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Morphological characteristics of Zingiberaceae in Serang District, Banten, Indonesia

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Abstract. *Windarsih G, Utami DW, Yuriyah S. 2021. Morphological characteristics of Zingiberaceae in Serang District, Banten, Indonesia. Biodiversitas 22: 5507-5529.* Zingiberaceae, known as ginger family, is a family of monocotyledon belonging to the Zingiberales order. This family is widely used its rhizome for various purposes, especially as medicinal plant. The morphological characters can be used to help the identification of species in the field of plant taxonomy. The aim of study was to characterize the morphological traits, both vegetative and generative organs, of Zingiberaceae from Serang District, Banten. Plant specimens were collected from Serang District, Banten, including in Pabuaran, Gunungsari, and Ciomas sub-district using purposive sampling. The examination of morphological characters data was conducted through observation and documentation. There were 13 species/varieties of Zingiberaceae collected from the studied area, i.e. *Amomum compactum*, *Alpinia purpurata*, *Curcuma xanthorrhiza*, *C. longa*, *C. heyneana*, *C. mangga*, *C. aeruginosa*, *Kaempferia rotunda*, *Etlingera elatior*, *Zingiber zerumbet*, *Z. officinale*, *Zingiber officinale* var. *rubrum*, and Z. *cassumunar*, in which the generative organs were found only in eight species/cultivars of them. Based on the morphological characters of vegetative organs, thirteen species/cultivars had a similarity distance coefficient from 37% to 94%; while based on the morphological characters of both vegetative and generative organs, the eight species/cultivars had a similarity distance coefficient from 31% to 94%. The results showed that using the characters of vegetative organs data were still able to provide consistent grouping results with the generative organs.

Keywords: Morphological characters, Zingiberaceae, Serang

INTRODUCTION

Zingiberaceae, known as ginger family, is a family of monocotyledon belonging to the Zingiberales order (Saensouk and Saensouk 2021) with about 57 genera and 1600 species globally (Maknoi et al. 2021). The family isdistributed in tropical and subtropical regions (Zahara 2020) across Afrika, Asia, and America with the center of diversity in Southeast Asia (Saensouk and Saensouk 2021). Zingiberaceae can be found abundantly in Indonesia, Malaysia, Brunei, Singapore, Thailand, and Philippines (Zahara 2019). The study of Zingiberaceae had been conducted in many regions in Indonesia, such as in South Sumatra (Hutasuhut and Tambunan (2018), Enggano Island (Ardiyani 2015), and Central Java (Setiawan et al. 2018; Lianah et al. 2020). However, until now, the number of species of Zingiberaceae in Indonesia is still not known exactly (Zahara 2020).

Zingiberaceae is aromatic perennial herb (Christenhusz and Byng 2016) which has pseudo-stem, single leaf and inflorescences with distinctive shape and color (Irayanti and Yadnya-Putra 2020), and has bulbous rhizome or creeping horizontally in the soil (Pitopang et al. 2019). Zingiberaceae, especially its rhizome, is widely used for spices, traditional medicinal ingredients, cosmetic, food, ornamental plants (Trimanto et al. 2018; Saensouk and Saensouk 2021), dye and perfume (Saensouk and Saensouk 2021). Zingiberaceae is used as medicinal plant because it contains various bioactive compounds that have pharmacological activities, such as anti-bacterial (Irayanti and Yadnya-Putra 2020), anti-hepatotoxic (Jagtap 2015), inflammatory (Sikha et al. 2015), anti-viral (Pant et al. 2013), antidiabetic (Nwozo et al. 2014), anti-cancer (Pawar et al. 2011), hypocholestraemic (Shafreen et al. 2018), anti-rheumatic (Abdel-Lateef et al. 2016), anti-fibrotic (Jose et al. 2014), gastroprotective (Jeon et al. 2015), anti-arthritic, anti-oxidant, anti-cardio protective, anti-arrythmic, and neuroprotective (Nithya and Jayshree 2017).

The morphological characters have been widely used to help the description and identification of plant in the taxonomy field (Zahara 2020; Hassemer et al. 2020). Traditionally, plant taxonomy relies on morphological characters for group division (Viscosi and Cardini 2011) to reveal the development, form and external structure of plants that are useful to study similarity of plants and origin. The morphological characters can be described and observed, both qualitatively (i.e. leaf blade shape) or quantitatively (i.e. length of leaf blade). The morphological characters of plant can be used as diagnostic or key characters in plant identification, description, classification, and solving taxonomic problem (Iroka et al. 2015).

Morphological characters may have variation in the form and structure among plant species (Susetyarini et al. 2020), even among individuals within the same species. The variation is mostly seen in leaf, stem, and flower. This variation of morphological characters can be caused by

positional effect, environmental, and juvenility factors (Iroka et al. 2015). In many cases, the morphological characters show the difference between in the juvenile and mature plants due to the growth and development of morphological structure of young plant which are not perfect (Susetyarini et al. 2020).

Anecdotal evidence suggests that there is high diversity of Zingiberaceae in Serang District, Banten Province, Indonesia. The Government of Serang District recognizes Zingiberaceae as essential biopharmaceutical plant. Various species of Zingiberaceae are widely cultivated in Serang District including ginger, galangal, East Indian galangal, turmeric, yellow turmeric, black turmeric, cardamom, lempuyang and temu kunci (BPS-Statistics of Banten Province 2020). Because of their importance in the context of Serang District region, the information of morphological characters is useful to help for identification of species for cultivation purpose. The study regarding morphological characters of Zingiberaceae in Banten Province had been conducted by Nikmatullah et al. (2015) in Pandeglang District in which 7 species were identified. Until now, the study on morphological characterization of Zingiberaceae in Serang District, Banten have never been carried out. Therefore, the aim of study was to identify the morphological characters, both vegetative and generative organs, of Zingiberaceae from Serang District, Banten.

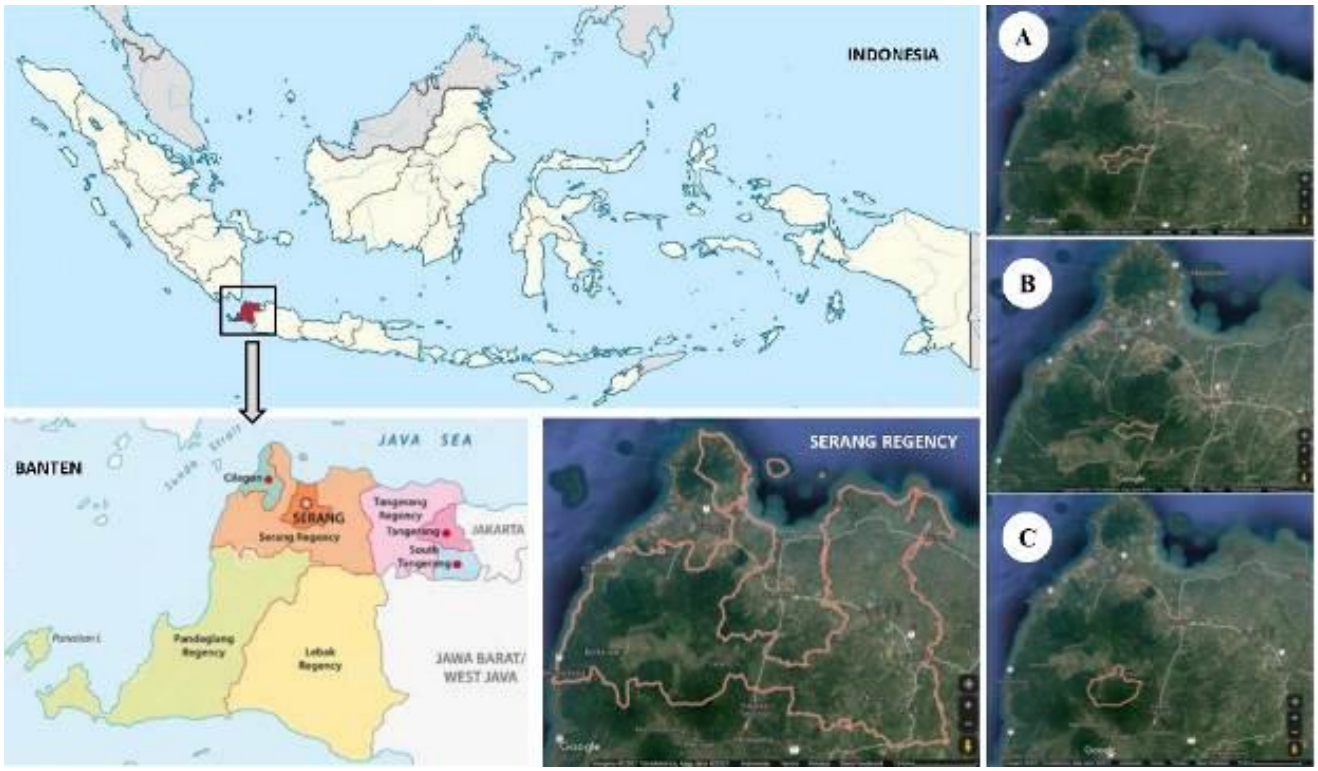
MATERIALS AND METHODS

Study area

The samples of plants were collected from Serang District, Banten, including Pabuaran, Gunungsari, and Ciomas sub-districts (Figure 1). The sites for samples collection included house yard, forest and abandoned land.

Procedure of samples collection

Exploratory survey was conducted in samples collection using a purposive sampling method. The data of morphological characters was collected through observation and documentation. From each species/variety found, 10 plants were taken for quantitative observation; from each plant as many as 30 rhizomes were observed according to UPOV (1996); and the generative organ sampling was conducted by a purposive sampling. The observed morphological characters are presented in Table 1 according to Tjitrosoepomo (2003), De Castro et al. (2018), and UPOV (1996). The observation of reproductive organs was conducted using a stereo mikroskop at a total magnification of 20x or 40x. The color determination was conducted based on RAL K7 Classic International Standard (Germany, 2018).



Picture 1. The location of sample collection of Zingiberaceae in Serang District area, Banten. A. Pabuaran, B. Gunungsari, C. Ciomas sub-districts

Table 1. Morphological characters of Zingiberaceae from Serang District, Banten, Indonesia examined and the scoring method used in this study

Morphological character	Scoring
Petiole	0 = absence, 1 = short petiole, 2 = long petiole
Leaf margin	0 = entire, 1 = undulate
Leaf venation	0 = penninervis, 1 = rectinervis
Plant growth direction	0 = erect, 1 = semi-erect
Pseudo-stem base colour	0 = green, 1 = reddish, 2 = red, 3 = brownish-red
Leaf shape	0 = oblong, 1 = lanceolate, 2 = narrow-lanceolate, 3 = others
Leaf apex	0 = acute, 1 = acuminate
Leaf base	0 = acute, 1 = acuminate, 2 = obtuse, 3 = emarginate, 4 = others
Rhizome shape	0 = spherical, 1 = elliptical, 2 = others
Rhizome surface	0 = smooth, 1 = medium, 2 = rough
Rhizome flesh colour	0 = white, 1 = yellowish-with, 2 = yellowish, 3 = yellow, 4 = dark-yellow, 5 = orange, 6 = reddish, 7 = blue
Anthocyanin colour of bud in rhizome	0 = white, 1 = yellowish-white, 2 = orange, 3 = pink, 4 = reddish, 5 = red
Growth direction of peduncle	0 = erect, 1 = humifusus
Colour of bractea on rachis of inflorescence	0 = purplish-pink, 1 = whiteness-green, 2 = yellowish-white, 3 = pink, 4 = green with yellowish-apex, 5 = green with reddish-apex, 6 = others
Corolla number	0 = two blades, 1 = three blades
Corolla colour	0 = white, 1 = yellow, 2 = pink, 3 = red
Corolla types	0 = actinomorphic, 1 = zygomorphic
Staminodes number	0 = 1 blade, 1 = two blades, 2 = three blades, 3 = four blades
Labellum colour	0 = yellow, 1 = yellow-red, 2 = white with yellow-purple bands in median blade, 3 = purplish-white, 4 = red
Stigma shape	0 = lobed, 1 = cup, 2 = club, 3 = truncate
Stigma colour	0 = white, 1 = black
Number horn of fertile anther	0 = absence, 1 = one horn, 2 = two horns
Horn colour of fertile anther	0 = white, 1 = black, 2 = others
Shape of sterile anther	0 = cylindrical, 1 = filiform, 2 = flat
Colour of sterile anther	0 = white, 1 = yellow

Data analysis

The data obtained were analyzed descriptively. The morphological characters were converted to binary data, and analyzed with Unweighted Pair Group Method with Arithmetic Mean (UPGMA) by NTSYs version 2.02 program (Rohlf 1997) to determine the level of similarity among species/cultivars. The determination of mean and standard deviation for quantitative data was conducted using Microsoft Office Excel 2007.

RESULTS AND DISCUSSION

The exploration conducted in this study recorded 13 species/varieties of Zingiberaceae from Serang District, Banten, including turmeric, yellow turmeric, temu giring, kunyit putih, torch ginger, ginger, red ginger, javanese cardamom, bangle, lempuyang gajah, mango ginger, black turmeric, and red galangal (Table 2).

Morphological characters

Based on the results, the thirteen species of Zingiberaceae found in the studied area are perennial, has fibrous root system, rhizomes that grow creeping horizontally in the soil, roots usually emerging from the surface of rhizomes; single leaf, symmetrical leaf blade, leaves arranged alternately in two opposite rows, there is a ligule at the junction between the leaf blade and the leaf sheath or between the petiole and the leaf sheath; leaf sheaths wrap around the true stem to form a pseudo-stem. The detailed characters of each species is described below.

Alpinia purpurata (K. Schum.)

Red galangal [*Alpinia purpurata* (K. Schum.)] has a semi-erect plant growth direction, number of pseudo-stems 106 stems, plant height 157.7-198.4 cm (174.84±16.99 cm); pseudo-stem is spherical, diameter 17.6-20.9 cm (18.58±1.11 cm), the base colour is reddish. Leaf consists of blade, sheath, and short-petiole; leaf shape is lanceolate, leaf apex is acute, leaf base is acute, leaf blade is green, leaf margin is entire, leaf venation is pinnate (penninervis), the midrib is prominent on the abaxial surface; petiole shape is triangular. Number of leaves 14-17 blades (15.50±0.85 blades), length of blade 39.6-49.4 cm (43.13±3.11 cm), leaf blade width 9.6-11.7 cm (10.92±0.61 cm), length of leaf sheath 79.0-93.9 cm (84.76±4.82 cm), length of ligule 4.5-5.0 mm (4.9±0.2 mm), length of petiole 0.8-1.1 cm (0.89±0.10 cm). True stem has a height of 87.5-128.7 cm (101.49±13.91 cm), segmented into nodes and internodes with an internode length of 10.7-12.3 cm (11.42±0.57 cm). Rhizome shape is spherical or elliptical, diameter 3.07-4.24 cm (3.52±0.35 cm), rhizome surface is smooth and reddish-white or reddish (altrose, RAL 3014) in colour, rhizome flesh is reddish-white or reddish (RAL 3014-altrose, 3015-hellrosa), anthocyanin colour of bud of rhizome is reddish. In this study, the generative organs were not found (Figure 2).

Table 2. Species/varieties of Zingiberaceae found in Serang District area, Banten, Indonesia

Species/varieties	Scientific name	Location
Red galangal	*Alpinia purpurata* (K. Schum.)	Pabuaran sub-district
Javanese cardamom	*Amomum compactum* Sol. Ex. Maton	Ciomas sub-district
Black turmeric	*Curcuma aeruginosa* Roxb.	Pabuaran sub-district
Temu giring	*Curcuma heyneana* Valeton & Zijp.	Pabuaran sub-district
Yellow turmeric	*Curcuma longa* L.	Pabuaran sub-district
Mango ginger	*Curcuma mangga* Val.	Pabuaran sub-district
Turmeric	*Curcuma xanthorrhiza* Roxb.	Pabuaran sub-district
Torch ginger	*Etlingera elatior* (Jack) R.M.Sm.	Ciomas sub-district
Kunyit putih	*Kaempferia rotunda* L.	Pabuaran sub-district
Bangle	*Zingiber cassumunar* Roxb.	Pabuaran sub-district
Ginger	*Zingiber officinale* Roscoe	Gunungsari sub-district
Red ginger	*Zingiber officinale* var. *rubrum*	Pabuaran sub-district
Lempuyang gajah	*Zingiber zerumbet* (L.) Roscoe ex Sm.	Pabuaran sub-district

Figure 2. Morphological characters of vegetative organs in red galangal (*Alpinia purpurata*) collected from Serang District, Banten. A. Plant performance, B. adaxial surface of leaf blade, C. abaxial surface of leaf blade, D-E. ligule, F. transverse section of petiole, G. transverse section of pseudo-stem, H. rhizome in the soil, I. bud of rhizome, J. longitudinal section of mature rhizome, K. transverse section of mature rhizome, L. longitudinal section of younger rhizome, M. transverse section of younger rhizome

Amomum compactum Sol. ex. Maton

Javanese cardamom (*Amomum compactum* Sol. ex. Maton) has a semi-erect plant growth direction, plant height 118.9-132.5 cm (123.85±3.87 cm), diameter of pseudo-stem 12.3-14.3 mm (13.22±0.97 mm), pseudo-stem base colour is red (purpurrot, RAL 3004). Leaf consists of blade and sheath, no petiole (sessile); leaf blade shape is lanceolate, green, leaf apex is acuminate, leaf base is acute, leaf venation is pinnate (penninervis), the midrib is prominent on the lower surface, leaf margin is undulate. Number of leaves 13-18 blades (15.60±1.58 blades), length of leaf sheath 44.7-58.8 cm (50.22±3.93 cm), length of ligule 0.5-0.6 cm (0.59±0.03 cm), length of leaf blade 34.1-39.4 cm (36.08±1.67 cm), leaf blade width 9.2-9.7 cm (9.39±0.23 cm), leaf apex is acuminate, leaf base is acute. True stem has a height of 68.5-79.4 cm (72.19±3.23 cm), segmented into nodes and internodes, length of internode 6.8-7.9 cm (7.12±0.33 cm). Rhizome is spherical, diameter 0.66-1.25 cm (1.03±0.15 cm), rhizome flesh is yellowish-white (beige, RAL 1001); rhizome surface is smooth and white (perlweib, RAL 1013), while rhizome appearing above the ground is dark-red (purpurrot, RAL 3004); anthocyanin color of bud of rhizome is red (purpurrot, RAL 3004) (Figure 3).

Inflorescence emerges from rhizome in the soil. A total height of inflorescence reaches 5.6 cm; the growth direction of peduncle is humifusus, length of peduncle 2.9-3.7 cm (3.30±0.57 cm), diameter of peduncle 0.37-0.50 cm (0.44±0.09 cm). Bracts on peduncle 3, length 1.1-1.9 cm (1.52±0.32 cm), width 0.89-1.18 cm (1.08±0.17 cm). Bracts on rachis of inflorescence are yellowish-white, 32-35 blades (33.33±1.53 blades), length 1.0-2.5 cm (2.11±032 cm). Length of rachis 3.4 cm, diameter 0.47 cm (Figure 4).

Flower is protected by a bracteole; bracteole has a length of 1.3-1.7 cm (1.53±0.17 cm), tubular with a tube length of 0.7-1.0 cm (0.88±0.13 cm). Flower has a length of 3.4-3.6 cm (3.50±0.14 cm). Calyx has a total length of

1.8-2.2 cm (2.00±0.16 cm), white, brownish-white tip; gamosepalous, tubular with a tube length of 1.5-1.7 cm (1.6±0.1 cm). Corolla is gamopetalous, tubular with a length of 1.4-2.2 cm (1.74±0.30 cm); has 2 blades, actinomorphic, length 0.7-1.1 cm (0.91±0.10 cm), width 0.4 cm, white. Staminodes has 2 blades, zygomorphic, bilabiate; one of blades is lateral staminodes, white blade colour with yellowish-tip, smaller, boat-shaped, length 1.0-1.5 cm (1.20±0.18 cm), width 0.40-0.43 cm (0.41±0.01 cm), while the others is labellum, white blade colour with 1 yellow band in median blade and 2 purple bands on the outside, boat-shaped, length 1.4-1.8 cm (1.52±0.16 cm), width 1.1-1.6 cm (1.30±0.26 cm). Fertile stamen 1, height 0.25-0.33 cm (0.30±0.03 cm). Sterile stamens 2, length 0.3-0.4 cm (0.33±0.04 cm), flattened, yellow. Pistil has a total length of 2.44-3.00 cm (2.82±0.22 cm); style colour is white, length 2.23-2.80 cm (2.61±0.22 cm); stigma is cup-shaped, white, length 0.18-0.24 cm (0.21±0.02 cm), diameter 0.15-0.23 cm (0.20±0.04 cm). Ovary has a length of 0.30-0.43 cm (0.35±0.05 cm), diameter 0.21-0.26 cm (0.24±0.03 cm), surface of ovary is golden-hairy, 3 lobes, each lobe contains many ovules (Figure 5).

Curcuma aeruginosa Roxb.

Black turmeric (*Curcuma aeruginosa* Roxb.) has an erect plant growth direction, plant height 145.8-176.0 cm (164.021±10.91 cm), diameter of pseudo-stem 25.7-40.3 mm (34.28±5.81 mm), pseudo-stem base colour is green. Leaf consists of blade, sheath, and petiole; leaf blade is green, leaf margin is entire; leaf shape is lanceolate, leaf

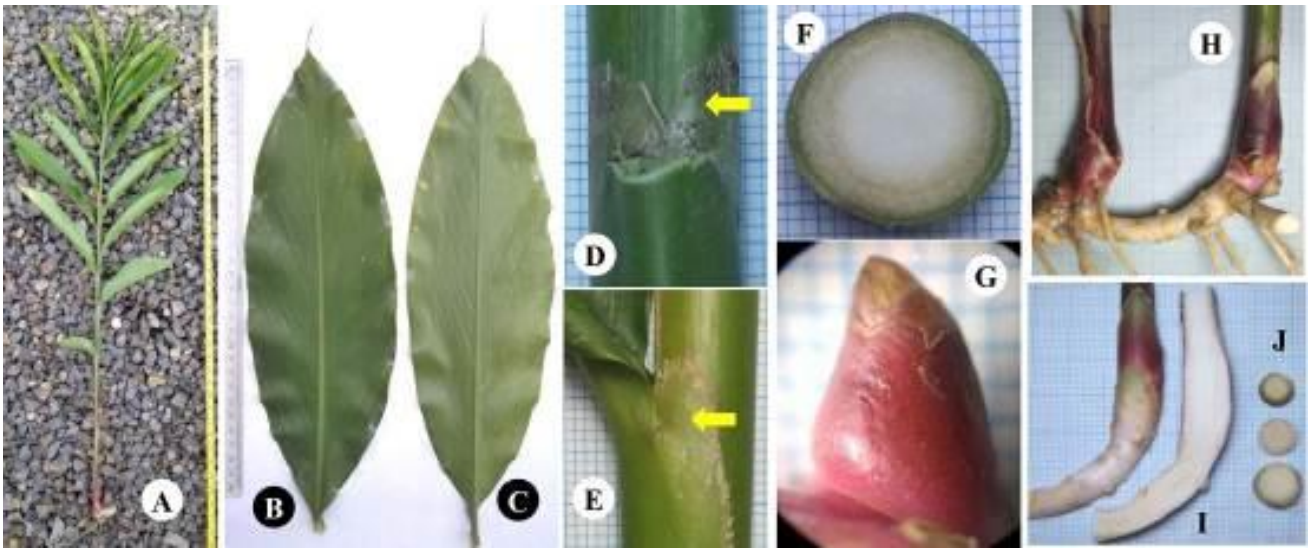


Figure 3. Morphological characters of vegetative organs in javanese cardamom (*Amomum compactum*) collected from Serang District, Banten. A. Plant performance, B. adaxial surface of leaf blade, C. abaxial surface of leaf blade, D-E. ligule, F. transverse section of pseudo-stem, G. bud of rhizome, H. rhizome in the soil, I. longitudinal section of rhizome, J. transverse section of rhizome

Figure 4. Morphological characters of inflorescence in javanese cardamom (*Amomum compactum*) collected from Serang District, Banten. A-B. Inflorescence, C. bracts of peduncle, D. bracts on rachis of inflorescence, E. rachis

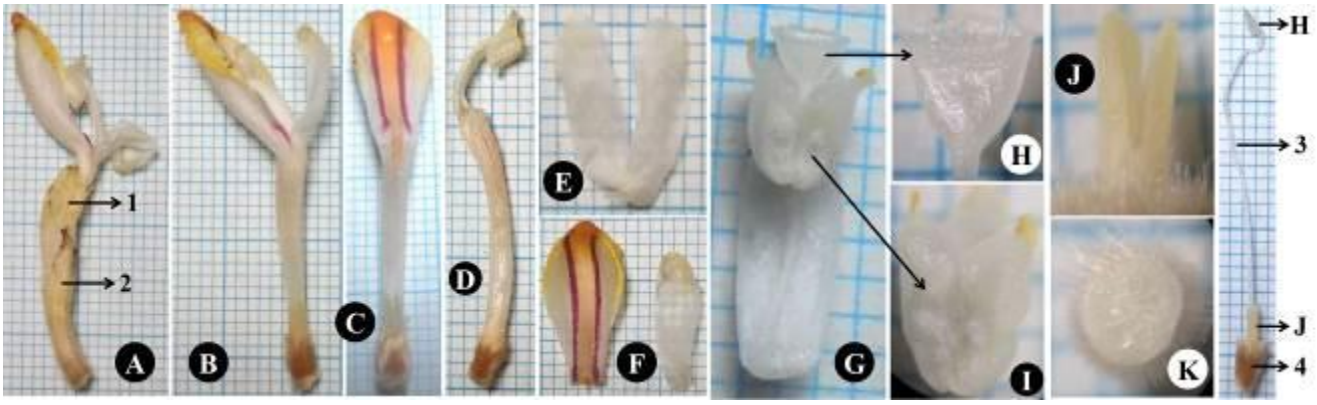


Figure 5. Flower parts of javanese cardamom (*Amomum compactum*) collected from Serang District, Banten. A. Flower with a bracteole and calyx, B. flower without bracteole and calyx, C. longitudinal section of flower, D. corolla tube, E= corolla, F.labellum (left) and lateral staminodes, G-K. reproductive organ parts, H. stigma, I. fertile stamen, J. sterile stamen, K. transverse section of ovary with 3 lobes that each lobe contains ovules; 1. calyx, 2. bracteole, 3. style, 4. ovary

apex is acuminate, leaf base is acuminate, leaf venation is pinnate (penninervis), the midrib is prominent on the abaxial surface; petiole is long, has semi-circle form, grooves deeply on adaxial surface. In a juvenile phase, the parts to the right and left of midrib on the adaxial surface of first leaf blade have a firm red-brown (weinrot, RAL 3005) colour, but progressively fades upward until finally the mature leaves are full green. Number of leaves 5-8 blades (6.60±0.97 blades), length of leaf sheath 55.7-67.4 cm (60.86±3.81 cm), length of ligule 0.20-0.25 cm (0,21±0.02 cm), length of petiole 25.6-33.7 cm (29.46±2.67 cm), length of leaf blade 76.8-85.9 cm (81.85±3.80 cm), leaf blade width 18.2-20.6 cm (19.25±0.81 cm), leaf apex is acuminate, leaf base is acute or acuminate. True stem has a height of 5.4 cm, segmented into nodes and internodes with an internode length of 1.2 cm. The rhizome is spherical, diameter 2.8-5.63 cm (3.65±0.89 cm), rhizome flesh is blue (pastellblau, RAL 5024), rhizome surface is rough and yellowish-white (sandgelb, RAL 1002), anthocyanin color of bud of rhizome is pink. Roots emerge from the surface of rhizome, root tip forms a tuber with a diameter of 2.18-3.23 cm (2.50±0.34 cm) and a length of 5.48-11.87 cm (7.79±2.23 cm). Generative organs were not found in this study (Figure 6).

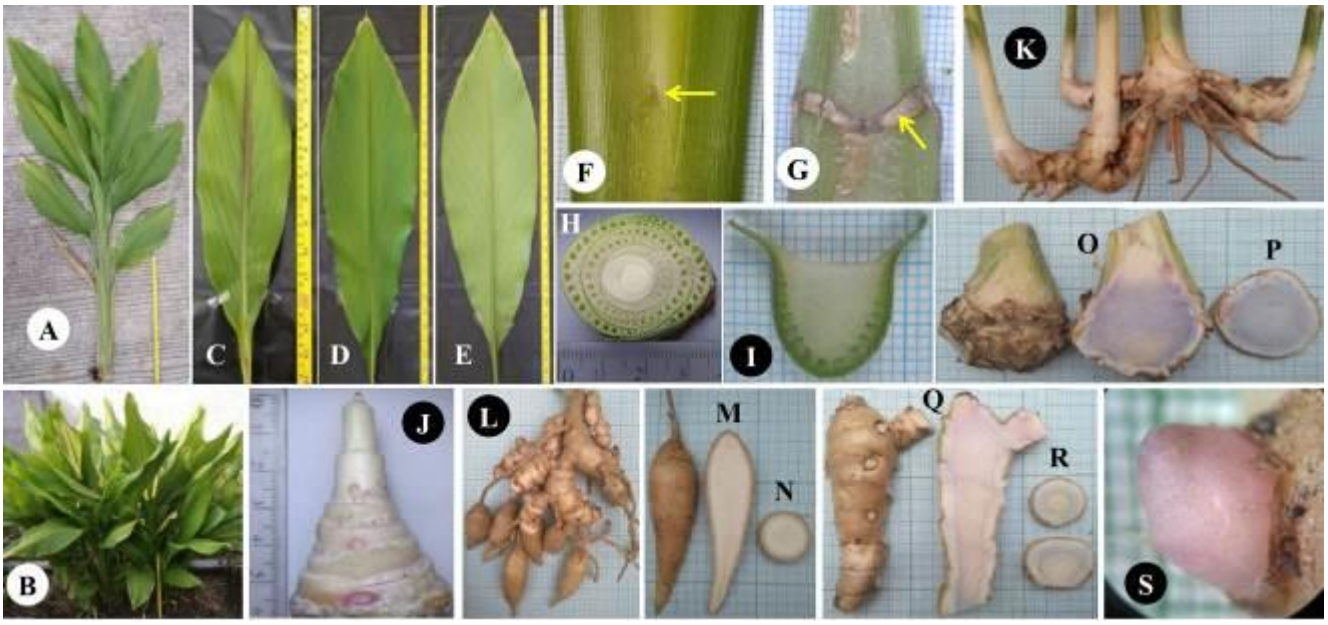


Figure 6. Morphological characters of vegetatives organ in black turmeric (*Curcuma aeruginosa*) collected from Serang District, Banten. A-B. Plant performance, C. adaxial surface of juvenile leaf with the brownis-red part to the right and left of midrib on the adaxial surface of leaf blade, D. adaxial surface of mature leaf blade, E. abaxial surface of mature leaf blade, F-G. ligule, H. transverse section of pseudo-stem, I. transverse section of petiole, J. true stem covered by leaf sheats, K. rhizome in the soil, L. rhizome with tubers in root ends, M. longitudinal section of tuber, N. transverse section of tuber, O. longitudinal section of main rhizome, P. transverse section of main rhizome, Q. longitudinal section of rhizome branch, R. transverse section of rhizome branch, S. bud of rhizome

Curcuma heyneana Valeton & Zijp.

Temu giring (*Curcuma heyneana* Valeton & Zijp.) has an erect plant growth direction, plant height 159.2-197.7 cm (176.51±15.50 cm), pseudo-stem diameter 2.49-4.11 cm (3.05±0.46 cm), pseudo-stem base is green. Leaf consists of blade, sheath, and petiole; leaf shape is lanceolate, leaf apex is acuminate, leaf base is acuminate, leaf margin is entire, leaf venation is pinnate (penninervis), leaf blade colour is green, the midrib is prominent on the abaxial surface; petiole is long, has semi-circle form, grooves deeply on the adaxial surface. Leaves number 6-8 blades (6.90±0.88 blades), length of leaf sheath 51.9-86.5 cm (65.18±11.11 cm), length of ligule 0.1-0.2 cm (0.14±0.04 cm), length of petiole 36.4-51.9 cm (43.14±5.58 cm), length of leaf blade 63.4-96.8 cm (76.34±10.24 cm), leaf blade width 16.5-20.8 cm (18.80±1.55 cm), leaf apex is acuminate, leaf base is acute or acuminate. Rhizome is spherical, diameter 2.1-4.6 cm (2.74±0.54 cm), the colour of surface and flesh of young rhizomes are yellow (schwefelgelb, RAL 1016), the colour of mature rhizome flesh is orange (RAL 1023-verkehrsgelb, 1007-narzissengelb), the colour of mature rhizome surface is orange (RAL 1006-maisgelb), rhizome surface is rough, anthocyanin color of bud of rhizome is white (Figure 7).

Inflorescence emerges from the shoot, the length of inflorescence is 14.2-15.5 cm (14.85±0.92 cm); the growth direction of inflorescence stalk (peduncle) is erect, diameter of peduncle is 0.99-1.00 cm (0.99±0.01 cm). The bracts on rachis of inflorescence that covering flowers range between 21-23 blades (22.00±1.41 blades), a total length of bract 1.5-7.4 cm (5.51±1.04 cm), the bract base attaches to the rachis by 0.8-2.8 cm (2.24±0.47 cm); bract tip is apart from each other, purplish-pink, length 0.6-5.5 cm (3.27±1.11 cm), width 0.5-4.1 cm (3.12±0.65 cm). Each bract supports up to 3 flowers that blooming alternately. The terminal bracts form a sterile cluster with longer blade and brightly coloured. Inflorescence type is racemose (Figure 8).

The flower is protected by a bracteole; bracteole has a length of 1.7-2.3 cm (1.98±0.23 cm) and a width of 0.8-1.0 cm (0.90±0.07 cm). A total length of flower reaches 5.4 cm. Calyx is translucent-white and has a length of 0.7-1.1 cm (0.85±0.10 cm). Corolla is gamopetalous, tubular with a tube length of 3.6 cm; has 3 blades, zygomorphic, white, length 1.0-1.8 cm (1.37±0.31 cm), width 0.6-1.4 cm (0.96±0.32 cm); one of blades is dorsal corolla, has a white horn-tip with a length of horn 0.2 cm; the other two blades are lateral corolla without horn-tip. Staminodes have 3 blades, zygomorphic; one of blades is labellum, larger with a length of 1.7-2.0 cm (1.85±0.21 cm) and a width of 1.6-1.7 cm (1.65±0.07 cm), has dark-yellow band in medium blade, while the other two blades are lateral staminodes, have a length of 1.4-1.6 cm (1.53±0.10 cm) and a width of 0.8 cm, pale yellow. Sterile stamens 2, tubular, yellow, length 0.40-0.45 cm (0.42±0.03 cm); fertile stamen 1, length 0.30-0.45 cm (0.38±0.06 cm), the tip has 2 white-horns. A total length of pistil is 4.1-4.7 cm (4.40±0.42 cm); stigma is lobed, white; ovary has a length of 0.2-0.4 cm (0.28±0.07 cm), diameter 0.25 cm, the surface of ovary is hairy (Figure 8).

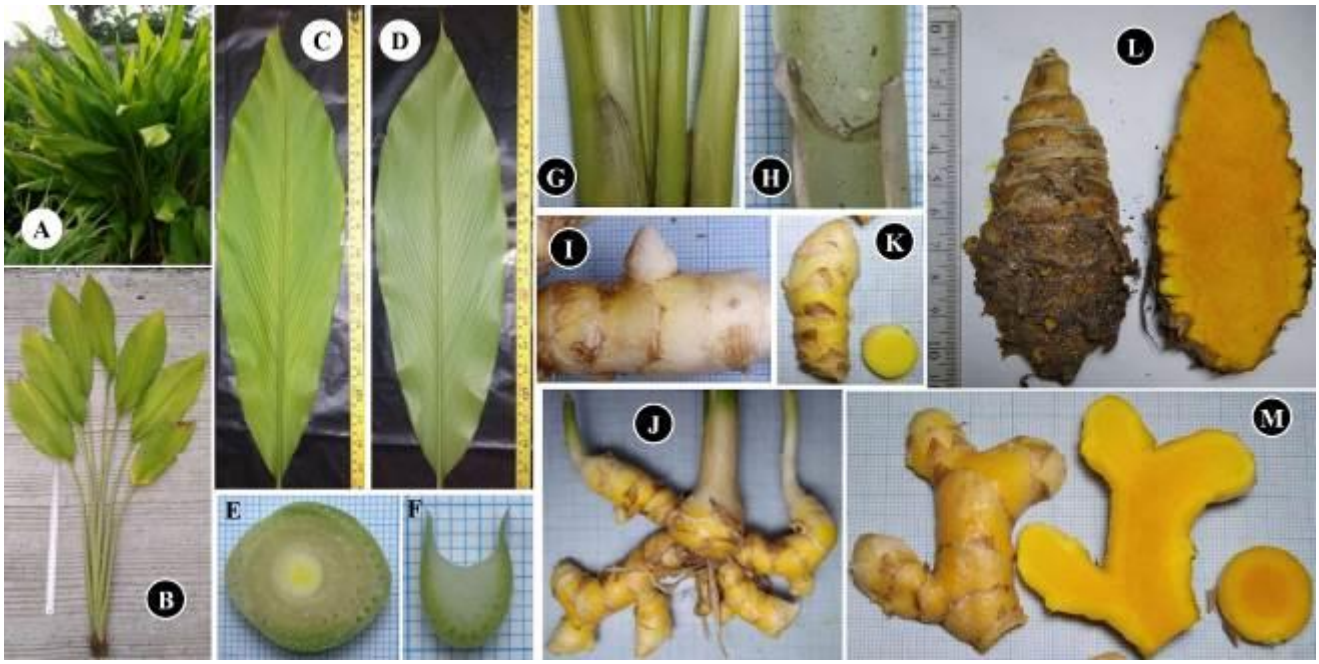


Figure 7. Morphological characters of vegetative organs in temu giring (*Curcuma heyneana*) from Serang District, Banten. A-B. Plant performance, C. adaxial surface of leaf blade, D. abaxial surface of leaf blade, E. transverse section of pseudo-stem, F. transverse section of petiole, G-H. ligule, I. bud of rhizome, J. rhizome, K. young rhizome, L. main rhizome, M. longitudinal and transverse sections of rhizome branches

Figure 8. The parts of temu giring (*Curcuma heyneana*) flower from Serang District, Banten. A-C. Inflorescence, D. fertile bract on rachis of inflorescence, E-H. flower, I. lateral staminodes (front side) and labellum (back side), J. lateral corolla (left and right) and dorsal corolla (middle), K.calyx, L. stigma and fertile stamen with two horns, M. ovary with 3 chambers which contains many ovules in each chamber

Curcuma longa L.

Yellow turmeric (*Curcuma longa* L.) has an erect plant growth direction, plant height 145.6-180.6 cm (163.43±11.63 cm), pseudo-stem diameter 3.15-3.95 cm (3.62±0.35 cm), pseudo-stem base is green. Leaf consists of blade, sheath, and petiole; leaf blade shape is lanceolate, leaf tip is acuminate, leaf base is acuminate, leaf margin is entire, leaf venation is pinnate (penninervis), midrib is prominent on the abaxial surface, leaf is green; petiole is long, has semi-circle form, the grooves deeply on the adaxial surface. Leaves have 5-8 blades (6.43±0.98 blades), length of leaf sheath 45.7-56.9 cm (51.73±3.85 cm), length of ligule 0.1-0.2 cm (0.13±0.04 cm), length of petiole 39.0-48.7 cm (44.00± 3.17 cm), length of leaf blade 64.4-81.0 cm (71.43±5.86 cm), leaf blade width 14.7-18.4 cm (17.03±1.32 cm), leaf tip is acuminate, leaf base is acuminate. Rhizome is spherical, diameter 2.03-2.68 cm (2.24±0.19 cm), the surface of rhizomes is rough and orange in colour (pastellorange, RAL 2003), rhizome flesh colour is orange (reinorange, RAL 2004), anthocyanin color of bud of rhizome is orange (Figure 9).

Inflorescence emerges from the shoot. A total length of inflorescence is 21.4 cm; the growth direction of inflorescence stalk (peduncle) is erect, length of peduncle 7.7 cm; length of inflorescence 13.7 cm. The bracts on inflorescence are light-green; towards the center of inflorescence, the colour of bracts is more whiteness-green. The bracts of inflorescence can be distinguished into sterile bracts and fertile bracts. Sterile bracts 3, the base of sterile bract attaches to peduncle with a length of 2.6-3.1 cm (2.90±0.35 cm), while the bract tip is apart from each other with a length of 4.1-6.2 cm (5.13±0.78 cm) and a width of 2.4-3.2 cm (2.90±0.49 cm), acute or obtuse. Meanwhile, fertile bracts 22 blades, the bract base attaches to rachis with a length of 1.2-3.0 cm (2.54±0.49 cm), while the bract tip is apart from each other with a length of 2.8-5.0 cm (3.83±0.77 cm), width 1.5-3.0 cm (2.69±0.36 cm), the apex is obtuse, acute, or rounded. Each fertile bract supports up to 4 flowers, the flowers in each bract bloom alternately. The terminal bracts form a sterile cluster with longer blade and brightly whitish-green coloured. Inflorescence type is racemose (Figure 10).

Flower has a total length of 5.1-5.3 cm (5.20±0.14 cm). Flower is protected by a bracteole; bracteole is yellowish-white, length 2.40-3.25 cm (2.91±0.37 cm), width 1.4-1.8 cm (1.63±0.21 cm), 3 blades, length of free-tip 0.5 cm, the apex is acute. Calyx is translucent-white, length 0.80-1.15 cm (0.94±0.12 cm), gamosepalous, the base forms a tube with a length of 0.5 cm. Corolla is gamopetalous, tubular with a tube length of 3.17-3.55 cm (3.34±0.17 cm); has 3 blades with a length of 1.2-1.6 cm (1.35±0.10 cm), width 1.0-1.7 cm (1.28±0.18 cm), zygomorphic, white; one of blades is dorsal corolla, has a white horn-tip with a length of 0.2-0.3 cm (0.24±0.05 cm); other two blades are lateral corolla without horn-tip. Staminodes has 3 blades, zygomorphic; one of blades is labellum, larger with a length of 1.5-2.0 cm (1.88±0.20 cm) and a width of 1.70-1.75 cm (1.72±0.03 cm), has dark-yellow band in median blade, while the other two blades are lateral staminodes with a length of 1.0-1.5 cm (1.26±0.14 cm) and a width of 0.6-0.8 cm (0.74±0.07 cm), white. Fertile stamen 1 with a length of 0.38-0.47 cm (0.42±0.03 cm), the stamen tip has 2 white-horns. Sterile stamens 2, tubular, length 0.3-0.4 cm (0.36±0.03 cm), yellow. The pistil has a total length of 4.3-

4.5 cm (4.40±0.14 cm), length of style 4.40-4.55 cm (4.48±0.08 cm); stigma is lobed, white, length 0.05-0.08 cm (0.06±0.02 cm), diameter 0.10-0.12 cm (0.11±0.01 cm); ovary has a length of 0.2-0.5 cm (0.33±0.11 cm), diameter 0.25-0.30 cm (0.27±0.02 cm), 3 chambers, each chamber contains many ovules (Figure 11).

Curcuma mangga Val.

Mango ginger (*Curcuma mango* L.) has an erect plant growth direction, plant height 161.5-194.0 cm (174.62±9.99 cm), pseudo-stem diameter 29.2-45.0 mm (32.58±4.57 mm), pseudo-stem base colour is green. Leaf consists of blade, sheath, and long-petiole; leaf shape is lanceolate, leaf apex is acuminate, leaf base is acuminate, green, leaf margin is entire, leaf venation is pinnate (penninervis), the midrib is prominent on the abaxial surface of leaf blade; petiole has semi-circle form, grooves deeply on the adaxial surface. Number of leaves 7-9 blades (7.2±0.63 blades), length of leaf sheath 65.4-78.5 cm (69.95±4.94 cm), length of ligule 0.2-0.3 cm (0.23±0.04 cm), length of petiole 29.3-39.9 cm (33.32±3.66 cm), length of leaf blade 72.3-84.5 cm (77.28±4.22 cm), width of leaf blade 15.8-19.1 cm (17.34±1.18 cm), leaf apex is acuminate, leaf base is acuminate. Rhizome is spherical, diameter 2.02-3.25 cm (2.41±0.30 cm), rhizome surface is rough and yellow (schwefelgelb, RAL 1016), rhizome flesh is yellow (schwefelgelb, RAL 1016), anthocyanin color of bud of rhizome is white. Generative organs were not found in this study (Figure 12).

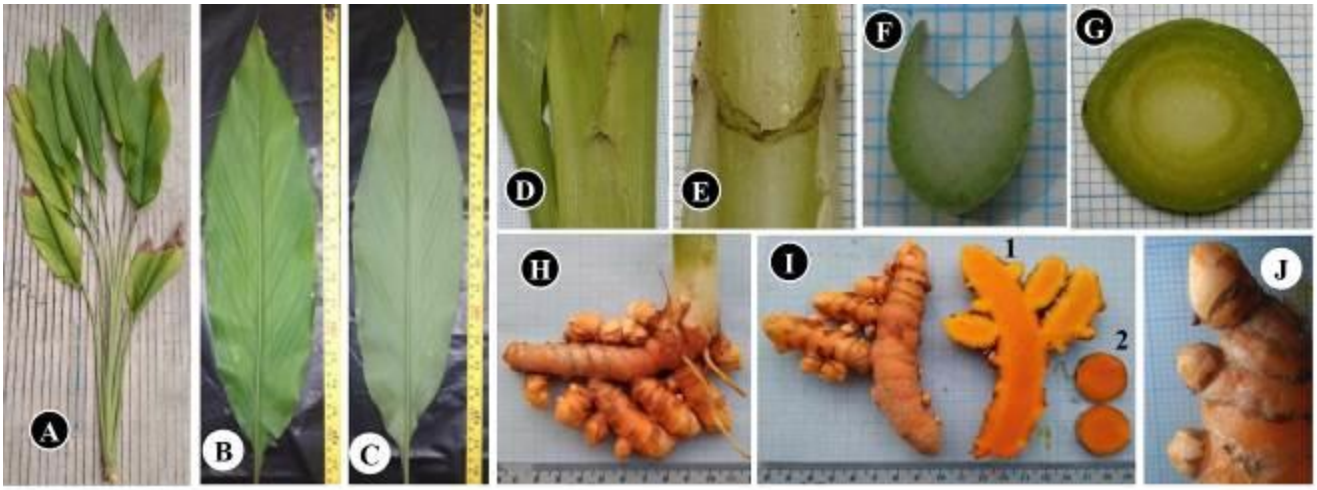


Figure 9. Morphological characters of vegetative organs in yellow turmeric (*Curcuma longa*) collected from Serang District, Banten. A. Plant performance, B. adaxial surface of leaf blade, C. abaxial surface of leaf blade, D-E. ligule, F. transverse section of petiole, G. transverse section of pseudo-stem, H. rhizome, I-1. longitudinal section of rhizome, I-2. transverse section of rhizome, J. bud of rhizome

Figure 10. Morphological characters of inflorescence in yellow turmeric (*Curcuma longa*) collected from Serang District, Banten. A. Inflorescence emerging from the shoot, B-C. inflorescence, D. sterile bracts that the base attaches peduncle, E. fertile bracts that the base attaches rachis and support the flowers, F. rachis

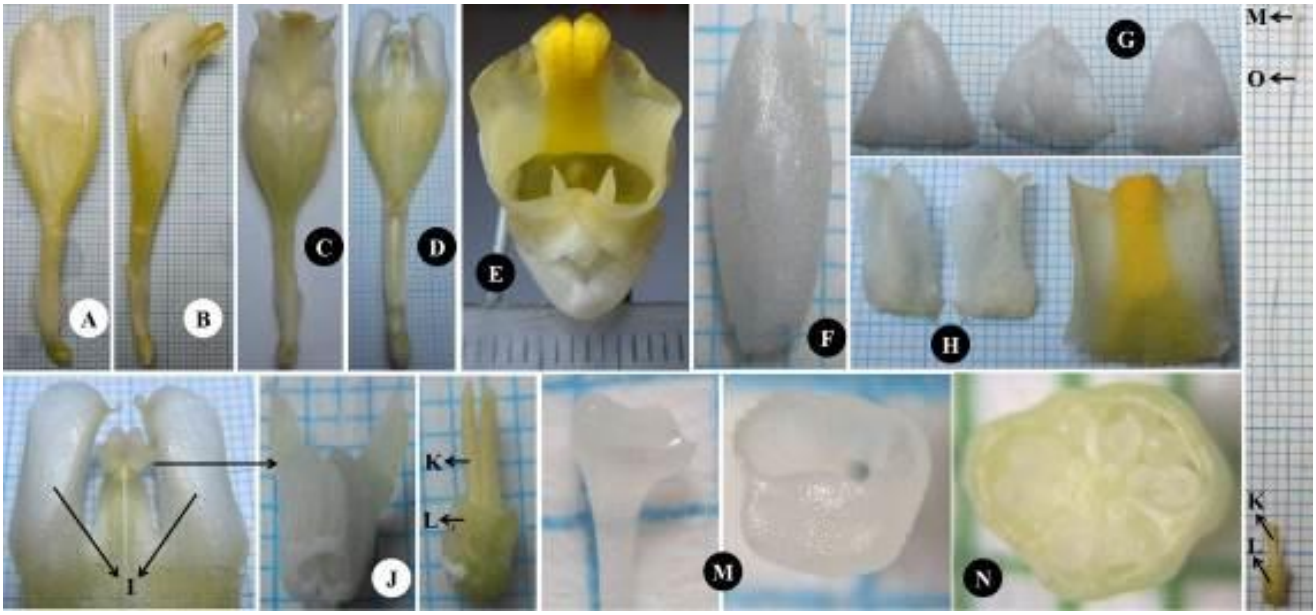


Figure 11. The parts of yellow turmeric (*Curcuma longa*) flower collected from Serang District, Banten. A-C. Flower, D. longitudinal section of flower, E. upper view of flower, F. calyx, G. dorsal corolla (left) and lateral corolla (middle and right), H. lateral staminodes (left and middle) and labellum (right), I. lateral staminodes, J. fertile stamen with 2 horns, K. sterile stamen, L. ovary, M. stigma, N. transverse section of ovary, O. style of pistil

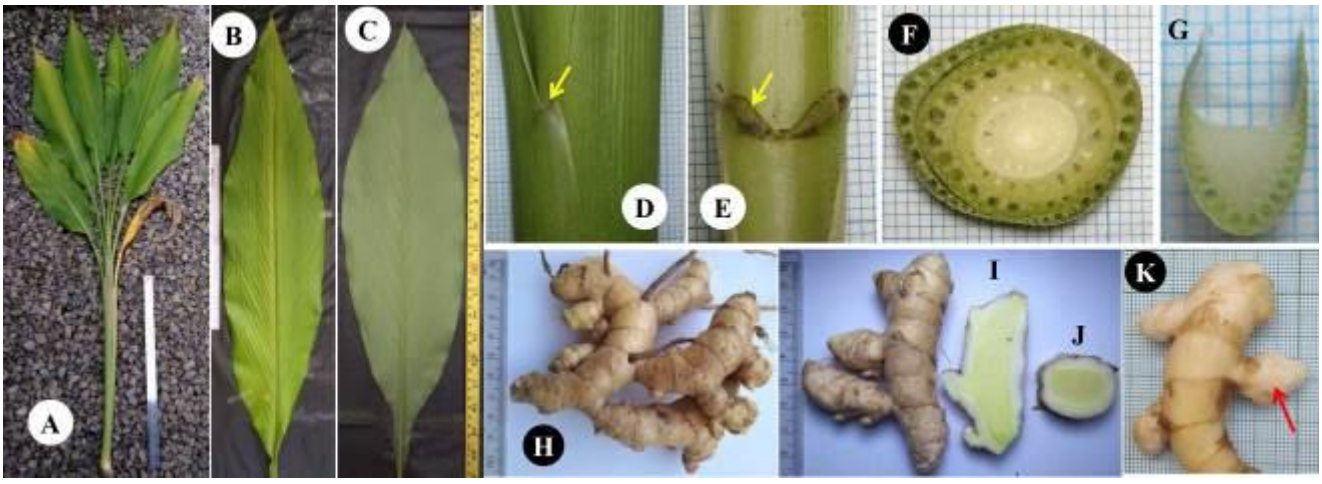


Figure 12. Morphology of vegetative organs in mango ginger (*Curcuma mangga*) collected from Serang District, Banten. A. Plant performance, B. adaxial surface of leaf blade, C. abaxial surface of leaf blade, D-E. ligule, F. transverse section of pseudo-stem, G. transverse section of petiole, H. rhizome, I. longitudinal sections of rhizome, J. transverse sections of rhizome; K. bud of rhizome

Curcuma xanthorrhiza Roxb.

Turmeric (*Curcuma xanthorrhiza* Roxb.) has an erect plant growth direction, plant height ranges between 197.7-213.7 cm (206.03±6.51 cm), pseudo-stem diameter 3.54-5.99 cm (4.39±0.87 cm), pseudo-stem base is green. Leaf consists of blade, sheath, and petiole; leaf shape is lanceolate, leaf apex is acuminate, leaf base is acuminate, colour of mature leaf is green, leaf margin is entire, leaf venation is pinnate (penninervis), midrib is prominent on the abaxial surface; petiole is long, has a semi-circle form, grooves deeply on the adaxial surface. In a juvenile phase, the midrib and the blade parts to the right and left of midrib on adaxial surface of first leaf have a firm brownish-red (weinrot, RAL 3005) colour, but progressively fades upward until finally the mature leaves are full-green. The number of leaves 4-9 blades (5.9±1.85 blades), length of leaf sheath 76.5-85.0 cm (80.10±2.49 cm), length of ligule 0.3-0.5 cm (0.38±0.08 cm), length of petiole 35.2-43.0 cm (37.58±2.32 cm), length of leaf blade 87.5-97.4 cm (92.34±3.59 cm), leaf blade width 20.1-24.7 cm (21.53±1.44 cm). Rhizome is spherical-shaped, diameter 2.76-6.22 cm (4.13±1.08 cm), rhizome surface is rough and yellowish-white to orange, rhizome flesh colour is orange (hellrotorange, RAL 2008), anthocyanin color on bud of rhizome is yellowish-white (Figure 13).

Inflorescence appears from rhizomes in the soil with a total inflorescence height of 38.1-50.7 cm (44.4±8.91 cm), length of inflorescence 21.5-28.9 cm (25.2±5.23 cm), inflorescence diameter reaches 16.9 cm; the growth direction of inflorescence stalk (peduncle) is erect, length of peduncle is 16.6-24.5 cm (20.55±5.59 cm), diameter of peduncle is 1.89-2.53 cm (2.21±0.45 cm). The bracts of peduncle have 5-7 blades (6±1.41 blades), length 2.8-23.2 cm (11.93±6.37 cm), green. The bracts on rachis of inflorescence have 23-52 blades, bract base attaches to rachis with a length of 0.3-3.0 cm (2.22±0.5 cm); the bract tip is separated from each other with a length of 2.7-7.3 cm (4.68±1.49 cm), widht 1.0-5.3 (4.19±0.87 cm), light-green to purplish-pink (apex part = bordeauxviolett-RAL 4004; center part = verkehrhornpur-RAL 4006) colour, obtuse or acute; each bract can protect up to 6 flowers. The terminal bracts form a sterile cluster with longer blade and brightly coloured. Inflorescence type is racemose (Figure 14).

Each flower is protected by a bracteole. Bracteole is translucent-white, the base part attaches to rachis of inflorescence, the margin is separated from each other. Flower has a total length of 5.7-6 cm (5.87±0.15 cm). Calyx is translucent-white, length 1.1-1.2 cm (1.18±0.05 cm); gamosepalous, the base part has a tube form, hairy, and attaches on the ovary; the tips are apart from each other with 3 pink-blades, length 0.1 cm. Corolla is gamopetalous, tubular with a length of tube 3.5-3.6 (3.58±0.05 cm); has 3 blades, zygomorphic, pink (hellrosa, RAL 3015), length 1.4-1.8 cm (1.63±0.14 cm), width 1.4-1.9 cm (1.58±0.22 cm); one of blades is dorsal corolla with acute-horn tip, white, length 0.3 cm; other two blades are lateral corolla without horn-tip. Staminodes have 3 blades, zygomorphic; one of blades is labellum, larger with a length of 1.7-1.8 cm (1.75±0.06 cm), width 2.0-2.1 cm (2.03±0.06 cm), has dark-yellow (hellrosa, RAL 3015) band in median blade; the others are lateral staminodes, smaller with a length of 1.2-1.3 cm (1.23±0.05 cm) and a width of 1.0-1.2 (1.10±0.05 cm), translucent-white with yellowish-pink tips; the base unites in a length of 0.3-0.4 cm (0.33±0.05 cm). Fertile stamen 1, length 0.5 cm, apex part has 2 white-horns. Sterile stamens 2, length 0.50-0.55 cm (0.53±0.03 cm), yellow, tubular. The pistil has a length of 4.8-5.0 cm (4.93±0.10 cm), length of style 4.82-4.93 cm (4.89±0.06 cm); stigma is lobed, white, length 0.7-0.8 mm (0.76±0.06 mm), diameter 1.8-1.9 mm (1.82±0.05 mm); the ovary has a length of 0.44-0.53 cm (0.47±0.04 cm), diameter 0.34-0.38 cm (0.36±0.02 cm), consists of 3 chambers, each chamber contains many ovules (Figure 15).

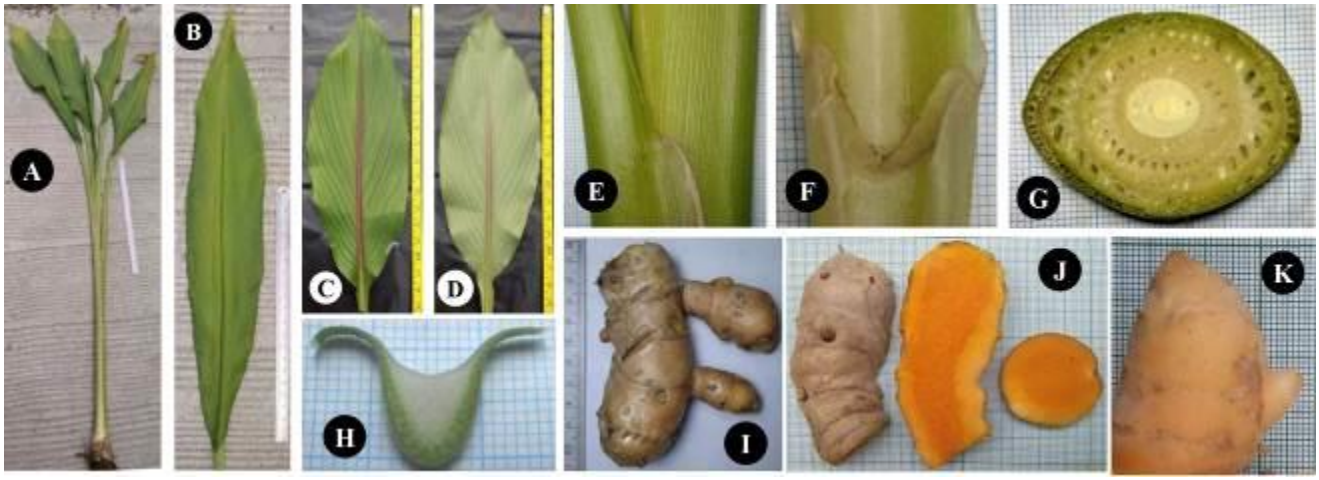


Figure 13. Morphological characters of vegetative organs in turmeric (*C. xanthorrhiza*) from Serang District, Banten. A. Plant performance, B. mature leaf blade, C. adaxial surface of juvenile leaf blade, D. abaxial surface of juvenile leaf blade, E-F. ligule, G. transverse section of pseudo-stem, H. transverse section of petiole, I. rhizome, J. transverse and longitudinal sections of rhizome, K. bud of rhizome

Figure 14. Morphological characters of inflorescence in turmeric (*C. xanthorrhiza*) from Serang District, Banten. A-C. inflorescence, D. fertile bract supporting flower, E. bracts on rachis of inflorescence, F. bracts of peduncle, I. rachis and peduncle

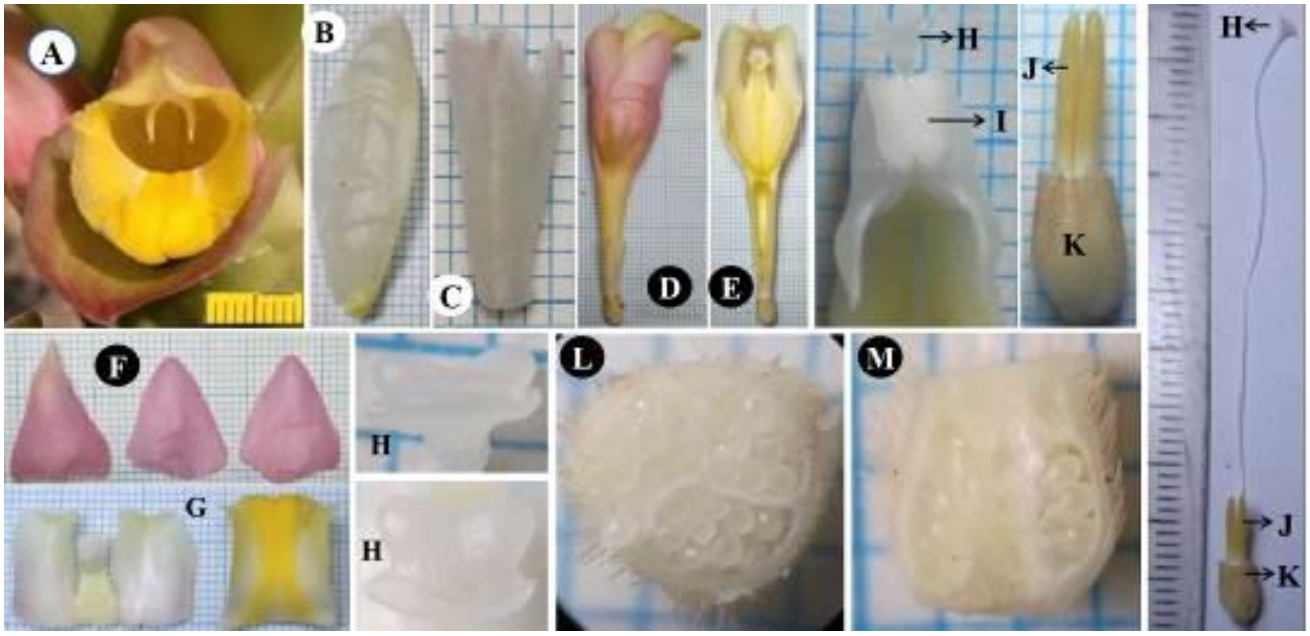


Figure 15. The parts of turmeric (*C. xanthorrhiza*) flower. A. Flower, B. bracteole, C. calyx, D. flower parts, E. longitudinal section of flower, F. dorsal corolla (left) and lateral corolla (middle and right), G. lateral staminodes (left) and labellum (right), H. stigma, I. fertile stamen, J. sterile stamen, K. ovary, L. transverse section of ovary, M. longitudinal section of ovary

Etlingera elatior (Jack) R.M.Sm.

Torch ginger [*Etlingera elatior* (Jack) R.M.Sm.] has a semi-erect plant growth direction, plant height 149.2-288.3 cm (254.34±45.11 cm), pseudo-stem diameter 3.05-3.82 cm (3.47±0.31 cm), pseudo-stem base has green colour. Leaf consists of blade, sheath, and petiole; leaf blade shape is lanceolate, green, thick, stiff, leaf apex is acuminate, leaf base is obtuse or emarginate, the adaxial surface of leaf blade is shiny and greener than the abaxial surface, leaf margin is undulate, leaf venation is pinnate (penninervis), midrib is prominent on the abaxial surface; petiole is short. Number of leaves 16-22 blades (19.25±2.49 blades), length of leaf sheath 103.9-142.7 cm (121.10±14.61 cm), length of ligule 1.2-1.5 cm (1.35±0.09 cm), length of petiole 1.2-1.4 cm (1.34± 0.08 cm), length of leaf blade 51.5-61.5 cm (56.73±3.97 cm), leaf blade width 9.9-16.2 cm (13.01±2.30 cm). True stem has a height of 106.4-179.5 cm (150.56±30.21 cm), segmented into nodes and internodes, length of internode 11.0-13.9 cm (12.26±1.08 cm). Rhizome is spherical, diameter 2.84-3.67 cm (3.20±0.32 cm), rhizome flesh is yellowish-white (elfenbein, RAL 1014); rhizome surface is smooth, soft, yellowish-white (elfenbein, RAL 1014), hairy, scale leaf is smooth and yellowish-white in colour (elfenbein, RAL 1015); anthocyanin colour of bud of rhizome is pink (Figure 16).

Inflorescence emerges from rhizome in the soil, total height of inflorescence 40.4-42.8 cm (41.6±1.70 cm); inflorescence stalk (peduncle) has an erect growth direction, length 33.3-34.5 cm (33.90±0.85 cm), spherical, diameter 1.67 cm; length of inflorescence 7.1-8.3 cm (7.70±0.85 cm), diameter of inflorescence 14.39 cm. Bracts number on peduncle 8-9 blades (8.50±0.71 blades), length of bract blade 3.5-11.2 cm (8.36±2.31 cm), yellowish-light green in color, length of horn on bract tip 0.05-0.40 cm (0.14±0.13 cm); segmented into nodes and internodes with length of internode 0.7-6.6 cm (3.72±1.74 cm). Bracts on rachis of inflorescence are pink (rose, RAL 3017) or younger, can be divided into sterile bracts (not supporting flowers) and fertile bracts (supporting flowers). Sterile bracts are arranged in outer rings of inflorescence, bract base is separated from each other, 16 blades, length 6.6-9.0 cm (7.71±0.73 cm), widht 1.9-4.4 cm (3.15±0.75 cm), bract apex is acute, obtuse, or rounded, bract apex has a horn with a length of 0.1-0.5 cm (0.30±0.13 cm). Fertile bracts are arranged in inner rings to the center of inflorescence, each bract is separated from each other, length 0.6-6.7 cm (3.45±1.05 cm), widht 0.2-2.2 cm (0.73±0.28 cm), bract apex is rounded, acute, or obtuse. Number of fertile bracts reaches 248 blades, each bract protects one flower, number of flower bud reaches 244 flowers. Inflorescence type is racemose, flower blooms from the outer rings to the center of inflorescence. Rachis has a height of 3.7 cm and a diameter of 1.16 cm (Figure 17).

Flower has a length of 4.7-4.9 cm (4.78±0.10 cm). Each flower is protected by a bracteole; bracteole is translucent-white and slightly reddish, length 1.8-2.4 cm (2.05±0.30 cm), the base unites to form a tube in a length of 2.1-2.3 cm (2.20±0.14 cm), the free-apex forms 2 blades with a length of 0.1-0.2 cm (0.13±0.05 cm). Calyx has a length of 3.2-3.5 cm (3.35±0.13 cm), gamosepalous, the base unites to form a tube with a length of 3 cm, the free-apex forms 2-3 blades with a length of 0.05-0.30 cm (0.16±0.07 cm), red (orientrot, RAL 3031). Corolla is gamopetalous, tubular with a tube length of 2.4-2.5 cm (2.45±0.06 cm), white; has 3 blades, red, zygomorphic; one of blades is shorter than others with a length of 2.1-2.2 cm (2.18±0.05 cm) and a width of 0.4-0.5 cm (0.47±0.06 cm), while the other two blades have a length of 2.5-2.7 cm (2.56±0.07 cm) and a width of 0.20-0.35 cm (0.30±0.05 cm). Lip/labellum has 1 blade with a length of 1.8-2.0 cm (1.93±0.10 cm), width

1.6-1.7 cm (1.68±0.05 cm), red (orientrot, RAL 3031) with yellow-edges, rhombus-shaped with the blade edges folding to cover pistil and stamen. Fertile stamen 1 with a length of 0.6 cm. Sterile stamens 2, flat-shaped, length 0.25-0.33 cm (0.29±0.04 cm), width 0.18-0.21 cm (0.19±0.01 cm), yellow. Pistil has a total length of 3.5-3.7 cm (3.63±0.10 cm), length of pistil stalk (style) 3.4-3.5 cm (3.43±0.06 cm); stigma shape is club, black, length 0.10-0.18 cm (0.15±0.04 cm), diameter 0.23-0.30 cm (0.27±0.03 cm); ovary has a length of 0.27 cm and a diameter of 0.2 cm, 3 lobes, each lobe contains many ovules (Figure 18).

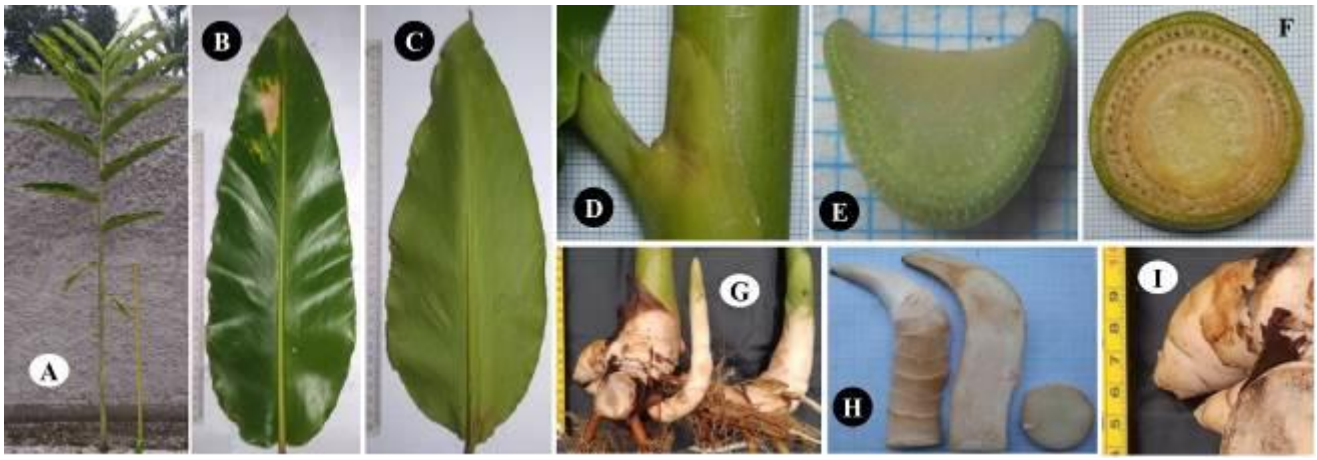


Figure 16. Morphological characters of vegetative organs in torch ginger (*Etlingera elatior*) from Serang District, Banten. A. Plant performance, B. adaxial surface of leaf blade, C. abaxial surface of leaf blade, D. ligule, E. transverse section of petiole, F. transverse section of pseudo-stem, G. rhizome, H. transverse and longitudinal sections of rhizome, I. bud of rhizome

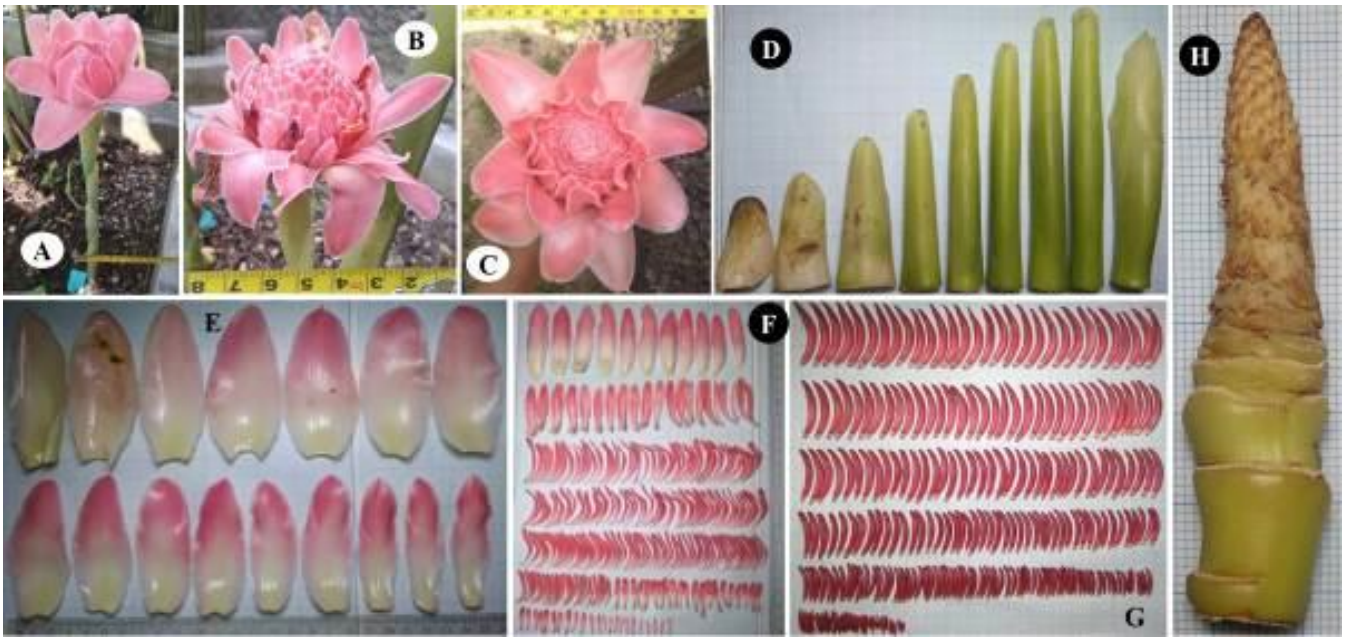


Figure 17. Morphological characters of inflorescence in torch ginger (*Etlingera elatior*) from Serang District, Banten. A-C. Inflorescence, D. bracts of peduncle, E. sterile bracts on rachis of inflorescence that not supporting flowers, F. fertile bracts on rachis of inflorescence that supporting flowers, G. bud of flowers, H. rachis

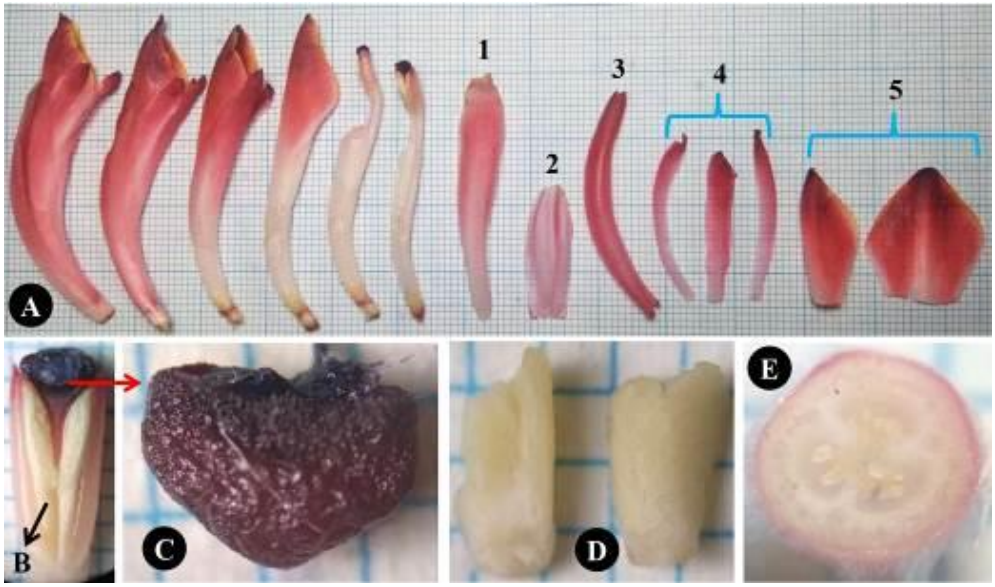


Figure 18. Parts of flower in torch ginger (*Etlingera elatior*) from Serang District, Banten. A. Parts of flower, B. fertile stamen, C. stigma, D. sterile stamen, E. transverse section of ovary; 1. fertile bract that supporting flower, 2. bracteole, 3. calyx, 4. corolla, 5. lip/labellum

Kaempferia rotunda L.

Kunyit putih (*Kaempferia rotunda* L.) has an erect plant growth direction, plant height 79.2-98.0 cm (88.80±9.41 cm), pseudo-stem diameter 2.67-3.02 cm (2.84±0.82 cm), pseudo-stem base is brownish-red. Leaf consists of blade, sheath, and petiole; leaf shape is oblong or lanceolate, leaf apex is acuminate, leaf base is acuminate, adaxial surface of leaf blade is dark-green with whitish-tinge, the abaxial surface of leaf blade is green and hairy like velvet; leaf margin is undulate, midrib protrudes on the abaxial surface, midrib and leaf base are brownish-purple (weinrot, RAL 3005), leaf venation is pinnate (penninervis); petiole is long, green, and slightly brownish-purple (weinrot, RAL 3005), grooves deeply on the adaxial surface. Leaves number 5-7 blades (6.00±0.82 blades), length of leaf sheath 32.5-33.9 cm (33.33±0.74 cm), length of ligule 0.1-0.2 cm (0.13±0.06 cm), length of petiole 8.8-17.0 cm (11.93±4.43 cm), length of leaf blade 37.4-47.0 cm (43.30±5.16 cm), leaf blade width 10.7-12.3 cm (11.66±0.59 cm), leaf apex is acuminate, leaf base is acuminate. True stem has a height of 1.5-2.5 cm (1.97±0.50 cm), segmented into nodes and internodes, length of internode 0.5-0.9 cm (0.63±0.23 cm). The rhizome is spherical or elliptical, diameter 2.80-3.92 cm (3.23±0.39 cm), the surface of rhizome has brownish-yellow colour and medium roughness, rhizome flesh is white, anthocyanin colour of bud of rhizome is yellowish-white. Roots emerge from rhizome surface, root tip forms a white tuber with a diameter of 1.65-1.90 cm (1.78±0.09 cm) and a length of 3.00-3.93 cm (3.33±0.27 cm) (Figure 19).

Inflorescence emerges from rhizome in the soil with a total height of inflorescence reach 14 cm. The inflorescence stalk (peduncle) is short, has an erect growth direction; bracts on peduncle numbered 8-9 blades (8.50±0.71 blades) with a length of 3.0-7.2 cm (5.04±1.45 cm) and a width of 1.6-3.9 cm (2.75±0.78 cm), light-green to green in colour (schwarzrot, RAL 3007), bract tip is acute, acuminate, or rounded. Rachis is flat with a diameter of 1.06 cm. Inflorescence type is racemose that can support up to 10 flowers that blooming simultaneously from the very edge to the center of inflorescence (Picture 20).

Each flower is protected by bracteole. Bracteole is yellowish-white, length 2.0-2.2 cm (2.10±0.14 cm), width 1.2 cm, the edges are separated from each other, the base attaches to rachis, the apex has two blades with a length of 0.5 cm. Calyx has a length of 4.1-5.0 cm (4.58±0.37 cm); gamosepalous, the base is tubular, attaches on ovary tip, length of tube 2.3-3.0 cm (2.67±0.27 cm); the tip has blades with a length of 1.6-2.1 cm (1.90±0.20 cm). Corolla is gamopetalous, tubular with a tube length of 3.4-5.3 cm (4.16±0.69 cm); has 3 blades, white, zygomorphic, the apex is acute; one of blades is dorsal corolla, larger with a length of 5.5-6.7 cm (6.01±0.41 cm) and a width of 0.8-1.0 cm (0.91±0.09 cm), while the other two blades are lateral corolla, have a length of 4.2-5.8 cm (5.01±0.45 cm) and a width of 0.60-0.71 cm (0.67±0.05 cm). Staminodes have 4 blades, consists of lateral staminodes with 2 white-blades separated from each other, length 3.3-4.8 cm (4.16±0.54 cm), width 1.2-1.8 cm (1.49±0.23 cm), while the other two blades are labellum, purplish-white, length 1.7-2.7 cm (2.25±0.31 cm), width 1.1-1.7 cm (1.45±0.23 cm), the base of both attaches each to other. Fertile stamen 1, length 0.6-0.7 cm (0.68±0.04 cm). Sterile stamens 2, length 0.60-0.84 cm (0.69±0.08 cm), tubular, white. Pistil has a total length of 4.50-6.25 cm (5.43±0.64 cm), length of style 4.4-6.1 cm (5.32±0.63 cm); stigma has cup-shape, white, length 0.10-0.15 cm (0.11±0.02 cm), diameter 0.14-0.20 cm (0.17±0.03 cm); ovary has a length of 0.3-0.7 cm (0.50±0.18 cm), diameter 0.26-0.43 cm (0.33±0.09 cm), 3 lobes, each lobe contains many ovules (Figure 20).

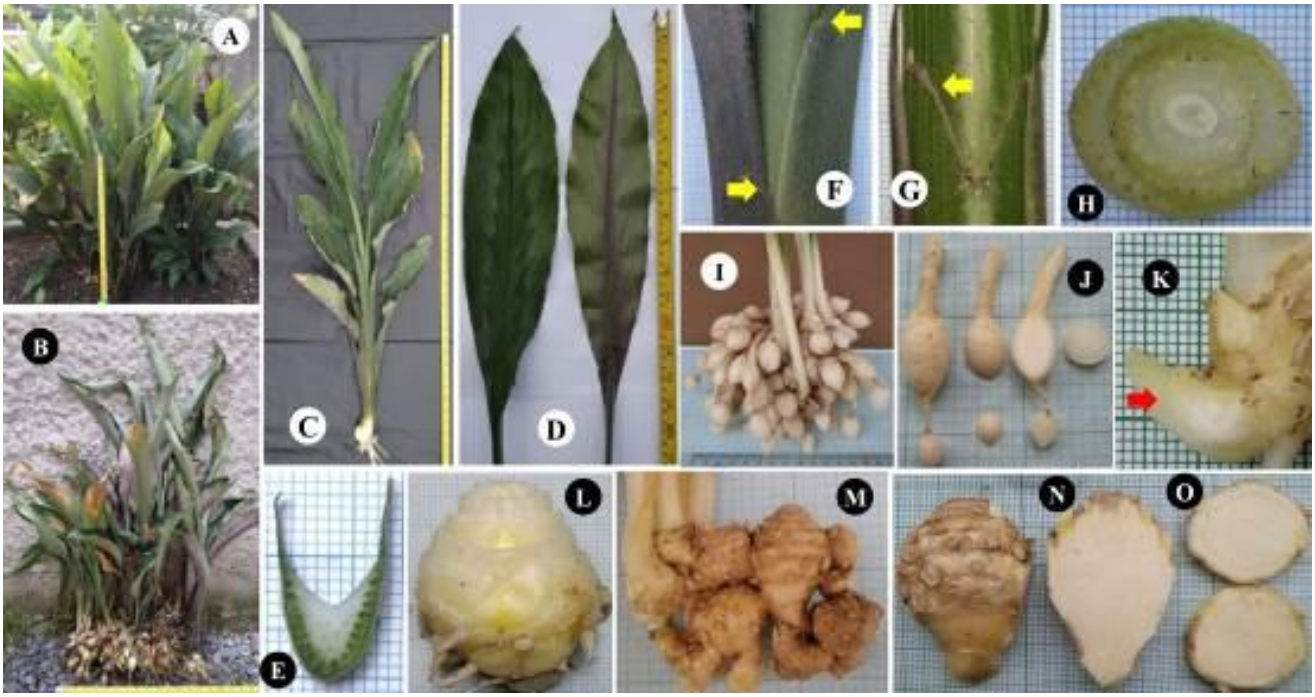


Figure 19. Morphological characters of vegetative organs in kunyit putih (*Kaempferia rotunda*) collected from Serang District, Banten. A-C. Plant performance, D. adaxial (left) and abaxial (right) surfaces of leaf blade, E. transverse section of petiole, F-G. ligule, H. transverse section of pseudo-stem, I. rhizome and tuber in the soil, J. tuber in root ends, K. bud of rhizome, L. true stem, M. rhizomes, N. longitudinal section of rhizome, O. transverse section of rhizome

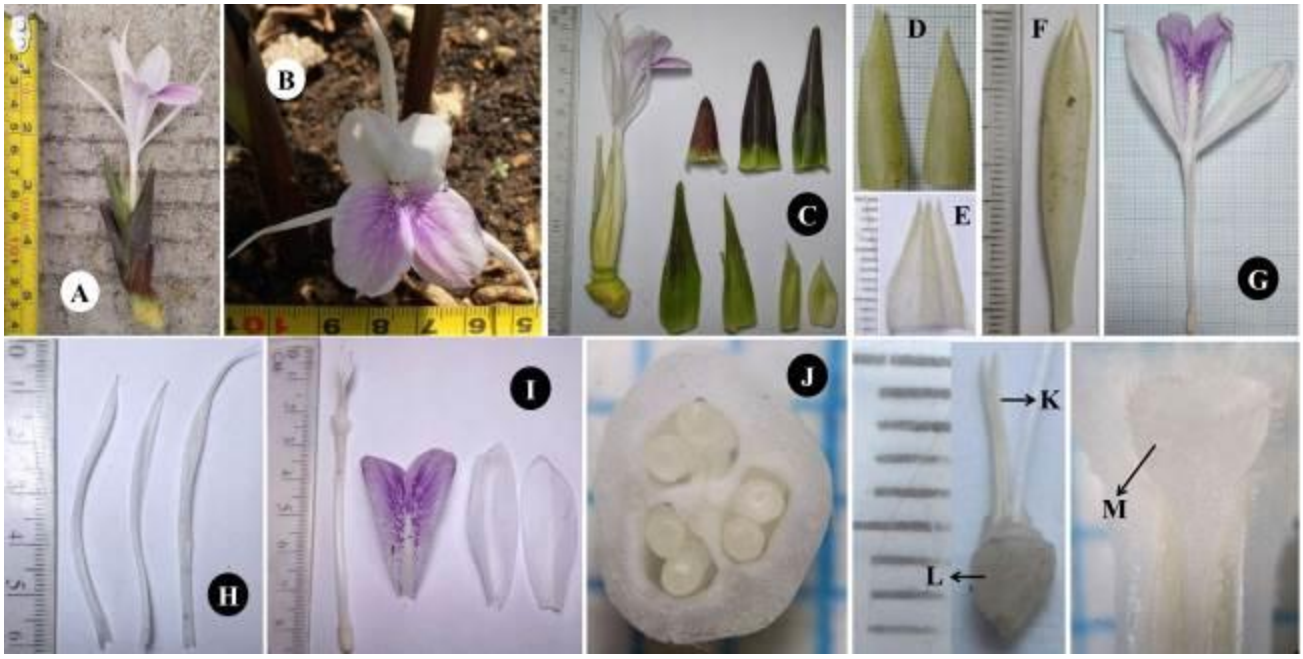


Figure 20. Morphological characters of generative organs in kunyit putih (*Kaempferia rotunda*) from Serang District, Banten. A. Inflorescence, B. flower, C. bracts of peduncle, D. bracts of rachis, E. bracteole, F. calyx, G. transverse section of flower, H. corolla, I. tube corolla (left), labellum (middle), and lateral staminodes (right), J. transverse section of ovary with 3 chambers containing many ovules in each chamber, K. sterile stamen, L. ovary, M. stigma with style in a groove of fertile stamen

Zingiber cassumunar Roxb.

Bangle [*Zingiber cassumunar* Roxb., synonym of *Zingiber montanum* (J. Koenig) Link ex A. Dietr] has a semi-erect plant growth direction, plant height 171.5-202.5 cm (183.01±9.47 cm), diameter of pseudo-stem 15.8-18.1 mm (16.62 ±0.77 mm), the base of pseudo-stem is reddish. Leaf consists of blade, sheath, and petiole; leaf blade shape is narrow-lanceolate, green, leaf apex is acute, leaf base is acute, leaf margin is entire, leaf venation is parallel (rectinervis), midrib is prominent on the abaxial surface.

Number of leaves 46-57 blades (50.10±3.63 blades), length of sheath 26.0-29.4 cm (27.39±1.04 cm), length of ligule 0.3-1.0 cm (0.41±0.21 cm), length of leaf blade 35.7-38.3 cm (36.81±0.79 cm), leaf blade width 5.0-5.6 cm (5.25±0.22 cm), leaf tip is acute, leaf base is acute; petiole is short, length 0.8-1.0 cm (0.89±0.06 cm), grooves on the adaxial surface. True stem has a height of 147.0-175.8 cm (158.36±11.20 cm), segmented into nodes and internodes with a length of internode of 5.7-9.8 cm (7.36±1.27 cm). Rhizome is spherical, diameter 3.27-4.50 cm (3.79±0.39 cm), rhizome surface is rough and brownish-yellow, rhizome flesh colour is dark-yellow (ginstergelb, RAL 1032), anthocyanin colour of bud of rhizome is pink. Generative organs were not found in this study (Figure 21).

Zingiber officinale Roscoe

Ginger (*Zingiber officinale* Roscoe) has a semi-erect plant growth direction, plant height 109.7-121.6 cm (112.83±3.42 cm), pseudo-stem diameter 10.2-13.0 mm (11.14±0.93 mm), pseudo-stem base colour is red. Leaf consists of blade, sheath, and short-petiole; leaf blade shape is narrow-lanceolate, leaf apex is acute, leaf base is acute, leaf margin is entire, leaf venation is parallel (rectinervis). Number of leaves 31-34 blades (32.90±0.99 blades), length of ligule 0.4-0.7 cm (0.51±0.07 cm), length of petiole 0.8 cm, length of leaf blade 27.7-29.1 cm (28.03±0.48 cm), leaf blade width 3.1-3.4 cm (3.22±0.09 cm). Rhizome shape is elliptical, diameter 2.47-2.80 cm (2.62±0.10 cm), rhizome flesh is yellowish-white (sandgelb, RAL 1002), rhizome surface is rough and has yellowish-white (beige, RAL 1001) colour, anthocyanin color of bud of rhizome is yellowish-white (Figure 22).

Inflorescence emerges from pseudo-stem shoot or rhizome in the soil. A total height of plant producing inflorescence from pseudo-stem shoot ranges from 37.1-50.8 cm (43.95±9.69 cm). Meanwhile, inflorescence that emerging from rhizome in the soil, has a total height of inflorescence by 22.5-34.9 cm (28.64±4.36 cm), the growth direction of inflorescence stalk (peduncle) is erect, length of peduncle 16.6-27.3 cm (22.09±4.03 cm), length of inflorescence 5.7-8.1 cm (6.84±0.75 cm), diameter of inflorescence 2.00-2.37 cm (2.18±0.11 cm). Number of bracts on peduncle reaches 5 blades. Bract on rachis of inflorescence is green, bract apex is yellow, 22-32 blades (26.33±3.11 blades), length 0.3-3.2 cm (2.33±0.21 cm), width 0.2-2.7 cm (2.02±0.27 cm), each bract supports one flower (Figure 22C-F).

A total length of flower ranges between 4.0-4.7 cm (4.36±0.19 cm). Each flower is protected by a bracteole; bracteole has a length of 2.4-2.6 cm (2.51±0.08 cm), width 1.30-1.9 cm (1.47±0.16 cm), translucent-white, the apex is green, the edges are free, the base attaches on rachis. Calyx is gamosepalous, has a total length of 0.7-1.0 cm (0.84±0.07 cm), translucent-white, the base is tubular to form a tube, attaches on ovary. Corolla is gamopetalous, tubular with a tube length of 1.9-2.8 cm (2.29±0.29 cm); has 3 blades, zygomorphic, yellow; one of blades is dorsal corolla, larger with a length of 1.6-2.1 cm (1.76±0.12 cm) and a width of 0.55-0.70 cm (0.66±0.05 cm), while the other two blades are lateral corolla, have a length of 1.2-1.7 cm (1.45±0.12 cm) and a widht of 0.30-0.35 cm (0.31±0.02 cm). Staminodes have 3 blades, zygomorphic, yellow with red edges; one of blades is labellum, larger with a length of 1.2-1.5 cm (1.39±0.09 cm) and a width of 0.8-1.4 cm (1.19±0.19 cm), while the other two blades are lateral staminodes, have a length of 0.5-0.8 cm (0.60±0.09 cm) and a width of 0.3-0.5 cm (0.36±0.05 cm). Fertile stamen 1, length 0.8-0.9 cm (0.86±0.05 cm), yellow, the apex has a black horn; sterile stamens 2, tubular, white, length 0.5-0.8 cm (0.61±0.08 cm). Pistil has a total length of 3.8-5.5 cm (4.65±1.20 cm); the stigma is truncate-shaped, white; ovary has a length of 0.2-0.3 cm (0.25±0.04 cm), diameter 0.23-0.28 cm (0.26±0.01 cm), 3 lobes, each lobe contains many ovules (Figure 23).

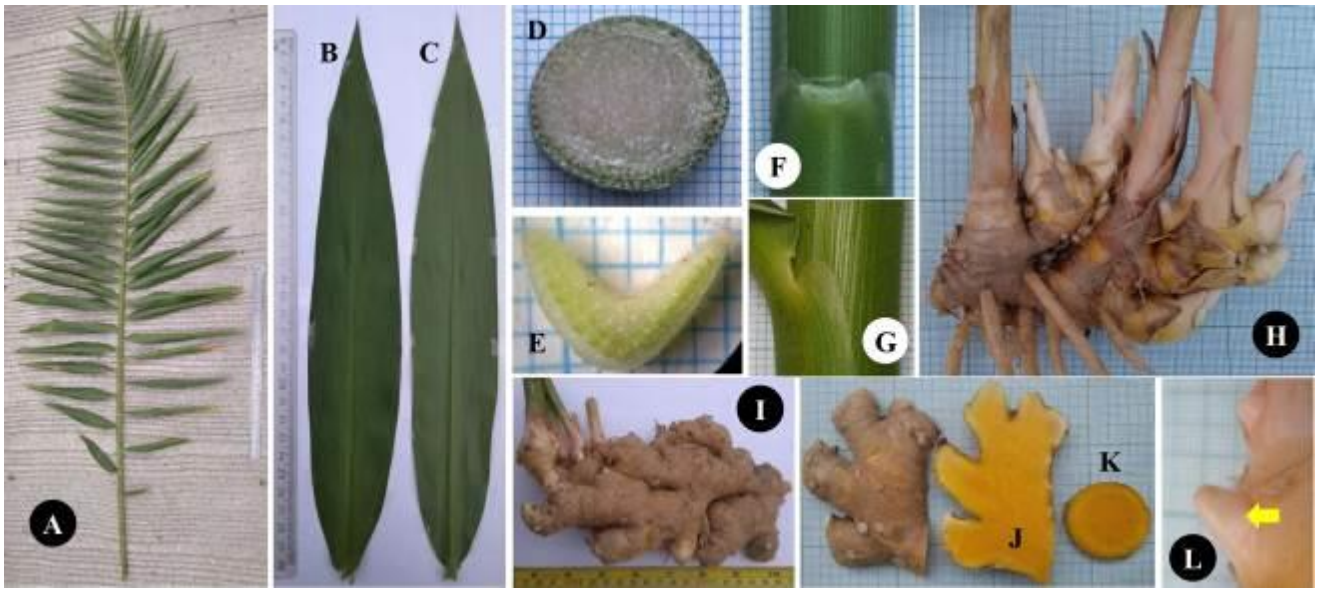


Figure 21. Morphological characters of vegetative organs in bangle (*Zingiber cassumunar*) collected from Serang District, Banten. A. Plant performance, B. adaxial surface of leaf blade, C. abaxial surface of leaf blade, D. transverse section of pseudo-stem, E. transverse section of petiole, F-G. ligule, H-I. rhizome in the soil, J. longitudinal section of rhizome, K. transverse section of rhizome, L. bud of rhizome

Figure 22. Morphological characters of vegetative organ and inflorescence in ginger (*Zingiber officinale*) from Serang District, Banten. A. Plant performance, B. leaf blade, C-E. inflorescence emerging from rhizome in the soil, F. bracts on rachis of inflorescence, G. pseudo-stem base having red colour, H. bud of rhizome, I. rhizome; 1. longitudinal section of rhizome, 2. transverse section of rhizome

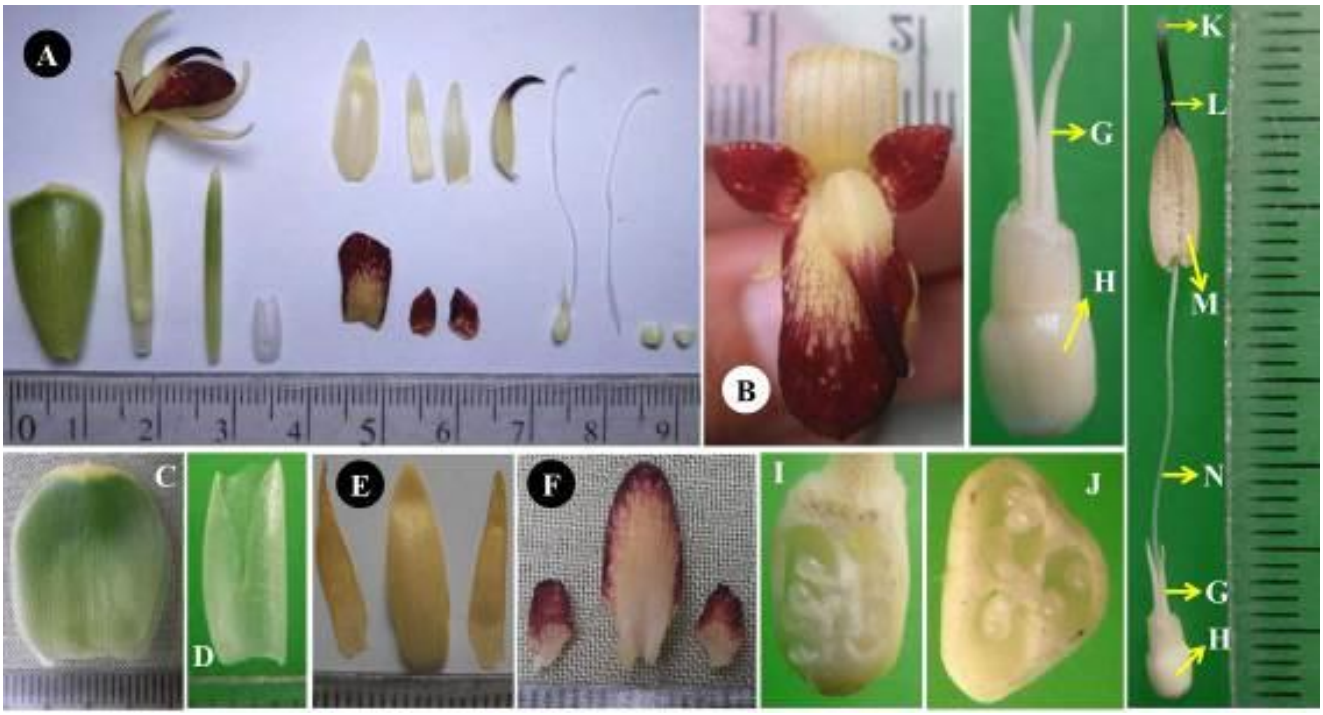


Figure 23. Flower of ginger (*Zingiber officinale*) from Serang District, Banten. A. Parts of flower, B. performance of flower from upper view, C. bract on rachis of inflorescence, D. calyx, E.lateral corolla (left and right) and dorsal corolla (middle), F. lateral staminodes (left and right) and labellum (middle), G. sterile stamen, H. ovary, I. longitudinal section of ovary, J. transverse section of ovary with 3 lobes containing ovules, K. stigma, L. black-horn of fertile stamen, M. fertile stamen, N. style of pistil

Zingiber officinale var. *rubrum*

Red ginger (*Zingiber officinale* var. *rubrum*) has a semi-erect growth direction, plant height 120.7-136.5 cm (125.74±4.65 cm); pseudo-stem is spherical-shaped with a diameter of 10.9-14.2 mm (12.13±1.10 mm), pseudo-stem base is red. Leaf consists of blade, sheath, and petiole; leaf blade is dark-green, narrow-lanceolate, leaf apex is acute, leaf base is acute, leaf margin is entire, leaf venation is parallel (rectinervis), midrib is prominent on the abaxial surface, abaxial surface of leaf blade is hairy; petiole is short, semi-circular in shape. Number of leaves 36-42 blades (39.0±2.0 blades), length of leaf sheath 34.2-37.6 cm (35.56±1.15 cm), length of ligule 1.0-1.2 cm (1.09±0.06 cm), length of petiole 0.5-0.7 cm (0.56± 0.07 cm), length of leaf blade 31.1-35.0 cm (32.54±1.41 cm), leaf blade width 2.0-3.2 cm (2.85±0.32 cm), leaf apex is acute, leaf base is acute. True stem has a height of 86.8-99.8 cm (92.2±4.02 cm), segmented into nodes and internodes with a length of internode by 5.7-7.2 cm (6.28±0.48 cm). Rhizome is elliptical in shape, diameter 2.81-3.63 cm (3.08±0.22 cm), rhizome surface is rough and red (purpurrot, RAL 3004), rhizome flesh is yellowish-white (hellelfenbein, RAL 1015), anthocyanin color of bud of rhizome is red (Figure 24).

Inflorescence emerges from pseudo-stem shoot or rhizome in the soil. Inflorescence emerging from rhizome in the soil, has a total height of inflorescence by 36.10 cm; the growth direction of inflorescence stalk (peduncle) is erect, length of peduncle 23 cm, diameter of peduncle 0.76 cm; length of inflorescence 11.7-19.0 cm (15.35±5.16 cm), diameter of inflorescence 2.67-2.90 cm (2.79±0.16 cm). Number of bracts on peduncle 9 blades, green, length 3.1-6.8 cm (4.94±1.45 cm), width 1.6-3.6 cm (2.53±0.78 cm). Number of bracts on rachis of inflorescence 37-53 blades (45±11.31 blades), length 2.5-3.8 cm (2.92±0.18 cm), width 1.6-3.3 cm (2.82±0.32 cm), green, white-bract base, the apex is reddish-yellow (Figure 25).

Flower is protected by a bracteole; bracteole is white with a yellowish-green tip, length 2.6-3.0 cm (2.84±0.12 cm), width 1.5-2.0 cm (1.80±0.14 cm). Flower has a total length of 4.1-4.8 cm (4.43±0.27 cm). Calyx is translucent-white, gamosepalous, tubular, total length of calyx 1.0-1.2 cm (1.13±0.07 cm). Corolla is gamopetalous, tubular, with length of tube 1.9-2.6 cm (2.09±0.23 cm); has 3 blades, zygomorphic, yellow; one of blades is dorsal corolla, larger with a length of 1.6-1.9 cm (1.79±0.08 cm) and a width of 0.7-0.9 cm (0.8±0.06 cm), while the other two blades are lateral corolla, have a length of 1.4-1.8 cm (1.59±0.10 cm) and a width of 0.35-0.50 cm (0.4±0.04 cm). Staminodes have 3 blades, zygomorphic, yellow with red-edges; one of blades is labellum, larger with a length of 1.2-1.5 cm (1.34±0.11 cm) and a width of 0.9-1.2 cm (1.03±0.09 cm); the other two blades are lateral staminodes, have a length of 0.5-0.7 cm (0.63±0.07 cm) and a width of 0.4-0.6 cm (0.47±0.06 cm). Fertile stamen 1, length 0.9-1.0 cm (0.98±0.04 cm), the tip has a black horn; sterile stamens 2, tubular, white, length 0.50-0.85 cm (0.72±0.08 cm). Pistil has a length of 3.8-4.7 cm (4.09±0.25 cm); stigma is truncate-shaped, white. Ovary has a length of 0.2-0.3 cm (0.23±0.04 cm), diameter 0.27-0.34 cm (0.30±0.03 cm), 3 lobes, each lobe contains many ovules (Figure 25).

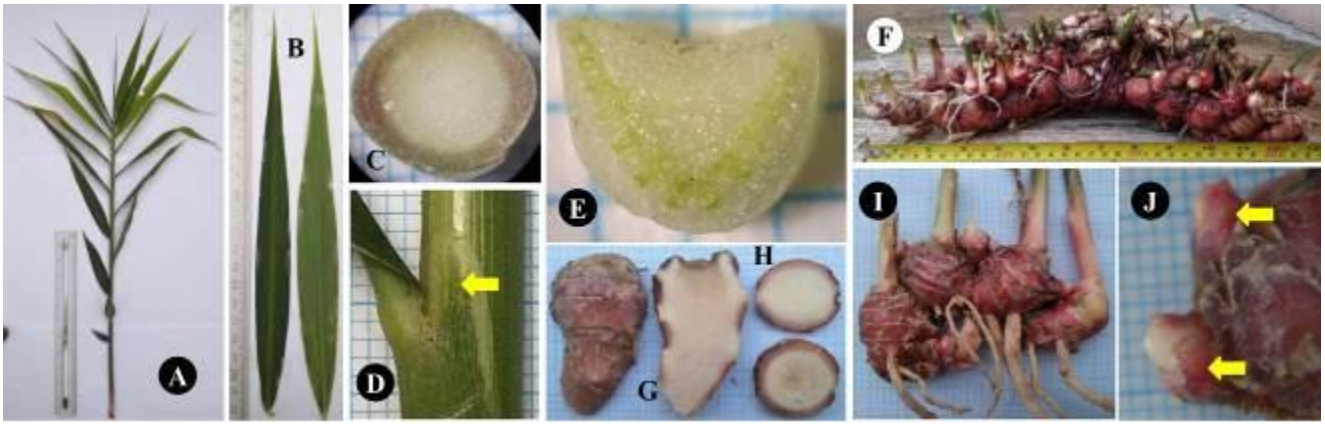


Figure 24. Morphological characters of vegetative organ in red ginger (*Z. officinale* var. *rubrum*) collected from Serang District, Banten. A. Plant performance, B. adaxial (left) and abaxial (right) surfaces of leaf blade, C. transverse section of pseudo-stem, D. ligule, E. transverse section of leaf petiole, F. arrangement of rhizomes in the soil, G. longitudinal section of rhizome, H. transverse section of rhizome, I. rhizome surface, J. buds of rhizome

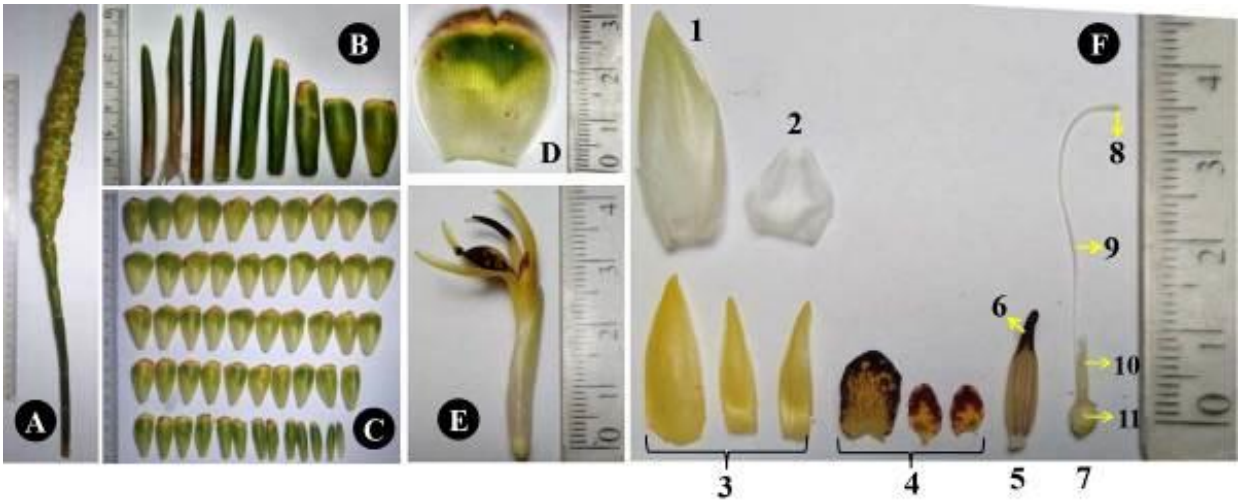


Figure 25. Morphological characters of generative organs in red ginger (*Z. officinale* var. *rubrum*) collected from Serang District, Banten. A. Inflorescence, B. bracts of peduncle, C-D. bracts on rachis of inflorescence, E. flower, F. parts of flower; 1. bracteole, 2. calyx, 3. dorsal corolla (left) and lateral corolla (middle and right), 4. labellum (left) and lateral staminodes (middle and right), 5-11. reproductive organ parts, 5. fertile stamen, 6. horn of fertile stamen, 8. stigma, 9. style, 10. sterile stamen, 11. ovary

Zingiber zerumbet (L.) Roscoe ex Sm.

Lempuyang gajah [*Zingiber zerumbet* (L.) Roscoe ex Sm.] has a semi-erect plant growth direction, plant height 136.2-164.1 cm (152.77±8.01 cm), pseudo-stem diameter 11.6-20.8 mm (15.81±2.97 mm), pseudo-stem base colour is reddish. Leaf consists of blade, sheath, and short-petiole; leaf shape is lanceolate, leaf apex is acuminate, leaf base is acute or obtuse, leaf blade is green, leaf margin is entire, leaf venation is pinnate (penninervis). Number of leaves 18-31 blades (23.10±3.98 blades), length of leaf sheath 29.6-35.2 cm (31.91±1.96 cm), length of ligule 2.4-3.1 cm (2.71±0.23 cm), length of petiole 1.1-1.5 cm (1.25±0.14 cm), length of leaf blade 27.5-32.4 cm (29.56±1.73 cm), leaf blade width 7.9-10.8 cm (9.04±0.85 cm). The leaf apex is acute or acuminate, the base of leaf is obtuse, acute, or rounded. True stem has a height of 97.7-122.6 cm (114.21±7.06 cm), segmented into nodes and internodes with length of internode by 5.6-11.8 cm (8.24±1.97 cm). Rhizome is spherical or elliptical in shape, diameter 2.85-4.87 cm (3.75±0.58 cm), rhizome surface is rough and yellowish-white (beige, RAL 1001), rhizome flesh is yellowish (perweib-schwefelgelb, RAL 1013-1016), anthocyanin color of bud of rhizome is white. Generative organs were not found in this study (Figure 26).

Relationship analysis

Based on the analysis of UPGMA using Program NTSYs version 2.02, the result showed the morphological characters of vegetative organs gave a high diversity among the thirteen species/cultivars. From the dendogram as presented in Figure 27, it can be seen that the thirteen species/cultivars had a similarity distance coefficient from 37% to 94%. The thirteen species/cultivars were divided into two main groups; group I includes *C. xanthorrhiza*, *C. longa*, *C. heyneana*, *C. mangga*, *C. aeruginosa*, *K. rotunda*, *E. elatior*, *A. compactum*, *Z. zerumbet*, and *A. purpurata*, while group II includes *Z. officinale*, *Z. officinale* var. *rubrum*, dan *Z. cassumunar*. Group I was divided into two small groups; sub-group A includes *C. xanthorrhiza*, *C. longa*, *C. heyneana*, *C. mangga*, *C. aeruginosa*, and *K. rotunda*, while sub-group B includes *E. elatior*, *A. compactum*, *Z. zerumbet*, and *A. purpurata*. The species of *C. xanthorrhiza*, *C. heyneana*, and *C. longa* had the highest similarity (94%), as well as between *Z. officinale* and *Z. officinale var. rubrum* (94%).

In this study, the generative organs were only found in eight species/cultivars of Zingiberaceae, i.e. *C. xanthorrhiza*, *C. heyneana*, *C. longa*, *K. rotunda*, *E. elatior*, *A. compactum*, *Z. officinale* and *Z. officinale* var. *rubrum*. The similarity distance based on morphological characters of vegetative and generative organs showed a kinship relationship among those eight species/cultivars Zingiberaceae from Serang District, Banten. Based on the analysis of UPGMA using Program NTSYs version 2.02, the result showed a high diversity among eight species/cultivars based on vegetative and generative organs. From the dendogram as presented in Figure 28, it can be seen that the eight species/cultivars had a similarity distance coefficient from 31% to 94%. Those eight species/cultivars were divided into two main groups; group I includes *C. xanthorrhiza*, *C. heyneana*, *C. longa*, *K. rotunda*, *E. elatior*, and *A. compactum*, while group II includes *Z. officinale* and *Z. officinale* var. *rubrum*. Group I was divided into two sub-groups, i.e. sub-group A (*C. xanthorrhiza*, *C. heyneana*, *C. longa*, *K. rotunda*) and sub-group B (*E. elatior*, *A. compactum*). The species of *C. xanthorrhiza* and *C. heyneana* showed the highest similarity (94%), as well as between *Z. officinale* and *Z. officinale* var. *rubrum* (94%).

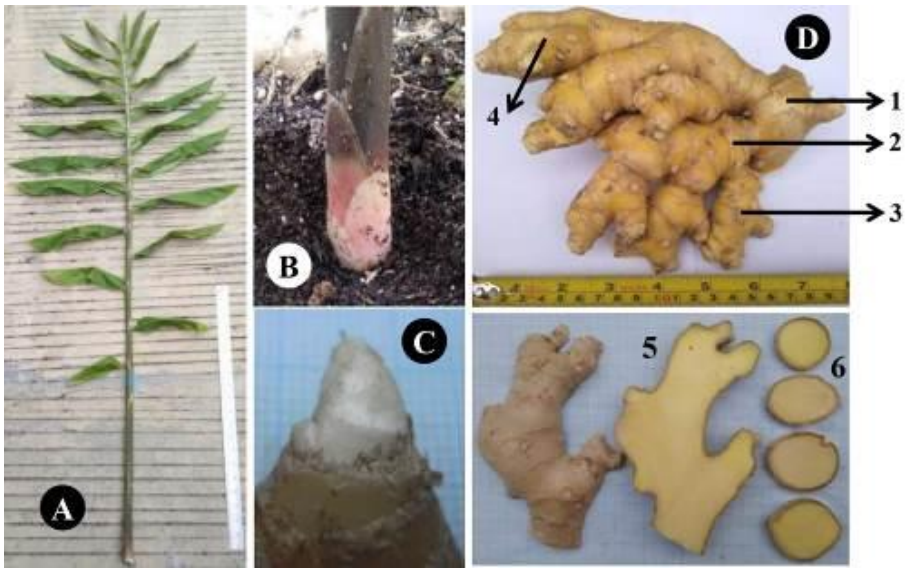


Figure 26. Morphological characters of vegetative organs in lempuyang gajah (*Zingiber zerumbet*) collected from Serang District, Banten. A. Plant performance, B. reddish-pseudo-stem base, C. bud of rhizome, D. rhizomes; 1. main rhizome, 2. primary rhizome, 3. secondary rhizome, 4. tertiary rhizome, 5. longitudinal section of rhizome, 6. transverse section of rhizome

Key to identification

Identification key to Zingiberaceae in Serang District, Banten based on vegetative and generative organs:

1 Leaf venation is rectinervis …… 2
Leaf venation is penninervis 3

2 Anthocyanin colour of bud in rhizome is yellowish-white … ……..…… *Z. officinale*
Anthocyanin colour of bud in rhizome is red …… ……..... *Z. officinale* var. *rubrum*

3 Plant growth direction is semi-erect, rhizome surface is smooth ……..…….. 4
Plant growth direction is erect, rhizome surface is medium or rough ……..…….. 5

4 Petiole is absence, growth direction of peduncle is humifusus; corolla 2 blades, actinomorf; staminodes 2 blades …… *A. compactum*
Petiole is short, growth direction of peduncle is erect; corolla 3 blades, zigomorf; staminode 1 blade ……... ……..... *E. elatior*

5 Leaf margin is undulate, pseudo-stem base colour is brownish-red, rhizome flesh colour is white, staminodes 4 blades, labellum colour is purplish-white, cup-shaped stigma, fertile stamen without horn ……..…… *K. rotunda*
Leaf margin is entire, pseudo-stem base colour is green, rhizome flesh colour is orange, staminodes 3 blades, labellum colour is yellow, lobed-shaped stigma, fertile stamen with horn …… 6

6 Colour of bractea on rachis of inflorescence is whiteness-green ……..…….. *C. longa*
Colour of bractea on rachis of inflorescence is purplish-pink …… 7

7 Anthocyanin colour of bud in rhizome is white, corolla colour is white ……..……. *C. heyneana*
Anthocyanin colour of bud in rhizome is yellowish-white, corolla colour is pink …….. *C. xanthorrhiza*

Discussion

In total, there were 13 species/cultivar of Zingiberaceae recorded in this study i.e. *Curcuma xanthorrhiza*, *C. longa*, *C. heyneana*, *C. mangga*, *C. aeruginosa*, *Kaempferia rotunda*, *Etlingera elatior*, *Amomum compactum*, *Alpinia purpurata*, *Zingiber zerumbet*, *Z. officinale*, *Z. officinale* var. *rubrum*, and *Z. cassumunar*. Based on the result of the analysis, there were variations in morphological characters, both on vegetative and generative organs among the 13 species/cultivars. The variations included petiole, leaf margin, leaf venation, plant growth habit, colour of pseudo-stem base, leaf blade shape, leaf blade apex, leaf blade base, rhizome shape by transversal section, rhizome surface roughness, colour of rhizome flesh, and anthocyanin colour of bud of rhizome. The absence of petiole was just found in *A. compactum*. All members of *Zingiber* have parallel leaf venation, except *Z. zerumbet* with pinnate leaf venation.

In Zingiberaceae, the rhizome is widely used to identify the species when the parts of plant above the ground disappear in the dry season based on the aromatic compounds and colour of rhizome flesh. Based on the result of this study, the colour of rhizome flesh varied into white (*K. rotunda*), yellowish-white (*E. elatior*, *Z. officinale*, *Z. officinale* var. *rubrum*, *A. compactum*), yellowish (*Z. zerumbet*), yellow (*C. mangga*), dark-yellow (*Z. cassumunar*), orange (*C. xanthorrhiza*, *C. longa*, *C. heyneana*), reddish (*A. purpurata*), and blue (*C. aeruginosa*). The blue colour of rhizome flesh can be used as a specific marker for *C. aeruginosa*, but it must to be conducted carefully because the blue colour will degrade when the rhizome is over-mature or due to the storage process. The red rhizome in *Z. officinale* var. *rubrum* was also reported by Setiawan et al. (2018). The result of our study is also in line with Kaliyadasa and Samarasinghe (2019) who reported that the genus of *Curcuma* has branched, fleshy, and aromatic rhizome, roots attached to the rhizome, and lanceolate leaf blade.

The morphology of generative organs in 8 species/cultivars, i.e. *C. xanthorrhiza*, *C. heyneana*, *C. longa*, *K. rotunda*, *E. elatior*, *A. compactum*, *Z. officinale* and *Z. officinale* var. *rubrum*, also had variation in the growth direction of peduncle, colour of inflorescence bract, number and colour of corolla blade, number of staminodes blade, colour of labellum, stigma shape and colour, number and colour of horn of fertile stamen tip, and sterile stamen shape and colour. The growth direction of peduncle can be a specific marker for *A. compactum* (humifusus). The terminal bracts of inflorescence rachis of *Curcuma* genus form a sterile cluster with longer blade and bright colour were also reported by Kaliyadasa and Samarasinghe (2019). The terminal bract of inflorescence in *C. xanthorrhiza* and *C. heyneana* has the same colour, however the colour of corolla can differentiate both of them (i.e. *C. xanthorrhiza* = pink, *C. heyneana* = white). The corolla character can differentiate *A. compactum* (actinomorphic, two blade) from other members of Zingiberaceae observed (zigomorphic, 3 blade). The number of staminodes varied in Zingiberaceae; *E. elatior* has 1 lip, *A. compactum* has 2 blades, genus of *Zingiber* and *Curcuma* have 3 blades, and *K. rotunda* has 4 blades. Black-stigma can be specific marker for *E. elatior* from other members of Zingiberaceae observed. The sterile stamen can become a specific character for genus of *Curcuma* with tubular-shaped.

Sirirugsa (1998) explained that *Curcuma* genus has two distinct flowering forms, i.e. inflorescence laterally from rhizome and terminally from the leafy shoots. The both inflorescences commonly cause identification problems due to the intraspecific and interspecific morphological variations. However, the difference of both in this study could not be distinguished in each species because the laterally inflorescence from rhizome was just found in C. *xanthorrhiza*, while terminally inflorescence from the leafy shoots were just found in *C. heyneana* and *C. longa*. Meanwhile, the inflorescences of *Z. officinale* and *Z. officinale* var. *rubrum* emerge both from rhizome and leafy shoot.

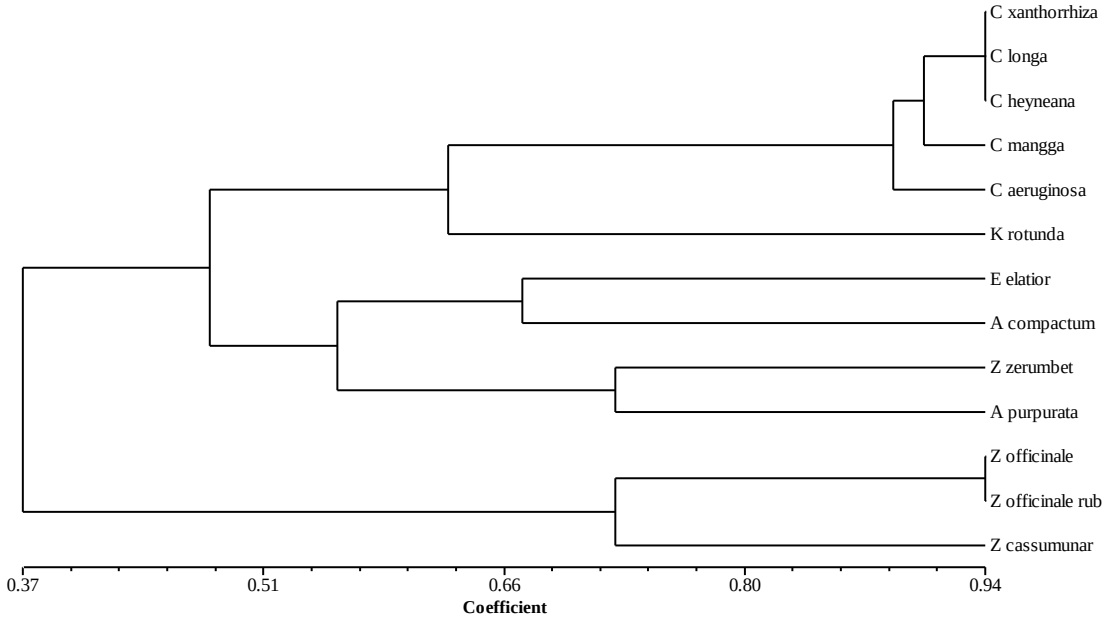


Figure 27. Dendogram of 13 species/cultivars collected from Serang District, Banten based on morphological characters of vegetative organs

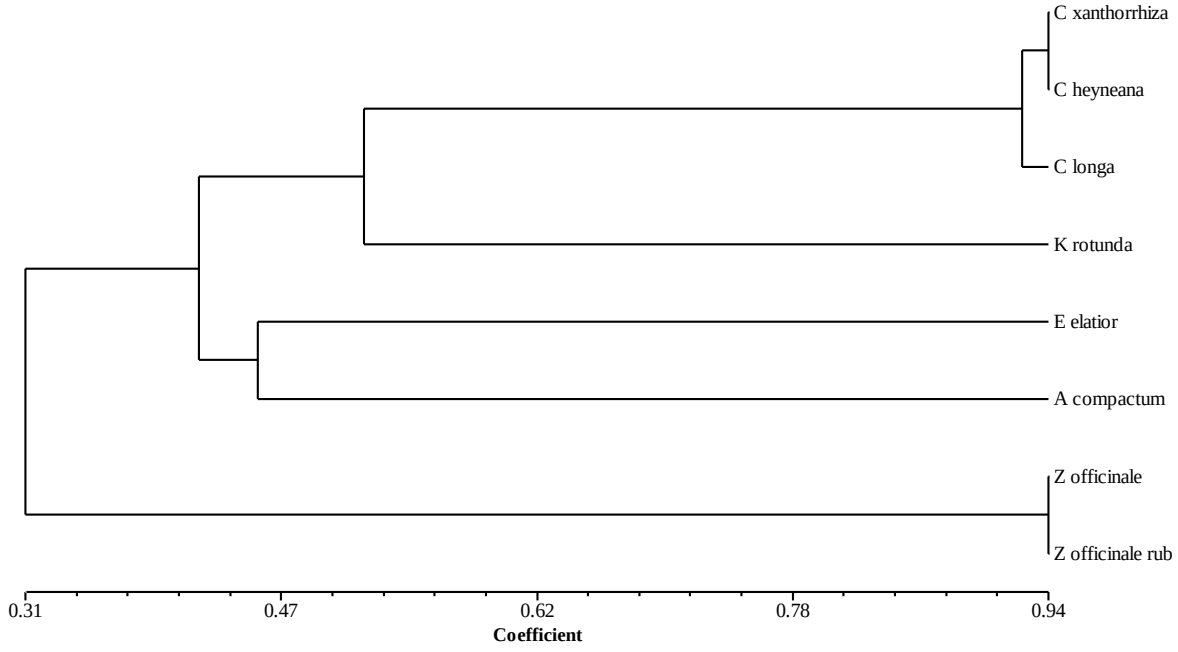


Figure 28. Dendogram of 8 species/cultivars collected from Serang District, Banten based on morphological characteristics of vegetative and generative organs.

The results of previous studies reported that the colour of rhizome flesh is deep orange-yellow (Abdel-Lateef et al. 2016) or yellowish-orange (Setiawan et al. 2018), while the result of this study is orange (RAL 1023-verkehrsgelb or 1007-narzissengelb). In other study by Setiawan (2018), the colour of rhizome flesh of red ginger is brightly yellowish-grey, while in this study it has yellowish-white (hellelfenbein, RAL 1015) colour. The use of international standard colour, such as RAL K7 Classic International Standard, can be one of solutions to avoid the subjectivity in colour perspective among botanist to determine the colour of plant morphological characters.

The use of morphological characters of vegetative organs can help taxonomical works, especially when the plant generative organs are not available. In this study, 13 species/cultivars of Zingiberaceae were observed for the morphological characters of vegetative organs, however only 8 species/cultivars were available to have vegetative

and generative organs. Based on the morphological characters of vegetative organs, *K. rotunda* is separated from genus *Curcuma* in sub-group A, while in group II *Z. cassumunar* is separated from *Z. officinale* and *Z. officinale* var. *rubrum*. The separation of *Z. zerumbet* from the *Zingiber* genus based on the morphological characters of vegetative organs in group II still has to be reconfirmed based on the morphological characters of generative organs which were not found in this study. Meanwhile, the use of vegetative and generative data was able to separate *C. longa* from *C. xanthorrhiza* and *C. heyneana*.

The kinship relationship between *C. xanthorhiza* and *C. heyneana* based on the morphological characters of vegetative organs only still give a consistent similarity distance coefficient (94%) with the results based on, both the morphological characters of vegetative and generative organs, as well as between *Z. officinale* and *Z. officinale* var. *rubrum* (94%). This result showed that the use of vegetative data has still been able to provide consistent grouping results with generative data.

The result of morphological characterization, both in vegetative and generative phases, had successfully helped to describe the members of Zingiberaceae observed and separate them into different groups based on similarity distance. The description of morphological characteristics of Zingiberaceae will useful for the identification of high economically Zingiberaceae for cultivation, especially in Serang District regions. The observation method of morphological characterization must be improved using the international standard method to overcome the subjectivity of qualitatively observation problem.

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