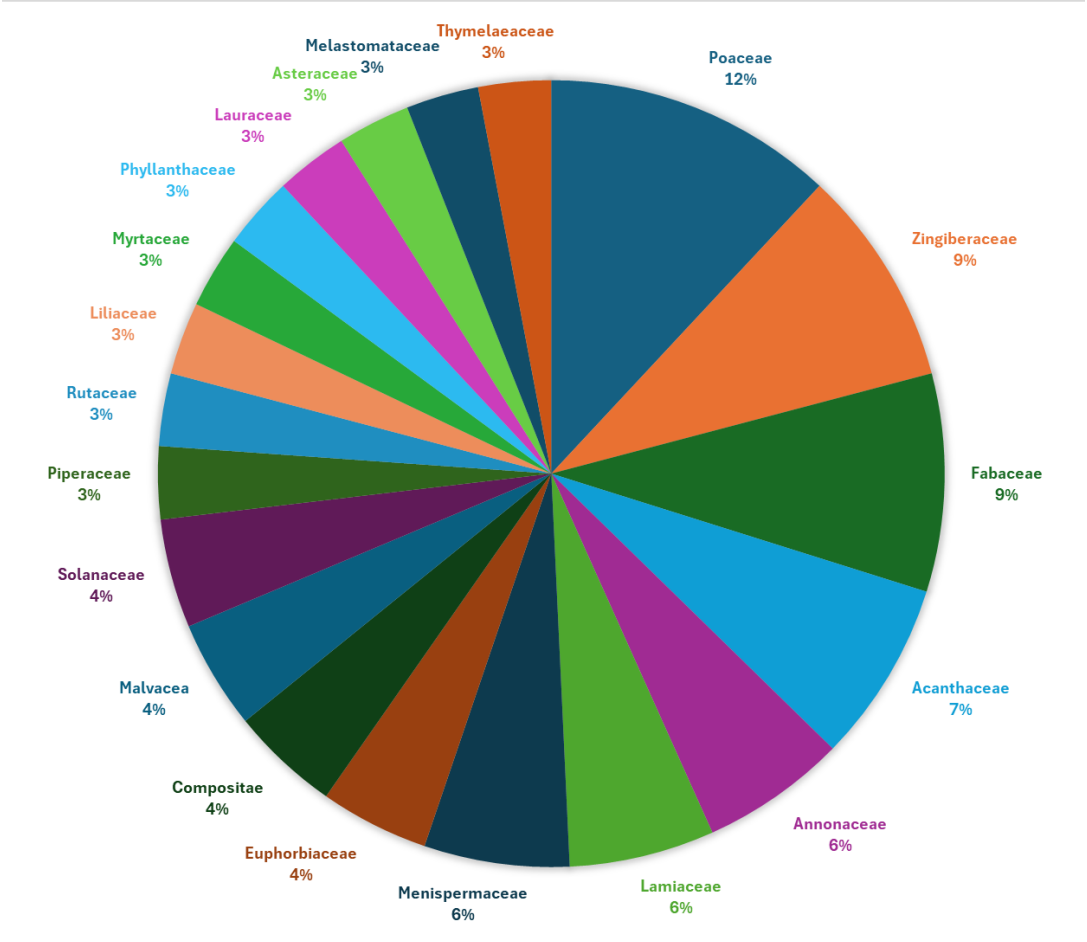

FIGURE 2: Ethnomedicinal plant families that are more dominant in the region under investigation

Rare Plants Documented with Potential Medical Uses

The most commonly referenced plant species in traditional Kenyah medicine is said to be *Coscinium fenestratum*, which is mostly used to treat non-medical substance toxicity (Sundara Rajoo et al., 2023a). Wounds, ulcers, digestive problems, fever, and other diseases have all been traditionally treated with this species. On the other hand, the species is solely used in traditional medicine by the Muruts of Sabah on Borneo to alleviate skin thinning and yellowing (Kulip, 2003). Akar penawar, meaning "the antidote root" in approximate translation, is the popular name of this plant species and another evidence of its importance in this culture's medicinal practices. Traditional medicine practitioners in the Indochina region, particularly those from Indian populations, have long recognized the medicinal value of this plant. Ayurvedic medicine, on the other hand, makes reference to the species not as a poisoning remedy but as one for a wide variety of other ailments, including diabetes, tetanus, fever, skin diseases, abdominal disorders, jaundice, inflammations, ulcers and general debility (Danapur et al., 2020). There is a lack of scientific evidence about its safety, despite its widespread use (Sundara Rajoo et al., 2023a). A new study that looked at the bioactive chemicals of this species found that it has a lot of them, and they can help prevent oxidative stress-related disorders (Basavaraj & Ashok, 2012). Having said that, research on the efficacy of *C. fenestratum* in poison treatment has not yet been conducted, therefore, additional research in this field is necessary.

Ayurvedic and traditional Southeast Asian medicine make extensive use of the plant *Piper betle*, more often known as betel pepper (Dwivedi & Tripathi, 2014). As a natural breath freshener, chewing the leaves of this plant is a popular practice after meals. Traditional Asian medicine makes considerable use of *P. betle* to treat a wide variety of illnesses. It was mentioned that nine additional ethnic groups in Borneo and the surrounding areas use it for various purposes namely the Malay for indigestion, the Suku Bima for nosebleeds, the Dayaks for headaches, the Dusun for reduced coughs, the Alune for vaginal discharge, and the Kulisus for postpartum care (Carsono et al., 2022; Sakinah & Misfadhila, 2020). Its principal use in Kenyah traditional medicine is fever treatment. Nevertheless, there are few accounts of this species being used for this purpose. Kenyah folks boil the leaves and use the water for cooking or a bath, rather than chewing them as is typical in other traditional medicine methods. Many people think this will help bring down fevers.

Sauropus androgynus, like *P. betle*, is established with pharmacological studies and extensively utilized in Ayurveda and traditional Malay medicine for a variety of ailments, including urinary tract infections, heart conditions, and problems with breastfeeding (T. Arif, 2020; Dwivedi & Tripathi, 2014). Despite this, the Kenyah employ it as a fever remedy, and records of the species' usage in this regard are few. A shrub native to India and some regions of Southeast Asia, *S.androgynus* can reach a height of half a meter. As a result, the species' widespread usage in Ayurveda and Malay traditional medicine comes as no surprise (T. Arif, 2020). The water is either drunk or used as a bath after boiling *S. androgynus*. According to Hikmawanti et al., (2021) and Zhang et al., (2020), the documented applications of this product were for urinary concerns, cardiovascular disorders, and post-partum symptoms and problems, including concerns related to lactation. Studies on the pharmacology of this species have mostly concentrated on these areas, with very little research into its potential for treating influenza virus or any clinical proof.

The woody climber *Derris elliptica*, which has no clinical evidence but has been well reviewed in pharmacology, is native to East Asia and can reach a maximum length of 12 meters. Southeast Asia, South Asia, tropical Africa, and tropical America are currently among its most common habitats. Much of the plant's value to indigenous peoples comes from its reputation for toxicity. Many Bornean tribes people utilize this plant to produce poison arrows for fishing and hunting (Rashed, 2020; Uy & Villazorda, 2015). It is also a key ingredient in organic pesticides made in Indonesia. Traditional Kenyah medicine makes use of the herb to alleviate flu and fever. Researchers have shown that this species has antisepsis properties and is frequently used to treat infections such as leprosy and abscesses (Sundara Rajoo et al., 2023a; Trang et

al., 2023). There is little information on this species' usage as a fever or influenza therapy, despite the abundance of records for it. Also, additional Bornean groups' traditional medical uses of this plant have been mostly undocumented. Although the species possesses a wide range of antimicrobial properties, clinical investigations have been few and far between, particularly when it comes to testing its efficacy against influenza (Rashed, 2020).

The Argentine shrub *Senna alata* is well studied plant in research that has spread over much of Asia and Africa from its original homeland. In traditional Chinese medicine and Malay medicine, this plant species is used to treat skin problems (Alshehri et al., 2022). Kenyah folks used the plant for scabies, boils, and bug bites or as repellent. *S. alata* and *Goniothalamus macrophyllus* were the two most often mentioned species for this group of ailments. The skin problems that *S. alata* was identified for were scabies, skin symptoms/complaints, and laceration. However, none of the reported use of Kenyah for *G. macrophyllus* were for anything other than bug bites or repellent. Various portions of the plant are utilized for numerous ailments in traditional medicine in Malaysia, which makes this species widely used. According to Shakri et al. (2020). the leaves can alleviate fever symptoms, while the roots can be utilized to promote menstruation. Traditional Kenyah medicine holds that burning the plant's wood like incense will both dispel pests and alleviate their bites. People in the Andaman Islands also think the smoke helps with asthma. The plant's ability to heal digestive issue and skin disorders, particularly cuts and pigmentation problems, has been confirmed by clinical research (Liu et al., 2022).

Orthosiphon aristatus, or kumis kucing as it is known in Indonesia, is a member of the Lamiaceae family. Traditional medicine practitioners have long relied on this plant for the treatment of a wide range of conditions, including bacterial and UTIs, inflammation, rheumatism, influenza, angiogenesis, jaundice, and infuenza. The plant is very established with clinical and biological research particularly famous for diabetes. Traditional medicine practitioners in Malaysia often prescribe *O. aristatus* aerial parts to manage hypertension, rheumatoid arthritis, gout, diabetes, and rheumatic fever (Batubara et al., 2020). Decoction of the plant is also consumed in Malaysia to eliminate bladder and kidney stones. *O. aristatus* has been utilised in the folk or traditional medicine of Asian cultures for centuries. Besides its principal use as a diuretic, the herb is used as a remedy against renal and urinary disorders as well as various other diseases (Chai et al., 2014). Both *S. alata* and *O. aristatus* have clinical proof of the cited Kenyah ethnomedicinal use thanks to their research establishments.

An aromatic perennial shrub that can reach a height of up to three meters, *Blumea balsamifera* has been evaluated and established in lab research, but there is no clinical data available on it. Traditional Malay medicine makes extensive use of this species as a postpartum remedy (Wannes & Tounsi, 2021). Numerous chemical and pharmacological investigations revealed that the species exhibited antifungal, wound healing, antioxidant, antibacterial ability (Pang et al., 2014). Nevertheless, the pharmacological wisdom of Kenyah using the plant to treat digestive, pregnancy and skin disease in clinical studies remains scarce and unexplored.

The claimed Kenyah uses of *Homalomena cordata* are diverse, spanning from fever and stomach issues to lacerations, boils, and even cancer. According to Rajoo et al. (2023), this practice is widespread in Southeast Asia and is used as a traditional remedy for various health problems, particularly those related to the digestive system and skin. Noteworthily, no clinical or even pharmacological evidence is available for this plant species, which is same for *Nephrolepis cordifolia* and *Rhynchospora colorata* which explained the significance of potential to open up for research.

Phytopharmacological Studies of Kenyah Ethnomedicine

According to Table 2, the research gap between modern study and traditional use of Kenyah medicinal plant will be thoroughly discussed followed by their data incompleteness in terms of pharmacological and clinical trial aspect. Firstly, a few plants used by the Kenyah are well studied, established with review article and clinical studies namely *Orthosiphon aristatus, Curcuma longa, Kaempferia galanga, Carica papaya, Piper betle, Piper nigrum, Annona muricata, Imperata cylindrica, Aloe vera,* and *Psidium guajava*. These plants are commonly used in Asean countries and easily accessible. Nevertheless, the clinical studies done on these plants are not correlated with the wisdom of Kenyah ethnomedicinal use for instance, *O. aristatus* is clinically tested for anti-lithiatic (renal stones) and antihypertensive but not on diabetes and stomach-aches. Similarly, for *K. galanga* which have been tested for knee osteoarthritis and anti-inflammation but unrelated clinical studies on cardiovascular, respiratory disease are not carried out.

Despite some plants are well established with review paper and their pharmacological yet found with limited or unrelated clinical studies conducted related to Kenyah ethnomedicinal usage such as *Graptophyllum pictum* with only antifungal studies, *Vernonia amygdalina* with only antimalarial studies, *Ageratum conyzoides* with arthritis and analgesic studies, *Euphorbia tithymaloidesa* with only antiviral studies and *Senna alata* with constipation and *Pityriasis versicolor* in humans' clinical studies.

On the other hand, certain medicinal plants are reported with zero clinical studies but related pharmacology to Kenyah ethnomedicinal uses such as *Eleutherine bulbosa, Pycnarrhena cauliflora, Justicia gendarussa, Derris elliptica, Blumea balsamifera, Coscinium fenestratum, Goniothalamus macrophyllus, Sauropus androgynus, Blechnum orientale*, *Abelmoschus esculentus, Citrus aurantifolia*, and *Anredera cordifolia.* These plants are well reported with review on pharmacology usage and even some related to the Kenyah people usage therefore are classified as the most potential to push for clinical studies. Nevertheless, no studies were reported with utilization of *C. aurantifolia* and *A. cordifolia* on panu or water fleas in relation with the Kenyah application.

Furthermore, limited studies on pharmacological uses on particular plant part used by Kenyah namely *Hibiscus rosa-sinensis* and *Abelmoschus manihot* which is profoundly studied on flower but not the leaves part which are used by Kenyah folks to treat pus urine and urinary tract infection (UTI) respectively. *Imperata cylindrica* is rarely studied on the roots particularly in the aspect of bone pain reported by the Kenyah people.

A few important plants are found to have limited pharmacological research and no reported review article namely *Pycnarrhena cauliflora, Excoecaria cochinchinensis, Pyrrosia piloselloides*, and *Goniothalamus macrophyllus* due to limited research and data available. *Nephrolepis cordifolia* has no pharmacological data about the root while *Rhynchospora colorata* has only been reported with an antibacterial study. Most importantly, a plant cited by the Kenyah namely *Homalomena cordata* has no research data available despite the potential for treating digestive and skin issue.

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TABLE 2: Ethnopharmacology of Kenyah Ethnomedicinal Plants

Plant	Common name	Main chemical constituent	Antioxidant (DPPH)	*In silico, in vitro, in vivo* general pharmacology	Clinical studies	Traditional Use by Kenyah	Reference
Orthosiphon aristatus	Cat's Whiskers	Leaves sinensetin, rosmarinic acid, (spearmint clinial), and eupatorine	Aqueous: IC_{50} = 9.6 ug/mL Ethanol: IC_{50} = 21.4 ug/mL Methanol: IC_{50} = 147-386 ug/mL	• Antidiabetic • Antiviral • Antimicrobial • Anti-Inflammatory • Antihypertensive • Anti-Angiogenic • Analgesic • Hepatoprotective	• Anti-lithiatic (renal stones) • Antihypertensive (no clinical study on diabetes and stomachache)	Diabetes, stomach-ache	(Batubara et al., 2020; Chai et al., 2014; Faramayuda et al., 2021)
Curcuma longa	Turmeric	Root Digalloyl-hexoside, Caffeic acid, hexoside, Curdione, Coumaric, Sinapic acid, Qurecetin-3-D-galactoside, Casuarinin, Bisdemethoxycurcumin, Curcuminol, Demethoxycurcumin, and Isorhamnetin, Valoneic acid bilactone, Curcumin, Curcumin-*O*-glucuronide (derivative are tested)	Ethanol: IC_{50} = 27.2 ± 1.1 µg/mL Ethyl acetate: IC_{50} = 9.861 mg/mL	• Antidiabetic • Anti-inflammatory • Antimicrobial • Hepatoprotective • Anticancer • Cardiovascular • Gastrointestinal	• Anti-inflammation • Skin • Central Nervous System • Respiratory • Cardiovascular • Gastrointestinal • Urogenital • Antidiabetic	General and Unspecified	(Chanda & Ramachandra, 2019; Memarzia et al., 2021; Rohman et al., 2020; Sabir et al., 2021; Salehi et al., 2019)
Kaempferia galanga	Ginger	Root Ethyl-para-methoxycinnamate and ethyl-cinnamate, 1,8-cineole, borneol,	Methanol: IC_{50} = 16.58 µg/ml.	• Antidiarrheal activity • Hypolipidemic activity	• Knee Osteoarthritis	Digestive, Cardiovascular, Respiratory	(Khairullah et al., 2021; Munda et al., 2018; Sikta et al., 2018;

		linoleoyl, methyl-cinnamate and pentadecane	Aqueous: IC_{50} = 19.5 ug/ml	• Anti-Tuberculosis Activity • Treatment of diabetes, hypertension, cough, asthma, joint fractures, rheumatism, urticaria, vertigo, and intestinal injuries	• Anti-inflammation		Taslim et al., 2019; S. Y. Wang et al., 2021)
Carica papaya	Papaya	Leaves pseudocarpain and carpain, enzymes (cystatin, chymopapain and papain), ascorbic acid, nicotinic acid, dehyrocarpaine and choline, carposide.	Methanol: EC_{50} = 7.8 ±0.06 mg/mL. Ethanol: IC_{50} = 75.05%	• Anthelmintic property • Antimalarial and anti-plasmodial property • Antimicrobial property • Antifungal • Antiviral • Anticancer • Anti-inflammatory • Antidiabetic • Anticancer • Male antifertility property • Hepatoprotective property • Anti-ulcer • Wound healing • Anti-sickling property	• Methicillin-Resistant Staphylococcus aureus (MRSA) (skin, wound and high vaginal swab) • Anticancer • Dengue fever • Inflammatory bowel diseases • Anti-ulcer, wound healing • Histaminergic	Diarrhoea, Skin	(Alara et al., 2022; Maisarah et al., 2013)

Piper betle	Sirih/betel	Leaves chavicol, chavibetol, carvacrol, eugenol, estragol, hydroxychavicol, Allylpyrocatechol, and β-Caryophyllene	Ethanol: IC_{50} = 9.362 µg/mL Methanol: IC_{50} = 345.7 µg/mL Ethyl acetate: IC_{50} = 23.25 µg/mL Hexane: IC_{50} = 144. 3 µg/mL Aqueous: IC_{50} = 179.5 µg/mL	• Antimicrobial • Analgesic • Anti-inflammatory • Anticancer • Antidiabetic • Hepatoprotective	• Antifungal (*Candida albicans*) • Anti-inflammatory activity (β-caryophyllene)	Sore throat Toothache Eye, Neurological, Respiratory	(Carsono et al., 2022; Dwivedi & Tripathi, 2014; Okonogi et al., 2021; Sakinah & Misfadhila, 2020)
Piper nigrum	Black pepper	Fruit/ Seed piperine, piperlonguminine, pellitorine, piperolein B, piperamide (piperine), piperettine, and (-)-kusunokinin (only piperine)	Hexane: IC_{50} =1830.0 lg/mL Chloroform: IC_{50} =164.9 lg/mL Methanol: IC_{50} = 153.9 lg/mL Aqueous: IC_{50} =1025.0 lg/mL	• Antimicrobial • Anticancer • Antidiabetic • Anti-inflammatory • Analgesic • Anticonvulsant • Neuroprotective effects	• Anticonvulsant • Liver and kidneys protective • Dementia and Alzheimer's	General and Unspecified	(Takooree et al., 2019; Talebi & Mojab, 2022)
Annona muricata	Soursop	Leaves Reticuline, coreximine, isoquinoline, aporphine and protoberberine, Annonacin and Megastigmanes.	Methanol: IC_{50} = 221 µg/mL Ethanol: IC_{50} = 70 µg/mL	• Antimicrobial • Anti-inflammatory • Anti-protozoan • Contraceptive	• Diabetes mellitus • Hypoglycemic activity • Anticancer	Digestive, Cardiovascular, Respiratory, Endocrine/Metabolic and Nutritional	(Coria-Téllez et al., 2018)

				• Hepato-protective • Anti-icteric • Hypoglycemic activities			
Imperata cylindrica	Cogon grass	Root Arundoin, cylindrin, friedelin, 14-epiarbor-7-en-3β-ol, 14-epiarbor-7-en-3β-yl formate, 14-epiarbor-7-en- 3-one, chromone, tricin**,** caryatin, jaceidin, 5-methoxyflavone**,** 5-hydroxyflavone	Ethanol: IC_{50} = 824.30 mg/mL Methanol: IC_{50} = 2.14 µg/mL	• Anti-inflammatory • Chemopreventio n • Neuroprotection	• Antiobesity	bone pain, Neurological	(Indriyanti et al., 2022; Jung & Shin, 2021; Nayim et al., 2023)
Aloe vera	Lidah buaya/ aloe	Leaves aloe-emodin, aloin, aloesin, emodin, and acemannan	Methanol: IC_{50} = 58.8 ± 0.4 µg/mL ethanol: EC_{50} = 58.36 µg/mL	• Burn Skin wound healing • Anti-Inflammatory Activity • Intestinal absorption • Antimicrobial and prebiotic Activity	• Ulcers and Swelling • Wound healing • Oral submucous fibrosis • Chronic periodontitis • Skin elasticity and wrinkles	Skin complication	(Khaing, 2011; López et al., 2013; Sánchez et al., 2020)
Eleutherine bulbosa	Dayak onion/ tears of virgin	Rhizome naphthalene, anthraquinone, and naphthoquinone (vitamin K)	Ethanol: IC_{50} = 1.48 µg/mL	• Anti-inflammatory • Anti-microbial • Anti-hypertension • Anti-cancer • Anti-diabetic	-no clinical study	Tonsillitis	(Kamarudin et al., 2021)

				• Anti-melanogenesis			
Psidium guajava	Guava	Leaves guavanoic acid, guavacoumaric acid, 2-hydroxyursolic acid, 2-hydroxyursolic acid, isoneriucoumaric acid, asiatic acid, ilelatifol d and β-sitosterol-3-O-β-d-glucopyranoside, Myricetin, luteolin and kaempferol	Ethanol: EC_{50} = 53±2.0 mg/g Aqueous: EC_{50} = 130±1.0 mg/g	• Anti-diarrhoeal • Antimicrobial • Anti-inflammatory • Anti-viral • Anti-inflammatory • Anti-plaque • Anti-mutagenic	• Infectious gastroenteritis • Infantile rotaviral enteritis • Dysmenorrhea	Diarrhoea	(Gutiérrez et al., 2008; Naseer et al., 2018)
Pycnarrhena cauliflora	Pokok Ajinomoto/bekai	Leaves Oxirane dodecyl, gamma sitosterol, vitamin E (α tocopherol), 9.12-Octadecadienoic acid (Z,Z)- (natural linoleic acid), 3-Tetradecanynoic acid (myristic acid), and Phenol, 2,4-bis(1,1-dimethyl ethyl).	Ethanol: IC50 0.634 mg/mL	• Anticancer (human breast cancer) • Antidiabetic (α-Glucosidase) • Antifungal (*M. Furfur*) (limited)	-no clinical study	For cancer and flavoring	(R. Maharani et al., 2020; Masriani et al., 2019; Novia Putri et al., 2023)
Graptophyllum pictum	Tricolor Caricature Plant	Leaves n-octanyl capriate and n-decanyl cetoleate, Phytol, Tetracosane, Tetratertacontane, Squalene, Vitamin E, Tetratriacontane and Stigmasterol	Ethyl acetate: IC_{50} = 0.78 ± 0.01 mg/mL Butanol: IC_{50} = 2.58 ± 0.08 mg/mL Hexane: IC_{50} = 7.60 ± 0.28 mg/mL	• Antidiabetic activity • Antimicrobial • Immunomodulatory • Anti-inflammation • Anti-analgetic • Wound healing • Anti-hemorrhoid	• Antifungal activity (*Candida albicans*)	To bathe the baby's lender and itch	(Jiangseubchatveera et al., 2017; Makkiyah et al., 2021; Tahseen et al., 2023)

			Aqueous: IC_{50} = 18.8 ± 0.69 mg/mL	• Estrogenic effects			
Justicia gendarussa	Variegated Water Willow	Leaves 2-(2'-amino-benzylamino) benzyl alcohol, 0-methyl ethers, 2-amino benzyl alcohol, stigmasterol, lupeol, 16-hydroxylupeol, ß-sitosterol, aromadendrin, ß -Sitosterol- ß -D-glycoside, gendarusin A, gendarusin B, , gendarusin, and friedelin	Methanol: IC_{50} = 71.31 ± 0.42 µg/mL Ethyl acetate: IC_{50} = 74.20 ± 0.44 % Ethanol: IC_{50} = 32 µg/ml	• Antifungal • Antibacterial and antimicrobial • Anti-inflammatory activity • Anti-helminthic	- no clinical study	For bathing babies and itching	(Fisol et al., 2022; Jain et al., 2024; Kavitha et al., 2014; Mondal et al., 2019; Nirmalraj & Perinbam, 2015)
Vernonia amygdalina	Bitter leaf	Leaves 6β,10β,14β trimethylheptadecan15 α-olyl-15-O-β-D-glucopyranosyl-1,5 β olide, glucuronolactone, 11 α-hydroxyurs-5,12-dien-28-oic acid3 α,25-olide, 10-geranilanyl-O-β-D-xyloside, 1-heneicosenol O-β-D-glucopyranoside, apigenin, luteolin (3′,4′,5,7tetrahydroxyflavone), vernolide, hydroxyvernolide, hydroxyvernolide , hydroxyvernolide,	Ethanol: IC_{50} = 27.310±0.702 mg/g Aqueous: IC_{50} = 89.030±0.365 mg/g	• Anti-inflammatory • Anticancer • Antimicrobial • Hepatoprotective • Antidiarrheal • Anti-diabetic • Neuroprotective • Antimalarial	• Antimalarial activity	General and Unspecified	(Ugbogu et al., 2021; W. Te Wang et al., 2020)

		diterpene (ingenol-3-angelate), vernomygdin, 4-methylumbelliferone, cryptolepine, isocryptolepine, neocryptolepine, courmarins, vernolepin, and vernoniosides.					
Ageratum conyzoides	Billygoat-weed, chick weed, goatweed, whiteweed, mentrasto	Leaves Precocene I, chromene, β-sitosterol, stigmasterol, lycopsamine and pyrrolizidine	Ethanol: IC_{50} = 18.9 µg/ml Methanol: IC_{50} = 22.50 ± 3.18 µg/mL Aqueous: IC_{50} = 570.00 ± 6.00 µg/mL	• Anti-inflammatory • Antihemorrhagic • Antiseptic • Antileprosy • Wound healing	• Arthritis • Analgesic	Blood bleach	(Kotta et al., 2020; Patil et al., 2010; Yadav et al., 2019)
Euphorbia tithymaloides	Seashell Devil's Backbone, Seashell Zigzag Plant	Leaves cycloartenone, dammaronol A, dotriacontan-1-ol, friedelanol, hentriacontan-1-ol, sitosterol, Kaempferol, quercitrin, isoquercitrin, scopoletin, pedilanthus coumarin A, pedilanthus coumarin B, 5,7-dihydroxy-8-(2-methylbutyryl)-4-phenylcournarin, theraphin C, isodispar B, isodisparinol B and isomesuol.	Water: IC_{50} = 218.3 ± 7.80 µg/mL Methanol: IC_{50} = 110.0 ± 3.10 µg/mL	• Anti-diabetic, • Analgesic • Hemostatic • Anti-microbial • Antifungal • Antihelminthic • Antimutagenic • Anti-inflammatory • Antivenom • Antihemorrhagic • Antiviral • Antitumor	• Anti-viral activity (Inhibition of HSV-2 replication)	broken bones	(Abreu et al., 2008; Srivastava et al., 2019)

Excoecaria cochinchinensis	Chinese Croton	Leaves baccatin, ursolic acid, agallochin J, agallochin K, kaempferol, luteolin, excolabdone A, β-sitosterol, daucosterine, Excolabdone, Glochidionionoside B, excoecariosides A and B	-not reported	• Anti-inflammatory Effect • Breast cancer • Gastric cancer cell • Antimicrobial	-no clinical data	Rheumatism	(Giang et al., 2005; Kui et al., 2021; Nguyễn Phú Hùng & Lê Thị Thanh Hương, 2021; WANG Ye-ling et al., 2014; WANG Yun-song et al., 2009; Yang et al., 2005; Yin et al., 2008)
Homalomena cordata	Heart Shaped Homalomena	Root No data available				Digestive and skin	
Senna alata	candle bush/tree	Leaves anthraquinones, anthracene derivatives of rhein, emodol, aloe-emodin, sennosides A and B, 4,5- dihydroxy-1-hydroxymethylanthrone and 4,5-dihydroxy-2-hydroxymethylanthrone	Water: IC_{50} = 12.05 mg/mL Methanol: IC_{50} = 734.25 µg/mL Water/Methanol: IC_{50} = 684.01 µg/mL Ethanol: IC_{50} = 66.01 ppm Ethyl acetate: IC_{50} = 78.23 ppm	• Antibacterial • Antifungal • Antimicrobial • Antiviral • Antiprotozoal	• Constipation • *Pityriasis versicolor* in humans	Digestive and skin	(Alshehri et al., 2022; Jeweldai Vedekoi & Sokeng Dongmo Selestin, 2020; Priya et al., 2021; Rahmawati et al., 2022)
Derris elliptica	Tuba	Roots rotenone, derieliptosides A-C, 2-	Aqueous: EC_{50} = 229.85 ppm	• Antibacterial activity	-no clinical data	Respiratory and Skin	(Rashed, 2020; Trang et al., 2023; Uy &

		hydroxy-5-aminorotenonon, elliptoic acid, coumaronochromone, 6,4'-dihydroxy-7,5'-dimethoxy-coumaronochromone	Ethanol: EC_{50} = 350.05 ppm	• Hepatoprotective drugs • Antifungal activity • Antidiabetic • Larvicidal			Villazorda, 2015)
Blumea balsamifera	Sembong, Capa, Telinga kerbau	Leaves 3,4,5-trihydroxy-3,7 dimethoxyflavonones, 3,4,5-trihydroxy-7-ethoxyflavanone, 3,-O-7-biluteolin, 1,8-cineole, borneol, β-caryophyllene, camphor, 4-terpineol, a-terpineol, and caryophyllene oxide, (11Z)-11-hexadecenoic acid, trans-2-undercenoic acid, 9-hexadecenoic acid, capric acid, and palmitic acid	Methanol: IC_{50} = 72 g/mL Aqueous: IC_{50} = 52.48 ± 2.48 mg/mL 50% EtOH: IC_{50} = 139.93 ± 8.47 mg/mL 95% EtOH: IC_{50} = 36.55 ± 6.61 mg/mL Hexane: IC_{50} = 2.15 ± 0.07 mg/mL	• Antimicrobial • Antifungal • Anti-inflammatory • Hypolipidemic • Anti-infertility • Hepatoprotective activity • Antidiabetic • Gastroprotective • Antitumor • Antityrosinase activities • Wound healing activity	-no clinical data	Digestive, Pregnancy and skin	(Jirakitticharoen et al., 2022; Pang et al., 2014; Wannes & Tounsi, 2021)
Coscinium fenestratum	Tree turmeric	Root berberine, jatrorrhizine, palmatine, berlambine, dihydroberlambine, 12, 13-dihydro-8-oxo berberine, tetrahydroberberine, oxyberberine, noroxy hydrastinine, 8-	Methanol: IC_{50} = 57.1 µg/mL Ethanol: IC_{50} = 32 µg/ml	• Antidiabetic • Anti-gonococcal • Anticancer • Antibacterial • Antimalarial • Antihypertensive • Antiulcer • Neuroprotector • Wound healing	-no clinical data	Respiratory, Digestive	(Basavaraj & Ashok, 2012; Danapur et al., 2020)

		oxoprotoberberine, and 8-oxoberberine					
Goniothalamus macrophyllus	Lukai Kampong	Stem and Root Stem: Goniothalamin (styryl-lactone), geranyl acetate, germacrene D, geraniol, linalool and camphene; root: cyperene, geranyl acetate, geraniol and linalool. α-pinene, bicyclogermacrene, α-copaene and δ-cadinene (volatile)	-not reported	• Antimicrobial activity • Human cervical cancer cell • Colorectal cancer • Biolarvicidal	-no clinical data	skin	(Alabsi et al., 2012; Humeirah et al., 2010; Kurniawan et al., 2023; Liu et al., 2022; Shakri et al., 2020)
Sauropus androgynus	Sweet leaf	Leaves 3-O-*β*-D-glucosyl-(1-6)-*β*-D-glucosylkaempferol (GGK), lignan glycosides, lignin diglycoside, megastigmane glucoside, chlorogenic acid, caffeic acid, and ferulic acid	Methanol: IC_{50} = 341 *μ*g/mL Ethanol: IC_{50} = 88.33 ± 3.53 ppm	• Antimicrobial • Anti-inflammatory • Anticancer properties • Antidiabetes activity • Lactation inducing activity • Antiobesity/ weight lost (ggk) • Lung injury • *S. Androgynus* induced bronchiolitis obliterans	-no clinical data	fever and influenza	(T. Arif, 2020; Hikmawanti et al., 2021; B. dou Zhang et al., 2020)
Blechnum orientale	Deer fern	Leaves and Stem Chlorogenic, blechnic acid Rosmarinic, 7-epiblechnic acid,	Methanol: IC_{50} = 10.9 ±1.6 *μ*g/mL	• Antimicrobial • Anti-inflammatory • Anticancer • Wound healing	-no clinical data	skin	(Lai et al., 2010; Waswa et al., 2022)

		8-epiblechnic acid, brainic acid, Luteolin, apigenin, 1,2,3-propanetricarboxylic acid 2-hydroxy-, triethyl ester, and hexanedioic acid, mono (2-ethylhexyl) ester	Chloroform: IC_{50} = 37.5 ±3.0 μg/mL Ethyl acetate: IC_{50} = 8.6 ±0.5 μg/mL Butanol: IC_{50} = 10.1 ±1.1 μg/mL Water: IC_{50} = 13.0 ±1.3 μg/mL	• Antitrematocidal • Antiulcer			
Pyrrosia piloselloides	Dragon Scales	<u>Leaves</u> 5-hydroxymethylfurfural, allopurinol, 3, 5-dihydroxy-6-methyl-2,3-dihydropyran-4-one, sulfolan-3-ol, linoleic acid and β-sitosterol acetate (GCMS)	Methanol: IC_{50} = 38.94 μg/mL Dicloromethane: IC_{50} = 12.82 ±1.6 μg/mL Hexane: IC_{50} = 41.16 ±1.6 μg/mL	• Breast cancer • Anti-proliferative • Antipyretic	-no clinical data	Tumour	(M. Z. Arif et al., 2018; Kamal et al., 2021; Wulandari et al., 2013)
Nephrolepis cordifolia	Fishbone fern	<u>Root</u> No data available (only leave)				for vagina	
Rhynchospora colorata	Starrush Whitetop	<u>Leaves</u> No data		• Antibacterial (*Shigella dysenteriae*)		For vaginal cleansing	(Dewi, 2021)
Hibiscus rosa-sinensis	Chinese hibiscus	<u>Leaves</u> Carotene, taraxeryl acetate, p-sitosterol, gentisic acid, ß-sitosterol, and malvalic acids	Aqueous: IC50 = 34.5±4.65 mg/mL Methanol: IC50 =	• Antifertility properties/reproductive • Antidiabetic • Antimicrobial • Dermatological	-no clinical data (leaves)	Pus urine	(Al-Snafi, 2018; Garg et al., 2012; Khristi & Patel, 2017;

			11.85±3.01 µg/mL	• Anti-inflammatory, antipyretic, analgesic • Immuno-modulatory • Effect in colitis			Missoum, 2018)
Abelmoschus manihot	Aibika	Leaves Rich in nucleotides, nucleosides, and nucleobases	Aqueous: IC50 = 1908.48 ± 46.47 ppm 70% Ethanol: IC50 = 340.09 ± 1.02 ppm Ethanol: IC50 = 430.92 ± 0.28 ppm Ethyl acetate: IC50 = 610.11 ± 2.90 ppm Hexane: IC50 = 955.16 ± 17.73 ppm	• Anti-inflammatory, analgesic, • Immunomodulatory • Bone loss	• Diabetic nephropathy	UTI	(Luan et al., 2020; Todarwal et al., 2011; Winata et al., 2024)
Abelmoschus esculentus	Okra	Leaves Tannin, lectin, coumaric acid, caffeic acid, ferulic acid, rosmarinic acid, and catechin	80% Methanol: IC50 = 60.1±1.20% 80% Ethanol: IC50 = 58.9±0.45%	• Antibacterial • Antifungal • Tyloxapol-induced hyperlipidemia • Phagocytic activity	-no clinical data (leaves)	UTI	(Abdel-Razek et al., 2023; Ashidi et al., 2013; Guebebia et al., 2023; Hafeez, Hassan, et al., 2020; Hafeez,

			100% Methanol: IC50 = 57.3±2.48% 100% Ethanol: IC50 = 56.4±0.65%	• Respiratory burst activity • Anti-fertility			Mona Hassan, et al., 2020; Nguyen et al., 2019)
Citrus aurantifolia	Lime	Fruit Limonene, hesperidin, γ-terpinene, geranial, β-pinene, neral, β-bisabolene, myrcene, didymin, hesperetin, isolimonexic acid, limonexic acid, limonin, and ascorbic aid	Water: IC50 = 47.72 ± 0.25 % 70% Methanol: IC50 = 50.83 ± 1,65 % 70% Ethanol: IC50 = 52.24 ± 3.37 %	• Antibacterial • Anticancer • Antitumor • Anti-cholesterol • Anti-larvae • Anti-mosquito, • Antidiabetic • Anti-inflammatory • Anticholinesterase	-no clinical data	Panu/Kutu Air Respiratory, skin	(Chriscensia et al., 2020; Şeker Karatoprak et al., 2021)
Anredera cordifolia	Madeira vine	Leaves 3,5,3',4'-tetrahydroxyflavone, 8-glucopyranosyl-4',5,7-trihydroxyflavone, myricetin, morin, phytol, alpha-pinene, 6,10,14-trimethyl pentadecanone, vitexin, isovitexin, Lupeol, β-sitosterol, and ursolic acid	Methanol: IC50 = 370.26 ppm Ethanol: IC50 = 318.85 ppm	• Cure of wound • Anti-bacterial • Anti-cholesterol, • Obesity • Postpartum • Anti-diabetes mellitus • Anti-inflammatory • Anti-hypertensive • Anti-cancer • Lowering uric acid	-no clinical data	Panu/Water fleas	(Alba et al., 2020; Marina Silalahi, 2024; Sidhartha et al., 2024)

Phytochemical Studies of Kenyah Ethnomedicine

According to Table 2, a few chemical constituents from Kenyah plants were scrutinized and classified to have complete clinical studies. Curcumin with its derivatives and piperine from *Curcuma longa* and *Piper nigrum* respectively have well established clinical studies. *C. longa, Sauropus androgynus* and *Abelmoschus esculentus* have caffeic acid that has been tested in clinical studies while *S. androgynus* and *Blechnum orientale* having chlorogenic acid has also been tested. It is also worth mentioning that certain chemical constituents that are more specifically found in a particular plant namely borneal (*Kaempferia galanga*), protoberberine (*Annona muricata*), tricin (*Imperata cylindrica*), 4-methylumbelliferone (*Vernonia amygdalina*), ursolic acid (*Excoecaria cochinchinensis*), sennosides (*Senna alata*), berberine (*Coscinium fenestratum*), allopurinol (*Pyrrosia piloselloides*), limonene, hesperidin, hesperetin, mycrcene (*Citrus aurantifolia*), ursolic acid (*Anredera cordifolia*) have underwent some clinical studies. More commonly found chemical compounds that are cited in the table with clinical studies conducted are namely β-caryophyllene, luteolin, lupeol, apigenin, Squalene, Stigmasterol, sitosterol, linoleic acid, 9-hexadecenoic acid, palmitic acid myristic acid, vitamin B3, C, E and K.

Beside the aforementioned chemical compound, all the unmentioned are potential for starting in silico pharmacological screening for the chemical moieties followed by proceeding for in vitro and in vivo then finally clinical trials. For instance, major constituent like sinensetin, rosmarinic acid, and eupatorine from leaves of *Orthosiphon aristatus*; Ethyl-para-methoxycinnamate and ethyl-cinnamate from *K. galanga* root; chavicol, chavibetol,and estragol from *Piper betle* leaves; aloe-emodin, aloin, aloesin, emodin, and acemannan of *Aloe vera*; guavanoic acid and guavacoumaric acid of *Psidium guajava* leaves; Precocene I and chromene from *Ageratum conyzoides* leaves; Excolabdone, Glochidionionoside B, excoecariosides A and B of *Excoecaria cochinchinensis* leaves; rotenone of *Derris elliptica*; jatrorrhizine and palmatine of the root of *C. fenestratum*; Goniothalamin, geranyl acetate and germacrene D of *Goniothalamus macrophyllus* stem; 3-O-*β*-D-glucosyl-(1-6)-*β*-D-glucosylkaempferol of *S. androgynus* leaves; 5-hydroxymethylfurfural from *Pyrrosia piloselloides* leaves; malvalic acids from the leaves of *Hibiscus rosa-sinensis*.

Terpenes and terpene derivatives are present in every “nglidah” plant, otherwise chemotaxonomic affinity (Gollin, 2004). In particular, the plants include a-pinene, 1,8 cineole, limonene, and piperitone, which are very volatile monoterpenes (Dehsheikh et al., 2020). Citrus, citronella, black pepper, spicy, slightly mentholated, topically numbing, and occasionally coriander-and licorice-like properties are all attributed to these, and other components found in nglidah species. These plants contain volatile oils that have pharmacologic effects on human health due to their diverse range of impacts on human physiology. Their antimicrobial properties make them a promising weapon in the fight against fever and other illnesses (Chouhan et al., 2017). Their expectorant and decongestant qualities suggest they could be helpful in alleviating respiratory issues. Because of their carminative, antispasmodic, and appetite-stimulating properties, in addition to being internally and externally counterirritant, they may be excellent analgesics for pain in muscles and bones and in the intestines (Snow & Spelman, 2011).

In communities where people depend on plants for medicine, they've noticed that certain visual features of plants, like their colour or texture, often relate to how effective they are as remedies (Ryan, 2010). For instance, they might have seen that plants with a milky sap tend to help with increasing breast milk production, or that red plants often help with blood-related issues. These associations between what plants look like and how they work have become important symbols (Gollin, 2004). But here is the key, it is not just about looks; These visual cues are linked to the chemical properties of the plants (Gonzálvez & Rodríguez-Gironés, 2013). So, instead of focusing on how a plant tastes or smells, these communities have learned to pay attention to the specific chemicals inside them. For example, they might look for certain compounds that make a plant taste bitter or feel rough, because these chemicals are often associated with medicinal effects. Thus, by understanding the chemical makeup of plants, these communities can better

predict which ones will be helpful for certain health issues. Further research in this field could delve into the specific chemical compounds found in medicinal plants and their interactions with the human body. Scientists could investigate how these compounds exert their effects individually and in combination with each other, as well as explore any potential adverse reactions or interactions with conventional medications. This provides a start to research that would provide a more comprehensive understanding of the therapeutic properties of traditional plant medicines and could lead to the development of new treatments for a range of health conditions.

CONCLUSION

There have been surprisingly few ethnobotanical studies conducted in Borneo, particularly among Orang Ulu communities such as the Kenyah. Adding to a better understanding of Kenyah indigenous populations' traditional medicine practices, this study reviewed the medicinal plant traditions of the Kenyah folks and adds to the existing body of knowledge. This review backs up the Kenyah's rational choice and usage of traditional medicines, however, additional studies are required to determine the exact medicinal uses of these plants and their efficacies in treating different or the right diseases. Both the preservation of key plant species and the creation of new medications can benefit from this research. Furthermore, information regarding the social and cultural milieu in which these plants are utilized, as well as how they are incorporated into the traditional medicinal practices of indigenous communities were summarized. *Derris elliptica* is one of the 61 plant species mentioned; nevertheless, other Bornean groups have not reported using it for influenza, despite its widespread usage in traditional medicine in Kenyah. It is worth mentioning that there is zero research data for *Homalomena cordata, Nephrolepis cordifolia,* and *Rhynchospora colorata* which highlights the importance of the prospective opportunities for future research. Also, to further our understanding of the ethnomedicinal systems of the Kenyah and other Bornean communities, additional comprehensive anthropological research is required.

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