International Journal of Herbal Medicine
Available online at www.florajournal.com

IJHM
International Journal of Herbal Medicine

E-ISSN: 2321-2187
P-ISSN: 2394-0514
www.florajournal.com
IJHM 2021; 9(4): 37-42
Received: 17-05-2021
Accepted: 19-06-2021

Saudah
1. Graduate School of Mathematics and Applied Science, Universitas Syiah Kuala, Jl. Tgk. Syech Abul Rauf, Darussalam, Banda Aceh, Indonesia
2. Faculty of Teacher Training and Education, Universitas Serambi Mekkah, Banda Aceh, Indonesia

Ernilasari
Faculty of Teacher Training and Education, Universitas Serambi Mekkah, Banda Aceh, Indonesia

Fitmawati
Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Riau, Pekanbaru, Riau, Indonesia

Dewi Indriyani Roslim
Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Riau, Pekanbaru, Riau, Indonesia

Zumaidar
Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Syiah Kuala, Jl. Tgk. Syech Abul Rauf No. 3, Darussalam, Banda Aceh, Indonesia

Darusman
Department of Soil Science, Faculty of Agriculture, Universitas Syiah Kuala, Jl. Tgk. Hasan Krueng Kalee No. 3, Darussalam, Banda Aceh, Indonesia

Monalisa
a. Department of Agribusiness, Faculty of Agriculture, Universitas Syiah Kuala, Jl. Tgk. Hasan Krueng Kalee No. 3, Darussalam, Banda Aceh, Indonesia
b. Research Center and Climate Change (PRPIA – ACCI), Syiah Kuala University, Banda Aceh, Indonesia

Arif Habibal Umam
a. Department of Forestry, Faculty of Agriculture, Universitas Syiah Kuala, Jl. Tgk. Hasan Krueng Kalee No. 3, Darussalam, Banda Aceh, Indonesia
b. Research Center and Climate Change (PRPIA – ACCI), Syiah Kuala University, Banda Aceh, Indonesia

Corresponding Author:
Saudah
1. Graduate School of Mathematics and Applied Science, Universitas Syiah Kuala, Jl. Tgk. Syech Abul Rauf, Darussalam, Banda Aceh, Indonesia
2. Faculty of Teacher Training and Education, Universitas Serambi Mekkah, Banda Aceh, Indonesia

A phytochemical screening of Bakkala (*Etlingera elatior*) originated from suakbugis, Aceh, Indonesia and its potential in ethnobotany

Saudah, Ernilasari, Fitmawati, Dewi Indriyani Roslim, Zumaidar, Darusman, Monalisa and Arif Habibal Umam

Abstract
Etlingera elatior is commonly used as a spices mixed in food and vegetables by Acehnese people. Because these plant species has a strong scent that will make food tasty. However, the use of *Etlingera elatior* as a medical plant in Acehnese society is still limited. Hence, we need to reveal the potential of *Etlingera elatior* by phytochemical screening. This study aims to determine the secondary metabolites of *Etlingera elatior* originated from SuakBugis and its potential in ethnobotanical studies. The research was conducted in SuakBugis, Nagan Raya District, Aceh, Indonesia. The laboratory experiment was conducted at Regional Health Laboratory, Jakarta. These research was begun from September to October 2020.The results of phytochemical screening showed that leaves of *Etlingera elatior* detected chemical compositions *i.e.* flavonoids, phenols, tannins, steroids, saponins and alkaloids; *Etlingera elatior* flowers extracts detected the presence of flavonoids, phenols, tannins, terpenoids, saponins and alkaloids; *Etlingera elatior* fruit extract contains chemical substances *i.e.* flavonoids, phenols, tannins, terpenoids and alkaloids. Furthermore, hopefully, based on the chemical compositions of *Etlingera elatior* will bring benefit in ethnobotanical studies, especially traditional medicine and natural cosmetic ingredients.

Keywords: *Etlingera elatior*, Bakkala, Suakbugis, phytochemical screening, Acehnese

1. Introduction
SuakBugisis one of the region, which is located in Darul Makmur Sub-District of Nagan Raya District, Indonesia. The SuakBugis region included in Tripa Peat Swamp Forest, where Tripahas high biodiversity and the largest carbon storage in Aceh [1]. On the other hand, deforestation and forest degradation have occurred over much of Tripain the last one decade. It was probably lead to the loss of biodiversity every years [2-3]. In some areas has converted to palm oil plantations and community garden. However, Tripa still remains plant diversity in primary forests. One of the interesting plants to study in SuakBugis is *Etlingera elatior* Jack. RM Smith. The *Etlingera elatior* is a plant species belongs to Zingiberaceae Familia [4]. In 1980, Rosemary Margaret Smith from the Royal Botanic Gardens Edinburgh introduced these species as *Etlingera elatior*. According to ref [4], *Etlingera elatior* has several synonymous names *i.e*. *Nicolaia elatior*, *Alpinia nutans*, *Phaeomeria speciosa*, and *Nicolaia speciosa*. Meanwhile, *Etlingera elatior* also has many local names, such as Kecombrang, Kincung, Honje, Kecicang, Cekala, Bongkot, Katimbang, Tere, Bungong Kala, *SihalaDairi*, Patikala, Wualae, etc [5-8]. There were many scientific articles reported that the *Etlingera elatior* is native to Malaysia. However, ref. [9] revealed that *Etlingera elatior* has been well known in Indonesia for hundreds of years. The distribution of *Etlingera elatior* (Jack.) in Indonesia including Sumatera, Borneo and Java. Ref. [10] also reported that *Etlingera elatior* is native to Sumatera Island (Indonesia) and Malaysia. In Aceh, these plant is well known as BakKala. *Etlingera elatior* or Bak Kalais commonly used as a spices mixed in food, such as *guleeplik u*, *guleeeungkot*, *guleesieitek*, *sambaibungongkala*, etc. *Etlingera elatior* also has a strong scent that will make food tasty. On the other hand, some literature reported that *Etlingera elatior* is effective as a medicinal plant because of its chemical composition. The previous study revealed that *Etlingera elatior* has potential for the treatment of various diseases such as a heal wounds, breast cancer, diabetes, typhoid fever symptoms, etc [11-13]. In line to ref. [14] kecombrang flower (*Etlingera elatior* (Jack) R.M. Sm.) have been widely used by local people for cancer drugs, tumor and also as a natural cosmetic ingredient. According to [15-16], *Etlingera elatior* contains secondary metabolites *i.e.* glycosides, phenols, terpenoids, tannins, flavonoids, steroids and saponins. In line to [17], the *Etlingera elatior* flower extract contains complex

chemical substances such as flavonoids, tannins, saponins, alkaloids and terpenoids, whereas its leaves extract contain a lot of flavonoids active compounds [18]. Ref. [19] also reported the phytochemical screening results of *Etlingera elatior* flower detected the presence of flavonoids, quinones, tannins, saponins and steroids/triterpenoids. Many literature reveals the potential of *Etlingera elatior* as one of the native plants of Indonesia. However, studies on the phytochemicals of Bak Kala (*Etlingera elatior*) originated from Aceh, especially in SuakBugisis relatively limited. Therefore, this study was carried out to determine the secondary metabolites of Bak Kala (*Etlingera elatior*) originated from SuakBugis, Nagan Raya District, Aceh, Indonesia. Furthermore, hopefully, the secondary metabolites of *Etlingera elatior* will bring benefit in ethnobotanical studies, especially in traditional medicine and natural cosmetic ingredients.

2. Materials and Methods

2.1 Study Area

The research was conducted in SuakBugis, Pulo Kruet Village, Darul Makmur Sub-District of Nagan Raya District, Aceh Province, Indonesia. The laboratory experiment was conducted at the Regional Health Laboratory, Jakarta. These research was begun from September to October 2020.The sampling location of Bak Kala (*Etlingera elatior*) in SuakBugis, Nagan Raya District is presented in Figure 1.

Fig 1: Distribution Map Location of *Etlingera elatior* sampling in Nagan Raya District

3. Procedures

3.1 Sample collection

The research used purposive sampling method, where in those place is considered much overgrown by Bak Kala (*Etlingera elatior*).The specimens were obtained from seven different sampling areas. Data collection in the field is done by exploration and direct collection. Plants samples such as leaves, flowers, fruit and rhizome. The leaves, flowers, fruit and rhizome were taken randomly from each clump of *Etlingera elatior* and cut using a knife. In addition, all samples are stored in plastic bags.

3.2 Extraction of *Etlingera elatior*

3.2.1 Leaves

Samples of *Etlingera elatior* leaves were dried under UV light and then ground into a powder. Maceration was carried out using 75% ethanol as a solvent. The simplicia was poured into the flask and added 75% ethanol and left for 5 days. Shaken at 90 rpm for 20 minutes (twice).After 5 days, as much as 75% ethanol was added to the pulp and shaken to obtain macerate. The macerated was evaporated using a rotary evaporator at a temperature of 60-700ºC to obtain a thick extract.

3.2.2 Fruit

Freeze-dried *Etlingera elatior* fruit powder was extracted using 0.1% HCl (v/v) in methanol with a ratio of sample and solvent (1:10).The extraction was carried out 2 times, the first was maceration for 24 hours at room temperature in the dark room, and the second was continued by maceration for 2 hours at room temperature in the dark room. The mixture was separated using a centrifuge at low temperature (4 °C) at 4200 rpm for 20 minutes. The mixture was then filtered using Whatman filter paper No.1 by vacuum filtration. The filtrate obtained was transferred into an extraction flask and evaporated with a rotary evaporator at a temperature of 50 °C. The extract was kept refrigerated at-21 °C [20].

3.2.3 Flowers

As much as 10 grams of *Etlingera elatior* flowers were dissolved in 10 mL of 96% alcohol. Macerated for 24 hours at room temperature and not exposed to direct sunlight, then filtered. After that, the *Etlingera elatior* flower extract is ready to use [21].

3.3 Phytochemicals screening

The samples used for phytochemical screening were ethanol extracts of leaves, flowers and fruits of *Etlingera elatior*. For each sample was carried out in Duplo.

3.3.1 Flavonoids Test

A total of 100 mg of extract was dissolved in 10 mL of methanol. Take 1 mL of extract, added 3 mL of methanol, 0.2 mL of 10% AlCl3, 0.2 mL of potassium acetate, and added distilled water to 10 mL. Kept for 30 minutes in a dark place (room temperature).The absorbance was measured by UV-Vis spectrophotometry at a wavelength of 431 nm. As a standard used quercetin concentration of 10-60 mg/L. Total flavonoid extract was expressed in mg of quercetin equivalent (QE)/gram of extract dry weight [22].

3.1.2 Phenolic Test
The total phenolic content was measured using the Folin-Ciocalteau method. As much as 300 µL of sample extract was poured into test tube. Mixed with 1.5 mL of Folin-Ciocalteau reagent (10 times dilution) and 1.2 mL of sodium carbonate solution (7.5% w/v).After 30 minutes, the absorbance was measured at a wavelength of 765 nm using a UV Vis spectrophotometer. For the preparation of the standard curve, a standard solution of gallic acid with a concentration of 30–80 ppm (mg/L) was used. Total phenols content is expressed in mg gallic acid equivalent (GAE)/ g dry weight extract [23, 20].

3.1.3 Tannins Test
As much as 1 mL of the test extract solution was reacted with 1% $FeCl_3$ solution. If a green-brown solution is formed, the tannins are condensed, whereas if it is blue-black then the tannins are hydrolyzed [24].

3.1.4 Steroids and Terpenoid Test
As much as 2 ml of the test solution was evaporated, the residue obtained was evaporated in 0.50 ml of chloroform, then 0.50 ml of anhydrous acetic acid was added. Then the mixture is dripped with 2 ml of concentrated sulfuric acid through the tube wall. If a bluish green colour is formed, it indicates the presence of sterols. If the results is a brownish or violet ring at the boundary of the two solvents it indicates the presence of triterpenoids [25].

3.1.5 Saponins Test
The extract was poured into a test tube, added 10 ml of boiling water and allowing to cool. Then, shaken vigorously vertically for 10 seconds. The presence of saponin is shown by a foam formation lasted more than 10 minutes which has 1-10 cm height. The foam does not disappear by adding 1 drop of 2N HCl [25].

3.1.6 Alkaloids
As much as 2 ml was evaporated on a porcelain cup until it got a residue. The residue was then dissolved with 5 mL of 2N HCL. The solution obtained was divided into 2 test tubes. Three drops of Dragendorff's reagent are added to the first tube. The second tube was added with three drops of Mayer's reagent. The formation of an orange precipitate in the first tube and a white to yellowish precipitate in the second tube showed the presence of alkaloids [25].

4. Results and Discussion
4.1 The Morphology of BakKala (*Etlingera elatior*)
Based on direct observation which took seven different locations in SuakBugis, Darul Makmur Sub-District of Nagan Raya District, Aceh, we found a lot of *Etlingera elatior* species distributed there. Generally, the species of *Etlingera elatior* found in SuakBugis grew as high as 3-4 meters, pseudo-stem, has upright stem with a midrib like a banana, forming rhizomes and green colour. The previous study reported that the height of the *Etlingera elatior* species can reach 2, 5-5 meters with an average of about 3 meters, upright stems and forming rhizomes, as well as has midrib [26-27]. The habitus of *Etlingera elatior* that are found in SuakBugis, Nagan Raya District is presented in Figure 2. Meanwhile, the plant specimens were collected from Suak Bugisare presented in Figure 3.

Fig 2: The plant of *Etlingera elatior* in SuakBugis, Nagan Raya District, Aceh, Indonesia

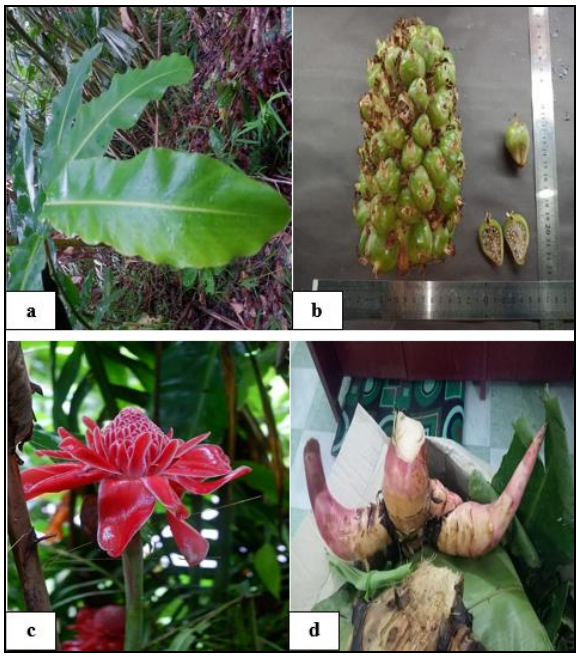

Fig 3: (a) leaves; (b) fruit; (c) flowers; (d) rhizome of Bak Kala (*Etlingera elatior*)

Based on Fig. 3shows the leaves, fruit, flowers, and rhizome of *Etlingera elatior* collected from SuakBugis, Nagan Raya District. These plant parts were observed one by one based on its morphology. The morphological characters observed included the colour, shape, number and size of each organ.
Generally, the *Etlingera elatior* leaves found in SuakBugishas the same colour as *Etlingera elatior* leaves that found in another place. Meanwhile, the leaves of *Etlingera elatior* originated from SuakBugisare single, leaves are green in colour and lanceolate shape (Figure 3a).The leaves have a length of 20-30 cm, whereas the width of the *Etlingera elatior* leaves of 5-15 cm. These plants have pinnate leaf bones and approximately 15-30 leaves arranged in two alternate rows. The leaves grow in two rows and grow alternately on the pseudo-stem. According to [28] the species of *Etlingera elation* with green leaves on the underside. The outer peduncle reaches 13 cm in length and curving outward when it blooms. In line to [29], *Etlingera elatior* leaves are lanceolate in shape, base and pointed tips of the leaf, as well as leaf buds are light green with yellow edges.

Based on the observation of *Etlingera elatior* fruit, it was found that there was one colour variation of the *Etlingera elatior* fruit, brownish yellow with a reddish tip and this fruit would be green with a dark brown tip when it is still young (Figure 3b). According to [30], *Etlingera elatior* does not have variations in the colour of fruits. The fruit size is small and grows in crowds [9] Reported that the fruit of *Etlingera elatior* looks like a pineapple. Although *Etlingera elatior* fruit found in SuakBugis only in yellow colour, but [28] revealed that the variations of colour in *Etlingera elatior* fruits includes pink, pale pink and white.

The *Etlingera elatior* flower was collected from SuakBugis only has one colour, name lyred (Figure 3c). The colour of Bak Kala flower is caused by anthocyanidins [31]. Anthocyanidins are natural pigments belonging to the flavonoid family. Actually *Etlingera elatior* has many variations of colours on its flowers *i.e*. red, pink, and white [32]. According to [28] the colour of *Etlingera elatior* flowers are pink, pale pink and sometimes white. Meanwhile, the flower of Bak Kala is a tubular compound and the peduncle have a length of 40-80 cm. The Bak Kala flower in flower-shaped collection, with bracts in elliptic-shaped, as well as fleshy. Crown in tubular-shaped, pink, up to 4 cm. The labellum similar to spatula shaped, about 4 cm in length, bright red with white or yellow margins. According to [33] the flower of *Etlingera elatior* in flower-shaped collection or called inflorescences. One inflorescence of Bak Kalacan exist in 3 or 4 months [10]. Reported that the young inflorescences looks like a spear-like head. Flowers stand on stems with a length of 0.8-2.0 meters. If we squeeze the bracts from the inflorescences, they will produce a strong aroma.

In this study, we are not only found leaves, fruit and flowers in SuakBugis but also found of rhizomes in *Etlingera elatior* clumps. Based on our observations to the rhizomes, it showed that rhizome has a diameter of 3-4 cm with a strong aroma. Rhizome was found in SuakBugis close to the soil surface. The rhizome has a reddish colour. According to [4] the rhizome is thick, yellowish white or reddish when young.

4.2 Phytochemical screening

Phytochemical screening was carried out to determine the class of compounds contained in the simplicia leaves, flowers, and fruit of Bak Kala (*Etlingera elatior*).Phytochemical screening were included flavonoids, phenols, tannins, terpenoids, steroids, saponins and alkaloids. The results of the phytochemical analysis of the leaves, flowers, and fruit extracts of Bak Kala (*Etlingera elatior*) are presented in Table 1.

Table 1: Phytochemical Analysis of Bak Kala (*Etlingera elatior*) Originated from SuakBugis, Nagan Raya District, Aceh, Indonesia

Phytochemical components	Test method	Sample Code/ Ethanol Solvent		
		EL	EFL	EFT
Flavonoids		+	+	+
Phenols		+	+	+
Tannins		+	+	+
Terpenoids		-	+	+
Steroids		+	-	-
Saponins		+	+	-
Alkaloids	Mayer	+	+	+
Alkaloids	Wagner	+	+	+
Alkaloids	Dragendorff	+	+	+

Note: + present; - absent
EL: *Etlingera elatior* Leaves
EFL: *Etlingera elatior* Flower
EFT: *Etlingera elatior* Fruit

The analysis of phytochemical in the extract of *Etlingera elatior* leaves showed the presence of the following compounds such as flavonoids, phenols, tannins, steroids, saponins and alkaloids, but no terpenoids (Table 1).Therefore, the undetected terpenoid compounds were represented by the absence of a brownish or purple ring at the boundary of the two solvents. According to [34], the chemical composition found in the pseudo-stems, leaves, flowers and rhizomes of *Etlingera elatior* are saponins and flavonoids. These compounds are mostly found in the leaves [18] also reported that leaf extract on *Etlingera elatior* Jack. RM contain a lot of active flavonoid compounds. Based on phytochemical screening analysis of the Bak Kala (*Etlingera elatior*)flower ethanol extract showed the presence of secondary metabolites such as flavonoids, phenols, tannins, terpenoids, saponins and alkaloids, but no steroids (Table 1).In line to [17] revealed that the *Etlingera elatior* flower extract contains chemical substances such as flavonoids, tannins, saponins, alkaloids and terpenoids [19] also revealed that the phytochemical screening analysis of *Etlingera elatior* flower extract showed that detected compounds such as flavonoids, saponins, tannins, steroids and terpenoids, but no alkaloids were detected. Flavonoids in the ethanol extract of *Etlingera elatior* flowers were indicated by a yellow-orange colour change in the amyl alcohol layer [35]. The preliminary phytochemical screening will help to determine the content of secondary metabolites in plants. The results of phytochemical screening of fruit extracts (Table1) showed that *Etlingera elatior* fruit extract contains active compounds, *i.e*. flavonoids, phenols, tannins, terpenoids, and alkaloids, but steroids and saponins were not detected. In line to [36], kecombrang fruit extract contains bioactive compounds such as flavonoids, tannins and triterpenoids.

5. Conclusions

Based on the results of morphological observations of the leaves, flowers, fruit, and rhizome showed that the *Etlingera elatior* leaves originated from SuakBugis are single, leaves are green in colour and lanceolate shape; *Etlingera elatior* fruit is brownish yellow with a reddish tip; the *Etlingera elatior* flower is red in colour; and the rhizome has a reddish colour. The results of phytochemical screening showed that the leaves of *Etlingera elatior* detected chemical compositions *i.e*. flavonoids, phenols, tannins, steroids, saponins and alkaloids; *Etlingera elatior* flowers extracts detected the presence of flavonoids, phenols, tannins, terpenoids, saponins and alkaloids; and *Etlingera elatior* fruit extract contains chemical substances *i.e*. flavonoids, phenols, tannins, terpenoids and alkaloids.

6. Acknowledgements

This study has been financially supported by Hibah Penelitian Kerjasama Perguruan Tinggi (PKPT) Kemenristek Dikti No. 089/SP2H/LT/DRPM/2020. The authors are very grateful to WRI (World Reseorces Institute).Our special thanks to Rayhannisa, S. Si who have helped during in the field.

7. References

1. Agus F, Wahdini W. Assessment of carbon stock of peatland at Tripa, Nagan Raya District, Nangroe Aceh Darussalam Province of Indonesia. Indonesian Centre for Agricultural Land Resources Research and Development; World Agroforestry Centre (ICRAF) Southeast Asia Regional Program; Berg am Irchel, Switzerland: Pan Eco; Medan, Indonesia: Yayasan Ekosistem Lestari:

Banda Aceh, Indonesia: Universitas Syiah Kuala 2008.
2. Wich SA, Meijaard E, Marshall AJ, Husson S, Aacrenaz M, Lacy RC *et al*. Distribution and conservation status of the orangutan (Pongo spp.) on Borneo and Sumatera: how many remain? Oryx 2008;42(3):329-339.
3. Thomy Z, Yulisma A, Harnelly E. Molecular phylogeny of trees species in tripa peat swamp forest, Aceh, Indonesia inferred by 5.8s nuclear gen. Biodiversitas Journal of Biological Diversity 2018;19(4):1186-1193.
4. de Guzman CC, Siemeonsma. Plant resources of South-East Asia. Backhuys Publishers, Leiden. Spices 18, 1999.
5. Poulsen. Book Review: Etlingera of Sulawesi. Gardens Bulletin Singapore 2012;64(2):529-531.
6. Jaavar FM, Osman CP, Ismail NH, Awang K. Analysis of essential oils of leaves, stems, flowers and rhizomes of *Etlingera elatior* (Jack) RM Smith. The Malaysia Journal of Analytical Science 2007;11(1):269-273.
7. Oktavia GAE, Kuswantoro F, Wardhani PK. Traditional utilization of ginger torch (Etlingeraelatior (Jack) RM Sm.) in Bedugul, Bali and its conservation in Bali Botanic Garden. AIP Conference Proceedings 2019.
8. Silalahi M. The ethnomedicine of the medicinal plants in Sub-Ethnic Batak North Sumatra and the conservation perspective. Disertation. Program Studi Biologi, Program Pasca Sarjana, FMIPA, Universitas Indonesia 2014.
9. Heyne K. Tumbuhan Berguna Indonesia I. Translated by Forestry Research and Development Agency. Yayasan Sarana Wana Jaya, Jakarta 1987.
10. Chan EWC, Lim YY, Wong SK. Phytochemistry and pharmacological properties of Etlingeraelatior: A review. Pharmacognosy Journal 2011;3(22):6-10.
11. Effendi MZ, Fadil MS, Sumarmin R. Bioactivity of torch ginger umbut extract (*Etlingera elatior*) against heal wounds of mice (Musmusculus). Eksakta: Berkala Ilmiah Bidang MIPA 2020, 21(2).
12. Nor NAM, NoordinL, Bakar NHA, Ahmad WANW. Evaluation of antidiabetic activities of *Etlingera elatior* flower aqueous extract *in vitro* and *in vivo*. Journal Appl. Pharm Sci 2020;10(8):043-051.
13. Sabilu Y, Sahidin, Mukaddin A, Bittikaka Y, Tawa RA, Paddo J. The utilization of sikala (*Etlingera elatior*) as traditional medicine in Porehu District, North Kolaka Regency, Southeast Sulawesi Province, Indonesia. Advances in Environmental Biology 2017, 11(9).
14. Agustina ZA, Suharmiati, Ipa M. Penggunaan kecombrang (*Etlingera elatior*) sebagai alternatif pengganti sabun dalam perilaku hidup bersih dan sehat suku Baduy. Media Litbangkes 2016;26:241-242.
15. Jackie T, Haleagrahara N, Chakravarthi S. Antioxidant effects of *Etlingera elatior* flower extract against lead acetate-induced perturbations in free radical scavenging enzymes and lipid peroxidation in rats. BMC Res Notes 2011;4:67.
16. Maimulyanti A, Prihadi AR. Chemical composition, phytochemical and antioxidant activity from extract of *Etlingera elatior* flower from Indonesia. Journal Pharmacogn. Phytochem 2015;3:233-238.
17. Lachumy SJT, Sasidharan S, Sumathy V, Zuraini Z. Pharmacological activity, phytochemical analysis and toxicity of methanol extract of *Etlingera elatior* (torch ginger) flowers. Asian Pac J Trop Med 2010;3(10):769-774.
18. Andriani L, Batubara R. Pemberian variasi konsentrasi maserat bunga kecombrang (*Etlingera elatior* Jack RM Sm) sebagai bioinsektisida terhadap nyamuk Aedes spp. Peronema for Sci J 2014;3(1):56-61.
19. Renaninggalih R, Mulkiya, Sadiyah ER, Si M. Karakterisasi dan pengujian aktivitas penolak nyamuk minyak atsiri daun kecombrang *Etlingera elatior* (jack) RM Sm. In: Prosiding Seminar Nasional Sains, Teknologidan Kesehatan 2014, 483-490.
20. Ramasamy S, Mazlan NA, Ramli NA, Rasidi WNA, Manickam S. Bioactivity and stability studies of anthocyanin-containing extracts from *Garcinia mangostana* L. and *Etlingera elatior* Jack. Sains Malaysiana 2016;45(4):559-565.
21. Maolana R, Juanda, Syarifah R, Ria R. Efektivitas penggunaan jenis pelarut dan asam dalam proses ekstraksi pigmen antosianin kelopak bunga rosella (*Hibiscus sabdarifa* L.). Jurnal Teknologi dan Industri Pangan 2012;4(3):20-25.
22. Ahmad S, Harris T, Limb E, Kerry S, Victor C, Ekelund U *et al*. Evaluation of reliability and validity of the general practice physical activity questionnaire (GPPAQ) in 60-74 year old primary care patients. BMC Family Practice 2015;16(113):1-9.
23. Chan EWC, Lim YY, Omar M. Antioxidant and antibacterial activity of leaves of Etlingera species (Zingiberaceae) in Peninsular Malaysia. Food Chem 2007;104(4):1586-1593.
24. Nirwana AP, Astirin OP, Widiyani T. Skrining fitokimia ekstrak etanol daun benalu kersen (Dendrophtoe pentandra L. Miq.). El-Vivo 2015;3(2):9-15.
25. Jones WP, Kinghorn AD. Extraction of plant secondary metabolites. In: Sarker SD, Latif Z, Gray AI. eds. Natural Products Isolation. 2nd Ed. New Jersey: Humana Press 2006, 341-342.
26. Ibrahim H, Mood J. The torch gingers: Sentinels of the forest. Garden Asia 2001, 12-19.
27. Choon SY, Ding P, Mahmud T, Shaari K. Phenological growth stages of torch ginger (*Etlingera elatior*) inflorescence. Pertanika J Trop. Agric. Sci 2013;39(1):73-78.
28. Poulsen AD. Etlingera Giseke of Java. Garden's Bulletin Singapore, Edn 2007;59:145-172.
29. Handayani D. Karakter vegetative sebagai ciri pembeda Etlingera elatior (Jack) RM Sm. Dan *Etlingera hemisphaerica* (Blume) RM Sm. Pada saat belum berbunga. Jurnal Biosains 2017, 3(3).
30. Putri ZA, Nurainas, Syamsuardi. Morphological characterization of population *Etlingera elatior* (Jack) RM Sm. (Zingiberaceae) in West Sumatra. Jurnal Biologi Universitas Andalas 2017, 5(1).
31. Adliani N, Nazliniwaty, Purba D. Lipstick formulation using natural dye from *Etlingera elatior* (Jack) RM Sm. extract. Journal of Pharmaceutics and Pharmacology 2012;1(2):87-94.
32. Larsen KH, Ibrahim S, Khaw H, Saw LG. Gingers of Peninsular Malaysia and Singapore. Natural History Publications, Malaysia 1999.
33. Aswani KM, Sabu, Smisha KP. Reproductive biology of Etlingeraelatior (Jack.) R.M. Sm. ornamental torch ginger. International Journal of Plant, Animal and Environmental Sciences 2013;3(2):75-80.
34. Sulaiman. Efektivitas pemberian ekstra ketanol 70% daun kecombrang (*Etlingera elatior*) terhadap larva instar III Aedes aegepty sebagai larvasida potensial. Skripsi, Fakultaskedokteran Universitas Lampung, Bandar Lampung 2013.
35. Soemarie YB, Apriliana A, Ansyori AK, Purnawati P.

Uji aktivitas anti bakterie kstra ketan ol bunga kecombrang (*Etlingera elatior* (Jack) RM SM.) terhadap bakteri Propionibacterium acnes. Al Ulum Sainsdan Teknologi 2019;5(1):13-16.
36. Isyanti M, Andarwulan N, Faridah DN. Karakteristik fisik dan fitokimia buah kecombrang (*Etlingera elatior* (Jack) RM Sm). Warta IHP 2019;36(2):96-105.