



Etlingera (Zingiberaceae) in Bogor Botanic Gardens: Potential Benefits and Its Conservation Status

Yeyen Novitasari

Research Center for Plant Conservation, Botanic Gardens, and Forestry, Nasional Research and Innovation Agency (BRIN)
Jl. Raya Jakarta-Bogor Km 46, Cibinong, Jawa Barat, 16911, Indonesia

*Corresponding Author

e-mail: yeyen.novitasari@brin.go.id

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ABSTRACT

Indonesia is one of mega biodiverse countries in the world, with a high global biodiversity index and many vascular plant species. However, not all plant species are known in terms of their uses, potential benefits, and conservation status. One of example is genus *Etlingera*, where further studies are required. Therefore, this study aimed to provide information on the potential benefits and uses of the genus *Etlingera* and to investigate its conservation status. The study was conducted using the method of literature study, an inventory of potential uses, and an inventory of the genus *Etlingera* living in Bogor Botanic Gardens through direct observation. Six species of the genus *Etlingera* were collected from the Bogor Botanic Gardens, namely *Etlingera brevilabrum*, *E. elatior*, *E. hemisphaerica*, *E. loerzingii*, *E. megaloscheilos*, and *E. walang*. conservation status of three species (*E. brevilabrum*, *E. hemisphaerica*, and *E. megaloscheilos*) is Least Concern (LC), two species (*E. elatior* and *E. walang*) are Data Deficient (DD), and one species (*E. loerzingii*) is Vulnerable (VU). All species are commonly used as spices, condiments, cosmetics, and traditional medicine to cure various diseases, possibly also as ornamental plants. The secondary metabolites present in some species, namely *E. brevilabrum*, *E. elatior*, and *E. hemisphaerica* can be used as antimicrobial, antifungal, and antioxidant agents.

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INTRODUCTION

Indonesia is the second mega biodiverse country in the world, with a global biodiversity index of 418.78 and a number of 19.232 vascular plant species (Nash, 2022; Darajati et al., 2016). Some of these plant species are commonly used by Indonesians for many purposes, such as medicines, food, and ornamental plants (Bahtiar et al., 2017).

Zingiberaceae or ginger family is a family of flowering plants with 1300 species in 52 genera of perennial herbs with tuberous rhizomes, distributed in tropical Africa, Asia, and America (Tamokou et al., 2017). The genera of Zingiberaceae in Bogor Botanic Gardens are *Alpinia*, *Amomum*, *Boesenbergia*, *Curcuma*, *Etlingera*, *Globba*, *Hedychium*, *Hornstedtia*,

Kaempferia, *Languas*, *Nanochilus*, *Plagiostachys*, and *Zingiber* (Ariati et al., 2019).

The genus *Etlingera* is easy to find in the Malesian region, especially in the humid forests of Sumatra. Some *Etlingera* species are used as ornamental plants in botanical gardens and tropical parks (Poulsen et al., 2009). There are approximately 200 species of *Etlingera* in the world and 74 species in Malesia (Puspitaningrum et al., 2017; Poulsen, 2012; Newman et al., 2004).

Bogor Botanic Gardens is an ex-situ conservation area that serves as a repository of plant diversity from various regions in Indonesia, especially lowland forest ecosystem. As the oldest botanical garden in Southeast Asia, according to

Republic of Indonesia Presidential Decree No. 93 of 2011, it has played an important role in plant conservation, research, education, tourism, and environmental services. Hence, Bogor Botanic Gardens, along with other botanical gardens in Indonesia, is required to carry out research and preservation activities to maintain and enhance the diversity of its plant collections (Pemerintah Republik Indonesia, 2011).

However, there is lack of information on plant collections in Bogor Botanic Gardens, especially those of the genus *Etlingera*, regarding their potential uses and the need for conservation. Thus, this research aimed to provide valuable insight into the potential benefits and the utilization of the genus *Etlingera* and studied its conservation status.

MATERIALS AND METHODS

Research Area

The study was conducted at Bogor Botanic Gardens from September to October 2022. The Bogor Botanic Gardens is in the heart of Bogor, West Java, Indonesia and is situated at an altitude of about 265 meters above sea level. The average temperature in Bogor is around 26°C, and the humidity level is usually approximately 70%. Bogor receives significant yearly rainfall, with an annual average of 3500-4000 millimeters. The heaviest precipitation occurs in December and January. The Bogor Botanic Gardens was established in 1817 and covers an area of around 87 hectares (Figure 1). The garden maintains a collection of plants from the lowland rainforest ecosystem and has 12.370 specimens from all over Indonesia.

Data collection

The research was conducted using the method of literature study, inventory of potential benefits,

and direct observation of living plant collections in Bogor Botanic Gardens to match the data from Bogor Botanic Gardens' catalog with the actual condition in the garden, whether the collected plants were still alive or dead, and to count the amount of living collections. Primary data were collected through direct observation of the living plant collections at Bogor Botanic Gardens to verify and confirm the living plant collections, especially the genus *Etlingera* in the garden, which matched the data in the registration book and the CarryMaps application. Through this direct observation, that obtained the current status and number of living collections and species of the genus *Etlingera* in Bogor Botanic Gardens. Secondary data, such as general information about the plants, inventory potential, native range, population trend, and plants conservation status, were retrieved from the IUCN Red List of Threatened Species and Global Biodiversity Information Facility (GBIF), and uses of the plants was collected through literature studies related to the objectives of this study. The collection data were then explained descriptively.

RESULT AND DISCUSSION

Genus Etlingera in Bogor Botanic Gardens and Its Conservation Status

There are six species of the genus *Etlingera* in Bogor Botanic Gardens (Table 1). Six *Etlingera* species are rhizomatous herbs that grow in the wet tropical biome (Ariati et al., 2019; Olander, 2019; Olander, 2020; Poulsen et al., 2009; Poulsen and Olander, 2019b; Poulsen and Olander, 2019a; Poulsen et al., 2019; Saw, 2019). All species of the genus *Etlingera* in Bogor Botanic Gardens are native to the region of Malesia, according to the



Figure 1. The map showing the study sites at Bogor Botanic Gardens

IUCN Red List of Threatened Species. The population trends of five species of the genus *Etilingera* in Bogor Botanic Gardens are unknown, except for *E. loerzingii*, which is declining since this species is endemic to Sumatra on the lower slopes of Barisan Mountains. Endemic species are particularly vulnerable to threats such as habitat loss, climate change, and human activities (Olander, 2020; Poulsen et al., 2009). In addition, Sumatran forests are under constant threat (WWF, 2019), and satellite imagery shows habitat destruction and conversion in some areas where the species has been found (GFW, 2023). *E. walang* is also endemic to Java (Table 1). All plant collections of the genus *Etilingera* in Bogor Botanical Gardens shown in Figure 2.

The conservation statuses of six species of the genus *Etilingera* in Bogor Botanic Gardens vary from Data Deficient, Least Concern, to Vulnerable based on IUCN Red List of Threatened Species. *Etilingera elatior* and *E. walang* are considered to be data deficient (DD). These species are reasonably well studied, but data on the distribution and native range are subject to considerable uncertainty. The native range of *E. elatior* may be Sumatra or Borneo. However, some sources give the range of this species as Peninsular Malaysia and Thailand. It is

also difficult to distinguish which collection is native or cultivated. Therefore, a genetic study is needed to determine the correct native range of *E. elatior* (Poulsen and Olander, 2019a). On the other hand, the distribution of *E. walang* is uncertain, despite the fact that this species is endemic to Java and has been recorded from Blambangan and western Java (Olander, 2019).

Three species, namely *Etilingera brevilabrum*, *E. hemisphaerica*, and *E. megalochelios*, are classified as Least Concern according to IUCN Red List of Threatened Species. These species exist in many places, some of which are protected areas. Their range extends from Java and Sumatra across Peninsular Malaysia to Thailand. However, the habitat of *E. hemisphaerica* has decreased, and is considered as a rare species that has difficulty adapting to disturbed areas. Therefore, a population size and decline study are needed to protect the species from threats (Saw, 2019). In contrast, *E. megalochelios* is one of the most tolerant species to disturbance and can thrive in a completely open habitat (Poulsen and Olander, 2019b). Furthermore, although habitat quality has decreased, *E. brevilabrum* had been found in deforested and disturbed areas and grows well. Therefore, these species have been categorized as

Table 1. Species of the genus *Etilingera* in Bogor Botanical Gardens (Ariati et al., 2019; Olander, 2019; Olander, 2020; Poulsen et al., 2009; Poulsen and Olander, 2019b; Poulsen and Olander, 2019a; Poulsen et al., 2019; Saw, 2019)

No.	Species	Number of Plant Collections	Source	Native Range	Population Trends	Conservation Status
1	<i>Etilingera brevilabrum</i> (Valeton) R.M. Smith	2	Central Kalimantan	Borneo to the Philippines	Unknown	Least Concern (LC)
2	<i>Etilingera elatior</i> (Jack) R.M. Smith	6	Java, Central and East Kalimantan, South Sulawesi, and Sumatra	Thailand to West Malesia	Unknown	Data Deficient (DD)
3	<i>Etilingera hemisphaerica</i> (Blume) R.M. Smith	2	Scotlands	Indonesia (Sumatra to Java), Malaysia, Thailand	Unknown	Least Concern (LC)
4	<i>Etilingera loerzingii</i> (Val.) R.M. Smith	2	North Sumatra	Sumatra	Decreasing	Vulnerable (VU)
5	<i>Etilingera megalochelios</i> (Griff.) A.D. Poulsen	1	South Kalimantan	West Malesia	Unknown	Least Concern (LC)
6	<i>Etilingera walang</i> (Blume) R.M. Smith	2	West Java and South Sulawesi	Java	Unknown	Data Deficient (DD)



Figure 2. Living plant collections of the genus *Etlingera* in Bogor Botanic Gardens, a). *E. brevilabrum*, b). *E. elatior*, c). *E. hemisphaerica*, d). *E. loerzingii*, e). *E. megaloscheilos*, f). *E. walang*

Least Concern (Poulsen et al., 2019). One of the six species of the genus *Etlingera* in Bogor Botanic Gardens, *E. loerzingii*, is considered vulnerable because this species is endemic to Sumatra and exists in six locations. It also has a small range (Olander, 2020).

2.2 Utilization and Potential Benefits of the Genus *Etlingera* in Bogor Botanical Gardens

Etlingera brevilabrum

The fruits of *E. brevilabrum* are edible, and the leaves are used for medicinal and roofing purposes (Poulsen et al., 2019). The extract of *E. brevilabrum* contains β -sitosterol, stigmasterol, phenols, phenolic acids, flavonoids, and hydroxycinnamic acid derivatives. Seventy-seven compounds of essential oils from eight groups of compounds were found in the rhizomes, stems, and leaves of *E. brevilabrum*. These compounds may have antimutagenic and antioxidant activity, antigenotoxic capacity, and lymphocyte potency (Mahdavi et al., 2013a; Mahdavi et al., 2013b, Mahdavi, 2014).

In addition, the liquid smoke of fresh and dried leaves of *E. brevilabrum* contains ten different classes of organic compounds. The presence of phenols, carboxylic acids, aliphatic acids, esters, and aromatic acids can potentially be used to cure some skin problems (Mahdavi, 2014). Strong antioxidant activity and excellent antimicrobial and antifungal activity have been demonstrated in the smoke liquid of *E. brevilabrum*. It can inhibit the growth of 14 microorganisms (Mahdavi et al., 2018).

Etlingera elatior

E. elatior, commonly known as torch ginger, is cultivated for its aromatic and decorative flowering shoots. In Indonesia, this plant has been cultivated for hundreds of years. The arils surrounding the seeds, leafy shoots, and young shoots are edible and

used as a forest snack and for medicinal purposes. However, this species is also known as an ornamental plant (Poulsen, 2012; Poulsen and Olander, 2019a). The plant is potentially developed as an ornamental plant and cropped flower in Bedugul (Oktavia et al., 2019).

E. elatior is used in traditional medicine by the natives of Gayo and Kabanjahe, Balinese, and local people in Samosir Island to treat cold, fever, cough, digestive (diarrhea) system problems, muscles and joints problems, the reproductive system, ear infections, hypertension, diabetes, antioxidants, anti-proliferative, anticancer, antimicrobial agents, as a shampoo, as eye drops, to increase breast milk production, skin whitening, anti-aging, and to improve maternal fitness postpartum. There are 99 types of essential oils in the leaves, 62 in the rhizomes, 26 in the stem, and 95 in the flowers (Silalahi, 2016, 2017; Hartini and Sahromi, 2016; Purwoko et al., 2019; Saudah et al., 2021). Due to the high antioxidant and flavonoid contents in *E. elatior*, the powder of the *E. elatior* flowers can be used as a substitute for making cookies (Sari et al., 2022).

In addition, the entire plant parts of *E. elatior*, such as shoots, stems, flowers, seeds, and fruits, have a high phenolic content, with the fruits containing the largest amounts of phenols. Almost all parts contain monoterpenes, terpenoids, sesquiterpenes, saponins, steroids, flavonoids, triterpenoids, alkaloids, and tannins. The plant extract can be used as an anticancer agent, especially an antileukemic agent (Rusanti et al., 2017), antioxidant (Maimulyanti and Prihadi, 2015), insect repellents and termiticides (Rislyana et al., 2015), antibacterial and antifungal agents to inhibit *Salmonella thypi*, *Shigella* sp., *Aspergillus flavus*, *Streptococcus mutans*, and in fish spoilage (Angin, 2015; Suryani et al., 2019; Nasution et al., 2020;

Nurlaili et al., 2022). Furthermore, the leaf and flower extracts of *E. elatior* can be used as a natural protein preservative, for example, in tilapia (*Oreochromis niloticus*) (Nurlaili et al., 2022). *E. elatior* can also be used as a functional food and to make jelly sweets (Muawanah et al., 2012). In addition, the leaf extract of *E. elatior* can heal wounds in rabbits (*Oryctolagus cuniculus*) effectively (Nastity et al., 2015).

Etilingera hemisphaerica

E. hemisphaerica is commonly known as the Black Tulip, Helani Tulip Ginger, or Tulip Ginger. As with *E. elatior*, the immature inflorescences are used to flavor food or spice in Indonesia. *E. hemisphaerica* and *E. elatior* can substitute for each other, as both have similar uses. Due to the attractive color of the inflorescence and some variations in the involucre bracts, this species has high potential as an ornamental plant (Saw, 2019; Handayani and Ariyanti, 2015). The half-ripe fruits are mixed raw into various salad or vegetable dishes, while the ripe fruits are made into fruit sweets. The stem of the plant can be eaten raw, cooked, or steamed (Ibrahim and Setyowati, 2016; Lim, 2014).

According to Ruyani et al. (2018) and Umar et al. (2021), the leaf extract of *E. hemisphaerica* contains tannins, saponins, alkaloids, flavonoids, antioxidants, minerals, and vitamin C. The leaves are used for wound cleansing, as an antibacterial agent against *Staphylococcus aureus* and *Bacillus cereus*, as an immunomodulator or immunostimulant, have a protective effect against HgCl₂ toxicity, can improve the evaluation of the stage of spermatogenesis, and potentially lower blood glucose and triglyceride levels (Ruyani et al., 2014; Gresinta, 2019; Noverita and Sinaga, 2021). In addition, *E. hemisphaerica* has sour flowers, and the fruit has a fragrant smell to treat skin problems, cancer, and tumors.

Etilingera loerzingii

The vegetative shoots and inflorescences are edible, delicious, aromatic, sour, and sweet in taste and smell. *E. loerzingii* has great potential as an ornamental plant like *E. elatior* (Olander, 2020; Poulsen et al., 2009).

Etilingera megalochelios

E. megalochelios is used as food. The fruits are sweet and edible, even if they are unpleasant (Poulsen and Olander, 2019b). The leaves and rhizomes of *E. megalochelios* contain many chemical compounds such as camphene, monoterpenes, sesquiterpenes, verbenol, aromadendrene, azulene,

borneol, myrcene, and sabinene. This species has enormous potential to be used as a natural preservative, herbal products, foods, cosmetics, nutraceuticals, and ornamental plants (Trimanto and Hapsari, 2018).

Etilingera walang

The leaves can be used as a condiment. The crushed leaves have an unpleasant smell similar to that of the rice bug, *Leptocorisa acuta* (walang sangit in Indonesian). More historically significant is the practice of burning leaves in the rice field in western Java to drive away this pest. Although no detailed information on the use of *E. walang*, as a ginger plant is available, this species can potentially be used as a spice, ornamentals, and traditional medicine (Olander, 2019; Pitopang et al., 2020; Jansen, 2022).

CONCLUSION

The six *Etilingera* species recorded from the Bogor Botanic Garden have varying conservation statuses. Three species are of Least Concern, two are Data Deficient, and one is Vulnerable. These plants are used for various purposes, such as spices, seasonings, cosmetics, and traditional medicine. They are also used for ornamental purposes. The secondary metabolites contained in some of these plants have antimicrobial, antifungal, and antioxidant properties that make them valuable for various applications. Conservation efforts are necessary for vulnerable species such as *Etilingera loerzingii*, which could be extinct if not protected. Collecting more information on the species with data deficiencies (*E. elatior* and *E. walang*) is also essential to accurately assessing their conservation status. The Bogor Botanic Gardens and other botanical gardens are critical in conserving plant species and preserving their genetic diversity.

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