Phyllanthus acidus

Scientific Name

***Phyllanthus acidus* (L.) Skeels**

Synonyms

Averrhoa acida L. basionym, *Cicca acida* (L.) Merr., *Cicca acidissima* Blanco, *Cicca disticha* L., *Cicca nodiflora* Lam., *Cicca racemosa* Lour., *Diasperus acidissimus* (Blanco) Kuntze, *Phyllanthus cicca* Müll. Arg., *Phyllanthus cicca* var. bracteosa Müll. Arg., *Phyllanthus cochinchinensis* (Lour.) Müll. Arg., *Phyllanthus distichus* (L.) Merr., *Phyllanthus distichus f. nodiflorus (Lam.)* Müll. Arg., *Phyllanthus longifolius* Jacq., *Tricarium cochinchinense* Lour.

Family

Phyllanthaceae, also placed in Euphorbiaceae.

Common/English Names

Country Gooseberry, Indian Gooseberry, Malay Gooseberry, Otaheite Gooseberry, Star Gooseberry, Tahitian Gooseberry, West Indian Gooseberry.

Vernacular Names

Brazil: Groselha (Portuguese);
Burmese: Thinbozihyoo, Mak-Hkam-Sang-Paw;
Chinese: E Mei Shu;
Costa Rica: Grosella (Spanish);
Chamorro: Iba;
Cuba: Cerezo Occidental, Grosella (Spanish);
El Salvador: Ciruela Corteña, Guinda, Pimienta (Spanish);
French: Grosella, Cerisier De Tahiti, Cherimbelier, Phyllanthe Sour, Surelle, Surette De La Martinique;
French West Indies: Groseillier Des Antilles (French);
German: Sternstachelbeerbaum;
Ghana: Dunyan (Huasa);
Guatemala: Grosella (Spanish);
Guinea-Bissau: Azedinha (Crioulo);
India: Chalmeri, Chota Aonla, Harfauri, Harparauri, Harphanevadi, Harpharevadi (Hindi), Rajamvali (Konkani), Gihori (Manipuri), Harparrevdi, Harpharori, Roi-Avala (Marathi), Lavali, Laveni, Pandu, Skandhaphara (Sanskrit), Aranelli (Tamil), Harfarauri (Urdu); Jimbling, Chalmeri, Harpharori, Kirinelli, Hariphal, Rachayusirika;
Indonesia: Ceremoi (Aceh), Cermen (Bali), Careme (Madurese), Ceremai (Malay), Carameng

T.K. Lim, *Edible Medicinal And Non-Medicinal Plants: Volume 4, Fruits*,
DOI 10.1007/978-94-007-4053-2_36, © Springer Science+Business Media B.V. 2012

(Sulawesi), Careme, Cerme (Sundanese) Karsinta, Kemlaka, Kemloko;
Jamaica: Cheramina, Jimbling, Short Jimbelin;
Kampuchea: Kântûet, Kântouot Srôk, Sloek Morom
Laotian: Nhom Baan, Mak-Nhom,
Malaysia: Cermai, Ceremai, Cermela, Camin-camin, Kemangur;
Mexico: Manzana Estrella (Spanish);
Nepalese: Harii Phala, Kaathe Amalaa, Paate Amalaa;
Nicaragua: Grosella (Spanish);
Philippines: Layoan (Bikol), Bangkiling, Poras, Kagindi (Bisaya), Bagbagútut Karmay, Karmai, Karamai, Bagbagutut (Iloko), Iba (Pampangan), Iba, Bangkiling, Karmai (Tagalog);
Portuguese: Cerejeira-Do-Taiti;
Puerto Rico: Cereza Amarilla, Cerezo De La Tierra, Cerezo Comun (Spanish);
Samoan: Vine;
Senegal: Azedina (Crioulo);
Spanish: Grosellero, Guinda;
Tahiti: Surette, Mue;
Thailand: Mayom;
Venezuela: Cerezo Agrio (Spanish);
Vietnam: Chùm Ruôt, Tâm Ruôt.

Origin/Distribution

Phyllanthus acidus is probably native to the coastal region of north-eastern Brazil, and has been frequently wrongly ascribed to Madagascar, India or Polynesia. It is now naturalized and cultivated pan-tropically in India, Thailand, Myanmar, Indonesia, South Vietnam, Laos, Peninsular Malaysia, Polynesia and all the larger islands of the West Indies.

Agroecology

Phyllanthus acidus thrives well in the tropics and sub tropics at low and medium altitudes in places with a short or prolonged dry season. The tree prefers hot, humid tropical lowlands. In north-eastern Brazil, the tree has been found in coastal forest and in Southeast Asia and El Salvador it is cultivated on humid sites, up to 1,000 m elevation. It tolerates a wide range of soils including very sandy soils. It quite cold hardy surviving the cold winter in Tampa, Florida. In the Pacific islands it occurs in open disturbed places, quarries and in home gardens.

Edible Plant Parts and Uses

The mature sour fruits may be eaten fresh but usually they are sprinkled with salt to remove the acidity. The fruits are excellent for processing into pickles (Plate 2) and sweetened dried fruits. In the Philippines, the fruit juice is used in cold drinks and the fruit is also processed into vinegar. In Malaysia, ripe and unripe fruit are cooked and served as a relish, or made into a thick syrup or sweet preserve. Pickled fruits are available in bottles in local markets. The fruits, combined

Plate 1 Cluster of fruit and leaves of star gooseberry

Plate 2 Pickled star gooseberry fruits

with other fruits are used in chutney or jam, because of their gelling properties. In Indonesia, the sour fruits are used as a condiment in cooking to flavour dishes and served as a substitute for *assam* and used as an ingredient in *sambal* and *sayur* or used in *rojak* mixture. Young leaves are eaten as cooked vegetable in Indonesia, Thailand and India.

Studies in Thailand showed that star gooseberry wine can be processed from the fruits by feermenting with the yeast, *Saccharomyces cerevesiae* (Sibounnavong et al. 2010). All the different formulations (different ratios of fruit juice and sugar) gave significantly higher amount of ethyl acohol than all the formulations of carambola wine.

Botany

A small, deciduous, sparingly-branched tree, 4–9 m tall with rough, grey, lenticelled bark and terete, glabrous branchlets clustered at the apex of the branches imparting an open and spreading crown. Stipules are deltoid-ovate, acuminate and 1–1.3 mm long. Leaves are pinnate, 20–40 cm long. Leaflets are alternate, simple, entire, shortly petiolate, broadly ovate to ovate-lanceolate, 4–9 cm × 2–4.5 cm, with obtuse to rounded base, acute apex and 3–9 pairs nerves (Plate 1). The petiole is 2.5 mm long. Flowers are small, pink, axillary in fascicles, with 2–6 staminate flowers in proximal axils; pistillate flowers are cauliflorous on old branchlets, rarely in distal axils. Staminate flowers are 4-merous with free filaments and anthers that dehisce vertically. Pistillate flowers are 4-merous, borne on a stout pedicel, with deeply lobed or split disk, connate, deeply bifid styles, staminodes and a superior, glabrous, 6–8 lobed ovary. Fruit is drupaceous, oblate, 1.5–2.5 cm diameter, shallowly 6- or 8-lobed, greenish–yellow to pale yellow, waxy and glossy and borne on 2–4 mm long pedicels (Plates 1–2). The flesh is firm, thin, sour enclosing a hard, bony, grooved stone containing 6–8 smooth, globose, 5–8 mm diameter seeds. Fruits develop in dense clusters along the old branchlets (Plate1).

Nutritive/Medicinal Properties

The nutritive values of Otaheite gooseberry fruit (per 100 g edible portion) are 28 k cal of energy, 91.7 g moisture, 0.7 g protein, 6.4 g carbohydrate, 0.6 g crude fiber, 5 mg calcium, 23 mg phosphorous, 0.4 mg iron, 0.01 mg thiamin, 0.05 mg riboflavin and 8 mg vitamin C (Ministry of Public Health, Thailand 1970).

Seventy-seven compounds: 45 terpenes, 18 esters, 7 acids, 4 aldehydes 2 phenols, 1 alcohol were identified from the volatile components of star gooseberry fruit (Pino et al. 2008). The total concentration of volatiles was 109 mg/kg fresh fruit, terpenes 100.1 mg/kg and acids 6.7 mg/kg. Among the terpenes many monoterpenes and sesquiterpenes were identified, chief constituents were by epi-α-muurolol (32.9 mg/kg) and α-cardinol (22.1 mg/kg). Hexadecanoic acid (3.8 mg/kg) was the predominant acid.

From the bark of *Phyllanthus acidus* the pentacyclic triterpenoids, phyllanthol and olean-12en-3β-ol (β-amyrin) were isolated (Sengupta and Mukhopadhyay 1996).

Some of the reported pharmacological activities of *P. acidus* plant parts are presented below.

Hepatoprotective and Antioxidant Activities

Oral administration of *Phyllanthus acidus* methanolic extracts to rats in rats with acute liver damage induced by carbon tetrachloride CCl(4) attenuated CCl(4)-induced increase in serum glutamate-oxalate-transaminase (GOT) and CCl (4)-induced increase in serum glutamate-pyruvate-transaminase (GPT) (Lee et al. 2006). Concurrently, the extract elevated the activity of liver reduced glutathione peroxidase (GSH-Px). The protective effects of *P. acidus* extract correlated with a reduction in liver infiltration and focal necrosis. These data demonstrated that *P. acidus* had hepatoprotective and antioxidant activities. Recent studies showed that *P. acidus* extracts and silymarin exhibited significant

hepatoprotective effect against CCl4-induced oxidative damage (Jain et al. 2011). This was evident from the decreases of serum aspartate transaminase (AST), alanine transaminase (ALT), alkaline phosphatase (ALP), levels and as lipid peroxidation and increases in the levels of total protein, reduced glutathione (GSH), superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPx) compared with control group. The biochemical results were substantiated with results of histopathological sections of the liver tissues. *P. acidus* extracts considerably shortened the duration of hexobarbitone-induced sleeping time in mice compared with control group and displayed remarkable DPPH-scavenging activity. The findings suggested that the hepatoprotective effect of *P. acidus* against CCl4-induced oxidative damage may be related to its antioxidant and free radical-scavenging potentials. The results of another study in wistar rats suggested that the aqueous extract of *P. acidus* leaves had significant hepatoprotective activity on acetaminophen and thioacetamide induced hepatotoxicity, which may be related to its high phenolic and flavonoid content and antioxidant properties (Jain and Singhai 2011). Acetaminophen and thioacetamide administration caused severe hepatic damage in rats as evident from significant rise in serum AST, ALT, ALP, total bilirubin and concurrent depletion in total serum protein. *P. acidus* extracts and silymarin prevented the toxic effects of acetaminophen and thioacetamide on the above serum parameters. The aqueous extract was found to be more potent than the corresponding ethanolic extract against both toxicants. The phenolic and flavonoid content (175.02 and 74.68 μg/ml, respectively) and 2,2-diphenyl-1-picrylhydrazil (DPPH) [IC_{50} = (33.2) μg/ml] scavenging potential was found maximum with aqueous extract as compared to ethanolic extract.

Anticancer Activity

Two novel water-soluble norbisabolane glycosides, phyllanthusol A and phyllanthusol B, isolated from the methanol extract of the roots of *P. acidus* were found to exhibit cytotoxic activity (Vongvanich et al. 2000). Phyllanthusols A (1) and B (2) exhibited cytotoxicity against BC (Breast cancer line) with EC_{50} at 4.2 and 4.0 μg/ml for 1 and 2, respectively and human carcinoma cell line KB with EC_{50} at 14.6 and 8.9 μg/ml for 1 and 2, respectively. KB is the cell line derived from a human carcinoma of the nasopharynx.

Anticystic Fibrosis Activity

Studies reported that extracts of *Phyllanthus acidus* had promising potential in treating cystic fibrosis (CF) (Sousa et al. 2007). *P. acidus* extract and co-application of its isolated components, adenosine, kaempferol and DHBA (2,3-dihydroxybenzoic acid) had similar activating effects on ion transport in mouse trachea. The herbal extract corrected defective electrolyte transport in cystic fibrosis airways by various parallel mechanisms including (1) increasing the intracellular levels of second messengers cAMP and Ca^{2+}, thereby activating Ca^{2+}-dependent Cl^- channels and residual CFTR-Cl^- conductance; (2) stimulating basolateral K^+ channels; (3) redistributing cellular localization of CFTR; (4) directly activating CFTR; and (5) inhibiting ENaC through activation of CFTR. These combinatorial effects on epithelial transport may provide a novel complementary nutraceutical treatment for the cystic fibrosis lung disease.

Hypotensive Activity

Recent studies showed that *P. acidus* leaf extract had hypotensive activity (Leeya et al. 2010). The hypotensive activity was attributed to the direct action of adenosine, 4-hydroxybenzoic acid, caffeic acid, hypogallic acid, and kaempferol were isolated from the n-butanol leaf extract. These five compounds had a direct action on the blood vessels of anesthitized rats by stimulating release of nitric oxide from the vascular endothelium, in part through stimulation of soluble guanylate cyclase, and opening of K(ATP) and K(Ca) channels in the vascular smooth muscle.

Antimicrobial Activity

Studies showed that *Phyllanthus acidus* leaf extract exhibited antimicrobial activity against *Eschericia coli, Staphylococcus aureus and Candida albicans* (Jagessar et al. 2008). The antimicrobial activity was selective and solvent dependent with the ethanolic extract, the most potent and hexane the least. In general, the order of antimicrobial activity followed the sequence: CH3CH2OH extract > EtOAc extract > CH2Cl2 extract > hexane extract. In another study, methanolic extracts of *Phyllanthus acidus* were also reported to possess strong in-vitro antibacterial activity against *Escherichia coli* and *Staphylococcus aureus* (Meléndez and Capriles 2006).

Antiplasmodial and Anticancer Activities

Recent studies showed that the leaf ethyl acetate, acetone, and methanol extracts of *P. acidus* exhibited good antiplasmodial activity with IC_{50} values of 9.37, 14.65, 12.68 μg/mL respectively and with selectivity indices of 4.88, 3.35, 3.42 for human laryngeal cancer cell line (HEp-2) and >11.75, >3.41, >3.94 for vero cells respectively (Bagavan et al. 2011).

Traditional Medicinal Uses

Phyllanthus acidus has been used in traditional ethnomedicine in Asia. The fruit is acid and astringent. The acrid latex of various parts of the tree is emetic and purgative. In India, the fruits are taken as liver tonic, to enrich the blood. The syrup is prescribed as a stomachic; and the seeds are cathartic. The decoction of the leaves is good diaphoretic and is also used as a demulcent in cases of gonorrhoea. The leaves are mucilaginous and demulcent and are given in gonorrhoea and are also administered as a sudorific. In the Philippines, a decoction of the leaves is applied to urticaria, and the fruit, which is astringent, is given at the same time, to eat. The bark yields a decoction, which is employed in bronchial catarrh. The root is drastically purgative and regarded as toxic in Malaya but is boiled and the steam inhaled to relieve coughs and headache. In Borneo, leaves are used, with pepper, for poulticing for lumbago, or sciatica, and the root is used externally to treat psoriasis of the soles of feet. In Java, the root infusion is taken in very small doses to alleviate asthma and the bark is heated with coconut oil and spread on eruptions on feet and hands. A leaf decoction is employed for urticaria. In Thailand, the extract from the root to cure skin diseases especially relief from itching. Leaves are used as one of the ingredients in Thai medicine to control fever. The juice of the root bark, which contains saponin, gallic acid, tannin and a crystalline substance which may be lupeol, has been employed in criminal poisoning. It was reported to produce headaches, sleepiness, and deaths accompanied by severe abdominal pains.

Other Uses

Bark extracts have nematicidal activity against the pine wood nematode, *Bursaphelenchus xylophilus* (Mackeen et al. 1997). The bark is used in India as a tanning agent. The wood is light-brown, fine-grained, attractive, fairly hard, strong, tough, durable if seasoned and used for utensils and other small objects. The tree also provides fuel-wood.

Comments

Star gooseberry is usually grown from seed but may also be propagated by budding, greenwood cuttings, or air-layers.

Selected References

Bagavan A, Rahuman AA, Kamaraj C, Kaushik NK, Mohanakrishnan D, Sahal D (2011) Antiplasmodial activity of botanical extracts against *Plasmodium falciparum*. Parasitol Res 108(5):1099–1109

Brown WH (1951–1957) Useful plants of the Philippines. Reprint of the 1941–1943 edn. 3 vols. Technical Bulletin 10. Department of Agriculture and Natural

Resources. Bureau of Printing, Manila. vol 1 (1951), 590pp, vol 2 (1954), 513pp, vol 3 (1957), 507pp

Burkill IH (1966) A dictionary of the economic products of the Malay Peninsula. Revised reprint, 2 vols. Ministry of Agriculture and Co-operatives, Kuala Lumpur. vol 1 (A–H), pp 1–1240, vol 2 (I–Z), pp 1241–2444

Council of Scientific and Industrial Research (CSIR) (1950) The wealth of India: a dictionary of Indian raw materials and industrial products, vol 2, Raw materials. Publications and Information Directorate, New Delhi

Jagessar RC, Mars A, Gomes G (2008) Selective antimicrobial properties of *Phyllanthus acidus* leaf extract against *Candida albicans, Escherichia coli* and *Staphylococcus aureus* using Stokes disc diffusion, well diffusion, streak plate and a dilution method. Nat Sci 6(2):24–38

Jain NK, Lodhi S, Jain A, Nahata A, Singhai AK (2011) Effects of *Phyllanthus acidus* (L.) Skeels fruit on carbon tetrachloride-induced acute oxidative damage in livers of rats and mice. Zhong Xi Yi Jie He Xue Bao 9(1):49–56

Jain NK, Singhai AK (2011) Protective effects of *Phyllanthus acidus* (L.) Skeels leaf extracts on acetaminophen and thioacetamide induced hepatic injuries in Wistar rats. Asian Pac J Trop Med 4(6):470–474

Lee CY, Peng WH, Cheng HY, Chen FN, Lai MT, Chiu TH (2006) Hepatoprotective effect of *Phyllanthus* in Taiwan on acute liver damage induced by carbon tetrachloride. Am J Chin Med 34(3):471–482

Leeya Y, Mulvany MJ, Queiroz EF, Marston A, Hostettmann K, Jansakul C (2010) Hypotensive activity of an n-butanol extract and their purified compounds from leaves of *Phyllanthus acidus* (L.) Skeels in rats. Eur J Pharmacol 649(1–3):301–313

Mackeen MM, Ali AM, Abdullah MA, Nasir RM, Mat NB, Razak AR, Kawazu K (1997) Antinematodal activity of some Malaysian plant extracts against the pine wood nematode, *Bursaphelenchus xylophilus*. Pest Manag Sci 51(2):165–170

Meléndez PA, Capriles VA (2006) Antibacterial properties of tropical plants from Puerto Rico. Phytomedicine 13(4):272–276

Ministry of Public Health (1970) Tables of nutrition values in Thai food per 100 gm of edible portion. Office of the Prime Minister, Royal Thai Government, Bangkok

Molesworth Allen B (1967) Malayan fruits: an Introduction to the cultivated species. Moore, Singapore, 245pp

Morton JF (1987) Otaheite gosseberry. In: Fruits of warm climates. Julia F. Morton, Miami, pp 217–219

Nguyen VD (1993) Medicinal plants of Vietnam. Self Publ, Cambodia and Laos, 528pp

Ochse JJ (1927) Indische Vruchten. Volkslectuur, Weltevreden, 330pp

Ochse JJ, Soule MJ Jr, Dijkman MJ, Wehlburg C (1961) Tropical and subtropical agriculture. 2 vols. Macmillan, New York. 1446pp

Pacific Island Ecosystems at Risk (PIER) (2006) *Phyllanthus acidus* (L.) Skeels, Euphorbiaceae. http://www.hear.org/pier/species/phyllanthus_acidus.htm

Pino JA, Cuevas-Glory LF, Marbot R, Feuntes V (2008) Volatile compounds of grosella (*Phyllanthus acidus* (L.) Skeels) fruit. Rev Cenic Cienc Quim 39(1):3–5

Purseglove JW (1968) Tropical crops: dicotyledons, vol 1 and 2. Longman, London, 719pp

Sengupta P, Mukhopadhyay J (1996) Terpenoids and related compounds—VII: Triterpenoids of *Phyllanthus acidus* Skeels. Phytochemistry 5(3):531–534

Sibounnavong P, Daungpanya S, Sidtiphanthong S, Keoudone C, Sayavong M (2010) Application of *Saccharomyces cerevisiae* for wine production from star gooseberry and carambola. J Agric Tech 6(1):99–105

Sousa M, Ousingsawat J, Seitz R, Puntheeranurak S, Regalado A, Schmidt A, Grego T, Jansakul C, Amaral MD, Schreiber R, Kunzelmann K (2007) An extract from the medicinal plant *Phyllanthus acidus* and its isolated compounds induce airway chloride secretion: a potential treatment for cystic fibrosis. Mol Pharmacol 71(1):366–376

Subhadrabanhdu S (2001) Under utilized tropical fruits of Thailand. FAO Rap publication 2001/26. 70pp

Vongvanich N, Kittakoop P, Kramyu J, Tanticharoen M, Thebtaranonth Y (2000) Phyllanthusols A and B, cytotoxic norbisabolane glycosides from *Phyllanthus acidus* Skeels. J Org Chem 65(17):5420–5423