Gnetum gnemon L.
Gnetaceae

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Local Names

Cambodia: khalet, voe, (general), klot (Phnom Kulen). **Indonesia:** belinjo, melinjo (general), gnemo, rukiti (Molluccas), ka'cuang (Dayak Kanayatn), ko'nyah (Enggano ethnic in Sumatra), lewehuka, mlinjo, morahuka (Wonani Island), tangkil (Betawi, Javanese, Sundanese). **Malaysia:** amaninjau (general), dodah (Bidayuh), sabong (Bintulu), belinjau, garintul, meninjau, melindju, malinju, sabe, sangkok, tankil (Peninsular), sabong (Iban). **Philippines:** bago (general), bago, magatungal (Lanao, Cotabato), bago, bagu (Bataan, Tayabas, Camarines), banago (Visaya, Bohol), kunan (Davao), nabo (Bicol)**. Papua New Guinea:** ambian, ambiamtupe (Maring), doro (Valaila), genda (Buna), suffitz (Yalu), tu-a (Suku). **Singapore:** melindjo. **Thailand:** puk miang (general), pee sae, phak miang (Thai), liang, miang phak kaniang, pak kaliang, peedae, phak (Southern Thailand). **Vietnam:** bet, gam cay, rau danh**. English:** Spanish koint fir (Asyira et al. 2016; Cadiz and Florido 2001; Chuakul et al. 2004; Manangka et al. 2017; Markgraf 1948; Neamsuvan et al. 2013; Rahayu et al. 2019; Royyani et al. 2018; Sunarti and Rugayah 2013; Ting et al. 2017; Walker 2016).

Botany and Ecology

***Description*:** Tree or shrub, up to 22 m tall, 40 cm diameter without buttresses, exceptionally a climbing shrub. Crown monopodial, narrow, cylindrical. Trunk gray, marked with conspicuous or faint rings. Leaves opposite, thin, yellow when dry, tapering at both ends, but varying in shape and size, 7.5–20 by 2.5–10 cm, ovate-oblong to lanceolate, dark green, shiny smooth and usually pointed at both ends.

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Fig. 1 Male strobilus of *Gnetum gnemon* (Gnetaceae). Bogor, West Java, Indonesia. (Photo © W. A. Mustaqim)

Secondary nerves bent, joining, petiole 6–18 mm. Inflorescence are borne on young shoots and older branches. Male inflorescences solitary, axillary, simple or once branched, yellowish, 3–6 cm long, collar 3 mm broad. Male flowers with broad sporophyll, twice as long as the perianth (3 mm). Sterile female flowers globose, tipped or beaked, 2 mm thick, 10–15 in a ring. Female inflorescence similar. Female flowers 5–8 at each node, globose, tipped or beaked, 3–4 mm long, inner tube exerted by 1 mm. Fruit ripening yellow, then orange-yellow or ink, sessile (exceptionally stalked), ellipsoid, shortly apiculate, 1–3.5 cm long, almost velvety, middle envelop ribbed (Markgraf 1948; Cadiz and Florido 2001). Seed is enclosed in fleshy covering about 1 mm thick. Seed coat is thin, brittle and separates ready from the seeds (Cadiz and Florido 2001) (Figs. 1 and 2).

***Phenology*:** In Indonesia, *Gnetum gnemon* bears fruits thrice a year from March to April, June to July, and September to October. In the Philippines, the fruits mature early in the rainy season (June–July). *G. gnemon* seeds are collected from mature reddish color fruits (Cadiz and Florido 2001).

***Distribution and Habitat*:** From Assam in India throughout Malaysia to Fiji, but nonnative in Andaman Islands, Sumatra, Java (Markgraf 1948); Solomon Islands, Malaysia, Sumba, Sulawesi, New Guinea, and Malay Peninsula, Philippines (Cadiz and Florido 2001). Grows in rainforest at lower altitudes, but shrub varieties ascending up to 1500 m (Markgraf 1948).

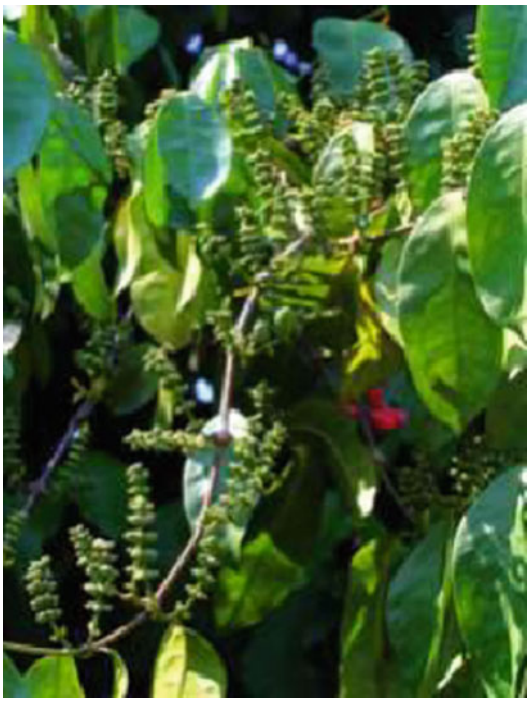

Fig. 2 Female strobilus of *Gnetum gnemon* (Gnetaceae). Bogor, West Java, Indonesia. (Photo © W. A. Mustaqim)

Local Medicinal Uses

Indonesia: *G. gnemon* is used as a traditional medicine by various ethnic groups. The Serawai community in Bengkulu province drink the boiled water of leaves and seed to treat toxicities (Adfa 2005); the Dayak people of Kalimantan use it to facilitate delivery (Due 2013); the Sundanese in Bogor use leaves in postpartum care and to increase breast milk secretion. Finely crushed leaves of *G. gnemon* along with those of *Litsea robusta* and *Artocarpus heterophyllus* are also pasted over the breasts during non-breastfeeding period to prevent swelling (Rahayu et al. 2019). **Cambodia:** The local communities in Phnom Kulen use the leaves to cure stomachache, as a tonic and to improve circulation (Walker 2016). **Thailand:** The local communities in Southern Thailand use the leaves decoction to cure the bodily discomfort (Chuakul et al. 2004).

Phytochemistry

Leaves: Extract of mature and young leaves contain alkaloid, leucoanthocyanin, saponin, tannin, and vitamin C (Mollejon and Gabane 2019). **Stems:** Stem crude extracts contain alkaloids, flavonoids, steroids, glycosides, phenols, polyphenols, tannins, reducing sugars, saponins, and terpenes (Thein et al. 2019). **Seeds:** The seeds contain resveratrol dimers (gnetin C, gnemonoside A, gnemonoside D), trans-resveratrol, glucoside, and trans-piceid (Tatefuji et al. 2014). The seed proteins are Gg-PHB (Matra et al. 2018), Gg-AOPI, and Gg-AOPII (Siswoyo et al. 2011). The dichloromethane extract of seed contain trans-resveratrol, piceid, gnetin C, gnetol, isorhapontigenin, ϵ-viniferin, gnemonol L, and gnemonol (Hafidz et al. 2017). **Seed coat:** Seed coat contains phenolic (3,4-dimethoxychlorogenic acid, resveratrol, 3-methoxyresveratrol) (Atuna et al. 2007), and stilbene derivative (isorhapontigaenin, resveratrol, gnetin D, gnetifolin K, gnetol) and lignan compound ((+)-lirioresinol B) (Cahyana and Ardiansah 2015).

The seed protein has antioxidant (Siswoyo et al. 2011) and antihypertension activities (Matra et al. 2018; Puspitaningrum et al. 2014). Gg-PHB shows the same activity as standard antihypertensive drugs (captopril) (Matra et al. 2018). Wistar rats were induced with prednisone 1.5 mg/kg body weight and 2% NaCl for 7 days and then treated on day 8 with *G. gnemon* protein doses of 5, 10, 20, and 30 mg/kg body weight, causing their blood pressure to decrease (Puspitaningrum et al. 2014). Gg-AOPI and Gg-AOPII proteins of *G. gnemon* seeds have antioxidant activity (Siswoyo et al. 2011) while Gg-PHB has antihypertensive activity (Matra et al. 2018). Antihypertensive activity of *G. gnemon* seed protein is related to its inhibitory activity against angiotensin-converting enzyme (ACE) (Matra et al. 2018). Leaves (Santoso et al. 2010) and seeds (Supriyadi et al. 2019) of *G. gnemon* have antioxidant activity. Mature leaves have higher antioxidant activity than young leaves (Santoso et al. 2010), while green seeds have more effective antioxidants than yellow and red seeds (Supriyadi et al. 2019). The 3,4-dimethoxychlorogenic acid, resveratrol, and 3-methoxyresveratrol from seeds have antioxidant activity with IC50 values of 523.7, 45.17, and 60.12 g/mL, respectively (Atuna et al. 2007). The anti-hypercholesterolemic activity of seed extracts is related to its ability to inhibit HMG-CoA reductase (Hafidz et al. 2017), or reducing triglycerides by oxidizing low density lipoprotein cholesterol (LDL), or modulating lipid metabolism (Ulfa et al. 2018). Molecular docking studies have shown resveratrol dimers such as gnemonol L, gnemoside, and ϵ-viniferin to have better binding energy for piceid monomers, gnetin C, gnemonol L, and gnemonol M. So, it is considered an HMG-CoA reductase inhibitor (Hafidz et al. 2017). The seed extract inhibits the growth of bacteria such as *Bacillus cereus* (Parhusip and Sitanggang 2011; Soehendro et al. 2015), *Staphylococcus aureus* (Parhusip and Sitanggang 2011; Dewi et al. 2012), *Pseudomonas aeruginosa* (Dewi et al. 2012), *Escherichia coli* (Soehendro et al. 2015), and *Enterobacter aerogenes* (Parhusip and Sitanggang 2011). The values of minimum inhibitory concentration (MIC) and minimal bactericidal concentration (MBC) of seed extract to *Bacillus cereus*, *Staphylococcus aureus*, and *E. aerogenes* were 0.26–1.46 g/mL, and 1.02–6.04 g/mL, respectively (Parhusip and Sitanggang 2011).

Local Food Uses

Indonesia: *G. gnemon* has been widely cooked as vegetable, snack, or staple food by local communities in Indonesia. The local people in Java Island use the leaves and seeds as vegetables, while mature seeds are used to make *emping*, the traditional chips (Siregar et al. 2016). The Enggano ethnic community in Bengkulu province processes the seeds by boiling, grilling and use to make porridge for staple foods (Royyani et al. 2018). Local people of Pidie (Nanggroe Aceh Darussalam province) fry *G. gnemon* leaves for chips; its strobilus is boiled and consumed as vegetable (Musafirah 2016). Both fresh and dry leaves have been used as vegetables by Dayak Kanayatn ethnic community of West Kalimantan (Manangka et al. 2017). **Malaysia:** The local people of Bintulu cook the leaves and seeds as vegetables for various dishes (Asyira et al. 2016). The young leaves are cut, washed, and stir fried with bamboo or coconut shoots and anchovies (Asyira et al. 2016). **Philippines:** The local people in South Central Mindanao cook the young leaves with coconut milk, fish, and vegetables or snail (*suso*); it is also used in the preparation of *sinigang* and *ginisang munggo* (Maghirang et al. 2018).

Biocultural Importance

Indonesia: Some local communities in Yogyakarta use *G. gnemon* leaves in the heirloom ritual *jamasan pusaka* (Sari et al. 2019). In Pidie, *G. gnemon* is used to prepare *emping* that is a mandatory snack for the groom during engagement ceremony. *Emping* is also used during wedding ceremonies (Musafirah 2016).

Economic Importance

Indonesia: The young leaves and seeds of *G. gnemon* are economic commodities that have long been traded in traditional and modern markets as both fresh and processed ingredients (Soehendro et al. 2015). Bark is the source of fiber for the local communities in Pidie (Musafirah 2016); inner bark is used for the famous Sumba bow string (Cadiz and Florido 2001).

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