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Some botanical aspects and antifungal activity of *Etlingera flexuosa* (Zingiberaceae) from Central Sulawesi, Indonesia

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Abstract. *Pitopang R, Umrah, Harso W, Nurainas, Zubair MS. 2020. Some botanical aspects and antifungal activity of* Etlingera flexuosa *(Zingiberaceae) from Central Sulawesi, Indonesia. Biodiversitas 21: 3547-3553. Etlingera flexuosa* is a species of *Etlingera* endemic to the island of Sulawesi and its natural distribution is restricted to Central and South Sulawesi, where it has been utilized for different purposes. Despite the limited knowledge in the aspects of botany and its antimicrobial activities, the use of plants as a source of alternative solutions to health problems is on the rise. The objectives of this study were to obtain some information about the several botanical aspects of *E. flexuosa* and its antifungal activity. This research was conducted from March to December 2019 and samples were collected from the montane forest of Lore Lindu National Park (LLNP) near Sedoa Village, Lore Utara Sub-district, Poso District, Indonesia. The identification of plant specimens and extractions was carried out at the Laboratory of Plant Biosystematics, Tadulako University, Palu, Indonesia. The antifungal activity was tested using agar diffusion methods. The results showed that *E. flexuosa* is a perennial herb naturally distributed in Sulawesi island. It usually grows in the pristine submontane and montane forests, sometimes in light and open condition or on the slope of natural disturbed forest at the altitude of 1500 -1700 m a.s.l. The forest is dominated by Fagaceae family, of which *E. flexuosa* has been utilized extensively by local community of Topo Baria ethnic for various purposes such as flavor enhancer in food, vegetable, traditional medicine, and as roofing materials. It contains some secondary metabolites such as flavonoids, tannins, saponins, terpenoids, alkaloids and steroids, and also shows antioxidant activity. Conclusively, the extract of *E. flexuosa* could be used as inhibiting agent for the growth of *Candida albicans* yeast.

Keywords: Antifungal, ethnobotany, *Etlingera flexuosa*, phytochemical

INTRODUCTION

Zingiberaceae is a perennial herb that produces aromatic rhizomes. It is one of the families from *Zingiberales* order present in most tropical and subtropical regions, as well as in Southeast Asia, where there is diversity of this family. It is comprised of 53 genera, of which 26 are restricted to Malesia region and about 1,200 species of which about 1,000 occur in tropical Asia (Larsen et al. 1999). The following genera belong to Zingiberaceae; *Zingiber, Alpinia, Ammomum, Boesenbergia, Curcuma, Elettaria, Etlingera, Globba, Hornstedtia, Kaempferia, Plagiostachys,* and *Vanoverberghia.*

One of the genera belonging to *Zingiberaceae* family is *Etlingera* Giseke plant. It consists of more than 57 species, which are mainly herbs existing in tropical and subtropical zones. It is distributed across India, Burma (Myanmar), Thailand, Indo-China and China, Malaysia, Polynesia, and Australia (de Gusman and Siemonsma 1999). According to Newman et al. (2004), 74 species of *Etlingera* were recorded in Malesia region, including 12 species in Peninsular Malaysia (Khaw 2001), 29 species in Borneo (Chan et al. 2007), 16 species in the Philippines (Poulsen and Docot 2018), And according to Poulsen (2012), there were estimated 150 - 200 species in total worldwide.

Etlingera flexuosa is one of 36 species of *Etlingera* described as new types and endemic to the island of Sulawesi. The natural distribution of the species is restricted to Central and South Sulawesi. It was previously described as a new species by Poulsen (2012) based on the specimen collected from Gunung Nokilalaki, Lore Lindu National Park Central Sulawesi province, Indonesia. It is known locally as *Karondo* among the Topo Baria ethnic, in Sedoa Village, Lore Utara Sub-district of Poso District, an indigenous ethnic in Central Sulawesi Indonesia.

Despite the limited knowledge about *E. flexuosa* from the aspects of botany such as ecology, ethnobotany, phytochemistry and its antimicrobial activities, its usage as a source of medicines is prevalent in developing countries as an alternative solution to health problems. Therefore, the objectives of the study were to obtain some information about the several botanical aspects of *E. flexuosa* and its antifungal activity.

MATERIALS AND METHODS

Plant materials

The *E. flexuosa* sample was collected from montane forest of Lore Lindu National Park (LLNP), Central Sulawesi, near Lake Kalimpa'a, Sedoa Village, Lore Utara Sub-district, Poso District, Central Sulawesi Province, Indonesia, about 80 km southeastern part of Palu, the capital of Central Sulawesi, Indonesia, between March and December 2019, as shown in Figure 1. LLNP is a protected area with about 220,000 ha of land and habitat to a number of Wallacean endemic plants and animals. The area has considerable conservation value and functions as a watershed for the surrounding areas.

The botanical exploration methods have been applied in observing the population of *E. flexuosa* in its natural habitat. Parameters observed and measured in this study include; general habitat, vernacular name, scientific name, family, collection-number, collector and plant habitus, geographic position (altitude, latitude, and longitude) and ecological data. The morphological character and terminology were in accordance with Stearn (1988) and Mabberley (2008).

The vegetation was analyzed using the double plot method (Milliken 1998). A plot size of 10 x 10 m was constructed with five (5) replicates placed separately to observe the species. A nested plot with 5 x 5 m size was constructed in each plot to record the sampling species, while a 2 x 2 m was constructed for the seedling and plant species understorey. Then, data of the abiotic factors such as; temperature, humidity, light intensity, and rainfall were obtained from secondary sources (Fauzan et al. 2018).

All the collected plant materials were identified at the Laboratory of Plant Biosystematic, Department of Biology, Faculty of Mathematics and Natural Sciences, Tadulako University, Indonesia. The plant specimens were identified using the specimen reference available at the Herbarium Celebence (CEB) of Tadulako University. These were determined by A.D Poulsen, a specialist on Zingiberaceae after which all the specimens were mounted, labeled, and kept at the CEB.

Ethnobotany

The ethnobotanical data such as the traditional utilization by local people (Topo Baria ethnic) were collected through direct interview with key informants such as; village leaders, religious leaders, traditional healers, and craft-people. The interviews were recorded through audio recorders and notebooks (Fathurrahman et al. 2016).

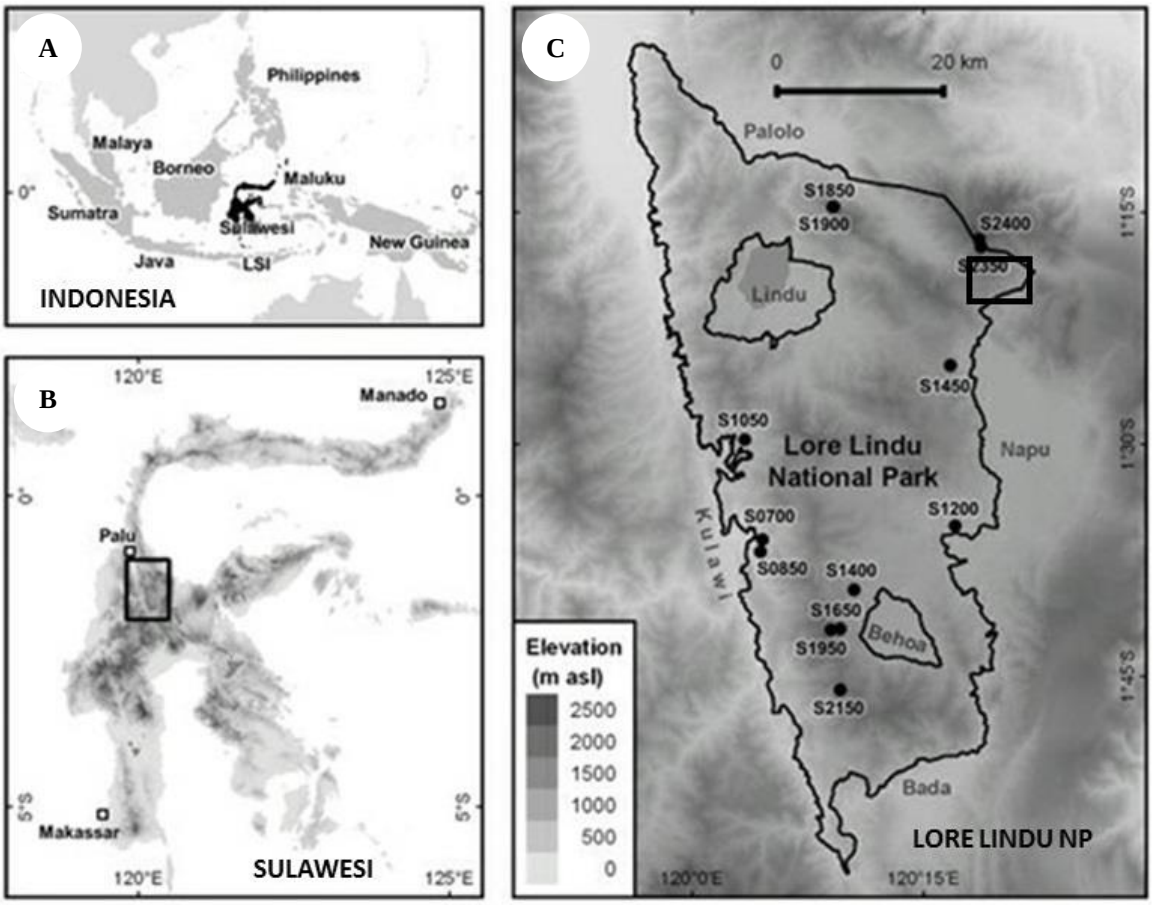

Figure 1. Map of the research site. A. Indonesian archipelago, B. Sulawesi island, C. Collecting localities are shown as a black rectangle in Lore Lindu National Park, Indonesia.

Plant extraction

Plant extraction and phytochemical analyses of all parts of each species were conducted at the Laboratory of Phytochemistry, Department of Pharmacy, Faculty of Mathematics and Natural Sciences, Tadulako University. The extraction was carried out using maceration method as described in a previous study (Ramadanil et al. 2019). Then, vegetative organs such as leaves, rhizome, and pseudostem, as well as reproductive organs such as inflorescence and fruit of *E. flexuosa*, were washed in running tap water three times and cut into 3 cm pieces and again washed, soaked in running tap water for five minutes and then air-dried. Fresh and dried leaves, rhizomes, and inflorescence of the species were extracted with 95% ethanol through maceration. The extracts were filtered, evaporated in a vacuum evaporator, and lypolized to produce dry extract.

Phytochemical evaluation

The phytochemical compounds data of *E. flexuosa* such as alkaloid, phenolic, flavonoid, tannins, and saponins were obtained from secondary sources (Ramadanil et al. 2019).

Qualitative test for antioxidant activity

Qualitative test for antioxidant activity of sample was conducted using the thin layer chromatography (TLC) method with DPPH (2,2-diphenyl-1-picrylhydrazyl) as spraying reagent. The appearance of yellow spots on TLC plate after DPPH spraying indicates a positive result (Okawa et al. 2001; Moharram and Youseef 2014).

Culture and growth media

Pure cultures of experimental fungi were obtained from the Laboratory of Microbiology, Department of Biology, Faculty of Mathematics and Natural Sciences, Tadulako University, Palu. The pure culture of *Candida albicans* was maintained on Potato Dextrose Agar (PDA) medium. Fungal culture was further maintained by subculturing regularly on the same medium and stored at 4^{o} C before it was used in this experiment. *C. albicans* was chosen based on its clinical and pharmacological importance (McCracken and Cowsan 1983). The fungal exists as a harmless commensal species in the gastrointestinal and genitourinary tract of healthy individuals (Nobile and Johnson 2015).

Antifungal activity

The antifungal activity was examined for hydroalcoholic extracts. Also, the antifungal activity of rhizome extracts against a pathogenic unicellular fungi, usually yeast, was investigated using the agar well diffusion method (Alzoreky and Nakahara 2003; Balouiri et al. 2016). The extract was screened for its antifungal activity against the *C. albicans*. Also, a set of four dilutions of *E. flexuosa* rhizome extract; 20, 40, 60, and 80%, as well as standard drugs were prepared in double-distilled water using nutrient agar tubes. Griseofulvin was used as the positive control was under similar conditions. The zones of growth inhibition for *C. albicans* around the disks were measured after 18 to 24 hours of incubation at 37°C. The sensitivities of the fungi species to the plant extracts were determined by measuring the sizes of inhibitory zones (including the diameter of disk) on the agar surface around the disks.

RESULTS AND DISCUSSION

Detailed information on botanical description, habitat, and ecology, specimen examined, photographs, ethnobotany, phytochemistry content, and antifungal activity are provided in details as follow:

Botanical description

The perennial herb was about 4.2 m high, in loose clump, with about 8-12 in number, and 10-15 cm apart. *Leafy stems* were red or purple, about 3.8-4 m long, with up to 22 leaves per shoot, and 5 cm base diameter. The sheath color was yellowish to purple, with scattered hairs, pubescent near margin, margin mainly glabrous, integer, ligule of about 15-25 mm long, slightly entire, asymmetrical, black, apex villose, petiole 15-42 mm long, dark purple, densely villose on margin; lamina elongated elliptic, 51-70 cm long x 12.5-18 cm wide with ratio 4,2-5,6 cm, green, midrib purple-red above and beneath, surface above with softly hairy, and apex acuminate. *Inflorescence* was 28-30 cm long, erect, arising from rhizome and receptacle 1.2 – 4 cm long. It was pink in the center, with 90-140 flowers, peduncle 4-14 cm long. The flowers were 4-6.5 cm long, erect at first, labellum ovate were 17-21 x 3.5-5 mm long, the labellum bends outwards with age, calyx 2.8-3,4 cm long, apex stamen of 11-16 mm long, apex of corolla lobes 11-15 mm, cream to pale pink at the base, bright pink towards the apex, corolla tube 2.6-3.5 cm long, stamen 12-16 mm long; filament 6-9 x 3-4 mm, with very broad base, with pink to cream color; anthers 5-7 x 3-4 mm long, with cream to pale pink in color. *Infructescence* with peduncle of about 8-12 cm long, bract, bracteole and calyx persistent, with 50-130 fruits per head, pedicel 0.3-1 cm long, fruit size of 2.3-3 x 2-3 cm, pyriform, soft spiny in upper half, reddish-brown, pubescent, seed 2-3 x 2-3 mm, black, rounded, and aril white. *Rhizome* with a stout of about 1-4 cm diameter, and pale yellowish brown to pale red in color.

Vernacular name: *Karondo* (Topo Baria languange, Sedoa, Lore Utara, Poso, Ramadanil Pitopang et al. 10041, *Katimba* (Pamona languange, Poso).

Specimen examined: Central Sulawesi, Poso District, Lore Utara Sub-district, Sedoa Village, Lore Lindu National Park, Danau Kalimpa'a, 01˚19.503'S, 120˚18.510'E, 1648m elevation on October 5, 2019. Ramadanil Pitopang, Zulfadly & Adrianus Tombi 10041 (CEB).

Figure 2. *Etlingera flexuosa* Poulsen shown behind the two young field assistants, B. Habitat of *E. flexuosa.* It grows in the montane forest of Lore Lindu National Park, Central Sulawesi, Indonesia on very wet soil near streams C. Ligule, D. Leafy shoot and flowering shoot, E. Infructescence, fruit in white circle, F. Inflorescence (flower) with labellum in white circle, G. Rhizome and its scale

Habitat and ecology

E. flexuosa grows on the very wet soil of the pristine evergreen montane forest, near streams at the altitude of 1200 - 1800 m a.s.l. This region usually receives an annual rainfall of about 1500-2000 mm, with mean maximum temperature of 30-32°C, while the mean minimum is usually around 18-21°C, and average of relative humidity of about 59.62 - 81.74% (Fauzan et al. 2018) The analyses of the vegetation showed that the forest was dominated by the following species of trees; "haleka/kaha" (*Castanopsis accuminatisima*), "palili' (*Lithocarpus havilandii*), 'baka' (*Cryptocarya crassinerviopsis*), 'poni (*Alsophila celebica*), 'damar" (*Agathis borneensis*), 'pondo' (*Pandanus sarasinorum*), 'kayu cina" (*Phylocladus hypophyllus*), 'karunia' (*Podocarpus neriifolius*), *Dacrycarpus imbricatus, 'Xanthomyrtus angustifolius, Acmena accuminatisima, Glochidion* sp, 'leda' (*Eucalyptus deglupta*), *Gordonia amboinensis, Polyosma integrifolia*, *Adinandra* sp, *Mallotus sp*, and *Erythrina subumbrans*.

The pole-like species were mainly *Mallotus barbatus, Aglaia argentea, Gordonia amboinensis, Litsea ferruginea, Neolitsea javanica, Achronichia trifoliata*, while the sapling species were mainly *Acmena accuminatisima, Rapanea minutifolia, Lasianthus* (Rubiaceae), *Polyosma integrifolia* (Escaloniaceae), *Homalanthus populneus* (Euphorbiaceae), and *Callophyllum soulattri* (Clusiaceae).

Herbs and understorey-like plant species were dominated by *Impatiens mamasensis* (Balsaminaceae), *Selaginella* sp. (Selaginellaceae), *Polygonum barbatum* (Polygonaceae), *Elatostema* sp (Urticaceae), *Cyrtandra hypogaea* (Gesneriaceae), *Medinilla speciosa* (Melastomataceae), *Alpinia eremochlamys* (Zingiberaceae), *Alpinia rubricaulis* (Zingiberaceae) and *Gunnera macrophylla* (Haloraganaceae)

In addition, some palms species were recorded and these include *Pinanga caesia, Calamus macrosphaerion, Calamus koordersianus, Calamus viridis* new spec, *Calamus tambingensis* spec. *nov., Calamus didymocarpus, Calamus inops, Calamus posoanus,* and *Daemonorops sp.* Some lianas species such as *Tetrastigma* sp, *Rubus mollucanus* (Rosaceae), and *Racemosbamboo celebica* (Poaceae) were also observed.

Table 1. The traditional uses of *Etlingera flexuosa* by Topo Baria ethnic in Lore Utara Sub-district, Poso District, Central Sulawesi, Indonesia

Organ/part of plant	Uses
Young leaves (shoot)	Eaten as vegetable
Leaves	Roof of hut
Rhizome	Medicine
Fruit	For cooking fish dishes as flavor enhancer

Table 2. Phytochemical component and antioxidant qualitative test of *Etlingera flexuosa* Poulsen (Zingiberaceae) from montane forest of Lore Lindu National Park, Central Sulawesi, Indonesia.

Chemical component and qualitative antioxidant test	Organ			
	Fruit	Leave	Pseudostem/ Leafsheat	Rhizome
Flavonoid [1)]	+	–	–	+
Tannin[1)]	Unevaluated	+	+	+
Saponin[1)]	+	+	–	+
Terpenoid[1)]	+	–	+	+
Alkaloid[1)]	–	–	–	+
Steroid[1)]	+	+	–	–
Qualitative antioxidant (DPPH) test	+	+	Unevaluated	Unevaluated

Notes : [1)]: Ramadanil et al. (2019), +: Present, - : Absent

Table 3. Summary statistics of inhibition zone of *E. flexuosa* rhizome extracts against *C. albicans*. Different lower case letter in the same column means significantly different values (DMRT test)

Treatment (%)	Zone of inhibition (mm)
20	9 ± 4.24 a
40	13.5 + 0.71 a
60	15 + 0.99 a
80	19 + 2.83 b
Griseofulvin (positive control)	28.4 ± 0.21 c

Ethnobotany

E. flexuosa has been used traditionally by Topo Baria community, an indigenous ethnic living in Sedoa Village, Lore Utara Sub-district, Poso District, Central Sulawesi, Indonesia. The plant is locally known as "Karondo" in the community. Table 1 shows the data on the traditional utilization of *E. flexuosa*.

Phytochemical component and antifungal activity

The result of the phytochemical screening of crude ethanol extract of *E. flexuosa* is presented in Table 2. Six different chemical compounds were detected in the plant extract, namely; flavonoids, tannins, saponins, terpenoids, alkaloids, and steroids.

Flavonoids are found in rhizome, tannins are obtained in all the parts of the plant, while saponins are present in the leaves and rhizome. Additionally, terpenoids are not found in the leaves, alkaloids only detected in the rhizome, while steroids are only found in the leaves.

Based on Table 3, it is evident that the extract of *E. flexuosa* rhizome has a promising inhibitory power against *C. albicans*. Also, the highest inhibitory power of this extract to *the* yeast was at a concentration of 80%, and statistically different from other treatments. However, there was no statistically significant difference among the extracts with concentrations of 20%, 40%, and 60% in the inhibition of *C. albicans.*

The lowest concentration of *E. flexuosa* extract, at 20%, still inhibited the growth of *C. albicans*. This means that the extract has the capacity to be used as herbal medicine for candidiasis, with little or no side effect.

Discussions

Etlingera flexuosa is one of flowering plant species described for the first time, from the province of Central Sulawesi, Indonesia (Poulsen 2012). It is a terrestrial herb with the ability to reach 5 m in height. This plant is very easy to recognize in the habitat due to its leaves sheath color usually yellowish to purple. The flowering shoots arise from the rhizome with pale pink flowers. The main characteristic of this species is its labellum bends which move outwardly with age.

The 42 species of *Etlingera* reported by Poulsen (2006) in Borneo are comparable to the 48 species identified in Sulawesi by (Poulsen 2012) in another study. Despite the fact that Borneo is about four times bigger than Sulawesi, the diversity of *Etlingera* in Sulawesi is indeed extraordinary. Moreover, 36 species from a total of 48 *Etlingera* of Sulawesi, which is about 75%, are new (Poulsen 2012). These new species are as follows: *Etlingera acanthoides, E. aculeatissima, E. aulocheilos, E. bicolor, E. biloba, E. borealis, E. bullata, E. calobates, E. canarina, E. caudata, E. chlorodonta, E. chrysantha, E. cylindrica, E. doliiformis, E. eburnea, E. echinulata, E. elegans, E. elliptica, E. flavovirens, E. grallata, E. hyalina, E. mendumiae, E. mucida, E. mucronata, E. orbiculata, E. orophilla, E. rubroloba, E. serrata, E. spinulosa, E. steringophora, E. translucens, E. tubilabrum, E. urophylla, E. xanthantha, E. yessiae* and *E. flexuosa* (Poulsen 2012).

Based on literature review, 50 species of *Etlingera* have so far been recorded from Sulawesi island, including a new species named *E. mamasarum*, collected from Gunung Gandangdewata, Western part of Sulawesi (Ardiyani and Poulsen 2019), as well as *E. megalocheilos*, recorded from Pangi Binangga Nature Reserve, Parigi Moutong District, Central Sulawesi (Trimanto and Hapsari 2018).

Also, the field observation of *E. flexuosa* showed that it often grows in the pristine submontane and montane forest, sometimes in light and open condition or on the slope of natural disturbed forest at an altitude of 1500 -1700 m a.s.l. According to Cannon et al. (2007) and Culmsee and Pitopang (2009), Sulawesi has a steep topography with about 20% land cover above 1000 m a.s.l. Most of the forests are in good or old-growth conditions and are

situated in mountain areas at montane elevations. The mountain forests in Sulawesi mainly cover the montane zone ranging from 1000 to 2400 m elevation.

The forest is dominated by *Castanopsis accuminatisima* (Fagaceae), *Lithocarpus* spp (Fagaceae), *Podocarpus neriifolius* (Podocarpaceae), *Phylocladus hypophyllus* (Podocarpaceae*), Eucalyptus deglupta* (Myrtaceae), as well as a number of endemic plant species such: *Alsophila celebica, Impatiens mamasensis, Pandanus sarasinorum, Pinanga caesea, Calamus viridis, Calamus posoanus, Etlingera sublimata,* and *Etlingera acanthoides*. According to Kessler et al. (2005), this region is categorized as Fagaceae forest, however, Culmsee et al. (2011) mentioned that the Fagaceae family makes up about 50% of the ground biomass in mountain forest of Central Sulawesi. Furthermore, about 20% of the total flora of Sulawesi are endemic species and the forest is also the habitat for some endemic Sulawesian fauna including; amphibians (Putri et al. 2019)

In the ethnobotany aspect, *E. flexuosa* has been extensively used by the local community of Topo Baria ethnic in various ways. The fruit is usually used as a flavor for cooking fish dishes and other foods. Its young shoot is edible as vegetable while the leaves are used as roofing material. This plant plays an important role in the traditional medicine of Topo Baria community. Its rhizome is usually used as traditional medicine for diarrhea.

Ginger plants are widely used as spices, condiments, and traditional medicine. The ethnomedicinal uses of the rhizomes and leaves of gingers were extensively reviewed by Ibrahim et al. (2007). The rhizomes could be eaten raw or cooked as vegetables and used as food flavoring ingredient (Larsen et al. 1999). According to Chan et al. (2011), the widely planted species include; *Alpinia galanga, Curcuma longa, Curcuma xanthorrhiza, Zingiber officinale, Zingiber zerumbet,* and *Etlingera elatior*. Pitopang et al. (2019) also reported 24 species of Zingiberaceae, some of which are endemic to Sulawesi, and used traditionally by three different local ethnics in Lore Lindu National Park.

Etlingera is one the genus of Zingiberaceae which has long been used in various communities for purposes such as traditional medicines, food, cosmetics, cooking spices, and ornaments. According to Chan et al. (2007), *E. elatior* is an aromatic plant widely used as traditional flavoring and for medicinal purposes. The inflorescence of *E. elatior* is edible, with nice taste in soup. The mixture of its leaves with other aromatic herbs in water is used by post-partum women for bathing to remove body odor. It is used as an alternative medicine for healing typhoid fever symptoms by Porehu community in Southeast Sulawesi (Sabilu et al. 2017). The flowers and fruit of *E. elatior* are used as a mixture of "cincang", traditional cuisine of Batak Karo sub-ethnic in North Sumatra. This is made from a mixture of cassava leaves (*Manihot utilissima*), banana pseudostem (*Musa paradisiaca*), and flowers of *E. elatior* (Silalahi and Nisyawati 2018).

The phytochemical analyses of the species showed the presence of some secondary metabolites such as-flavonoids, tannins, saponins, terpenoids, alkaloids, and steroids (Ramadanil et al. 2019). Generally, secondary metabolites are chemical compounds produced by plants but are not involved in the normal growth, although often play vital roles in protecting the plants against herbivores and microorganism (Theis and Lerdau 2003; Alabri et al. 2014). Qualitative antioxidant tests showed that the extracts of fruit and leaves have antioxidant compounds characterized by yellow spots on TLC plate. This is caused by the presence of flavonoids, tannins, saponins, terpenoids, and steroids, which have been reported to possess antioxidant activity (Chan et al. 2007; 2011).

In addition, the inhibitory test showed that the rhizome extracts of *E. flexuosa* inhibited the growth of the *C. albicans* fungus. This is shown by the formation of inhibition zones due to antifungal activity. The *E. flexuosa* samples could be used as inhibitor agents for the growth of the unicellular yeast. The antimicrobial activity of *E. flexuosa* against fungal infections is due to the presence of chemical compounds such as flavonoid, tannin, saponin, terpenoid, and alkaloid in its rhizome (Ramadanil et al. 2019).

Bona et al. (2016) also reported the extraction of essential oils from different species of the plant such as; "minth", "lavender", "tea tree", "basil" and "winter savory." All these are more effective in inhibiting both the growth and the activity of *C. albicans* compared with the use of the main drugs.

Flavonoids are group of phenolic compounds widely distributed in plants. These compounds are considered as health-promoting and disease-preventing dietary supplements. Flavonoids have been clinically proven to exert some protective effects on animals against various disease conditions including cardiovascular issues and cancer. The compounds also possess antibacterial, antiviral, and anti-inflammatory effects. Also, alkaloids are secondary metabolites having heterocyclic nitrogen with antibacterial, antiviral, and anticancer activities (Altemimi et al. 2017). Some of the flavonoids which have been reported for these biological activities include; kaempferol 3-glucuronide, quercetin 3- glucuronide, quercetin 3-glucoside, quercetin 3-rhamnoside, and (+)-catechin (Chan et al. 2007, 2011). According to Farhadi et al. (2018), flavonoids are a diverse group of natural products used in some traditional medicine systems for treating infectious diseases. Dong et al. (2008) revealed that the tannic acid in it destroys the integrity of cell wall.

In conclusion, the *E. flexuosa* plant is a terrestrial herb naturally present in Sulawesi, growing in the pristine evergreen montane forest, specifically on wet soil near the streams at the altitude of 1200 - 1800 m a.s.l. The forest is dominated by Fagaceae family and the *E. flexuosa* has been used traditionally by the Topo Baria community for different purposes. The plant is locally called "karondo" and its fruits are used for cooking fish dishes and as flavor enhancers. The young leaves are eaten raw or boiled as vegetable. Its rhizome is being used as medicine while the leaves are utilized to roof huts. The ethanol extract of *E. flexosa* rhizome contains some chemical components such as flavonoid, tannin, saponin, terpenoid, alkaloid, and antioxidant which inhibit the growth of the *C. albicans.*

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