

Ethnobotanical knowledge of *Etlingera elatior* for medicinal and food uses among ethnic groups in Aceh Province, Indonesia

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Abstract. Saudah, Zumaidar, Darusman, Fitmawati, Roslim DI, Ernilasari. 2022. Ethnobotanical knowledge of *Etlingera elatior* for medicinal and food uses among ethnic groups in Aceh Province, Indonesia. *Biodiversitas* 23: 4361-4370. The tribes in Aceh Province have been using *Etlingera elatior* for various medicinal purposes and as a spice in their culinary. Nonetheless, detailed information on the uses of *E. elatior* among communities in Aceh is lacking. Therefore, this research aimed to explore the ethnobotanical knowledge among local tribes in Aceh regarding the uses of *E. elatior* for food and medicine. This research was conducted on eight ethnic groups in Aceh Province (i.e., Acehnese, Gayo, Alas, Aneuk Jamee, Kluet, Tamiang, Singkil, and Simeulue). The data collection was carried out by using semi-structured interviews and field observation. A total of 240 respondents (135 male and 105 female) were selected purposively to obtain local knowledge on the uses, processing techniques and modes of application of *E. elatior* for medicinal and food purposes. Descriptive statistics were used to analyze the data to determine the level of knowledge and plant parts used, both measured in fidelity level (FL). The results showed that men, elderly people and farmers had more knowledge about the uses of *E. elatior* as medicine and food ingredients. Traditional medicines made from this herb were used to cure coughs, sprains, postpartum and earaches. *Makjun sejuk*, *pareng*, *lampok* and *tapal* were the concoction used in traditional medicine. Stem and fruit were the most commonly used plant parts for medicinal herbs, while pounding was the most common processing technique followed by squeezing and grinding either singly or in a mixture used by drinking and rubbing. The uses of *E. elatior* in food were found in several local dishes with the most common use in a curry called *Pliék U*. Flower buds and fruit was the most commonly used part in food ingredients. Despite the unique and high uses of *E. elatior* among tribes in Aceh, the gap in knowledge, especially between the older and younger generations, might impact the loss of local wisdom regarding the plant.

Keywords: Acehnese, fidelity level, medicinal herb, traditional knowledge

INTRODUCTION

Ethnographically, Indonesia is rich in culture and ethnic communities with distinctive features, characteristics, knowledge and practical experiences, one of which is regarding the utilization of plants (Nikita et al. 2016). Many local communities in Indonesia use plants collected directly from nature as a source of food (Nikita et al. 2016), as traditional medicine (Martin 2010; Elfahmi et al. 2014), and also as a flavoring spice. Spices are the edible parts of the plant that are traditionally added to foodstuffs for natural taste, aroma, visual appearance, and preservation purposes (Elfahmi et al. 2014). Herbs and spices have various historical uses by the community, mostly for culinary purposes and to cure diseases.

The province of Aceh is a region in Indonesia with an anthropological mixture of native communities and various immigrant groups (Elfahmi et al. 2014; Aisyah 2016). In general, there are 12 indigenous tribes recognized in Aceh (i.e., Aceh, Gayo, Alas, Tamiang, Aneuk Jamee, Kluet, Singkil, Sigulai, Simeulu, Devayan, Haloban, and Lekon)

in which each tribe has a wealth of distinctive knowledge and customs concerning traditional use of plants (Sujarwo et al. 2014). One of the plant species used by such tribes is *Etlingera elatior*, a herb belongs to Zingiberaceae family. In Aceh, this plant is locally called as *bak kala* (Acehnese tribe), *achoem cikalo* (Kluet tribe) and *kinchueng* (Aneuk Jamee tribe), *gensong* (Simeulue tribe), *acem cekalo* (Gayo tribe) and *kecombrang* (Alas). The variety of naming of *E. elatior* indicates that there is a diversity of ethnobotanical knowledge regarding this plant.

Etlingera elatior is used by the communities in Aceh for flavor enhancer, culinary, ornamental plants, and medicine (Wong et al. 2013). Flower buds are used in various traditional foods such as *anyang*, *urap*, *pecel*, and *sayur asem*, and the powder from the young stems is used as raw food for fresh vegetables. The ripe fruits are used as a mixture in chili sauce (Saudah et al. 2021). In Malaysia, young inflorescences are used in traditional foods such as *Asam laksa*, *nasi kerabu*, and *nasi ulam* (Chiang et al. 2010), while the inflorescences and fruit are cooked as vegetables and eaten raw as salads (Noweg et al. 2003). In

Thailand, young stems, flowers, and fruit are eaten as vegetables (Chongkrajak et al. 2013).

Besides the uses for food and spices, species from *Etilingera* genus have been used as medicinal plants to treat various ailments, for example earache, fever, eye pain, stomachache, jaundice, sore throat, rheumatic and respiratory problems as well as to clean the ear and as deodorant (Saudah et al. 2021; Shahid-Ud-Daula and Mohammad 2019). Some *Etilingera* species are used commercially as an ingredient in cosmetics especially for skin bleaches and anti-aging lipsticks (Nithitanakool et al. 2014; Ghasemzadeh et al. 2015; Adliani and Purba 2012). In addition, various types of *Etilingera* are also used for perfume (*E. baramensis*), shampoo (fruit of *E. elatior* and *E. pyramidosphaera*), and herbs (rhizome of *E. punica*) (Droop 2013). The active compounds in this plant are saponins, flavonoids, polyphenols, essential oils, and chlorogenic acid (Lachumy et al. 2010). Pharmacologically, *Etilingera* species have antioxidant activity (Chan et al. 2011), antibacterial (Shahid-Ud-Daula and Mohammad 2019), anti-inflammatory (Sahidin et al. 2019), antifungal (Ghasemzadeh et al. 2015), anti-cytotoxic (Mankhong et al. 2019), anti-cancer and tumor (Shahid-Ud-Daula and Mohammad 2019), repellent activity (Siregar et al. 2020), anti-aging (Ruyani et al. 2019) and anti-virus (Ruyani et al. 2020).

While the understanding of the biochemical and pharmacology of *E. elatior* is extensive, information concerning local knowledge and how to use *E. elatior* as food and medicine in Aceh is still limited and has not been scientifically documented. Furthermore, the benefits and uses of *E. elatior* have only been conveyed orally from generation to generation within the family and were not properly recorded. It is feared that this knowledge will disappear in line with the development of science and technology that shifts the use of traditional medicine to chemical-based drugs. Therefore, this research aimed to explore the ethnobotanical knowledge of local communities in Aceh regarding the uses of *E. elatior* for food and medicine. By doing so, further research and development of this plant can be facilitated to increase its use in culinary and phytopharmaceutical aspects.

MATERIALS AND METHODS

Study area

This research was conducted on eight ethnic groups in Aceh Province (Acehnese, Gayo, Alas, Aneuk Jamee, Kluet, Tamiang, Singkil, and Simeuleu). The Acehnese are one of the indigenous tribes who inhabit the province of Aceh, starting from Langsa on the northeast coast to Trumon on the southwest coast. The areas of residence of the Acehnese are Banda Aceh city, Aceh Besar District, Pidie District, Pidie Jaya District, Bireun District, North Aceh District, part of East Aceh District (which is also inhabited by Tamiang tribe), Aceh Jaya, West Aceh, Nagan

Raya, part of South Aceh District (which is also inhabited by Aneuk Jamee and Kluet tribes), and the city of Sabang. While in Aceh Tengah District, it is dominated by Gayo tribe, Southeast Aceh District by Alas and Gayo tribes, Singkil District by Singkil tribe, and Simeuleu District by Simeuleu tribe (Zainuddin 2012).

Data collection

The data collection was carried out by using semi-structured interviews and field observation. The community involved was divided into two, namely informants and respondents. Informants included village heads and traditional healers, while the respondents were people who inhabited the area of eight tribes in Aceh Province. The interviews were conducted with key respondents to obtain a detailed and deep information, as well as to general respondents informally to obtain a more general information (Hoffman and Gallaher 2007). The selection of key respondents was carried out using purposive sampling by visiting people who were believed to be familiar with the use of plants as medicine.

Data collected in the interviews included the use of plants, the parts of the plants used, the purpose of use, processing methods, methods of use and types of ingredients.

Data analysis

Through descriptive analysis, the most frequently used parts of plants for medicine and food were identified. The frequency of the parts of *E. elatior* used was evaluated through the level of knowledge of the respondents based on the parts of the plant using the formula described by Monteiro et al. (2006). This method was used to identify the level of agreement between the informants about the part of the plant used and how to use the plant which is formulated below:

$$F = \left(\frac{S}{N} \right) \times 100$$

Where:

F: Frequency

S: Number of respondents who gave information on the part of the plant used

N: Total number of respondents

Fidelity level (FL) was measured for specific purposes using certain parts of the plant and calculated using the formula suggested by Friedman et al. (1986).

$$FL(\%) = \left(\frac{n}{N} \right) \times 100$$

Where:

FL: Fidelity level

n: Number of respondents for a particular use

N: Total number of respondents



Figure 1. Map of the study area in Aceh Province, Indonesia

RESULTS AND DISCUSSION

Characteristics of respondents

In total, there were 240 respondents who provided information about the uses of *E. elatior*. The distribution of respondent groups based on age, education, and occupation are presented in Table 1. Based on the results of the interviews, the use of *E. elatior* was more widely known by men than women. Respondents in the elderly category provided much information about the use of *E. elatior*. Informants with junior high school education levels had higher knowledge regarding *E. elatior* than high school and elementary school levels. Respondents who were farmers had higher knowledge than other occupations.

Respondent's knowledge of the use of *Etlingera elatior*

The respondents knew *Etlingera elatior* a spice plant that is used as a flavoring ingredient in food and also as a medicinal plant. Male respondents in the old age group (61-90 years) had a high percentage of using *E. elatior* as a food ingredient and for medicinal purposes (Table 2). Similarly, female respondents in the old age group (61-90 years) had a higher percentage of using *E. elatior* as food and medicine compared to other age groups. Knowledge of the use of *E. elatior* as a food ingredient in the male and female groups in the elderly age group had a higher percentage than for medicinal uses.

Table 1. Characteristics of gender, age, education, and social status of respondents

| Variable | Category | Number of respondents | Percentage (%) |
|-----------------|---------------------|-----------------------|----------------|
| Gender | Female | 105 | 43.75 |
| | Male | 135 | 56.25 |
| Age | 20-35 years (Young) | 65 | 27.08 |
| | 36-60 years (Adult) | 81 | 33.75 |
| | 61 years > (Old) | 94 | 39.17 |
| Education level | Elementary (1-6) | 53 | 22.08 |
| | Secondary (7-9) | 80 | 33.33 |
| | Tertiary (10-12) | 55 | 22.92 |
| | University | 52 | 21.67 |
| Occupation | Farmers | 93 | 38.75 |
| | Employees | 64 | 26.67 |
| | Others | 83 | 34.58 |

Table 2. Respondent's knowledge (in percentage) on the use of *Etlingera elatior* as a food ingredient and medicinal plant

| Use | Gender | Age (years) | | |
|-----------------|--------|-------------|-------|-------|
| | | 20-35 | 36-60 | 61-90 |
| Food ingredient | Male | 7.91 | 14.16 | 26.66 |
| | Female | 9.58 | 16.25 | 25.41 |
| Medicinal plant | Male | 6.42 | 20.71 | 23.57 |
| | Female | 9.28 | 19.28 | 20.71 |

Level of local knowledge in using *Etlingera elatior* as a medicinal plant

Tribal communities in Aceh Province used *E. elatior* as a traditional medicinal plant to treat various ailments. There were 12 diseases mentioned by the respondents that can be cured with this plant (Figure 2, Table 3). Nonetheless, there were varying levels of knowledge amongst the tribes. Cough was the most commonly mentioned ailment to treat with *E. elatior*, followed by sprain and postpartum. The tribe of Kluet had complete

knowledge of the use of the plant for medicinal purposes, in which they mentioned twelve ailments.

Part of the plant *Etlingera elatior* is used as a medicinal plant

The respondents mentioned parts of *E. elatior* used as medicine, including rhizomes, leaves, fruit, stems, and flowers. The stem was the most widely part used as a medicinal herb, followed by fruit, while the rhizome, leaves, and flowers were used occasionally (Table 4).

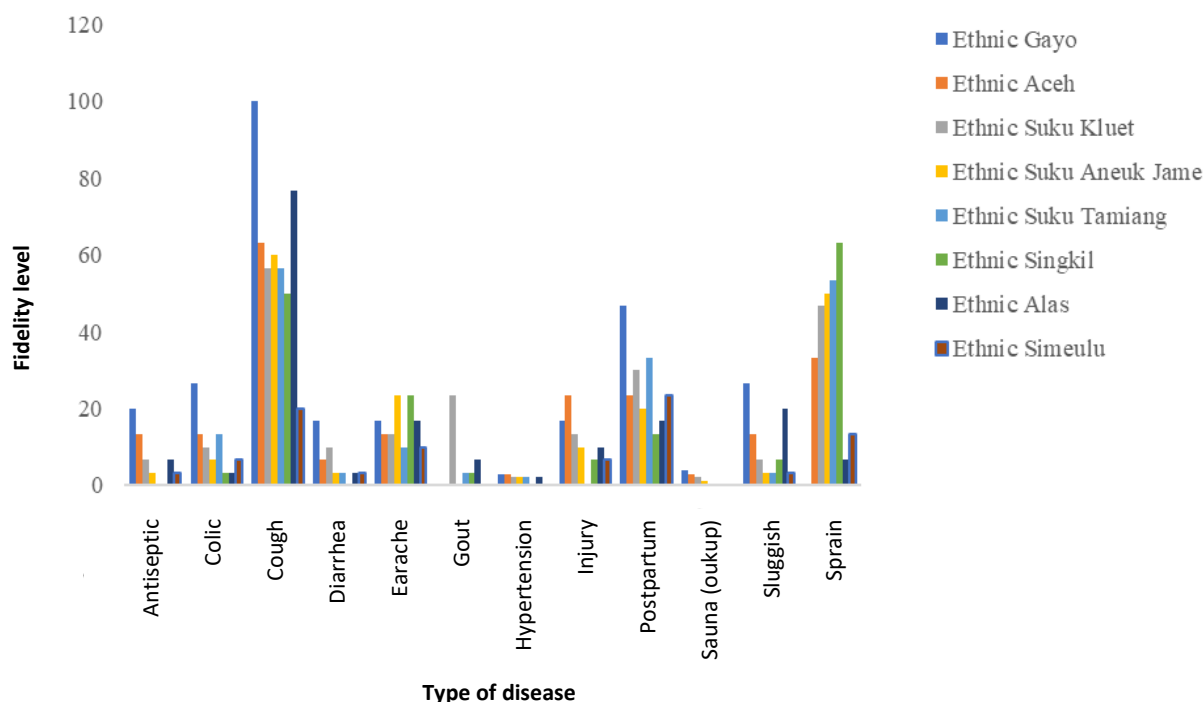


Figure 2. The level of knowledge (measured as fidelity level in percentage) of tribal communities in Aceh Province on the use of *Etlingera elatior* as a traditional medicinal herb

Table 3. Type of diseases cured by *Etlingera elatior* and level of knowledge of tribes regarding the medicinal uses of the plant

| Type of disease | Number of respondents | Fidelity level (%) | Ethnic group |
|-----------------|-----------------------|--------------------|--|
| Antiseptic | 16 | 6.67 | Gayo, Aceh, Kluet, Aneuk Jamee, Alas, and Simeulue |
| Uric acid | 10 | 4.17 | Kluet, Tamiang, Singkil, Alas, |
| Cough | 160 | 66.67 | Gayo, Aceh, Kluet, Aneuk Jamee, Tamiang, Singkil, Alas, and Simeulue |
| Diarrhea | 13 | 5.42 | Gayo, Aceh, Kluet, Aneuk Jamee, Tamiang, Singkil, Alas, and Simeulue |
| Hypertension | 14 | 5.83 | Gayo, Aceh, Kluet, Aneuk Jamee, Tamiang, Alas, and Simeulue |
| Sprain | 107 | 44.58 | Aceh, Kluet, Aneuk Jamee, Tamiang, Singkil, Alas, and Simeulue |
| Sluggish | 25 | 10.41 | Gayo, Aceh, Kluet, Aneuk Jamee, Tamiang, Singkil, Alas, and Simeulue |
| Injury | 26 | 10.83 | Gayo, Aceh, Kluet, Aneuk Jamee, Tamiang, Singkil, Alas, and Simeulue |
| Postpartum | 62 | 25.83 | Gayo, Aceh, Kluet, Aneuk Jamee, Tamiang, Singkil, Alas, and Simeulue |
| Sauna (oukup) | 10 | 4.17 | Gayo, Aceh, Kluet, Aneuk Jamee |
| Colic | 25 | 10.41 | Gayo, Aceh, Kluet, Aneuk Jamee, Tamiang, Singkil, Alas, and Simeulue |
| Earache | 38 | 15.83 | Gayo, Aceh, Kluet, Aneuk Jamee, Tamiang, Singkil, Alas, and Simeulue |

Table 4. Parts of *Etlingera elatior* used as medicinal herbs among tribes in Aceh Province

| Plant part | Number of respondents | Fidelity level (%) |
|------------|-----------------------|--------------------|
| Rhizome | 6 | 2.50 |
| Stem | 215 | 89.58 |
| Leaf | 5 | 2.08 |
| Flower | 2 | 0.83 |
| Fruit | 128 | 53.38 |

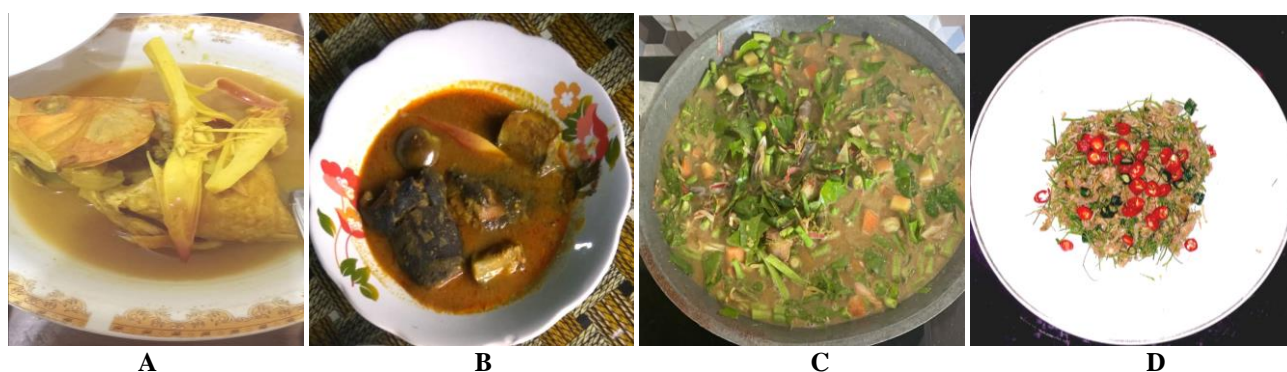
Methods processing and application of plants *Etlingera elatior* as a medicinal plant

The processing *E. elatior* for medicinal uses was carried out simply through roasting, boiling, sticking, and pounding either solely or in a mixture. Processing *E. elatior* as a single ingredient was carried out by roasting, boiling, or pounding (Table 5), while the processing of a

mixture was carried out by grinding. The application of *E. elatior* for medicine was mainly carried out by drinking and smearing, while washing and sticking were low. This is because the potions taken will have a direct effect on the disease and not last long.

Utilization of *Etlingera elatior* as a food ingredient

Based on the interviews with the respondents, *E. elatior* is used as a food ingredient and can be found in 12 traditional dishes in Aceh Province (Table 6). The curry *Pliék U* was culinary with the highest use of *E. elatior* as an ingredient in cooking (Figure 3). Flowers and fruit were the most widely used parts of the plant used for food, followed by rhizomes, stems, and leaves. The use of flowers and fruits in traditional dishes gave a specific flavor to the dish.

**Figure 3.** The culinary from Aceh Province use *Etlingera elatior* as an ingredient: A. Sea fish cooking, B. *Limbek*, C. *Pliék U* curry, D. *Lambai***Table 5.** Method of processing and application of *Etlingera elatior* as a medicinal herb

| Processing method | Number of respondents | Fidelity level (%) | Application method | Ethnic group |
|-------------------|-----------------------|--------------------|--------------------|--|
| Grilled, squeezed | 160 | 66.67 | Drink, smeared | Gayo, Aceh, Kluet, Aneuk Jamee, Tamiang, Singkil Alas, Simeulue |
| Pounded, squeezed | 221 | 92.08 | Drink, smeared | Gayo, Aceh, Kluet, Aneuk Jamee, Tamiang, Singkil, Alas, Simeulue |
| Boiled | 86 | 25.58 | Smeared | Gayo, Aceh, Kluet, Aneuk Jamee, Alas, Simeulue |
| Grind | 56 | 23.33 | Pasted | Gayo, Kluet |
| Crushed | 8 | 3.33 | Affixed | Gayo, Aceh, Kluet, Aneuk Jamee, Tamiang, Singkil, Alas, Simeulue |

Table 6. Types of cuisine using *Etlingera elatior* in Aceh Province, Indonesia

| Culinary name | Number of respondents | Fidelity level (%) | Parts used |
|---|-----------------------|--------------------|-------------------------------|
| <i>Pliék U</i> curry | 165 | 68.75 | Flowers |
| Sweet potato curry | 129 | 53.75 | Flowers |
| Fresh vegetable | 128 | 53.33 | Stem shoots (<i>terpuk</i>) |
| <i>Limbek</i> (freshwater fish cooking) | 100 | 41.67 | Flowers and fruits |
| Stir-fried ferns | 96 | 40.00 | Flowers |
| Chicken curry | 82 | 34.17 | Rhizomes and young stems |
| Sauce <i>kecombrang</i> | 58 | 24.17 | Fruits |
| Stir-fried papaya flower | 52 | 21.67 | Flowers |
| <i>Lambai</i> | 33 | 13.75 | Flowers |
| Sea fish cooking | 28 | 11.67 | Flowers and fruits |
| Lobster cooking | 12 | 5.00 | Flowers, fruits, and leaves |
| Syrup | 5 | 2.08 | Flowers and fruits |

Discussion

Demographic aspects affect traditional knowledge on the use of *Etlingera elatior* as medicine and food

Male respondents had more knowledge regarding the use of *E. elatior* compared to women. Direct observation in the field showed that men often used *E. elatior* both as food and medicine because the processing was easy and could be eaten raw. Torres-Avilez et al. (2019) mentioned that men have better knowledge of medicinal plants than women because of their association with the forest (Reyes-García et al. 2013).

Knowledge regarding the use of *E. elatior* as food and medicinal ingredient was greater in older and adult people, while such knowledge was low in young people. Elderly and adults have the opportunity and knowledge to learn with better direct experience in using plants compared to the younger generation (Wassie et al. 2015). These results suggest that the interaction between environment and age influences respondents' level of knowledge about the use of plants. Furthermore, de Almeida et al. (2010) stated that respondents with old age have a higher level of knowledge about the use of medicinal plants because this knowledge has been passed down from generation to generation by parents and has been introduced since they were teenagers.

Lack of knowledge among younger people is believed to be influenced by the modernization in which they are more interested in modern medicine (Reyes-García et al. 2013; Abebe 2019). Lack of interest in inheriting knowledge about medicinal plants resulted in the erosion of local knowledge related to the use of plants as medicine (Saynes-Vásquez et al. 2013; Mirutse et al. 2009). This results in a lack of knowledge transfer on the use of plants from the older to the younger generation. Knowledge transfer is very important in order to preserve existing knowledge. If the capacity is limited to a few people and not passed on, they lose their knowledge after their death and make the function of plants as medicine disappear (Moghanloo et al. 2019).

The uses of *Etlingera elatior* as traditional medicine by tribes in Aceh

Tribal communities in Aceh Province know that *E. elatior* is a multifunctional herb that can be used as a spice, food ingredient, and medicine. In traditional medicine, the stems and fruits are the main components in the composition of medicines. There are several concoctions consisting of *E. elatior*, namely *pareng*, *cool makjun*, *lampok*, *oukup*.

Pareng

Pareng is one of the traditional medicine made from a decoction of young stems of *E. elatior* which is used as a post-circumcision wound cleanser by the Gayo tribal community to prevent infection. The use of macerated stem as a wound cleanser is related to the content of secondary metabolites in *E. elatior* namely flavonoids (Lim 2014), antibacterial (Suryani et al. 2019), and antimicrobial activity (Soemarie et al. 2019). Several research mentions the use of macerated stem in traditional medicine to treat infections, digestive system disorders (Phumthum et al.

2018), worm infections, abdominal pain, and anemia (Samarang et al. 2015).

In addition, people empirically use macerate of *E. elatior* with the addition of a slight salt as cough medicine. This treatment practice has also been carried out by the Batak community (Silalahi et al. 2015) and Gayo tribe by using macerate from the stems to treat coughs and fever, while the decoction of the young stems is used as an antiseptic (Saudah et al. 2021). A mixture of ingredients from the macerated stem of *E. elatior* with *Uncaria gambir* (gambir) is used as a medicine for diarrhea and stomach pain. Phytochemically, the stems of *E. elatior* contain a very high content of phenolics, tannins, saponins, and flavonoids. Furthermore, *E. elatior* stem extract also contains camphene, linalool, phenolic and sesquiterpene compounds, which have antimicrobial activity (Mahdavi et al. 2017) and act as natural antioxidants (Naufalin and Herastuti 2017). The content of saponins in *E. elatior* can produce foam, and it has a bitter taste, which can reduce the surface tension of worms in intestinal infections in such a way that anthelmintic activity can work optimally (Samarang et al. 2015).

Lampok

Lampok traditional medicinal herbs are formulated from a mixture of *E. elatior* rhizomes (*terpuk*), *Myristica fragrans* (nutmeg), leaves of *Kaempferia galanga* (sand ginger/*kencur*), rhizomes of *Acorus calamus* (*jeuringi*), *Sida rhombifolia* (*oen sikili*), and whiting. This herb is traditionally used by the Kluet tribe which is believed to be effective in relieving pain and swelling due to gout. The pharmacological activities of this herb are antispasmodic (Ganjewala and Srivastava 2011), anti-rheumatic and anti-inflammatory (Akinboro et al. 2011).

Makjun sejuk

Makjun sejuk is a post-natal traditional medicinal herb formulated from a mixture of macerated fruit, the stem of *E. elatior*, *Zingiber officinale* (ginger), *Kaempferia galanga* (*kencur*), *Curcuma longa* (turmeric), *Zingiber cassumunar* (*bangle*), *Zingiber zerumbet* (*lempuyang*), *Foeniculum vulgare* (anise), *Nigella sativa* (black cumin), and *Piper nigrum* (pepper). The perceived effectiveness of these herbs is to relieve postpartum fatigue, restore body stamina, accelerate wound drying, shed bloodstones, and shrink the stomach (Zumaidar et al. 2019). The use of aromatic plants in the concoction of *makjun sejuk*, specifically the Zingiberaceae species, is related to secondary metabolites, which contain aromatherapy and essential oils (Batubara et al. 2016). The use of aromatic species helps mothers to overcome anxiety, reduce stress and improve mood after childbirth. The pharmacological properties of these herbs are antioxidant, antidepressant, anti-inflammatory, neurodegenerative, analgesic, anti-tumor, and immunomodulatory activities (Jamal et al. 2011).

Tapal

Tapal is produced from a mixture of macerate of fruit *Etlingera elatior* with whiting and is used as a stomach

potion for postpartum mothers. Furthermore, it is believed that the use of these herbs promotes uterine contractions, thins the abdomen, removes bloodstones, and accelerates the dehydration of the uterus (Zumaidar et al. 2019). The concoction of macerate of *E. elatior* with a mixture of *Curcuma longa* (turmeric), *Zingiber officinale* (ginger), *Alpinia galanga* (galangal), and *Oryza sativa* L. var. *glutinosa* (glutinous rice) is also used to increase stamina. The perceived effectiveness can relieve tiredness and fatigue. These medicinal herbs with a mixture of aromatic ingredients can help to restore energy, increase blood flow, and refresh the body (Siti et al. 2009). The antioxidant content has activity as an immunostimulant that can respond to the immune system (Fristiohady et al. 2019). The ripe fruit of *E. elatior* used in traditional medicinal herbs can lower cholesterol levels in the body. In addition, the ripe fruit of *E. elatior*, which is eaten raw, is useful as an antihypertensive drug (Mohamad et al. 2005), while the decoction of the fruit is used to treat earache (Maimulyanti and Prihadi 2015). The use of *E. elatior* fruit as a traditional medicinal herb has been carried out by the Aneuk Jamee tribes of South Aceh and Batak Karo to treat fever and cough (Silalahi and Nisyawati 2018; Suwardi et al. 2021). A mixture of macerated fruit of *E. elatior* with whiting has also been used to treat bruises caused by sprains. The pharmacological activity of the extract of ethanolic of *E. elatior* fruit is an antipyretic in male mice with a decrease in temperature of 1.237 °C. Furthermore, *E. elatior* fruit also contains strong protocatechuic with powerful anti-inflammatory and antioxidant activity (Malik et al. 2018).

In addition, the leaves of *E. elatior* mixed with several other leaves are used as bath ingredients for postpartum mothers. Aromatic herbs are believed to help to eliminate body odor, refresh the body, make the body feel warm, expel angina and smooth the skin. The essential oil content in *E. elatior* leaves antimicrobial properties and has been recommended for various health problems in traditional medicine systems in Southeast Asia (Malik et al. 2018). The use of *E. elatior* leaves by Karo Batak people as an aromatic ingredient is adequate for postpartum mothers (Silalahi and Nisyawati 2018). These aromatic herbs are believed to be natural and safer with no side effects (Giannenas et al. 2019). Bathing with boiled water containing plant extracts can relieve fatigue in postpartum mothers and have a cooling effect on the content of essential oils that are produced by plants (Phumthum et al. 2018). Bathing with warm water from a mixture of leaves and accompanied by a gentle massage on the abdomen can reduce fatigue and remove dirty blood in postpartum mothers (Indriastuti and Tahiruddin 2019). The use of aromatic materials can treat various human diseases, including bronchitis, pneumonia, pharyngitis, diarrhea, periodontal disease, wounds, and several other diseases

Plant parts of *Etlingera elatior* for medicinal uses

Rhizomes, stems, leaves, and fruit of *Etlingera elatior* were used by tribes in Aceh for medicinal purposes. Research conducted by Silalahi and Nisyawati (2018), revealed that the stem and fruit of *E. elatior* are used as

medicinal herbs of Batak Karo sub-ethnic in North Sumatra. The use of stems for medicines is also widely used by the Thai people (Phumthum et al. 2018). A previous study in South Aceh also showed that the fruit is used to treat coughs (Suwardi et al. 2020). The content of nutrients such as potassium, pectin, beta-carotene, and vitamin C in *E. elatior* fruit is useful in protecting the body from disease and can help the healing process of disease (Rachkeeree et al. 2018). The benefits of vitamin C in fruits play important roles in health by increasing iron absorption, strengthening blood vessels, increasing antibody levels, lowering cholesterol, preventing cardiovascular disease and connective tissue, healing wounds, and preventing bleeding gums. The mineral composition (i.e., calcium, potassium and iron) of *E. elatior* is an important nutrient that plays a role in the body's biochemical pathways (Rachkeeree et al. 2018). In addition to the vitamin and mineral content, the fruit also contains phytochemicals that act as antioxidants and remove free radicals (Slavin and Lloyd 2012).

Methods of processing and use of *Etlingera elatior* in medicine

The processing of *E. elatior* for medicinal uses was different amongst ethnic groups in Aceh Province, depending on the type of disease being treated. Roasting, boiling, squeezing, pounding, and grinding were the common methods of preparation used to treat various ailments among them. Processing by pounding and squeezing had the highest frequency compared to roasting by squeezing. This processing is considered simple, easy, and can be consumed directly. Processing by roasting on fire is believed to have more medicinal properties. The process of single ingredient of the medicinal plant can facilitate bioactive compounds to produce the desired pharmacological effects (Parasuraman et al. 2014). Mixing two or more medicinal herbs has a greater impact when compared to a single herb (Izzo 2012).

The application of medicinal herbs was carried out through drinking and smearing. The use of drinking was mainly carried out to treat the internal organs, while the smear method was used to treat the physical part of the body. The potion will have a quick reaction when taken and accelerate healing faster because it goes directly into the body (Java 2017). The smeared herb provides properties through the pores of the skin and into the bloodstream.

Utilization of *Etlingera elatior* as a food ingredient

E. elatior was mainly used by tribal communities in Aceh Province as the ingredient and additive in some traditional foods. Traditional food is known as ancestral knowledge inherited from individuals or community groups (Ivanova et al. 2015). The use of *E. elatior* in traditional foods in Aceh Province was often used in cooking *Pliék U* curry, mashed sweet potato leaves, freshwater fish cooking (*limbek*), fresh vegetables, stir-fried ferns, chicken curry, and cooking chickpea flowers. *Pliék U* curry is a traditional Acehese vegetable-based cuisine often served at certain events and one of the special menus favoured by people in Aceh Province (Saudah et al. 2021). The mixture of

flowers *Etlingera*, cassava leaves (*Manihot utilissima*), and fruit of papaya (*Carica papaya*), water spinach (*Ipomoea aquatica*), *cepokak* (*Solanum torvum*), leaves and young *melinjo* fruit (*Gnetum gnemon*), bean (*Vigna unguiculata*) were cooked with coconut milk (*Cocos nucifera*) and gave a distinctive taste, which is characterized by sweet, sour and spicy aromas (Benvenuti et al. 2016; Fernandes et al. 2018; Skrajda-Brdak et al. 2020). The young inflorescences have also been used as a cooking ingredient and condiment for food flavoring in the preparation of the traditional dishes of *asam laksa*, *nasi kerabu*, and *nasi ulam* (Chan et al. 2007; Chiang et al. 2010). Flower buds of *E. elatior* have also been used by traditional communities on a wide variety of processed food as a spice and flavorings in foods such as cooking ointment, chili, *pecel*, mashed potatoes, and vegetables (Chan et al. 2008).

The mixture of *E. elatior* flowers with cassava leaves (*Manihot utilissima*) and *cepokak* (*Solanum torvum*) are processed with mashed sweet potato leaves. A mixture of papaya (*Carica papaya*), grated coconut (*Cocos nucifera*) and flower buds of *E. elatior* is a food menu consumed by people in their daily lives. The specific taste and distinctive aroma of flowers of *E. elatior* provide a therapeutic effect on health. In addition, *E. elatior* has high fiber, fat, protein content, and various other constituents such as vitamins (Wijekoon et al. 2011). The high fiber content has the potential to reduce blood cholesterol levels, hypertension, diabetes, the risk of heart disease, and constipation (Wijekoon et al. 2011; Fernandes et al. 2018).

Another processing of flowers of *E. elatior* is as a health drink in the form of a syrup that can relieve thirst, increase energy and help the digestive process of food. Furthermore, flower extract of *E. elatior* contains secondary metabolites as antioxidant and antibacterial activity, which can be developed into functional food products (Pangestika et al. 2021). Various ethnic communities have used the fruit as a spice in various processed food. The fruit of *E. elatior* is used as a spice in the processed food of *palumara* in the Palopo people, as a substitute for acid to remove the fishy odor of freshwater fish in the Batak Karo tribe, as well as some traditional food preparations such as *arsik* and *terites* (Silalahi and Nisyawati 2018b; Asmara et al. 2020).

Fruit juice mixed with *E. elatior* is used in seafood dishes such as lobsters. The combination of flowers and fruit juices of *E. elatior* produces a broth with a savory taste and distinctive aroma in cooking. The use of *E. elatior* fruit extract gives a savory taste to food, and increases appetite (Purba et al. 2018). The use of fruit extracts is also used in traditional foods in the Tamiang and Kluet tribes (Suwardi et al. 2020). Besides increasing appetite, the addition of fruit extracts in traditional foods is also believed to have medicinal properties (Asmara et al. 2020).

Some local communities also use shoots and young stems of *E. elatior* as vegetables. Indigenous peoples of Sabah and Thailand also consume shoots and young stems that are processed into salads or consumed raw with meat (Noweg et al. 2003; Chan et al. 2013; Purwoko et al. 2019; Rachkeeree et al. 2018).

The parts used as food ingredients

Flower and fruit buds were the most widely used parts as food ingredients by local people in Aceh Province. The use of flower buds in the culinary has been practiced for a long time ago. Flower buds with a distinctive flavor and aroma provide a delicious sensation when added to seafood dishes and coconut milk dishes because they can neutralize the fishy smell of seafood and nausea caused by coconut milk (Purwoko et al. 2019). The content of essential oils is very dominant, namely mono and sesquiterpenoids, which are characteristics of flowers of *E. elatior* because of their volatile nature, therefore, they are often used as a special flavoring of food (Zulak and Bohlmann 2010). The fruit is used as a substitute for tamarind in some traditional dishes. The use of acid in cooking gives a savory taste with a delicious broth. The acid content in fruit has fiber that can launch the digestive system (Jeevani et al. 2011).

To conclude, the results of this study showed that ethnic communities in Aceh Province used *E. elatior* for medicinal purposes and food ingredients. Traditional medicines made from this herb were used to cure coughs, sprains, postpartum and earaches. The types of concoction were *pareng*, *cool makjun*, *lampok* and *tapal*. The use of *E. elatior* in food is often found in a local culinary called *Pliék U* curry. There were differences in knowledge among social groups in which men had more knowledge about the use of *E. elatior* than women, as well as the older people had better information than the younger, and people with junior high school education levels had higher knowledge than high school and elementary school, and farmers had higher knowledge than other occupations. The gap in knowledge, especially between the older and younger generations, might impact the loss of local wisdom. Therefore, there is a need to transfer knowledge among communities in an effort to conserve traditional knowledge.

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REFERENCES

- Abebe FB. 2019. Ethnobotanical studies of medicinal plants used to treat human and livestock ailments in southern nations, nationalities and peoples' region, Ethiopia: A systematic review. *J Plant Stud* 8 (1): 1. DOI: 10.5539/jps.v8n1p1.
- Adliani N, Purba D. 2012. Lipstick formulation using natural dye from *Etlingera elatior* (Jack) R.M.Sm. extract. *J Pharm Pharmacol*. DOI: 10.31227/osf.io/wp5n3.
- Aisyah S. 2016. Perdagangan di nusantara abad ke-16. *E-Journal Pendidikan Sejarah* 4 (3): 721-735. [Indonesian]
- Akinboro A, Mohamed KB, Asmawi MZ, Sulaiman SF, Sofiman OA. 2011. Antioxidants in aqueous extract of *Myristica fragrans* (Houtt.) suppress mitosis and cyclophosphamide-induced chromosomal aberrations in *Allium cepa* L. cells. *J Zhejiang Univ Sci B* 12 (11): 915-922. DOI: 10.1631/jzus.B1000315.
- Asmara KT, Nisyawati, Silalahi M. 2020. Ethnomedicinal plants used by batak angkola subethnic of Bulumario Village, Sipirok, South

- Tapanuli, North Sumatera. 10(ICoBioSE 2019), 101-106. DOI: 10.2991/absr.k.200807.024.
- Batubara I, Zahra U, Darusman LK, Maddu A. 2016. The essential oil of Zingiberaceae leaf as antioxidant and antiglycation. *Indones J Essential Oil* 1 (1): 44-52. DOI: 10.21776/ub.ijeo.2016.001.01.05.
- Benvenuti S, Bortolotti E, Maggini R. 2016. Antioxidant power, anthocyanin content and organoleptic performance of edible flowers. *Sci Hort* 199, 170-177. DOI: 10.1016/j.scienta.2015.12.052.
- Chan EWC, Lim YY, Omar M. 2007. Antioxidant and antibacterial activity of leaves of *Etlingera* species (Zingiberaceae) in Peninsular Malaysia. *Food Chem* 104 (4): 1586-1593. DOI: 10.1016/j.foodchem.2007.03.023.
- Chan EWC, Lim YY, Wong LF, Lianto FS, Wong SK, Lim KK, Joe CE, Lim TY. 2008. Antioxidant and tyrosinase inhibition properties of leaves and rhizomes of ginger species. *Food Chem* 109 (3): 477-483. DOI: 10.1016/j.foodchem.2008.02.016.
- Chan EWC, Lim YY, Wong SK. 2011. Phytochemistry and pharmacological properties of *Etlingera elatior*: A review. *Pharmac J* 3 (22): 6-10. DOI: 10.5530/pj.2011.22.2.
- Chan EWC, Lye PY, Eng SY, Tan YP. 2013. Antioxidant properties of herbs with enhancement effects of drying treatments: A synopsis. *Free Radicals Antioxidants* 3 (1): 2-6. DOI: 10.1016/j.fra.2013.02.001.
- Chiang EW, Yan LY, Ali NAM. 2010. Composition and antibacterial activity of essential oil from leaves of *Etlingera* species (Zingiberaceae). *Intl J Adv Sci Arts* 1 (2): 1-12.
- Chongkrajak W, Ngamniabsakul C, Poulsen AD. 2013. Morphological diversity and distribution of *Etlingera littoralis* (König) Giseke (Zingiberaceae) in southern Thailand. *Walailak J Sci Technol*. DOI: 10.2004/wjst.v10i6.634.
- de Almeida CFCBR, Ramos MA, de Amorim ELC, de Albuquerque UP. 2010. A comparison of knowledge about medicinal plants for three rural communities in the semi-arid region of northeast of Brazil. *J Ethnopharmacol* 127 (3): 674-684. DOI: 10.1016/j.jep.2009.12.005.
- Droop J. 2013. BOOK REVIEW - *Etlingera* of Sulawesi. A. D. Poulsen. Natural History Publications (Borneo), Malaysia. *Edinburgh J Bot* 70 (3): 491-492. DOI: 10.1017/s096042861300019x.
- Elfahmi, Woerdenbag HJ, Kayser O. 2014. Jamu: Indonesian traditional herbal medicine towards rational phytopharmacological use. *J Herbal Med* 4 (2): 51-73. DOI: 10.1016/j.hermed.2014.01.002.
- Fernandes L, Ramalhosa E, Pereira J, Saraiva J, Casal S. 2018. The unexplored potential of edible flowers lipids. *Agriculture* 8 (10), 146. DOI: 10.3390/agriculture8100146.
- Friedman J, Yaniv Z, Dafni A, Palewitch D. 1986. A preliminary classification of the healing potential of medicinal plants, based on a rational analysis of an ethnopharmacological field survey among Bedouins in the Negev Desert, Israel. *J Ethnopharmacol* 16 (2-3): 275-287. DOI: 10.1016/0378-8741(86)90094-2.
- Fristiody A, Zubaydah WOS, Wahyuni W, Mirda M, Saripuddin S, Andriani R, Purnama LOMJ, Sahidin S. 2019. Immunomodulator activity of effervescent granule of wualae fruit (*Etlingera elatior* (Jack) R.M. Smith) based on specific phagocytic activity. *Borneo J Pharm* 2 (2): 35-40. DOI: 10.33084/bjop.v2i2.868.
- Ganjewala D, Srivastava AK. 2011. An update on chemical composition and bioactivities of *Acorus* species. *Asian J Plant Sci* 10 (3): 182-189. DOI: 10.3923/ajps.2011.182.189.
- Ghasemzadeh A, Jaafar HZE, Rahmat A, Ashkani S. 2015. Secondary metabolites constituents and antioxidant, anticancer and antibacterial activities of *Etlingera elatior* (Jack) R.M.Sm grown in different locations of Malaysia. *BMC Compl Altern Med* 15 (1): 335. DOI: 10.1186/s12906-015-0838-6.
- Giannenas I, Sidiropoulou E, Bonos E, Christaki E, Florou-Paneri P. 2019. The history of herbs, medicinal and aromatic plants, and their extracts: Past, current situation and future perspectives. *Feed Additives: Aromatic Plants and Herbs in Animal Nutrition and Health*. Elsevier. DOI: 10.1016/B978-0-12-814700-9.00001-7.
- Hoffman B, Gallaher T. 2007. Importance indices in ethnobotany. *Ethnobot Res Appl* 5, 201-218. DOI: 10.17348/era.5.0.201-218.
- Indriastuti D, Tahiruddin T. 2019. Hot bath therapy for postpartum mothers: the ethnocaring practice in the Muna Tribe, Southeast Sulawesi, Indonesia. *Public Health Indones* 5 (4): 105-115. DOI: 10.36685/phi.v5i4.312.
- Ivanova L, Terziyska I, Trifonova J, Ivanova L, Terziyska I, Trifonova J. 2015. Characteristics of traditional food - the viewpoint of the tourism business Characteristics of traditional food - the viewpoint of the tourism business In recent years there has been a clear shift in tourism demand from material expressions of culture. *J Service Manag* 4(July): 123-130.
- Izzo AA. 2012. Interactions between herbs and conventional drugs: Overview of the clinical data. *Med Principles Practice* 21 (5): 404-428. DOI: 10.1159/000334488.
- Jamal JA, Ghafar ZA, Husain K. 2011. Medicinal plants used for postnatal care in Malay traditional medicine in the Peninsular Malaysia. *Pharmacog J* 3 (24): 15-24. DOI: 10.5530/pj.2011.24.4.
- Java W. 2017. Ethnobotanical study of medicinal plants in Karangwangi, District of Cianjur, West Java. *Biosaintifika: J Biol Biol Educ* 9 (2): 345-356. DOI: 10.15294/biosaintifika.v9i2.5756.
- Lachumy SJT, Sasidharan S, Sumathy V, Zuraini Z. 2010. Pharmacological activity, phytochemical analysis and toxicity of methanol extract of *Etlingera elatior* (torch ginger) flowers. *Asian Pac J Trop Med* 3 (10): 769-774. DOI: 10.1016/S1995-7645(10)60185-X.
- Lim TK. 2014. Edible medicinal and non medicinal plants: Volume 8, flowers. *Edible Medicinal and Non Medicinal Plants: Volume 8, Flowers* (Vol. 8). DOI: 10.1007/978-94-017-8748-2.
- Mahdavi B, Yaacob WA, Din LB. 2017. Chemical composition, antioxidant, and antibacterial activity of essential oils from *Etlingera sayapensis* A.D. Poulsen & Ibrahim. *Asian Pac J Trop Med* 10 (8): 819-826. DOI: 10.1016/j.apjtm.2017.08.006.
- Maimulyanti A, Priyadi AR. 2015. Chemical composition, phytochemical and antioxidant activity from extract of *Etlingera elatior* flower from Indonesia. *J Pharmacog Phytochem* 3 (6): 233-238.
- Malik F, Ningsi A, Bafadal M, Saktiani DN, Wahyuni W. 2018. Uji efek antipiretik ekstrak etanol buah wualae (*Etlingera elatior* (Jack) R.M. Smith) terhadap mencit jantan (*Mus musculus* L.) galur Balb/C. *Pharmauho: Jurnal Farmasi, Sains, dan Kesehatan* 4 (1): DOI: 10.33772/pharmauho.v4i1.4622.
- Mankhong S, lawsipo P, Srisook E, Srisook K. 2019. 4-methoxycinnamyl p-coumarate isolated from *Etlingera paviana* rhizomes inhibits inflammatory response via suppression of NF- κ B, Akt and AP-1 signaling in LPS-stimulated RAW 264.7 macrophages. *Phytomedicine* 54, 89-97. DOI: 10.1016/j.phymed.2018.09.193.
- Martin GJ. 2010. *Ethnobotany. Ethnobotany: A Methods Manual*. Routledge. DOI: 10.4324/9781849775854.
- Mirutse G, Asfaw Z, Woldu Z. 2009. Medicinal plants of the Meinit ethnic group of Ethiopia: An ethnobotanical study. *J Ethnopharmacol* 124 (3): 513-521. DOI: 10.1016/j.jep.2009.05.009.
- Moghanloo L, Ghahremaninejad F, Vafadar M. 2019. Ethnobotanical study of medicinal plants in the central district of the Zanjan county, Zanjan province, Iran. *J Herbal Drugs* 9 (3): 121-131.
- Mohamad H, Lajis NH, Abas F, Ali AM, Sukari MA, Kikuzaki H, Nakatani N. 2005. Antioxidative constituents of *Etlingera elatior*. *J Nat Prod* 68 (2): 285-288. DOI: 10.1021/np040098l.
- Monteiro JM, Albuquerque UP. de, Lins-Neto EM. de F, Araújo EL. de, Amorim ELC. de. 2006. Use patterns and knowledge of medicinal species among two rural communities in Brazil's semi-arid northeastern region. *J Ethnopharmacol* 105 (1-2): 173-186. DOI: 10.1016/j.jep.2005.10.016.
- Naufalin R, Herastuti SR. 2017. Antibacterial activity of *Nicolaia speciosa* fruit extract. *Intl Food Res J* 24 (1): 379-385.
- Nikita, Saerang D, Pontoh W. 2016. Provinsi Sulawesi Utara. *Jurnal EMBA* 4 (1): 484-495. [Indonesian]
- Nithitanakool S, Teeranachaideekul V, Ponpanich L, Nopporn N, Junhunkit T, Wanasawas P, Chulasiri M. 2014. In vitro and in vivo skin whitening and anti-aging potentials of hydroglycolic extract from inflorescence of *Etlingera elatior*. *J Asian Assoc Schools Pharm*.
- Noweg T, Abdullah AR, Nidang D. 2003. Forest plants as vegetable for communities bordering the Crocker Range National Park. *ASEAN Review of Biodiversity and Environmental Conservation (ARBEC)*, January-March 2003: 1-18.
- Pangestika W, Nusaibah N, Dwiyanan AN. 2021. Pemanfaatan kitosan dan ekstrak bunga kecombrang untuk pembuatan minuman kesehatan. *Media Teknologi Hasil Perikanan* 9 (2): 43-50. DOI: 10.21776/ub.jpa.2021.009.01.5. [Indonesian]
- Parasuraman S, Thing G, Dhanaraj S. 2014. Polyherbal formulation: Concept of ayurveda. *Pharmacog Rev* 8 (16), 73. DOI: 10.4103/0973-7847.134229.
- Phumthum M, Srithi K, Inta A, Junsongduang A, Tangjitman K, Pongamornkul W, Trisonthi C, Balslev H. 2018. Ethnomedicinal plant diversity in Thailand. *J Ethnopharmacol* 214, 90-98. DOI: 10.1016/j.jep.2017.12.003.

- Purba EC, Silalahi M, Nisyawati. 2018. Gastronomic ethnobiology of "terites"—a traditional Batak Karo medicinal food: A ruminant's stomach content as a human food resource. *J Ethnic Foods* 5 (2): 114-120. DOI: 10.1016/j.jef.2018.06.002.
- Purwoko A, Turnip H, Maser WH. 2019. The pattern of *Etlingera elatior* cultivation in agroforestry systems and its use as traditional medicines and food by local people of Kabanjahe, North Sumatra, Indonesia. *Biodiversitas*, 20 (7): 1998-2003. DOI: 10.13057/biodiv/d200728.
- Rachkeeree A, Kantadoun K, Suksathan R, Puangpradab R, Page PA, Sommano SR. 2018. Nutritional compositions and phytochemical properties of the edible flowers from selected Zingiberaceae found in Thailand. *Front Nutr* 5 (February), 1-10. DOI: 10.3389/fnut.2018.00003.
- Reyes-García V, Guèze M, Luz AC, Paneque-Gálvez J, Macía MJ, Orta-Martínez M, Pino J, Rubio-Campillo X. 2013. Evidence of traditional knowledge loss among a contemporary indigenous society. *Evol Human Behav* 34 (4): 249-257. DOI: 10.1016/j.evolhumbehav.2013.03.002.
- Ruyani A, Parlindungan D, Kartika E, Putra JR, Sundaryono A, Susanta A. 2020. Leaf ethanolic extract of *Etlingera hemesphaerica* Blume alters mercuric chloride teratogenicity during the post-implantation period in *Mus musculus*. *Toxicol Res* 36 (2): 131-138. DOI: 10.1007/s43188-019-00010-8.
- Ruyani A, Putri RZE, Jundara P, Gresinta E, Ansori I, Sundaryono A. 2019. Protective effect of leaf ethanolic extract *Etlingera hemesphaerica* Blume against mercuric chloride toxicity in blood of mice. *J Dietary Suppl* 16 (1): 51-65. DOI: 10.1080/19390211.2018.1429516.
- Sahidin S, Salsabila S, Wahyuni W, Adryan F, Imran I. 2019. Potensi antibakteri ekstrak metanol dan senyawa aromatik dari buah wualae (*Etlingera elatior*). *Jurnal Kimia Valensi* 5 (1): 1-7. DOI: 10.15408/jkv.v5i1.8658. [Indonesian]
- Samarang, Isnawati R, Murni. 2015. Potential content of karondo (*Etlingera elatior*) as a traditional worm medicine for the Kulawi community in Central Sulawesi. *Penyakit Bersumber Binatang* 2 (2): 1-8. [Indonesian]
- Saudah, Ernilarari, Fitmawati, Roslim DI, Zumaidar, Darusman MAHU. 2021. A phytochemical screening of Bakkala (*Etlingera elatior*) originated from Suakbugis, Aceh, Indonesia and its potential in ethnobotany. *Intl J Herbal Med* 9 (4): 37-42.
- Saudah, Fitmawati, Roslim DI, Zumaidar, Darusman, Ernilarari. 2021. Ethnobotany *Etlingera elatior* (Jack) R.M. Smith (Cikala) in Ethnic Gayo. 14 (Kobicinc 2020), 205-209. DOI: 10.2991/absr.k.210621.034.
- Saynes-Vásquez A, Caballero J, Meave JA, Chiang F. 2013. Cultural change and loss of ethnobotanical knowledge among the Isthmus Zapotecs of Mexico. *J Ethnobiol Ethnomed* 9 (1): 40. DOI: 10.1186/1746-4269-9-40.
- Shahid-Ud-Daula AFM, Kuyah MAA, Kamariah AS, Lim LBL, Ahmad N. 2019. Phytochemical and pharmacological evaluation of methanolic extracts of *Etlingera fimbriobracteata* (Zingiberaceae). *South Afr J Bot* 121, 45-53. DOI: 10.1016/j.sajb.2018.10.013.
- Shahid-Ud-Daula AFM, Mohammad AB. 2019. Genus *Etlingera* - A review on chemical composition and antimicrobial activity of essential oils. *J Med Plants Res* 13 (7): 135-156. DOI: 10.5897/JMPR2019.6740.
- Silalahi M, Nisyawati. 2018. The ethnobotanical study of edible and medicinal plants in the home garden of Batak Karo sub-ethnic in north Sumatra, Indonesia. *Biodiversitas* 19 (1): 229-238. DOI: 10.13057/biodiv/d190131.
- Silalahi M, Supriatna J, Walujo EB. 2015. Local knowledge of medicinal plants in sub-ethnic Batak Simalungun of North Sumatra, Indonesia. *Biodiversitas* 16 (1): 44-54. DOI: 10.13057/biodiv/d160106.
- Siregar AZ, Pradana MG, Rahmi D. 2020. Effect of kecombrang (*Etlingera elatior*) as larvacide to control *Aedes aegypti* (Diptera: Culicidae). *International Conference and the 10th Congress of the Entomological Society of Indonesia (ICCESI 2019) Effect*, 8 (Iccesi 2019), 35-40. DOI: 10.2991/absr.k.200513.006.
- Siti ZM, Tahir A, Farah AI, Fazlin SMA, Sondi S, Azman AH, Maimunah AH, Haniza MA, Haslinda SMD, Zulkarnain AK, Zakiah I, Zaleha WCW. 2009. Use of traditional and complementary medicine in Malaysia: a baseline study. *Compl Ther Med* 17 (5-6): 292-299. DOI: 10.1016/j.ctim.2009.04.002.
- Skrajda-Brdak M, Dąbrowski G, Konopka I. 2020. Edible flowers, a source of valuable phytonutrients and their pro-healthy effects - A review. *Trends Food Sci Technol* 103, 179-199. DOI: 10.1016/j.tifs.2020.06.016.
- Slavin JL, Lloyd B. 2012. Health benefits of fruits and vegetables. *Advances Nutr* 3 (4): 506-516. DOI: 10.3945/an.112.002154.
- Soemarie YB, Apriliana A, Ansori AK, Purnawati P. 2019. Uji aktivitas antibakteri ekstrak etanol bunga kecombrang (*Etlingera elatior* (Jack) R. M.Sm.) terhadap bakteri *Propionibacterium acne*. *Al Ulum Jurnal Sains dan Teknologi*, 5(1), 13. DOI: 10.31602/ajst.v5i1.2469. [Indonesian]
- Sujarwo W, Arinasa IBK, Salomone F, Caneva G, Fattorini S. 2014. Cultural erosion of Balinese indigenous knowledge of food and nutraceutical plants. *Econ Bot* 68 (4): 426-437. DOI: 10.1007/s12231-014-9288-1.
- Suryani N, Nurjanah D, Indriatmoko D. 2019. Antibacterial Activity of kecombrang rod extract (*Etlingera elatior* (Jack) R.M.Sm.) on dental plaque bacteria *Streptococcus mutans*. *Jurnal Kartika Kimia* 2 (1): 23-29. DOI: 10.26874/jkk.v2i1.19. [Indonesian]
- Suwardi AB, Mardudi, Navia ZI, Baihaqi, Muntaha. 2021. Documentation of medicinal plants used by Aneuk Jamee Tribe in Kota Bahagia Sub-District, South Aceh, Indonesia. *Biodiversitas* 22 (1): 6-15. DOI: 10.13057/biodiv/d220102.
- Suwardi AB, Navia ZI, Harmawan T, Syamsuardi, Mukhtar E. 2020. Ethnobotany and conservation of indigenous edible fruit plants in south Aceh, Indonesia. *Biodiversitas* 21 (5): 1850-1860. DOI: 10.13057/biodiv/d210511.
- Torres-Avilez W, Nascimento ALB. do, Santoro FR, Medeiros PM. de, Albuquerque UP. 2019. Gender and its role in the resilience of local medical systems of the Fulni-ô people in NE Brazil: Effects on structure and functionality. *Evid-Based Compl Altern Med* 2019, 1-15. DOI: 10.1155/2019/8313790.
- Wassie SM, Aragie LL, Taye BW, Mekonnen LB. 2015. Knowledge, attitude, and utilization of traditional medicine among the communities of Merawi Town, Northwest Ethiopia: a cross-sectional study. *Evid-Based Compl Altern Med* 2015, 1-7. DOI: 10.1155/2015/138073.
- Wong SK, Lim YY, Chan EWC. 2013. Botany, uses, phytochemistry and pharmacology of selected Apocynaceae species: A review. *Pharmacog Commun* 3 (3): 2-11. DOI: 10.5530/pc.2013.3.2.
- Wassie SM, Aragie LL, Taye BW, Mekonnen LB. 2015. Knowledge, attitude, and utilization of traditional medicine among the communities of Merawi Town, Northwest Ethiopia: A cross-sectional study', *Evid-Based Compl Altern Med* 2015: 1-7. DOI: 10.1155/2015/138073.
- Wijekoon JO, Karimand MM, Bhat R. 2011. Evaluation of nutritional quality of torch ginger (*Etlingera elatior* Jack.) inflorescence. *Intl Food Res J* 18 (4): 1415-1420.
- Zainuddin H. 2012. Tarikh Aceh dan Nusantara. LKSPM, Banda Aceh.
- Zulak KG, Bohlmann J. 2010. Terpenoid biosynthesis and specialized vascular cell of conifer defense', *J Integr Plant Biol* 52 (1): 86-97. DOI: 10.1111/j.1744-7909.20100.00910.x.
- Zumaidar, Saudah, Rasnovi S, Harnelly E. 2019. Indigenous knowledge of postnatal mother care using plants by acehnese. *IOP Conf Ser: Earth Environ Sci* 364 (1). DOI: 10.1088/1755-1315/364/1/012025.