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# THE GENUS *Cnidoscolus* Pohl (EUPHORBIACEAE) IN JAVA

## MARGA *Cnidoscolus* Pohl (EUPHORBIACEAE) DI JAWA

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### Abstract

The information on Euphorbiaceae in Java island has been recorded in the Flora of Java Volume 1 by C.A. Backer and R.C. Bakhuizen v/d Brink Jr. However, the latest information on Euphorbiaceae of Java has not been provided since the book was published. Several additional species have been found from Java and this study aims to report additional information on Euphorbiaceae of Java. The study was carried out in four provinces: Banten, West Java, Central Java, and East Java from March to September 2019. The result of this study shows that there is one additional genus in Java, namely *Cnidoscolus* Pohl. The genus only consists of 1 species in Java, *i.e. C. aconitifolius* (Mill.) I.M. Johnst. The species is native to Mexico and Mesoamerica and it was commonly cultivated in Java as vegetable crops. In Malesia, *C. aconitifolius* was recorded before from Brunei, Singapore, and The Philippines. Thus, its presence in Java was considered as a newly distributional record for Malesia region.

**Keywords**: Chaya, *Cnidoscolus*, Euphorbiaceae, Java, Malesia

### *Abstrak*

*Informasi mengenai suku Euphorbiaceae di Pulau Jawa telah direkam dalam buku Flora of Java Volume 1 oleh C.A. Backer and R.C. Bakhuizen v/d Brink Jr. Meskipun demikian, informasi terkini mengenai Euphorbiaceae di Jawa belum tersedia sejak buku tersebut terbit. Beberapa jenis tambahan telah ditemukan dari Jawa dan penelitian ini bertujuan untuk melaporkan informasi tambahan mengenai Euphorbiaceae yang ada di Jawa. penelitian telah dilakukan di empat propinsi: Banten, Jawa Barat, Jawa Tengah, dan Jawa Timur pada bulan Maret hingga September 2019. Hasil penelitian menunjukkan adanya suatu marga tambahan di Jawa, yaitu Cnidoscolus Pohl. Marga tersebut hanya terdiri dari satu jenis saja di Jawa, yaitu C. aconitifolius (Mill.) I.M. Johnst. Jenis ini berasal dari Meksiko dan Mesoamerika dan telah umum dibudidayakan sebagai tanaman sayur di Jawa. Di kawasan Malesia, C. aconitifolius telah direkam sebelumnya dari Brunei, Singapura, dan Filipina. Oleh karena itu, keberadaannya di Jawa ditetapkan sebagai sebuah rekaman distribusi baru untuk kawasan Malesia.*

***Kata kunci**:* Chaya, *Cnidoscolus*, Euphorbiaceae, Jawa, Malesia

## INTRODUCTION

Euphorbiaceae is composed of 225 genera and more than 6300 species, which are widely distributed in the world, except Arctic and Antarctica, with greatest diversity in the tropics (Webster, 1994; Govaerts et al., 2000; Gray, 2011; Secco et al., 2012; Challen, 2015; Christenhusz et al., 2017). There are 91 genera with 1,354 species of Euphorbiaceae in Malesian region (Djarwaningsih, 2017). In Java, the Euphorbiaceae *s.l.* comprises of 60 genera and 209 species (Backer & Bakhuizen van den Brink, 1963).

The taxonomical information on plant diversity in Java had been considered complete after the publication of Flora of Java vol. 1–3. The books recorded 2067 genera with 6100 species (Backer & Bakhuizen van den Brink, 1963; 1965; 1968). Until now, the book series are still used as the main reference for studying plant species in the Java and Madura region. This is because the Flora of Java were considered adequately representative of the existence of flora in the island (Djarwaningsih 2010).

The updated information on Euphorbiaceae of Java has not been provided after the first volume of Flora of Java was published. Since then, several additional species have been reported from Java, *i.e. Balakata baccata* (Roxb.) Esser., *Endospermum diadenum* (Miq.) Airy Shaw, *Euphorbia graminea* Jacq., *E. hyssopifolia* L., and *Suregada glomerulata* (Blume) Baill. (Djarwaningsih, 2012; Djarwaningsih, 2013; Irsyam et al., 2019). The number of additional species will be increased in the future. The reports on additional species will be needed in compiling an updated information on Euphorbiaceae of Java. Thus, the purpose of this study is to report other additional species of Euphorbiaceae from Java island.

## MATERIALS & METHODS

Field study was conducted from March to September 2019 in Banten (Serpong), West Java (Bandung, Bekasi, Bogor, Sukabumi, Sumedang, Tasikmalaya), Central Java (Banyumas, Kebumen), and East Java (Blitar, Malang, Probolinggo, Situbondo). The field study was done using the Exploring Method (Rugayah et al., 2005). The materials used in this study were collected using van Balgooys's method (1987). The data recorded included collector names, collection number, locality, date, vernacular name, uses, and habitat. The materials were preserved, identified, and deposited in Herbarium Bandungense (FIPIA), School of Life Sciences and Technology (SITH), Institut Teknologi Bandung (ITB). The observation of living specimens was also carried out in Bogor Botanical Gardens, Bogor.

The plant materials were identified using *Cnidoscolus* (Euphorbiaceae) escaped in Malesia? (van Welzen & Fernández-Casas, 2017), *Cnidoscolorum notulae*: *C. aconitifolius* (Miller) I.M.Johnston subsp. *aconitifolius* (Fernández-Casas, 2007), O gênero *Cnidoscolus* Pohl (Crotonoideae-Euphorbiaceae) no Estado de Pernambuco, Brasil (de Melo & de Sales, 2008), and The Genus *Cnidoscolus*: Generic Limits and Intrageneric Groups (McVaugh, 1944). The botanical terms used are based on Beentje (2012).

## RESULTS

### TAXONOMIC TREATMENT

***Cnidoscolus*** Pohl, Pl. bras. icon. descr. 1: 56. 1827; de Melo & de Sales, Acta. Bot. Bras. 22(3) 809 2008.

Shrubs or trees, monoceous, with milky latex and stinging hairs. Stipules present. *Leaves* simple, alternate; petiole long, glandular; lamina palmatilobed to palmatipartited. *Inflorescences* dichasial, terminal or pseudo-axillary, unisexual. *Staminate flowers*: sepals 5, white, petaloid, connate; petals absent; stamens 4–30, distinct or connate in 2–6-whorled; pistillodes absent. *Pistillate flowers*: sepals 5, white, petaloid, distinct; petals absent; staminodes often present, filiform; pistil 3-

carpellate; styles 3; stigmas 2-furcated. *Fruits* loculicidal and septicidal capsules. *Seeds* ovoid, with or without caruncle.

Species ca. 97 in the New World and only 1 species found in Malesia (*Cnidoscolus aconitifolius* (Mill.) I.M.Johnst.). The genus is new to Malesia region (McVaugh, 1944; van Welzen & Fernández-Casas, 2017; Maya-Lastra & Steinmann, 2018).

***Cnidoscolus aconitifolius*** (Mill.) I.M.Johnst., Contrib. Gray Herb., new ser.68(iii): 86 1923; Fernández-Casas, Adumbrationes 21: 3-4 2007; van Welzen & Fernández-Casas, Blumea 62: 84-86 2017; Maya-Lastra & Steinmann, Phytotaxa 346(1): 3-4 2018. – *Jatropha aconitifolia* Miller, Gard. Dict. ed. 8 6 1768. Type: Mexico, Veracruz, 1730, *W. Houston s.n.* (holotype BM-000820498).
Figure 1
*Cnidoscolus chayamansa* McVaugh, Bull. Torrey Bot. Club 72: 466 1944. Type: Belize, Orange Walk: Honey Camp, coastal region, 17 September 1929, *C.L. Lundell 494* (holotype US-00096482; isotypes CAS-0002041, DS, F-V0055996F, K-000254128, MO149391, NY-00246387, S).
*Cnidoscolus chaya* Lundell, Bull. Torrey Bot. Club 72: 321 1945. Type: Mexico, Yucatán: km 27, Merida–Progreso road, 30 July 1938, *C.L. Lundell & A.A. Lundell 8201* (holotype LL-00042025; isotype LL-00371617, MICH-1210004).
*Jatropha deutziiflora* Croizat, J. Wash. Acad. Sci. 33: 16 1943. Type: Mexico, Oaxaca: Tuxtepec, Chiltepec and vicinity, 8 August 1940, *G. Martinez-Calderon 77* (holotype US-00027189; isotypes A-00047014, GH-00047015).
*Jatropha fragrans* Kunth, Nov. Gen. Sp. 2: 105 1817. – *Cnidoscolus fragrans* (Kunth) Pohl, Pl. Bras. Icon. Descr. 1: 63 1827. Type: Cuba, La Habana: Regla, *A. Bonpland & F. Humboldt 1333* (holotype P-00669927; isotype P-00545646).
*Jatropha napifolia* Desr., Encycl. 4: 15 1797. – *Cnidoscolus napifolius* (Desr.) Pohl, Pl. Bras. Icon. Descr. 1: 63 1827. Type: France. Based on plants cultivated in the Jardin du Roi in Paris (original material not traced).
*Jatropha palmata* Willd., Sp. Pl. 4: 562 1805. – *Cnidoscolus palmatus* (Willd.) Pohl, Pl. Bras. Icon. Descr. 1: 63 1827. Type: Honduras, Puerto Caballos, *H. Karsten 12* (holotype B-W-17922010).
*Jatropha papaya* Medik., Bot. Beob. 1782 194 1782. Type: Germany. Based on some trees grown from seed by Medikus in his Botanical Garden [i.e. Mannheim] (original material not traced).
*Jatropha quinquelobata* Mill., Gard. Dict. ed. 8 2 1768. – *Cnidoscolus quinquelobatus* (Mill.) León, Mem. Soc. Cub. Hist. Nat. "Felipe Poey" 15: 236 1941. Type: Cuba, Without locality, 1731, *W. Houston s.n.* (holotype BM-000820455). Type: Cuba, Without locality, 1731, *W. Houston s.n.* (holotype BM-000820455).
*Jatropha urens* var. *longipedunculata* Brandegee, Univ. Calif. Publ. Bot. 7: 368 1917. – *Cnidoscolus longipedunculatus* (Brandegee) Pax & K.Hoffm., Pflanzenr. IV, 147, XVI: 193 1924. Type: Mexico, Veracruz: Aacuapan, 1916, *C.A. Purpus 7639* (holotype UC-191126; isotypes GH-00047023, MO-159591, NY-00263494, US-00027198).

Shrub to small tree, up to 4 m high, with milky latex. *Stem* terete, with large leaf-scars; bark yellowish brown, fissured. *Branches* shiny green, white-blotched, with or without stinging hairs. *Stipules* narrowly lanceolate, 2–3 × 1 mm, apex acuminate, brown. *Leaves* simple, alternate; petiole slender, 5.5–28 cm long, green, glabrous; lamina 3-lobed or 5–7(–9)-partited, 6–23 × 7–30 cm; dark green above, yellowish green beneath, coriaceous; nectary gland present at base. *Inflorescence* terminal, dichasial subumbelliform; peduncles up to 29 cm long with few short pilose hair, green; bracts and bracteolas triangular-linear. *Staminate flowers* salverform, petaloid sepals connate, 5-lobed; tube 6–10 mm long, green; lobes obovate to orbicular, 3–4 × 4–5 mm, white, green beneath; stamens 10, 2-whorled, outer stamens 4 mm long; inner stamens 7 mm long; filaments filiform, white; anthers oblong, 1–2 × 0.5–1 mm, white, dorsi-basifixed; pistillode present, filamentous, white. *Pistillate flowers* campanulate, petaloid sepals 5, free, lobes oblong, 6–7 × 3 mm, white; disc 5-lobed, glabrous, white; ovary superior, ellipsoid, 3 mm long, triloculate, shiny green, glabrous;

style very short, ± 1 mm; stigma bifurcate, white, glabrous. *Fruits* capsule, indehiscent, ovoid, 1 × 0.6 cm. *Seeds* abortive.

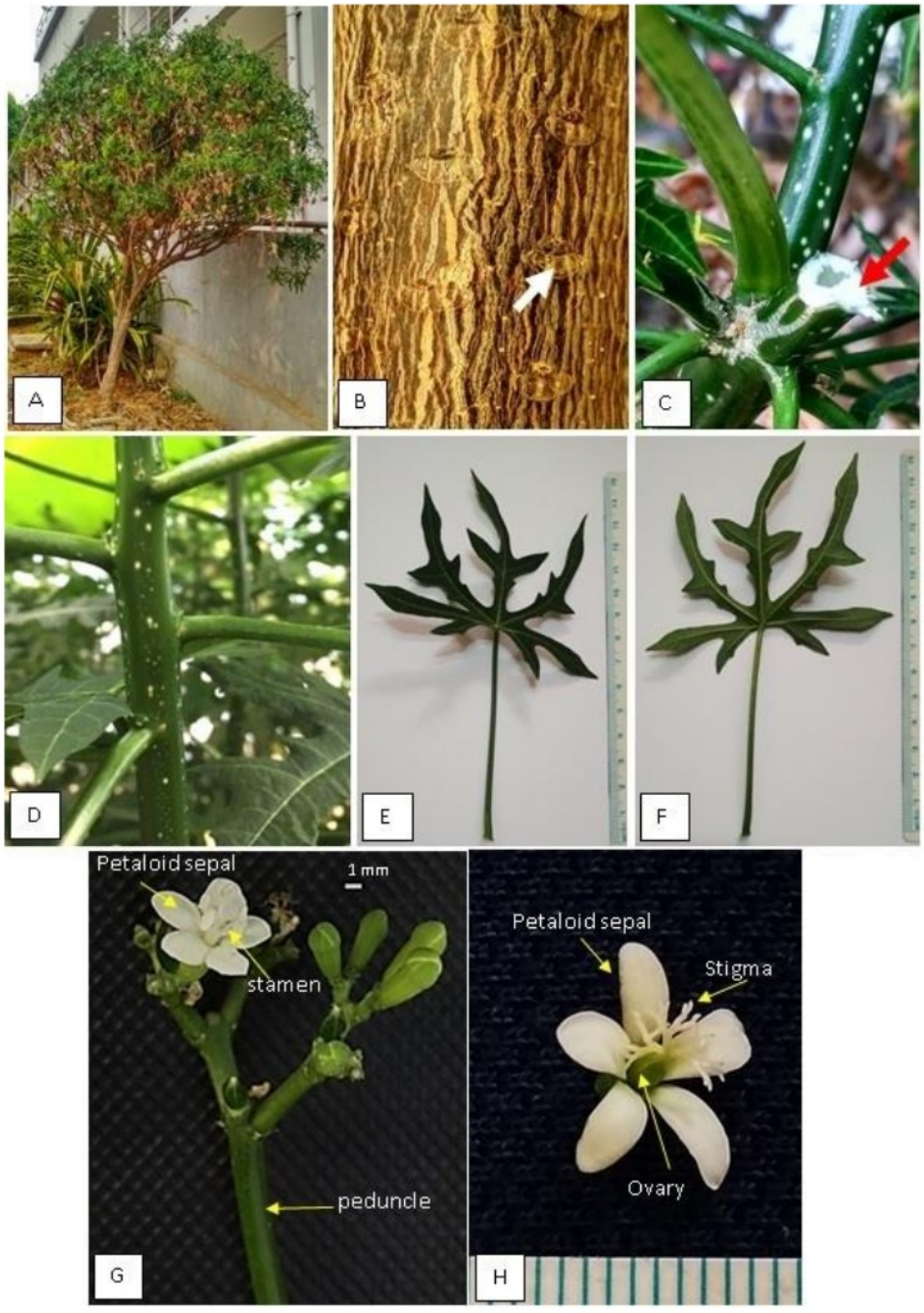


**Figure 1**. Morphological characters of *Cnidoscolus aconitifolius* (Mill.) I.M.Johnst. (A) habit, (B) stem with large leaf-scars (arrow) and fissured bark, (C) milky latex (arrow), (D) spirally arranged leaves, (E) adaxial leaf surface, (F) abaxial leaf surface, (G) inflorescence with stamine flowers, (H) pistillate flower

Distribution: Native from Northern Mexico and Mesoamerica (van Welzen & Fernández-Casas, 2017).
Habitat: homegardens, roadsides or open areas.
Specimen examined: **BANTEN.** Desa Setu, Serpong, Tangerang Selatan, 26 September 2019, *Nuralih s.n*. (FIPIA). **WEST JAVA.** Mekarwangi, Dago Atas, Lembang, Bandung, 25 March 2019, *ASD Irsyam 221* (FIPIA); Labtek IX B Building, campus area, ITB, Bandung, 26 September 2019, *ASD Irsyam 308* (FIPIA); Jatiwaringin, Pondok Gede, Bekasi, 24 September 2019, *ASDI 307* (FIPIA); Jl. Sawah Baru, Babakan Lio, Dramaga, Bogor, 23 March 2019, *MR Hariri 21* (FIPIA); Haruman Residence, Loji, Bogor Barat, 23 March 2019, *Peniwidiyanti s.n*. (FIPIA); Kampung Benda, Desa Karang Tengah, Cibadak, Sukabumi, 31 March 2019, *ASD Irsyam 224-225* (FIPIA); Labtek IB Building, ITB, Jatinangor, Sumedang, 25 March 2019, *ASD Irsyam 220* (FIPIA); Asrama Yavaveem, Cipedes, Tasikmalaya, March 2019, *D Andari s.n*. (FIPIA). **CENTRAL JAVA.** Karangmangu, Baturraden, Banyumas, 25 September 2019, *Peniwidiyanti s.n*. (FIPIA); Desa Mirit, Kecamatan Mirit, Kebumen, 24 September 2019, *Peniwidiyanti s.n*. (FIPIA). **EAST JAVA.** Jl. Raya Garum, Ngebra, Tawangsari, Blitar, 05 May 2019, *Peniwidiyanti 027* (FIPIA); Jl. Raya Pakiskembar, Krajan Barat, Pakis, Malang, 03 May 2019, *Peniwidiyanti 024* (FIPIA); Jl. Raya Wandit Barat, Krajan, Mangliawan, Pakis, Malang, 03 May 2019, *Peniwidiyanti 023* (FIPIA); Jl. Wana Bhakti, Lumbang, Probolinggo, 05 May 2019, *Peniwidiyanti 026* (FIPIA); Desa Trigonco, Kecamatan Asembagus, Situbondo, 14 September 2019, *MR Hariri 49* (FIPIA).
Etymology: The epithet *aconitifolius* means aconite-leaved (Gledhill, 2008).
Vernacular names: Pepaya jepang, chaya (Indonesia); *gedang pager* (Sunda); Tree spinach, chaya (English).
Uses: Vegetable crops.

## DISCUSSION

The genus *Cnidoscolus* comprises 97 species distributed in the New World (McVaugh, 1944; de Melo & de Sales, 2008; Maya-Lastra & Steinmann, 2018). Taxonomically, Linnaeus placed the *Cnidoscolus* within *Jatropha* L. in 1753. Later, the genus was regarded as distinct genus by Pohl in 1827. Because both genera showed different morphological characters. *Cnidoscolus* has stinging hairs, nectary glands at the apex of petiole, and white petaloid sepals which are absent in *Jatropha* (McVaugh, 1944; Miller & Webster, 1962; de Melo & de Sales, 2008; van Welzen & Fernández-Casas, 2017).

The presence of the genus *Cnidoscolus* Pohl in Java has not been recorded by Backer and Bakhuizen van den Brink in the Flora of Java (Backer & Bakhuizen van den Brink, 1963). The genus consists of only one species in Java, namely *C. aconitifolius* (Mill.) I.M.Johnst. It should be noted that the name *Cnidoscolus chayamansa* McVaugh is a synonym of *C. aconitifolius*. The species was collected from 13 locations in Banten (Serpong), West Java (Bandung, Bekasi, Bogor, Sumedang, Tasikmalaya, Sukabumi), Central Java (Banyumas, Kebumen), and East Java (Blitar, Malang, Probolinggo, Situbondo). *C. aconitifolius* may still be present in other locations, given that the species is a cultivated plant. Figure 2 shows the distribution of *C. aconitifolius* on the island.

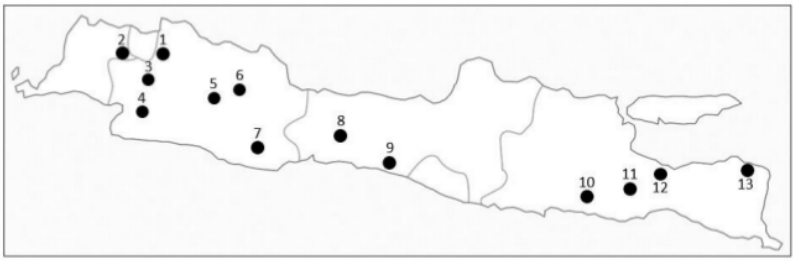


**Figure 2**. Distribution map of *Cnidoscolus aconitifolius* in Java. (1) Bekasi, (2) Serpong, (3) Bogor, (4) Sukabumi, (5) Bandung, (6) Sumedang, (7) Tasikmalaya, (8) Banyumas, (9) Kebumen, (10) Blitar, (11) Malang, (12) Probolinggo, (13) Asembagus-Situbondo

*Cnidoscolus aconitifolius* is thought to enter Java via the trade of cultivation route. There was no information when chaya appeared for the first time in Java. However, the species might be introduced after the Flora of Java was published in 1963. Our finding also provides a new distributional record of *Cnidoscolus* for Flora Malesiana, because the previous records were known from Brunei, Singapore, and Philippines (Peregrine, 1983; Chen et al., 2015; van Welzen & Fernández-Casas, 2017).

In 1984, Breckon divided *C. aconitifolius* into 2 subspecies, i.e. *C. aconitifolius* subsp. *aconitifolius* and *Cnidoscolus aconitifolius* subsp. *polyanthus* (Pax & K.Hoffm.) Breckon (Fernández-Casas, 2007). *C. aconitifolius* subsp. *aconitifolius* distributed from Northern Mexico to Guatemala and *C. aconitifolius* subsp. *polyanthus* native to Michoacán, the small area in South-Western Mexico (Kolterman et al., 1984; Fernández-Casas, 2007). Morphologically, *C. aconitifolius* subsp. *aconitifolius* has campanulate pistillate flowers. Meanwhile, the shape of pistillate flowers of *C. aconitifolius* subsp. *polyanthus* are salverform (Fernández-Casas, 2007). Based on this character, all materials collected from Java were identified as *C. aconitifolius* subsp. *aconitifolius* due to their campanulate pistillate flowers (Figure 1-H).

Ross-Ibara and Molina-Cruz (2002) grouped *C. aconitifolius* into four cultivars, namely *Estrella*, *Picuda*, *Chayamansa*, and *Redonda*. The cultivar *Estrella* has five spreading, non-overlapping leaf lobes with dentate margin, whereas the *Picuda* has five to nine narrowly lobes and strongly dentate to pinnatafid. The cultivar *Chamayansa* was characterized by five obovate lobes, and usually overlapping to the central three lobes. The last cultivar, *Redonda*, has three lobes with entire to slightly dentate margins and lacking in stinging hairs (Ross-Ibarra & Molina-Cruz, 2002). Thus, the species from Java was grouped into the cultivar *Picuda*, due to their five to nine narrowly lobes (Figure 3).


**Figure 3.** (A) the leaf of *C. aconitifolius* in this study, (B) the leaf of cultivar *Picuda* based on Ross-Ibarra & Molina-Cruz (2002)

Naturally, the wild type of *C. aconitifolius* was armed by stinging trichomes on its trunk, branches, and leaves. The glandular trichome consists of a multicellular elongate cell with a swollen tip. These trichomes produce serotonin, a stinging compound, to against herbivores. When a herbivore rushed against *C. aconitifolius*, the tip of hairs will be broken, penetrates the skin, and serotonins are expelled. Later, serotonin stimulates inflammation to the animal. The stinging trichomes are lacking in the cultivated one (Lookadoo & Pollard, 1991; Ross-Ibarra & Molina-Cruz, 2002; Abdala-Roberts & Parra-Tabla, 2005). However, *C. aconitifolius* collected from Malang, East Java, still have stinging trichomes on their branches, although just in small amounts. The previous study showed that artificial defoliation induces trichome production in leaves and petioles of *C. aconitifolius* (Abdala-Roberts & Parra-Tabla, 2005).

All the *C. aconitifolius* collected from Java produces abortive seeds and the same case was also reported in the Philippines. That is because the cultivated form has sterile staminate flowers. Therefore, *C. aconitifolius* is propagated vegetatively through cuttings and stem fragmentation

(Ross-Ibarra & Molina-Cruz, 2002). Although vegetatively propagated, the species was escaped from cultivation near Cebu City in the Philippines (van Welzen & Fernández-Casas, 2017). But, van Welzen & Fernández-Casas (2017) noted that the escaped population would not appear to be invasive.

*C. aconitifolius* is widely brought from Central America to other regions as vegetable crops (Ross-Ibarra & Molina-Cruz, 2002) and became a popular vegetable in West and East Java. Many people plant this species in their garden or yard. More importantly, it has also being sold on several traditional markets in Bogor and Serpong with at a price of five thousand rupiah for two bundles (Figure 4). The young leaves of *C. aconitifolius* are traditionally consumed as *lalaban* or *pecel* and can be processed into several local culinary such as *rendang*, *buntil*, *opor*, *rolade*, or a mixture of pudding and drinks. In Tasikmalaya, the leaves were used as a natural green food coloring by squeezing it (Sudartini et al., 2016).

Chemically, *C. aconitifolius* leaves had high contents of vitamins A, vitamins C, b-carotene, protein, calcium, phosphorus, iron, thiamin, riboflavin, and niacin (Peregrine, 1983; Kuti & Kuti, 1999; Ross-Ibarra & Molina-Cruz, 2002; Blancke, 2016). In addition, the other phytochemical constituent extracted from *C. aconitifolius* were stearic acid, oleic acid, palmitic acid, acyclic diterpene alcohol, linoleic acid ester, pyrrolidone, ketone, and palmitic acid ester (Omotosho et al., 2014). Besides those beneficial compound, the raw leaves contain cyanogenic glycoside that toxic to animals and humans. Therefore, it should be cooked or boiled to hydrolyze the compound and reduce the risk of poisoning (Kuti & Konoru, 2006; Morais et al., 2016; Moura et al., 2018).

**Figure 4.** The leaves of *C. aconitifolius* (arrows) has been sold as vegetable at Pasar Bogor, in front of Bogor Botanic Gardens, West Java

Euphorbiaceae are important medicinal plants in the world and *C. aconitifolius* has been also used as traditional medicine (Ross-Ibarra & Molina-Cruz, 2002; Mwine & Damme, 2011; Moura et al., 2019). In Mexico, *C. aconitifolius* leaves tea is commonly used to treat diabetes, kidney stones, obesity, and malnutrition (Ross-Ibarra & Molina-Cruz, 2002; Blancke, 2016; Sanchez-Hernandez et al., 2017). The species has been also used therapeutically as alcoholism medication, anti-cholesterol, anti-insomnia, anti-arthritic, anti-arteriosclerosis, scorpion sting antidote, strengthens nails, cleanses the cardiovascular system, lactagogue, and stimulants for digestion, brain and vision (Miranda et al., 2010; Adaramoye et al., 2011; Poot-Lopez et al., 2012; Sanchez-Hernandez et al., 2017; Moura et al., 2019). The previous pharmacological studies showed that leaves extract of *C. aconitifolius* has antimutagenic, anti-inflammatory, cardioprotective, antimicrobial, and antioxidant activities (Awoyinka et al., 2007; Loarca-Piña et al., 2010; Adeniran et al., 2013; García-Rodríguez et al., 2014). The leaves extract also caused increased death of HT-29 cells or colon carcinoma cells

(Kumarasamy et al., 2014). Based on these studies, *C. aconitifolius* can be developed as a medicinal plant in Indonesia.

## CONLUSION

The genus *Cnidoscolus* is a new record for Java, Indonesia. It only comprises of one species in Java, namely *C. aconitifolius* (Mill.) I.M.Johnst. The genus and species have not been recorded before in the Flora of Java. This species was introduced from Central America and is widely cultivated as vegetables due to their edible leaves. The presence of *C. aconitifolius* in Java would be a new distributional record for Flora Malesiana. The species has been traditionally used as medicine in Mexico. Meanwhile, pharmacological studies revealed some activities of *C. aconitifolius* leaves extract as anticancer, antioxidant, antimutagenic, antidiabetic, and anti-cholesterol. Thus, the species can be developed as a medicinal plant in Indonesia.


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