Ethnopharmacology of Karo Oil as Traditional Medicine by Karo Ethnic Group in Berastagi (North Sumatra), Indonesia

Anggi Chatie Yunida Aritonang, Muhammad Fauzan Lubis and Wawan Sujarwo

Correspondence

Anggi Chatie Yunida Aritonang[1], Muhammad Fauzan Lubis[1*] and Wawan Sujarwo[2]

[1]Department of Pharmaceutical Biology, Faculty of Pharmacy, Universitas Sumatera Utara, Jalan Tri Dharma No. 5 Kampus USU, Medan 20155, Indonesia.
[2]Research Center for Ecology and Ethnobiology, National Research and Innovation Agency of Indonesia (BRIN), KST. Soekarno, Jalan Raya Jakarta-Bogor Km.46, Cibinong 16911, Indonesia.

*Corresponding Author: fauzan.lubis@usu.ac.id

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Research

Abstract

Background: The Karo ethnic group in Berastagi, North Sumatra, Indonesia, relies on traditional remedies like Karo oil for various health purposes. However, scientific documentation of its medicinal properties is lacking. This study aimed to document its traditional use, medicinal plants, and community-based development efforts.

Methods: Semi-structured interviews were conducted with eight knowledgeable Karo informants. Non-probability sampling ensured selection aligned with research objectives and cultural context. Data were analyzed using the Miles and Huberman Model, exploring medicinal plants and calculating quantitative indices.

Results: The study identified 39 plant families and 84 medicinal plants used in Karo oil. Common families were Zingiberaceae, Lamiaceae, Arecaceae, Rutaceae, and Apiaceae. The production involves collecting raw materials, separation, grinding, heating, filtering, and packaging. Karo oil treats muscle and joint disorders, skin conditions, indigestion, fever, and aids in postnatal recovery. Native plant species, like *Vitis gracilis* and *Anoectochilus reinwardtii* play a crucial role in traditional medicine.

Conclusions: The Karo community possesses rich traditional knowledge of medicinal plants specially for oil production. However, modernization and a lack of successors threaten this knowledge. Conservation efforts are crucial for preserving this valuable cultural heritage.

Keywords: Community health, Cultural heritage, Local wisdom, Natural remedies, Traditional healing

Background

Indonesia, recognized for its extensive archipelago and abundant biodiversity, holds the world's second-largest tropical forest and stands as the second mega biodiversity country after Brazil (Ersam 2004, Ningsih 2016). With a total of 31,750 plant species, including 25,000 flowering plants (Retnowati & Rugayah 2019, Setiawan 2022), Indonesia possesses a diverse botanical landscape. Despite the potential medicinal properties found in approximately 15,000 plant species, only around 7,000 are actively employed as raw materials for medicinal purposes (Setiawan 2022).

One of the communities deeply intertwined with this rich biodiversity is the Karo ethnic group, residing in the highlands of North Sumatra. The Karo people are known for preserving their cultural heritage, particularly in the form of traditional remedies (Silalahi 2020). In anthropological literature, the Karo ethnic group is classified within the six Batak groups: Karo, Simalungun, Pakpak, Toba, Angkola, and Mandailing, and is recognized as having the strongest patrilineal system in Indonesia. However, the Karo ethnic group prefers to identify themselves as Karo or Batak Karo rather than Batak (Kipp 1993, Sitepu & Ardoni 2019). The Karo people have their own language, known as the Karo language, and their traditional clothing is dominated by the colors red, black, and golden yellow.

Local wisdom essentially encompasses the cognitive knowledge of communities regarding the structure of their environment, its functionality, the natural responses to human actions, and the ideal relationships that should exist between humans and their natural surroundings. This wisdom manifests in the creation of systems for natural resource management. Various traditions, rituals, and daily human activities embody deep meanings related to their interaction with the environment (Hasyim *et al.* 2022). This phenomenon is evident among the Karo ethnic community. The behavior of the Karo people is significantly influenced by their natural environment (Ginting & Barus 2017), including the utilization of natural resources as traditional medicine.

Karo oil, a traditional remedy made from natural ingredients and passed down through generations by the Karo community, exemplifies the intricate interaction between culture and nature. Its efficacy has been recognized and utilized by the people of North Sumatra for an extended period (Lubis 2018). Karo oil is a specific type of herbal oil used for medicinal purposes by the Karo ethnic group. It is typically formulated from a blend of various locally sourced herbs and natural ingredients, which may include specific plants unique to the Karo region. Karo oil's formulation is deeply rooted in the local flora and the traditional knowledge of the Karo people. Both the ingredients and the preparation methods are tailored to the local knowledge and cultural practices of the Karo ethnic group. Karo oil is essentially known as massage oil (Karo language: *minyak pengalun*), a term derived from its most common use as massage oil. Karo oil is popular as home traditional remedy and is commonly used as a first aid for minor injuries. The use of Karo oil as a traditional remedy aligns with the growing interest in traditional healthcare services, as reported in the National Basic Health Research (Indonesian: *Riset Kesehatan Dasar* or RISKESDAS) of 2018 by the Indonesia Ministry of Health. The data reveals that 35.2% of 113,330 samples from the North Sumatra population utilized traditional health services. This figure marks a significant increase compared to the RISKESDAS of 2013, which recorded only 26.3% of 95,203 samples from the North Sumatra population.

Indonesian society has long demonstrated a cultural inclination towards harnessing the diverse botanical resources for multifaceted needs, ranging from clothing, sustenance, pest control, traditional ceremonies, industrial raw materials, cosmetics, and notably, herbal medicine in daily life (Ernilasari *et al.* 2023). Rooted in this rich tradition is the widespread practice of traditional medicine, a hallmark of Austronesian communities across various ethnic groups in Indonesia. Among these practices, massage therapy emerges as a prevalent form of traditional healing, wherein an assortment of massage oil is employed, each formulated based on unique recipes passed down through generations, encompassing compositions, customs, beliefs, local traditions, and traditional knowledge (Rahayu *et al*. 2022). This deeply ingrained cultural practice not only reflects indigenous wisdom but also underscores the profound connection between humans and nature.

The significance of such traditional practices extends beyond mere cultural heritage, it serves as a repository of valuable knowledge regarding the therapeutic properties of botanical substances. This is where the field of ethnopharmacology comes into play. In this context, the research on Karo oil by the Karo ethnic community holds particular significance. Karo ethnic community, situated in North Sumatra, Indonesia, have long utilized Karo Oil as a traditional remedy, indicative of their profound understanding of local flora and its medicinal properties. Investigating the ethnopharmacological aspects of Karo oil not only sheds light on its traditional uses but also offers an opportunity to uncover novel therapeutic compounds and pathways, bridging indigenous wisdom with modern scientific inquiry. The insufficient documentation regarding the use of medicinal plants within specific communities contributes to the challenge of preserving traditional remedies (Rosita *et al*. 2007, Ningsih 2016). Moreover, the impacts of modernization, influenced by external cultures and particularly adopted by the younger generation, are gradually eroding local knowledge within these communities (Bodeker 2000, Windardi *et al.* 2006, Ningsih 2016). Therefore, an ethnopharmacological approach is deemed essential to explore the local knowledge of specific communities concerning native and traditional medicinal practices and the biodiversity components associated with this knowledge (Pirintos *et al*. 2022).

The overarching goal of ethnopharmacology is the development of drugs, especially for local use, encompassing the discovery of drugs, complex plant extracts (phytotherapy), detailed information on small segments of local flora and fauna, databases on plant use for pharmaceutical purposes, and the development of native resources, particularly local plant

gardens and small-scale herbal production (Heinrich & Gibbons 2001). In this context, this research is conducted with the aim of further exploring local knowledge regarding Karo oil as a traditional remedy by the Karo ethnic community. The sustainability of the practice of using Karo oil, believed to have extraordinary potential due to its practicality, affordability, and minimal associated risks, forms the basis of the urgency of this research. The results of this study are expected to make a significant contribution to the inventory of local knowledge related to the use of Karo oil. The information obtained is anticipated to serve as a rich foundation for further developments in this field. Additionally, these findings are expected to stimulate the development of medicines relevant to the local wisdom of the Karo ethnic community, making it a positive step in the preservation of cultural heritage and traditional knowledge.

Materials and Methods

Study area

Berastagi Sub-district, located in the Karo Regency, is characterized by its diverse topography, with 65% of the area being flat to undulating, 22% undulating to hilly, and 13% hilly to mountainous. This region boasts moderately to highly fertile soil, supported by an average rainfall ranging from 2,100 to 3,200 mm per year, making it ideal for agriculture. Situated at elevations ranging from 1,265 to 1,417 meters above sea level, Berastagi experiences a tropical climate, with temperatures ranging from 19°C to 26°C and an average humidity of 79% (BPS Karo 2022).

The sub-district comprises six villages and four urban wards, with a total population of 52,226 and 12,334 households, respectively. The majority of the population, around 75%, belongs to the Karo ethnic group, with the remaining consisting of various other ethnicities such as Tobanese, Simalungunese, Dairinese, Pakpaknese, Niasnese, Javanese, Acehnese, and Chinese descendants. The main livelihood of the residents is farming, although there are also civil servants, entrepreneurs, traders, farm laborers, and private sector employees. Noteworthy agricultural products include fruits, vegetables, flowers, tubers, legumes, cereals (grains), and spices. Additionally, residents engage in sideline activities such as raising poultry, cattle, buffalo, goats, and fish ponds to supplement their income (BPS Karo 2022).

The region's spatial planning is heavily influenced by the values derived from religious regulations and guidance. The Karo people strongly adhere to their noble customs and traditions, which can be leveraged in the development process. The spatial formation of settlements in this area largely follows Karo cultural concepts. The population of Berastagi includes not only the indigenous population but also many migrants who choose Berastagi as a place to seek employment. Some of them become traders in tourist destinations such as the Berastagi Fruit Market, Gundaling Hill, and Berastagi Forest Park, while others work as guides or employees in various tourist locations in the Berastagi Sub-district.

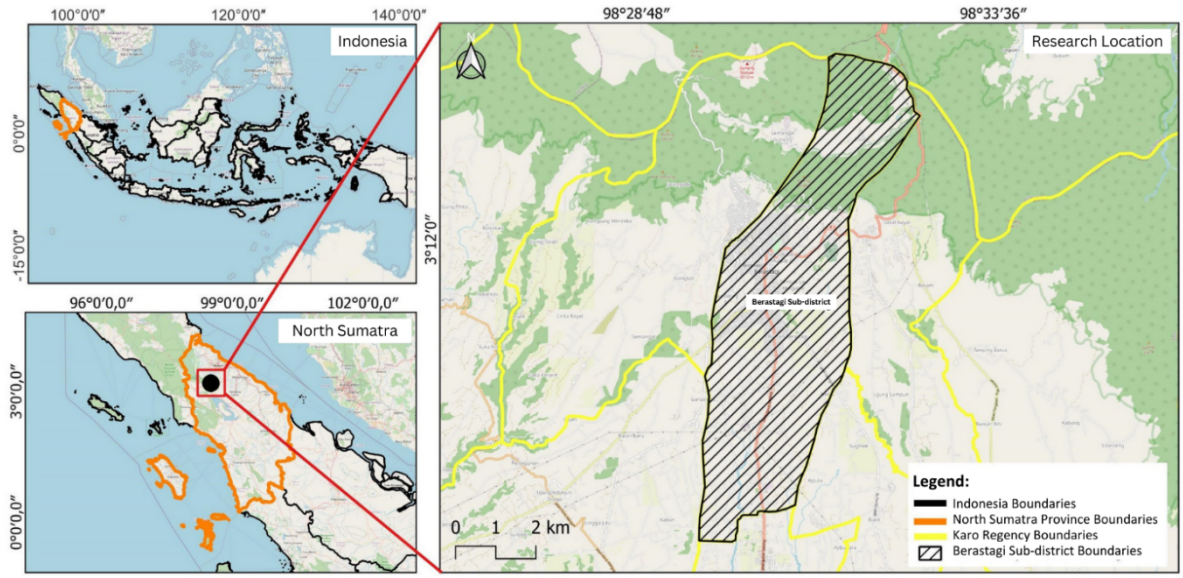

Figure 1. Map of research location in Berastagi Sub-district, Karo Regency, Indonesia

Data collection

This research employed a combination of qualitative and quantitative methods, using semi-structured interviews and direct observation for data collection. Heinrich and Jäger (2015) underscored the importance of selectively choosing informants in ethnopharmacological studies, particularly those with expertise trusted by the local community.

In this study, informants were selected as key informants using both snowball and purposive sampling techniques, ensuring they met specific criteria. These techniques are non-probability sampling methods commonly used in qualitative research to identify informants with certain characteristics or experiences. Snowball sampling involves selecting initial informants who

meet the research criteria and then asking them to refer other potential informants. All informants must meet the established criteria. This method is particularly useful when the population under study is small or difficult to access (Brewerton & Millward 2001, Taherdoost 2016, Firmansyah & Dede 2022) as is often the case in research involving traditional knowledge or practices.

Informants in this research were individuals experienced in producing traditional Karo oil, acknowledged by the community for their knowledge and proficiency in utilizing Karo oil for healing. Key informants were identified through consultations with the local community and officials to ensure alignment with the local wisdom of the Karo ethnic community. Inclusion criteria involved individuals of Karo ethnicity residing in Berastagi, Karo Regency, with experience in making Karo oil, while exclusion criteria covered informants unwilling to provide relevant information for the research problem. These criteria were established to ensure the selection of informants aligned with the research objectives and the cultural context of the Karo ethnic community. From these criteria, eight informants of Karo oil as a traditional remedy were identified. After interviewing these eight key respondents, we observed that the information collected no longer increased. Through the snowball sampling approach in the study area, we found that no new recommendations for informants emerged other than those we had already interviewed. The interview was conducted in the Karo local language and Bahasa Indonesia. Informants were asked to mention natural ingredients used in the production of Karo oil, as well as provide additional information about other functions of each plant part used, how the plants were obtained, frequency of use, reasons for use, and conservation efforts. Informants were also asked to explain the process of making and using Karo oil, as well as the local wisdom values contained within it.

Taxonomy methods

The identification of medicinal plant species was conducted to determine their species and family names. Morphological characteristics were observed using several identification books, including Flora of Java (Backer and Bakhuizen van den Brink 1968) and Medicinal Plants of North Sumatra (Silalahi *et al.* 2018, SIlalahi *et al*. 2019). Validation of species and family names was done by comparing them with current and related publications, as well as using online database portals such as the International Plant Name Index (IPNI 2024), Plants of the World Online (POWO 2024), and the Global Biodiversity Information Facility (GBIF 2024). Floristic distribution information refers to the Plants of the World Online (POWO 2024) database. Meanwhile, their conservation status was identified using data obtained from the International Union for Conservation of Nature (IUCN 2024). Also, field verification was performed by cross-referencing identified plant species in forests, gardens, and markets, with specimen samples collected and authenticated by a taxonomist from the National Research and Innovation Agency (*Indonesian: Badan Riset dan Inovasi Nasional* or BRIN), incorporating local knowledge provided by community members. This comprehensive approach, integrating literature, databases, and fieldwork, ensured the accuracy and validity of botanical data.

Data analysis

The data obtained from the interview results were identified and analyzed using a process of collecting, reducing, presenting, verifying, and concluding the data (Miles & Huberman 1994). The presentation of data took the form of tables and diagrams using Microsoft Excel. To determine the importance value of food plant species among local communities, various methods are employed, including the calculation of use value (UV), relative frequency of citation (RFC), and index of cultural significance (ICS). The use value (UV) index indicates the relative importance of species known locally. It is based on the number of uses and the number of people citing a plant, and has been widely utilized (Prance *et al.* 1987, Sujarwo & Caneva 2016). The relative frequency of citation (RFC) index indicates the importance of each species locally, regardless of utilization categories (Tardío & Santayana 2008, Sujarwo & Caneva 2016). The index of cultural significance (ICS) evaluates or measures the importance of a plant species for the local community (Turner 1988, Rahayu *et al.* 2012). The UV, RFC, and ICS values can be used to depict the distribution of local community knowledge in utilizing plants, using these formulas:

$$\text{Use Value (UV)} = (\sum \text{Ui}) / \text{N}$$

Where: Ui= the quantity of uses reported by individual informants for a specific species, N= the total number of informants.

$$\text{Relative Frequency of Citation (RFC)} = \text{FC} / \text{N}$$

Where: FC= the number of informants who reported the uses of plant species, N = the total of informants.

$$\text{Indices of Cultural Significance (ICS)} = \sum_{i=1}^{n} (q_i \; x \; i_i \; x \; e_i) ni$$

Where: qi= the value of quality, ii= intensity value, ei= exclusivity value.

Results and Discussion

Informant characteristics

Sociodemographic factors significantly influence informants' knowledge regarding the use of medicinal plants. Based on our research, we found that five out of eight of our informants were women (Table 1).

Table 1. Demographics of informants

Informant's code	Gender	Age (years)	Age group	Marital status	Level of education	Experience (years)	Occupation
IF1	Woman	77	Old-aged adult	Widowed	No Formal Education	30	Entrepreneur
IF2	Woman	57	Middle-aged adult	Widowed	Diploma	15	Teacher
IF3	Woman	54	Old-aged adult	Married	Diploma	30	Entrepreneur
IF4	Woman	53	Middle-aged adult	Widowed	No Formal Education	25	Traditional healer
IF5	Woman	47	Middle-aged adult	Married	Bachelor	20	Entrepreneur
IF6	Man	56	Middle-aged adult	Married	High School	37	Traditional healer
IF7	Man	41	Middle-aged adult	Married	Bachelor	16	Entrepreneur
IF8	Man	25	Young adult	Single	Diploma	11	Entrepreneur

In conveying information, female informants tended to provide more detailed information. This is consistent with the findings of Costa *et al.* (2021) which indicate the influence of gender in the social communication structure regarding beneficial plants, ultimately affecting the socio-ecological networks within traditional communities. Women tend to have more knowledge about known plant species and are more likely to share their knowledge compared to men. Additionally, women have more cohesive networks with centrally connected individuals, making their networks more cohesive.

Figure 2. Filling out questionnaires and interviews with informants

In this study, we found that the most dominant age group among the informants is the middle-aged adult group, with six people (Table 1). Data regarding age groups indicate that those in the age group of 45-59 years have a better understanding of utilizing plants as traditional medicine compared to the younger population. We also had difficulty finding informants in the younger age group. The younger generation tends to be less knowledgeable about the production of Karo oil, including the children of the informants we interviewed, who also lack this local knowledge. This is in line with a study in Tehran, Iran, which revealed significantly lower use of medicinal plants in the age group of 15-40 years (Moradi *et al*. 2008). Younger and middle-aged individuals more frequently use complementary treatment methods (Lafferty *et al*. 2004). The difference in local knowledge of medicinal plants between older and younger community members shows the erosion of knowledge. The erosion of local knowledge occurs because knowledge is only conveyed through verbal communication (oral), has no written documentation, the parent's community has diminished knowledge, and the influence of modernity. Older people still retain and preserve some of the folk knowledge that had critical survival value in the past, but which is of little practical benefit or intellectual interest to the younger generation (Sujarwo *et al*. 2014). Modernity has lowered young people's appreciation of local knowledge of traditional medicinal plants (Aziz *et al.* 2020). According to interview results, the level of knowledge about traditional medicine, habitual factors, and the high cost of chemical medicines can be other reasons why the elderly group is more inclined to use traditional medicines.

Marital status among the informants is predominantly married, with four informants, followed by widowed and single statuses, with three and one informant respectively (Table 1). These results are consistent with previous research indicating that single individuals use fewer medicinal plants compared to married individuals (Moradi *et al.* 2008). However, when reviewed based on knowledge sources, six informants reported knowledge passed down through generations, and two informants claimed knowledge of making traditional Karo oil from their marital partners. Previous research stated that there

is no significant relationship between marital status and the number of children and the use of herbal remedies (Sabery *et al*. 2019). Yet, differences in results may be attributed to differences in sample size and distribution, as well as cultural differences among the informants in different studies. The Karo community's habit of working together in the kitchen can provide skills for their partners.

The most commonly encountered educational level among the informants was diploma degree with four informants followed by bachelor degree and no formal education with two informants, while the least represented group was those with high school level education with one informant (Table 1). Interviews revealed that the informants' knowledge of plants used for treating various diseases is passed down from generation to generation. These findings indicate that formal education level does not significantly influence the understanding of medicinal plants, thus emphasizing the notion that education is not limited to formal schooling.

From the results of interviews with informants, three categories of livelihoods were identified: producers who are also entrepreneurs (five informants), traditional healers (two informants), and teacher (one informant). Based on the interviews, it was found that knowledge about the production and use of traditional Karo oil is inherited from their parents or acquired from their spouses. This traditional knowledge, initially used for personal purposes, is then developed as a product for their business and providing income.

Characteristics of medicinal plants

The Karo ethnic group in the Berastagi Sub-district utilizes a total of 39 plant families, encompassing 84 medicinal plants that were identified, as detailed in Table 2. Knowledge of plant utilization is primarily influenced by the local biodiversity (Eyssartier *et al.* 2008, Silalahi *et al*. 2013). The most extensively used family is Zingiberaceae (see Figure3). For the sub-ethnic group Batak Karo, Zingiberaceae and Rutaceae are the main ingredients used in the preparation of traditional remedies (Nasution 2009, Silalahi *et al.* 2013).

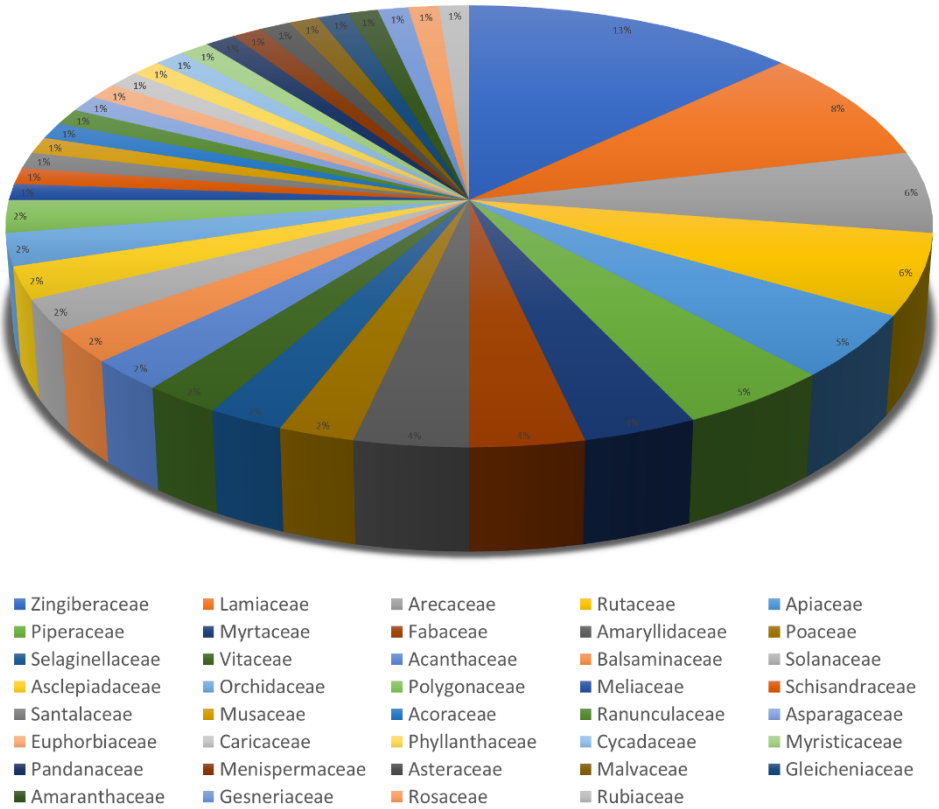

Figure 3. Plant families used in Karo oil

Zingiberaceae thrives in tropical and sub-tropical regions, growing well in both lowlands and highlands up to an altitude of over 2000 meters above sea level, particularly in areas with high rainfall, including Indonesia (Lianah 2020). Among the Zingiberaceae species utilized by the Karo ethnic group in Berastagi Sub-district are *Curcuma longa*, *Curcuma xanthorrhiza*, *Curcuma zedoaria*, *Elettaria cardamomum, Etlingera elatior*, *Kaempferia galanga*, *Zingiber officinale* var. *amarum*, *Zingiber officinale* var. *officinarum*, *Zingiber zerumbet*, *Zingiber officinale* var. *rubrum*, and *Zingiber montanum*.

In addition to its use in traditional Karo oil, the community harnesses the rhizomes of these plants to treat various ailments, including digestive disorders, body aches, cough, diarrhea, headaches, appetite stimulation, digestive disturbances, and stamina enhancement. In another location, namely Sei Bingai Sub-district, Langkat Regency, Indonesia, Karo ethnic group utilizes plants from the Zingiberaceae family as body warmers, remedies for muscle pain, fever medicine, post-delivery care, fever reduction, abdominal pain relief, relief from flatulence, appetite enhancer, cough treatment, and body warmer (Hati *et al.* 2023). Zingiberaceae exhibits antioxidant, anti-inflammatory, antidiabetic, hepatoprotective, anticancer, neuroprotective, anticancer, and antimicrobial activities (Aolga 2022).

The medicinal plants employed by the Karo ethnic group are procured from various sources, including yard or home gardens, fields, and acquisitions from farmers or traders in the market. The purchase of plants for the production of traditional Karo oil is necessitated by the fact that not all plants can be consistently cultivated or available in the Berastagi Sub-district. To maintain a stock of plant ingredients and ensure a continuous supply, makers of Karo oil must dry the plants so that they can be used when needed. Common plants such as *Carica papaya, Citrus aurantiifolia, Cocos nucifera, Coleus amboinicus, Cordyline fruticosa, Cymbopogon nardus, Ocimum basilicum, Orthosiphon stamineus, Parkia timoriana, Piper betle,* and *Syzygium polyanthum* are frequently found in the yard or home gardens. Prihatini *et al.* (2018) reported that there is economic improvement associated with utilizing home gardens for cultivating commercially valuable plants. However, several drawbacks are observed in commercial home gardens, including the loss of local plant species and varieties, and a higher dependence on inputs from the market or external sources. Therefore, the development of sustainable home gardens is crucial for the future, where plant diversity must be preserved to provide ecological functions or ecosystem services and economic production must be enhanced to boost the income of rural communities.

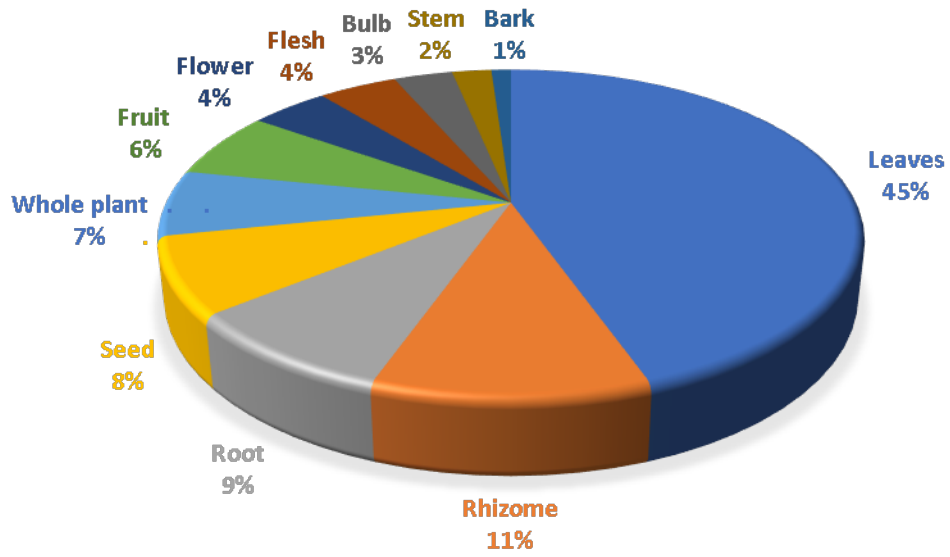

Figure 4. Percentage of plant parts used in Karo oil

Informants commonly utilize leaves as the primary plant part (see Figure 4). Leaves are preferred due to their ease of access and simple utilization. They are readily available in nature, easy to find, and their collection and processing are straightforward. It is recognized that leaves possess a greater number of healing properties compared to other plant parts (Pelokang *et al.* 2018).

Traditional Karo oil production process

The traditional Karo oil production process entails a sequential series of steps, as reported by all informants. The process commences with the collection of raw materials, followed by a separation based on hardness, categorizing spice groups for manual pounding, onions and ginger groups for slicing and subsequent grinding using a grinding machine, and combining leaf and flower groups in a unified container. This initial separation simultaneously serves as a quality sorting mechanism. After thorough cleansing and re-sorting of all components, a large container is heated, and all ingredients are introduced until they wilt. Subsequently, a selected base oil, either coconut or palm oil, is added according to producer preferences.

The use of coconut oil or palm oil as the base oil is also found in several types of massage oil in Indonesia, such as Telon oil from Central Java (Sari *et al.* 2021), Tawon oil from South Sulawesi (Loihala *et al*. 2022), and Kutus-kutus oil from Bali (Maunati 2021). Oil based on coconut oil tends to be lighter than those based on palm oil. The aroma and heat level of the oil also vary depending on the material used. The heat sensation produced by Karo oil comes from ingredients from the Piperaceae and Zingiberaceae families, which are typically added in large quantities. Karo oil with a heating sensation is usually intended for adults, while for children, ingredients from the Piperaceae and Zingiberaceae families are used in small quantities or not at all, as mentioned by informants, indicating their use as a requirement (the term requirement refers to

the specific guidelines or practices followed by the Karo people when making traditional medicine). In making traditional medicine, the Karo people rely on the philosophy of *kesaya silima-lima* (*kesaya* = medicine, *silima lima* = five). *Kesaya silima-lima* means five types of basic plants in making the concoction, namely galangal (*Kaemparia galanga*), garlic (*Allium sativum*), ginger (*Zingiber officinale*), pepper (*Piper nigrum*), and shallot (*Allium cepa*) (Silalahi 2019).

Variations in these formulations are often tailored to the type of disease being treated. To alleviate pain, oil formulations contain more ginger and turmeric due to their anti-inflammatory properties (Zhou *et al.* 2022). In terms of aroma, the amount of pandan and lemongrass is also considered to provide a relaxing effect (Idhayanti *et al.* 2022). Furthermore, differences in formulation variations can also be influenced by the availability of local ingredients and informant preferences. Each informant has a family recipe that has been passed down through generations, and some develop variations to suit market demands. The herbal oil made by the Karo ethnic group have undergone many changes compared to those passed down by their ancestors. For example, if the market prefers the aroma of lemongrass oil, the informant will adjust the recipe by using more lemongrass. Additionally, informants adapt to the availability of raw materials they can obtain. The use of various local raw materials also reflects efforts to utilize natural resources around them in a sustainable and cultural manner (Rahayu 2006). Based on interviews with informants, the use of natural materials derived from animals considers religious values, so for some informants, they no longer use animals as ingredients in making Karo oil. Other types of oil also produced by informants are massage oil to enhance the vitality of adult men. For these types of oil, informants use leeches (*Hirudo medicinalis*). In other Karo traditional medicines such as *tawar* and *kuning* (*param*), animal products like crocodile spurs (*Syngnathoides biaculatus*), and seahorses (*Hippocampus kuda*) are also used. The use of animal-derived ingredients in traditional Karo medicine is generally for medicines that function to increase stamina and sexual fertility.

Figure 5. Karo oil processing

The cooking process takes approximately 4-8 hours, depending on the desired quantity, with occasional stirring. The completion of the cooking process is determined by the characteristic aroma of Karo oil, the dryness of the combined ingredients, and the traditional assessment method where the producer inserts their finger into the hot oil, if the finger does not show signs of blistering, the cooking process is complete. The next steps include filtering, cooling, and packaging. The distinctive aroma of Karo oil comes from the components of various plants used, giving it an overall scent profile, but the oil can have a dominant scent from a single component, such as citral in oil containing a large amount of lemongrass (Hunter 2009, Chatri *et al.* 2017).

In the Berastagi Sub-district community, the main equipment used in making Karo oil is large pan, which are dedicated solely to this purpose, similar to the herbal oil-making process reported by Rahayu *et al*. (2022). The pan should not be used for any other purposes. Out of eight informants, only one informant cooks oil using more modern equipment, such as large tanks, which is reasonable given that the production process can yield up to 700 bottles of 100 ml size in a single production run. Each Karo oil maker has unique preferences regarding ingredients and the quantity of oil they want to make. The cooking process can also vary depending on the amount of ingredients used. For example, to make a smaller quantity of oil, the cooking process may only take around four hours, while for a larger quantity, it could take up to six hours or more. So, the cooking time for Karo oil varies depending on the quantity desired and the preferences of each maker. When cooking Karo oil, informants prefer to use firewood because they believe it produces oil with a stronger aroma and better heating process. Some common types of firewood used are *Citrus sinensis*, *Durio zibethinus*, and *Pinus merkusi*, obtained from the forest. The wood used should be hardwood because it burns slowly, emits high energy, and does not produce unpleasant odors that can affect the aroma of the oil produced (Rahayu *et al*. 2022).

The diseases treated

Based on interviews with informants, Karo oil is believed to treat various groups of diseases. It can effectively address muscle and joint disorders such as ankle strains, sprains, rheumatism, muscle and joint pain, and aid in strengthening the muscles of infants and toddlers. Additionally, Karo oil is considered beneficial in alleviating skin conditions including burns, incision wounds, itching, insect bites, and bruises. For common health issues, Karo oil has been proven useful in managing indigestion, fever, bloating, and postnatal recovery. Karo oil also provides relief from conditions such as paralysis, back pain,

gout, and varicose veins. Coupled with its body-warming effect, Karo oil emerges as a popular choice in traditional medicine for various health concerns.

Karonese have a tradition of consuming traditional medicines, both singularly in the form of herbal concoctions. Some commonly known concoctions among the Karo people are known as *tawar*, *parem*, Karo oil, *sembur*, and *oukup*. *Tawar* is a fine dry powder from various types of plants, *tawar* is beneficial for treating flatulence, stomach pain, and improving blood circulation. *Parem* is a solid concoction made from a mixture of plants and rice flour (*Oryza sativa*) as a thickener, the benefits of *parem* include warming the body, relieving muscle aches, and treating fever. Karo oil is herbal oil, a liquid concoction of plant extracts with the addition of coconut oil (*Cocos nucifera*) to increase volume (Silalahi *et al*. 2018). *Sembur* is a traditional remedy made from a blend of seeds and spices. What sets it apart is its application method, where it is chewed and then applied to the specific body part. Alternatively, it can be brewed in hot water and consumed (Hennisa *et al.* 2017). *Oukup* is a traditional treatment of the Karo Batak people using a steaming technique from boiling water containing natural spices (Kaban 2023).

Due to the presence of natural ingredients in Karo oil, the community as consumer of Karo oil believes that it has the ability to treat several diseases. Almost all plant species found in the raw materials of manufacturing have the potential to be used for pharmaceutical products. Karo traditional oil have various health benefits, including treating various diseases such as muscle and bone problems, digestion, heart and cholesterol, respiratory, skin, blood and immune system, kidneys, blood pressure, inflammation, cancer, nerves, including common ailments such as fever, cough, wounds, and bloating. Karo oil is commonly used topically, applied or rubbed on specific parts of the body for light massage. Informants have stated that Karo oil is safe for oral consumption as it does not contain harmful ingredients. However, for administrative reasons, the packaging only indicates external (topical) use.

Floristic distribution

The historical relationship between Indonesia and China, especially in North Sumatra, has developed over centuries, significantly impacting local culture and biodiversity. China has a history of more than two thousand years of sea transport of silk to overseas countries and tribes, gaining the reputation of the "Maritime Silk Road" due to its sea transportation. However, some scholars suggest that to reflect changes in the structure of exchanged cargo and goods, the term "silk" can be substituted with other commodities. The essence of the "Maritime Silk Road" lies in the sea route channel, facilitating not only the export of silk but also the exchange of ambassadors, trade, and culture between ancient China and overseas countries (Hong 2016).

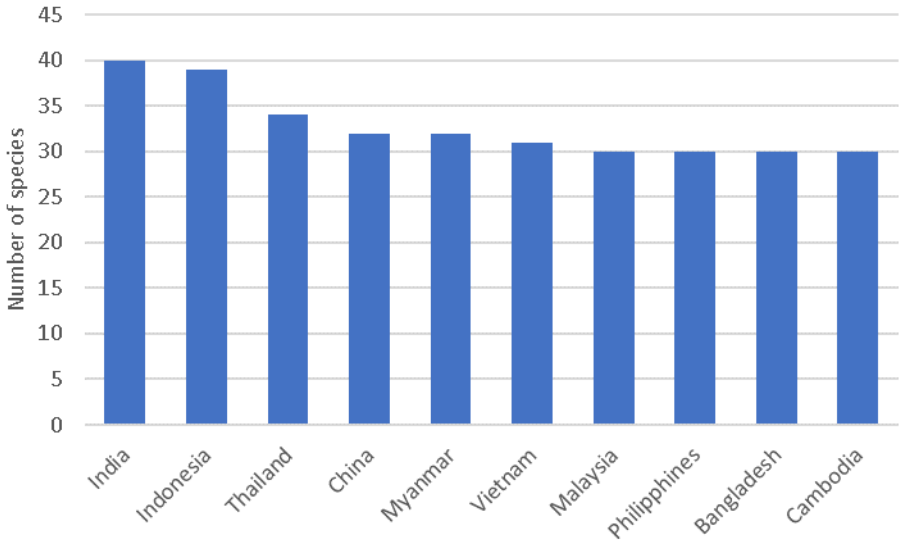

Figure 6. Plant origin used in Karo oil

Data from Plants of the World Online (2024) indicate that regions with the highest documentation of native plants include India, Indonesia, Thailand, China, and Myanmar. In Karo oil production, 32 native Chinese plants are used, illustrating the strong history of plant exchange and traditional knowledge between Indonesia and China. This exchange likely occurred through ancient maritime trade routes, including the Maritime Silk Road, which facilitated not only the transportation of goods but also the transfer of knowledge and culture (Hong 2016).

The migration of the Chinese community to North Sumatra began during the Ming Dynasty (1368-1644), with Chinese settlers becoming the dominant ethnic group in Medan (the capital of North Sumatra Province) by 1930. The arrival of the Chinese brought many positive influences, leading to cultural acculturation between the North Sumatran community and the Chinese (Sijabat and Rudiansyah 2022). Acculturation is a phenomenon that occurs when groups of individuals with different cultures

have direct and continuous contact, resulting in changes to the original cultural patterns of one or both groups (Berry 2005). The use of native Chinese plants in traditional Karo oil production highlights this process of acculturation, as the Karo people have incorporated these plants into their traditional practices, enriching their cultural heritage. The ongoing cultural exchange and preservation of traditional practices underscore the importance of the historical and cultural ties between Indonesia and China, contributing to the narrative of cultural diversity and long-term international relations between the two countries.

Conservation status and conservation efforts

The gathered medicinal plants yielded 28 species documented on the IUCN (International Union for Conservation of Nature and Natural Resources) Red List, categorized as Vulnerable (VU), Near Threatened (NT), Least Concern (LC), and Data Deficient (DD) (IUCN 2024) (refer to Table 2). Among these, *Cycas rumphii* is designated as Near Threatened (NT) due to its rarity, warranting conservation efforts, and *Santalum album* is classified as Vulnerable (VU). Additionally, 13 species are classified under Least Concern (LC), while 13 species hold a Data Deficient (DD) status. This data underscores that the majority of these medicinal plants exhibit a relatively low risk of rarity, however, it remains imperative to preserve these species to ensure their sustained presence. Conservation efforts by the informants involve cultivating medicinal plants in their yard and private fields. This cultivation has psychological impacts as individuals can freely utilize the available plants in their surroundings to meet spice needs as complements to cooking ingredients and for employing herbal remedies in managing mild symptoms in first aid. The cultivation of medicinal plants also contributes positively to the environment, creating a serene and aesthetically pleasing atmosphere in areas with family medicinal gardens. Additionally, the family medicinal garden cultivation program has economic prospects, particularly in the management of herbal medicine that can be distributed to the community (Sari *et al*. 2023).

Quantitative indices

Based on calculations, five plant species show the highest use values: *Allium cepa* (2.875), *Zingiber officinale* Roscoe var. *officinarum* (2.75), *Vitis gracilis* (2.5), *Allium sativum* (2.5) and *Anoectochilus reinwardtii* (2.5). *Allium cepa*, especially its leaves, is utilized by the Karo community to prepare *parem* remedies and treat diarrhea, coughs, immune modulation, and abscesses. Zingiber officinale Roscoe var. officinarum, the rhizomes are used as a *tawar* remedies, treating incisional wounds, fever, sore throat, and flatulence. *Vitis gracilis*, which is a native plant from Sumatra, is commonly known to the Karo ethnic community, this plant is usually found in forest. The leaves of this plant are used to increase appetite, increase immunity, and relieve menstrual pain. *Anoectochilus reinwardtii*, which is also a native plant from Sumatra, is used in whole plant. Apart from being a medicinal plant, this plant is also cultivated as an ornamental plant because it has a unique pattern. This plant is used for *parem* remedies, *tawar* remedies, treating cancer and heart disease. Allium sativum, commonly known as garlic, utilizes its bulb to prepare *parem* remedies, wound healing, gout, stomach ulcers, heart conditions, and abscesses.

The Relative Frequency of Citation (RFC) or the diversity value of plants utilized by the community in Karo oil ranges from 0.125 to 1. The highest RFC values are for *Vitis gracilis* (1)*, Cymbopogon nardus* (1)*, Citrus hystrix* (1)*, Elettaria cardamomum* (1)*,* and *Allium cepa* (0.875). These high RFC values indicate that these species are widely used in treating various diseases in the community*. Cymbopogon nardus* and *Citrus hystrix* are easily accessible and cultivated by the community. *Vitis gracilis* is a plant that can be easily obtained in private fields or state forest areas permitted for use by the community. *Elettaria cardamomum* and *Allium cepa* are one of the common spice types cultivated by local farmers in the Berastagi Sub-district and are readily available in large quantities in the local market.

The calculation of the Cultural Significance Index (ICS) based on plant utilization in Karo oil among the community in the Berastagi Sub-district shows five plant species with highest ICS values: *Cymbopogon nardus, Allium cepa, Zingiber officinale* roscoe var. *officinarum, Cocos nucifera, and Zingiber officinale* Roscoe var. *amarum.* The ICS value indicates the importance of each plant species for the community in the study area, serving as a basis for considering important and potentially economically valuable species to increase local community income as well as for conservation purposes (Helida *et al.* 2016).

Economic value

Karo oil not only serves as a traditional medicine with significant health benefits for the Karo ethnic community in Berastagi Sub-district, but also provides important economic impacts. The production and sale of Karo oil are integral parts of their economic and cultural life. Karo oil is sold directly by informants in traditional markets in Berastagi Sub-district, through online marketplaces or social media, and by resellers. It is priced between IDR 15,000 and IDR 150,000 (1 USD = 16,000 IDR) for sizes ranging from 100 ml to 1000 ml. Price differences are influenced by factors such as raw materials, sales location, and packaging size. Karo oil which is made from coconut oil has a more expensive price because coconut oil is more expensive than palm oil. Traditional markets offer direct access to local consumers with varying purchasing power (Sari 2021), while sales through resellers can reach a wider market with higher prices (Humairoh 2022), including outside North Sumatra province. Six out of eight informants mentioned that they market Karo oil in Berastagi's traditional market, indicating that the local market remains their mainstay. Additionally, the size of the packaging also affects its selling price. Larger packaging usually offers a cheaper price per ml, appealing to consumers who wish to purchase in large quantities. This pricing strategy allows producers to accommodate various market segments, from consumers with limited budgets to those looking for products in large quantities for more specific needs (Saufika 2020).

There is also great potential to develop Karo oil. Three out of eight informants already have resellers selling Karo oil outside North Sumatra province, indicating demand beyond the local market. With increasing interest in natural and traditional products, Karo oil has the potential for further development. To realize this potential, producers can focus on improving product quality and effective marketing strategies. Support from local governments and the use of e-commerce platforms and social media for further promotion can help Karo oil become known and accepted in a broader market.

Limitations and recommendations

One limitation of our study is the potential for selection bias in the choice of informants. Despite efforts to select key informants based on specific criteria and consultation with the local community, there may have been individuals who were not included in the study but could have provided valuable insights into the traditional use of Karo oil. Additionally, the exclusion criteria, while necessary to ensure the relevance of the information collected, may have inadvertently excluded individuals who could have contributed valuable perspectives. Another limitation is the reliance on self-reported information from informants, which may be subject to recall bias or inaccuracies. Despite efforts to verify the information provided by informants through cross-referencing with literature and fieldwork, some degree of error or misinterpretation cannot be completely ruled out. Based on the findings of our study, future research could focus on exploring the pharmacological properties of Karo oil. This could involve conducting laboratory studies to identify the active compounds in Karo oil and their potential effects on health. Pharmacological studies could help validate the traditional uses of Karo oil and identify potential new applications.

Conclusion

Generally, the use of medicinal plants in Karo oil demonstrates a relatively high level of species diversity and holds significant importance in the local community's healthcare practices. However, there has been a decline in the utilization of these medicinal plants due to increasing preferences for modern treatment and the lack of involvement of the younger generation in some parts of the community. This research provides comprehensive documentation on the utilization of various medicinal plant species, their uses, and the traditional value of Karo Oil as traditional medicine by the Karo ethnic group in Berastagi Sub-district. Additionally, this study holds significant value in documenting and preserving biodiversity and local knowledge related to the use of traditional medicine.

Declarations

List of abbreviations: RISKESDAS: *Riset Kesehatan Dasar*, BPS: *Badan Pusat Statistik*, UV: Use Value, RFC: Relative Frequency of Citation, ICS: Index of Cultural Significance.

Ethical considerations and consent to participate: The study proposal was approved by the Health Research Committee Ethics Universitas Sumatera Utara (USU) with code of ethics no.: 1212/KEPK/USU/2023. Informed written consent was obtained from each informant, and the principles of information confidentiality and patient anonymity were strictly observed. Research principles and procedures were thoroughly explained to the subjects, and they participated voluntarily. The informants shown in Figure 2 agreed to have their images published. Informants genuinely declared their consent to participate in the research interviews after reading and receiving detailed explanations and fully understanding the nature of this study.

Data and material availability: The data are only stored by authors.

Disclosure statement: The authors declare that there is no competing interest.

Author's contributions: ACYA: Conceptualization, Methodology, Data curation, Project Administration, Writing - original draft. MFL: Review and editing. WS: Conceptualization, Methodology, Funding administration, Writing - review and editing.

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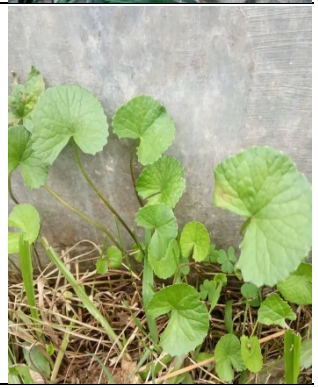
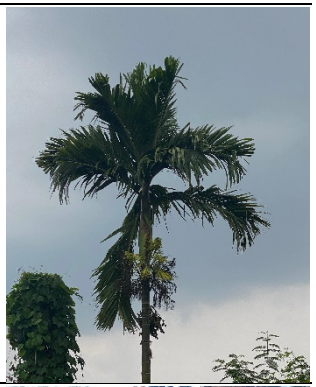
Figure 4. Percentage of plant parts used in Karo oil

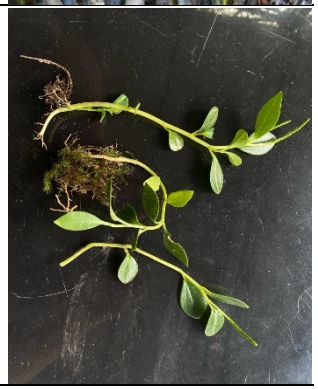
Family	Latin name	Local name	Medicinal use (s)	Used part	Source	Habitat	Quantitative Indices			IUCN	Figure
							UV	RFC	ICS		
Acanthaceae	*Strobilanthes cernua* Blume	*Paris*	*Oukup*	Leaves	Wild	Forest	0.5	0.5	6	NA	
	Strobilanthes phyllostachya Kurz	*Keji beling*	Epilepsy	Leaves	Cultivation	Yard	0.125	0.125	3	NA	

Acoraceae	*Acorus calamus* L.	*Jerango*	Cough, fever *oukup*	Rhizome	Cultivation	Field	0.75	0.25	6	LC	
Amaranthaceae	*Achyranthes bidentata* Blume	*Sebrani*	Fracture, knee swelling, rheumatism, sprain	Leaves	Wild	Forest	1.625	0.5	6	NA	
Amaryllidaceae	*Allium cepa* L.	*Pia*	Abscess, diarrhea, cough, immunity enhancer, *parem*,	Bulb	Cultivation	Field	2.875	0.875	30	NA	

	Allium sativum L.	*Lasuna*	Abscess, gout, incision wound *parem*, , abscess	Bulb	Cultivation	Field	2.5	0.875	15	NA	
	Allium tuberosum Rottler ex Spreng.	*Gundera*	Fever, rheumatism, bone strengthening , immunity enhancer	Bulb, leaves	Cultivation	Field	0.5	0.125	12	NA	
Apiaceae	*Centella asiatica* (L.) Urb.	*Pegaga*	Gastritis, respiratory distress, flatulence, toothache	Leaves	Cultivation	Yard	1.625	0.5	6	LC	

Coriandrum sativum L.	*Ketumbar*	*Oukup*, immunity enhancer	Seed	Cultivation	Garden	0.625	0.375	9	NA	
Cuminum cyminum L.	*Jinten putih*	Anti-inflammation, gastritis	Seed	Cultivation	Garden	0.25	0.125	9	NA	
Pimpinella anisum M.Bieb.	*Adas manis*	Diabetes, fever, cough	Seed	Cultivation	Garden	0.375	0.125	3	NA	

Arecaceae	*Areca catechu* L.	*Mayang*	Chest pain, diarrhea, flatulence, gastritis, rheumatism	Fruit, Root	Cultivation	Yard	1	0.875	9	DD	
	Arenga pinnata (Wurmb.) Merr.	*Pola*	Fever, *tawar*	Root	Cultivation	Garden	0.5	0.375	9	LC	
	Calamus acanthospathus Griff.	*Rotan*	*Tawar*, stamina enhancer	Root	Wild	Forest	1	0.625	9	NA	

	Cocos nucifera L.	*Kelapa*	Chickenpox, fever, *tawar*	Flesh, root	Cultivation	Yard	1.25	0.5	30	NA	
	Nipa fruticans (Wurmb.) Thunb.	*Nipah*	Gastritis, *tawar*	Root	Cultivation	Forest	0.25	0.125	1.5	LC	
Asclepiadaceae	*Dischidia nummularia* R.Br.	*Pabornis betina*	*Parem*, swelling, abscess	Whole plant	Wild	Forest	0.375	0.125	1.5	NA	

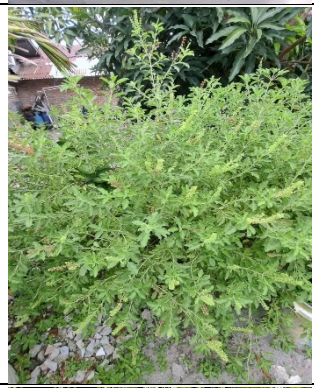
	Hoya macrophylla G.Don	*Tapak gajah*	*Tawar*	Leaves	Wild	Forest	0.5	0.5	6	NA	
Asparagaceae	*Cordyline fruticosa* (L.) A,Chev.	*Kalinjuhang*	Abscess, hemostatic, hemoptysis, dysentery, menorrhagia, bleeding hemorrhoids	Leaves	Cultivation	Yard	1.25	0.375	3	LC	
Asteraceae	*Gynura procumbens* (Lour,) Merr.	*Sambung nyawa*	Diabetes, hypertension	Leaves	Cultivation	Yard	0.75	0.375	6	NA	

Balsaminaceae	*Impatiens balsamina* L.	*Kiung*	Chickenpox, *parem* for children	Flower	Wild	Forest	0.5	0.25	6	NA	
	Impatiens platypetala Lindl.	*Sapa*	Abscess, jaundice	Flower	Wild	Forest	0.5	0.25	6	NA	
Caricaceae	*Carica papaya* L.	*Mbertik*	Diabetes, cancer, fever	Leaves	Cultivation	Yard	0.625	0.25	6	DD	

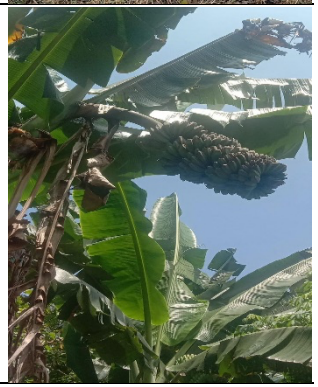
Cycadaceae	*Cycas rumphii* Miq.	*Pakis haji*	Gastritis, itching skin	Leaves	Cultivation	Yard	0.25	0.125	1.5	NT	
Euphorbiaceae	*Aleurites moluccana* (L.) Wild.	*Kembiri*	Abscess, appetite enhancer	Seed	Cultivation	Garden	0.25	0.125	3	LC	
Fabaceae	*Cassia alata* L.	*Gelinggang*	*Oukup*	Leaves	Cultivation	Yard	0.5	0.5	6	LC	

Fabaceae	*Parkia timoriana* (DC.) Merr.	*Kedawung*	Flatulence	Seed	Cultivation	Yard	0.125	0.125	1.5	LC	
Fabaceae	*Quercus infectoria* G.Olivier	*Manjakani*	*Oukup*, itching skin, leukorrhea	Fruit	Cultivation	Garden	1	0.375	6	LC	
Gesneriaceae	*Aeschynanthus sumatranus* Ohwi.	*Sigaratundal*	*Parem*, abscess	Leaves	Wild	Forest	0.75	0.5	6	NA	

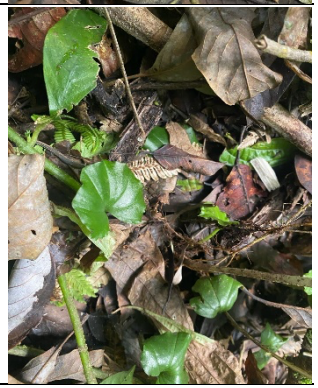
Gleicheniaceae	*Gleichenia linearis* (Burm.f.) C.B.Clarke	*Sampil-pil*	Fever, itching skin	Leaves	Wild	Yard	0.5	0.25	3	LC	
Lamiaceae	*Cinnamomum burmanni* (Nees & T.Nees) Blume	*Kayu manis*	*Oukup*	Bark	Cultivation	Garden	0.625	0.625	9	NA	
Lamiaceae	*Coleus amboinicus* Lour.	*Terbangun*	Fever, flatulence, headache, incision wound, mouth ulcer	Leaves	Cultivation	Yard	2.25	0.75	6	NA	

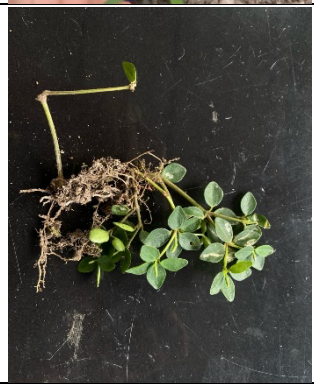
Lamiaceae	*Ocimum basilicum* L.	*Kemangi*	*Oukup*	Leaves	Cultivation	Yard	0.125	0.125	4.5	NA	
Lamiaceae	*Ocimum tenuiflorum* L.	*Ruku-ruku*	Dyspepsia, herniated nucleus pulposus	Leaves	Cultivation	Yard	0.375	0.25	3	NA	
Lamiaceae	*Orthosiphon aristatus* (Blume) Miq.	*Kumis kucing*	Hypertension, renal impairment, rheumatism	Leaves	Cultivation	Yard	0.75	0.25	6	NA	

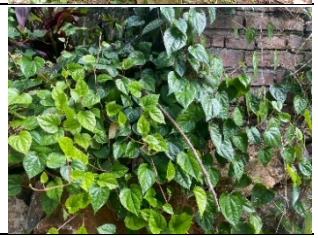
Lamiaceae	*Pogostemon cablin* (Blanco) Benth.	*Nilam*	*Oukup*, pain	Leaves	Cultivation	Garden	0.875	0.5	9	NA	
Lamiaceae	*Vitex trifolia* L.	*Legundi*	Cough, dyspepsia, immunity enhancer	Leaves	Cultivation	Yard	0.375	0.25	3	NA	
Malvaceae	*Urena lobata* L.	*Sampelulut*	Abscess, cough, fever, fracture	Leaves, root	Wild	Forest	0.375	0.125	3	NA	

Meliaceae	*Tinospora crispa* (L.) Miers.	*Brotowali*	Diarrhea, fever, itching skin, incision wound, gastritis	Leaves, stem	Cultivation	Yard	0.625	0.125	3	NA	
Menispermaceae	*Cyclea barbata* Miers.	*Pupuk mula jadi*	Hypertension, malnutrition	Leaves	Wild	Field	0.5	0.25	6	NA	
Musaceae	*Musa x paradisiaca* L.	*Galuh sitabar*	Constipation, fever, stomachache	Leaves	Cultivation	Field	0.375	0.125	8	LC	

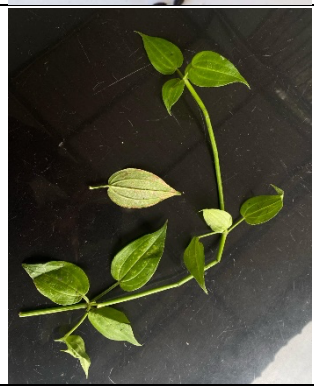
Myristicaceae	*Myristica fragrans* Houtt.	*Pala*	Insect bite, *sembur*	Fruit	Cultivation	Garden	1.25	0.875	24	DD	
Myrtaceae	*Melaleuca leucadendra* L.	*Kayu putih*	Fever	Leaves, root	Cultivation	Garden	0.5	0.5	6	DD	
Myrtaceae	*Syzygium aromaticum* (L.) Merr. & L.M.Perry	*Cengkeh*	Body warmer, flatulence, immunity enhancer	Flower	Cultivation	Garden	1.5	0.75	12	NA	

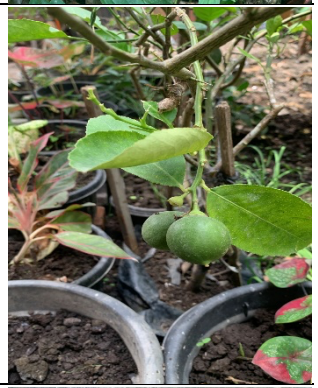
Myrtaceae	*Syzygium polyanthum* (Wight) Walp.	*Salam*	Stomachache, joint pain	Leaves	Cultivation	Yard	0.25	0.125	9	NA	
Orchidaceae	*Anoectochilus reinwardtii* Blume	*Surat dibata*	*Parem*, cancer, cardiac, *tawar*	Whole plant	Wild	Forest	2.5	0.625	9	NA	
	Nervilia aragoana Gand.	*Selembar sebulan*	*Parem, tawar*	Whole plant	Wild	Forest	0.5	0.25	6	NA	

Pandanaceae	*Pandanus amaryllifolius* Roxb.	*Pandan*	*Oukup*	Leaves	Cultivation	Yard	0.75	0.75	12	DD	
Phyllanthaceae	*Phyllanthus urinaria* L.	*Meniran*	Fever, incision wound	Leaves	Cultivation	Yard	0.5	0.375	6	NA	
Piperaceae	*Peperomia trifolia* (L.) A,Dietr.	*Pabornis jantan*	*Oukup, parem*	Whole plant	Wild	Forest	0.25	0.125	1.5	NA	

Piper aduncum L.	*Sirih hutan*	Digestive aids, incision wounds, nausea, *oukup*	Leaves	Cultivation	Yard	0.5	0.125	9	LC	
Piper betle L.	*Belo, sirih*	Swollen	Leaves	Cultivation	Yard	0.375	0.375	9	NA	
Piper nigrum L.	*Lada mbiring*	Epilepsy, gastritis, gout, cardiac	Fruit	Cultivation	Garden	1.875	0.625	24	NA	

Poaceae	*Cymbopogon nardus* L.	*Sereh wangi*	Epilepsy, insect repellent, *oukup*	Whole plant	Cultivation	Yard	2.25	1	30	NA	
	Vetiveria zizanioides L.	*Akar wangi*	Fever, *oukup*	Whole plant	Cultivation	Garden	0.5	0.25	3	NA	
Polygonaceae	*Drymoglossum piloselloides* (L.) Presl.	*Sisik naga*	Swollen	Leaves	Wild	Forest	0.375	0.375	6	NA	

	Persicaria chinensis (L.) H.Gross.	*Siang-siang*	*Parem* for children	Flower, leaves	Wild	Forest	0.375	0.375	6	NA	
Ranunculaceae	*Nigella sativa* L.	*Jinten*	Cholesterol, hypertension	Seed	Cultivation	Garden	0.5	0.25	9	NA	
Rosaceae	*Rubus pyrifolius* Hook.f	*Sirap-rap igung*	*Oukup* for children	Leaves	Wild	Forest	0.25	0.25	6	NA	

Rubiaceae	*Hedyotis hedyotidea* (DC.) Merr.	*Waren karang*	*Tawar*, back pain, *oukup*	Leaves	Wild	Forest	0.75	0.25	3	NA	
Rutaceae	*Citrus aurantiifolia* Swing.	*Rimo bunga, jeruk nipis*	Abscess, fever, sore throat	Flesh, leaves	Cultivation	Yard	1.625	0.625	12	NA	
	Citrus hystrix DC.	*Rimo mungkur, jeruk purut*	Abscess, fever, malnutrition	Flesh, leaves	Cultivation	Yard	1.5	1	24	NA	

Citrus limon L.	*Rimo susu*	*Oukup*	Flesh	Cultivation	Field	0.125	0.125	9	NA	
Murraya paniculata (L.) Jack.	*Kemuning*	Diarrhea, respiratory distress, toothache	Leaves	Cultivation	Yard	0.625	0.25	3	NA	
Zanthoxylum acanthopodium	*Tuba, andaliman*	Cough, *tawar*	Fruit	Cultivation	Field	0.25	0.125	9	LC	

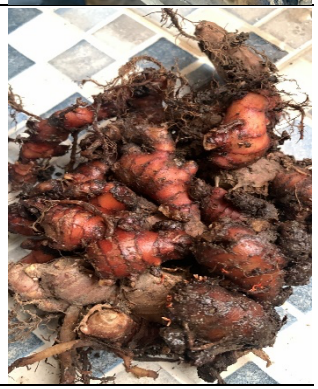
Santalaceae	*Santalum album* L.	*Cendana*	*Oukup*	Stem	Cultivation	Garden	0.25	0.25	6	VU	
Schisandraceae	*Illicium verum* Hook,f	*Bunga lawang*	Bad breath, cough, toothache	Flower	Cultivation	Garden	0.625	0.375	9	NA	
Selaginellaceae	*Selaginella doed erleinii* Hieron	*Asar-asar Betina*	Chest pain, hemoptysis	Leaves	Wild	Forest	0.5	0.5	3	NA	

	Selaginella inter media (Blume) Spring.	*Asar-asar Jantan*	Chest pain, hemoptysis	Leaves	Wild	Forest	0.5	0.5	3	NA	
Solanacea	*Nicotiana tabacum* L.	*Mbako*	Incision wound	Leaves, root	Cultivation	Garden	0.625	0.625	12	NA	
	Solanum verbascifolium L.	*Lancing, lancing kerangen*	Chest pain, dry cough, productive cough, incision wound, *parem*	Leaves	Wild	Forest	1.25	0.25	3	NA	

Vitaceae	*Cayratia japonica* (Thunb.) Gagnep.	*Kerpebalu*	*Parem*, swelling, abscess	Leaves	Wild	Forest	1.125	0.625	6	NA	
	Vitis gracilis BL.	*Gegaten Harimau*	*Tawar*, stomachache, gastralgia	Leaves	Wild	Forest	2.5	1	24	NA	
Zingiberaceae	*Curcuma longa* L.	*Kuning gersing*	Hypertension, diarrhea, *oukup*	Rhizome	Cultivation	Field	1.625	0.625	12	DD	

Curcuma xanthorrhiza Roxb.	*Temu lawak*	*Oukup*, diarrhea, diabetes, appetite enhancer	Rhizome	Cultivation	Field	1	0.375	9	NA	
Curcuma zedoaria Rosc.	*Temu putih*	Cough, stomachache, fever, *parem*	Rhizome	Cultivation	Field	0.5	0.125	6	DD	
Elettaria cardamomum (L.) Maton	*Kapulaga*	*Oukup*, stamina enhancement	Seed	Cultivation	Field	1.75	1	9	NA	

Kaempferia galanga L.	*Kaciwer*	Fever, headache, hypertension, respiratory distress, sore throat, malaria	Rhizome	Cultivation	Field	1.875	0.625	9	DD	
Etlingera elatior (Jack) R.M.Sm.	*Cekala kabang*	Cough, fever	Fruit	Cultivation	Garden	0.25	0.125	9	NA	
Zingiber montanum (J. Koenig)	*Bengle*	Headache, *oukup*, immune enhancement	Rhizome	Cultivation	Field	1.125	0.375	9	DD	

Zingiber officinale Roscoe var. *amarum*	*Jahe emprit*	Gout, dyspepsia, cardiac	Rhizome	Cultivation	Field	0.75	0.5	30	DD	
Zingiber officinale Roscoe var. *officinarum*	*Jahe gajah*	*Tawar*, wound, fever, sore throat, flatulence	Rhizome	Cultivation	Field	2.75	0.875	30	DD	
Zingiber officinale Roscoe var. *rubrum*	*Jahe merah*	Immune enhancement, body warmer, sore throat	Rhizome	Cultivation	Field	0.75	0.25	12	DD	

	Zingiber zerumbet (L.) Roscoe ex Sm.	*Lempuyang*	Fever, stamina enhancement, appetite enhancer	Rhizome	Cultivation	Field	0.375	0.5	9	DD	

Notes: Medicinal use (s)= Other uses of the plant based on local knowledge of the Karo ethnic group, VU= Vulnerable, NT= Near Threatened, LC= Least Concern, DD= Data Deficient, NA= Not Available, *Oukup*= Traditional sauna using plants, *Parem*= Solid mixture of plants and rice flour, *Sembur*= Traditional medicine is made from a variety of plants that are chewed and then sprayed onto the body as needed, *Tawar*= Fine dry powder from various plants, Field= Dry land planted with annual crops that have high economic value, Forest= A specific area covered by vegetation predominantly consisting of trees and permitted for use by local communities, Garden= An area planted with a single type of tree and typically lasts a long time with one harvest not depleting it entirely, Yard= A plot of land surrounding the house, with clear boundaries planted with various types of plants.

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