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A Review on the Phytochemical and Pharmacological Activitities of *Luffa acutangula* (L.) Roxb.

Tinjauan Fitokimia dan Aktivitas Farmakologi dari Gambas *Luffa acutangula* (L.) Roxb.

Erna Harfiani*, Dhigna Luthfiyani Pradana, Hany Yusmaini

Departement of Pharmacy, Faculty of Medicine, University of Pembangunan Nasional Veteran Jakarta
Jl. RS. Fatmawati No.1, Pondok Labu, Jakarta Selatan 12450 Indonesia

*Corresponding author email: ernaharfiani@upnvj.ac.id

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ABSTRACT

Indonesia is a country with a tropical climate, so it can be a place to live for various plants in the world. The use of plants in Indonesia as an alternative treatment requires a lot of research because many plants have not been studied for their chemical compounds and pharmacological effects. Ethnopharmacological studies of a plant can be the basis for medicinal plant research. Empirically, *Luffa acutangula* (L.) Roxb. (angled luffa, *gambas*) is a plant that has various therapeutic benefits. This study aimed to determine pharmacognostic properties (macroscopic and microscopic fradments of crude drugs), chemical compound content, and pharmacological activity of *L. acutangula* extract in literature studies. Literature searching were performed by online searching using Google Scholar, Science Direct, and PubMed as the databases. *L. acutangula* has been used empirically in Indonesia for helping in the treatment of various diseases. The phytochemical content of *L. acutangula* extract will affect its pharmacological activity. Phytochemical analysis of *L. acutangula* leaf powder, namely there are chemical compounds of alkaloids, glycosides, saponins, carbohydrates, amino acids, and lipids. Analysis of the ethanol extract of *L. acutangula* contained chemical compounds of alkaloids, glycosides, saponins, carbohydrates, and steroids. Analysis of the aqueous extract of *L. acutangula* contained alkaloids, saponins, carbohydrates, terpenoids, and triterpenoids. The pharmacological activities of *L. acutangula* included antimicrobial, anticancer, antioxidant, hypoglycemic, hepatoprotective, gastroprotective, immunomodulatory, antiparasitic, anti-inflammatory, analgesic, and anti-thyroid. *L. acutangula* which contain various phytochemical compounds is potentially to be further studied to develop its pharmacological benefits.

Keywords: characterization, *gambas*, *Luffa acutangula* (L.) Roxb., pharmacological activity, phytochemical.

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ABSTRAK

*Indonesia merupakan negara yang beriklim tropis, sehingga dapat menjadi tempat hidup dari berbagai tanaman di dunia. Pemanfaatan tanaman di Indonesia sebagai alternatif pengobatan memerlukan banyak penelitian karena masih banyak tanaman yang belum diteliti kandungan senyawa kimia dan efek farmakologinya. Kajian etnofarmakologi dari suatu tanaman dapat menjadi dasar penelitian tanaman obat. Secara empiris, gambas (*Luffa acutangula *(L.) Roxb.) merupakan salah satu tanaman yang memiliki berbagai manfaat terapi. Tujuan kajian ini untuk mengetahui karakterisasi makroskopik dan mikroskopik serbuk simplisia, kandungan senyawa kimia dan aktivitas farmakologi dari ekstrak gambas secara studi literatur. Penelusuran literatur dilakukan secara daring dengan menggunakan pangkalan data Google Scholar, Science Direct, dan PubMed. Tanaman gambas telah dipergunakan secara empiris di Indonesia dan bermanfaat untuk membantu dalam penanganan berbagai penyakit. Kandungan fitokimia ekstrak gambas mempengaruhi aktivitas farmakologinya. Analisis fitokimia dari serbuk daun gambas menunjukkan adanya kandungan senyawa alkaloid, glikosida, saponin, karbohidrat, asam amino, dan lipid, sedangkan analisis terhadap ekstrak etanol gambas menunjukkan keberadaan alkaloid, glikosida, saponin, karbohidrat, dan steroid. Ekstrak air gambas mengandung alkaloid, saponin, karbohidrat, terpenoid, triterpenoid. Aktivitas farmakologi gambas antara lain sebagai antimikroba, antikanker, antioksidan, hipoglikemi, hepatoprotektif, gastroprotektif, immunomodulator, antiparasit, anti inflamasi, analgetik, dan anti tiroid. Gambas yang mengandung berbagai senyawa fitokimia, berpotensi untuk terus dilakukan dikembangkan potensi manfaat farmakologinya.*

***Kata kunci**: aktivitas farmakologi, fitokimia, gambas, karakterisasi,* Luffa acutangula *(L.) Roxb.*

Introduction

Indonesia's natural wealth is very diverse, including plants, animals, and minerals. Plants in Indonesia have many benefits, one of which is as medicinal plant. Angled luffa (*Luffa acutangula* (L.) Roxb.) is a plant originating from India, especially the western, central and southern regions of India. This plant can grow in tropical and sub-tropical climates, but it is found in many parts of Indonesia (Raja et al., 2017).

L. acutangula is from Cucurbitaceae family. The Cucurbitaceae family consists of various squash, melon, and pumpkin, including plants such as cucurbits, pumpkins, luffas, and watermelons (Tupe et al., 2013). The community has widely used *L. acutangula* from generation to generation. Almost all parts of the plant can be used, the parts that are widely used are the fruit, seeds, leaves, and roots. *L. acutangula* has been used by Indonesians for food, vegetables and to treat skin and is used to treat various diseases, such as skin disorders due to fungi. *L. acutangula* is mainly consumed/cooked as a vegetable, and

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also its dry form is used as a cleaning sponge (Anitha & Miruthula, 2014). Luffa seeds have a very bitter taste and are empirically used in the Madura area, East Java, by some residents as a medicine when exposed to malaria. One of the medicinal plants traditionally used to treat diabetes mellitus is luffa seeds (*L. acutangula L. Roxb*). Various research results have shown the effect of lowering blood sugar levels from the seeds or fruit of luffa in the alloxan-induced diabetes test method and glucose load. The acute toxicity test shows that the luffa fruit extract is not toxic up to a dose of 3000 mg / kgBB rats (Jyothi et al., 2010).

Indonesia has many medicinal plants that have not been studied for their chemical compound content and potential pharmacological activity. Phytochemicals are naturally occurring bioactive compounds found in plant foods that work with nutrients and dietary fiber to protect against disease. Phytochemicals are non-nutritional plant chemicals with protective or disease prevention properties, some of which are lycopene in tomatoes, isoflavones in soybeans & flavonoids in fruits (Tupe et al., 2013). Ethnopharmacological studies of a plant can be the basis for medicinal plant research. *L. acutangula* is a plant that has therapeutic benefits, as are luffa seeds. Therefore, it is necessary to study the chemical compounds in *L. acutangula* and the pharmacological activity of the *L. acutangula* extract. The phytochemical content of luffa extract will affect its pharmacological activity.

Pharmacognosy *L. acutangula*

Description

L. acutangula fruits are cylindrical or club-shaped, pale yellow-brown, 9-12 cm long and 2-4 cm wide. It tapers towards the base and is covered with 8-10 longitudinal ribs. There are three spaces, where the inside is fibrous and can be easily removed from the outside, on the inside there are seeds of luffa. The seeds are black, taste bitter, oval. Generally 0.6-0.8 cm in length with a width of 0.5 - 0.6 cm (Vaidya M, 2016). The cross-section of the *L. acutangula* fruit can be seen in Figure 1.

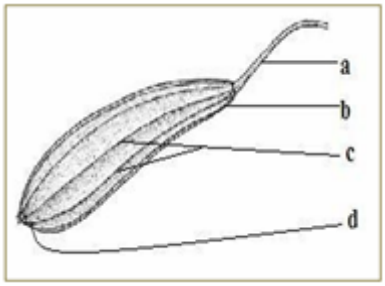

Figure 1. Cross-section of *L. acutangula* fruit. (a) trunk, (b) basic, (c) plot, (d) peak/end (Anitha & Miruthula, 2014)

Identity

The Indonesian local name for *L. acutangula* is oyong. The word "loofah" (oyong) comes from Arabic. This plant is also called ridge gourd, angled loofah, Chinese okra, dish-cloth gourd, ribbed loofah, silk gourd, silky gourd, sinkwa towel sponge, sinqua melon, vegetable sponge susemi (Korea), hecima (Japan),

patolla (Philippines), gambas/ oyong/ kimput (Indonesia) (Jyothi et al., 2010; Raja et al., 2017).

Chemical content

The chemical content of luffa fruit includes carbohydrates, carotene, fat, protein, amino acids, alanine, arginine, glycine, sitein, glutamic acid, hydroxyproline, leuain, serine, tryptophan, flavonoids, saponins, luffangulin, cucurbitacin, oleanolic acid, myristic acid amino acids, and oligosaccharides. While the seeds contain oil, including palmitic, stearic, and myristic acid (Jyothi et al., 2010; Vaidya M, 2016). The nutritional content of *L. acutangula* includes lots of fiber, vitamins, and minerals, including Vitamin B2, Vitamin C, carotene, niacin, calcium, phosphorus, iron and small amounts of iodine and fluorine (Manikandaselvi, et al., 2016). Luffa fruit seeds also contain luffangulin, alkaloids, triterpenoids and curcubitasin (Mardiyanti et al., 2005). *L. acutangula* seeds contain abundant protein and fat (39 and 44%) higher than other plant seeds (Swetha & Muthukumar, 2016).

Taxonomy of L. acutangula

The taxonomy *L. acutangula* is described as follow (Jyothi et al., 2010):

Kingdom : Plantae (plants)
Subkingdom : Tracheobionta (vascular plant)
Super Division : Spermatophyta (produces seeds)
Division : Magnoliophyta (flowering plants)
Class : Magnoliopsida (dashed two dicot)
Order : Cucurbitales
Family : Cucurbitaceae (pumpkin-Labuan tribe)
Genus : Luffa
Species : *Luffa acutangula* (L.) Roxb.

Characterization

Specific parameters of the crude drugs

1. Organoleptic examination (including shape, smell, taste, and color)

   L. acutangula fruit is cylindrical, pale yellowish-brown, 9-12 cm long, and 2-4 cm wide (Vaidya M, 2016). The *L. acutangula* leaves can be seen in Table 1.

2. Macroscopic tests

   This method is used to find the morphological, and color specificities of the luffa crude drugs. The shape and color of the luffa can be seen in Figure 2. The appearance of the fruit of *L. acutangula* is greenish-brown and when it is old it becomes yellowish-brown, extending like a tube with a rounded tip, tapering to the base and the skin is wrinkled and jagged. The appearance of the leaves is brownish yellow petiole, 3-8 cm long; slightly bent, wrinkled and angled with pale / light green lamina, 6-9 cm long, wrinkled and wide. The appearance of the luffa seeds looks black, 11-12 mm long, has an oval flat shape rounded at the tip with a tapered edge (Al-Snafi, 2019).

Table 1. Organoleptic examination of *L. acutangula* leaves (Raja et al., 2017)

Characteristic	Petiole	Lamina
Colour	Brownish yellow	Light green
Odour	Specific	-
Size	3-8 cm	6-8cm
Shape	Angular, twisted	Curled, corrugated

Figure 2. Macroscopic test image (shape and color) of *L. acutangula* (Vaidya M, 2016; Jyothi et al., 2010)

3. Microscopic test

Microscopic test was carried out on crude drug powder and observed general *L. acutangula* leaf fragments by observing under a microscope. Microscopic observation of *L. acutangula* crude drug can be seen in Figure 3.

Appearance of *L. acutangula* seeds using a SEM microscope, it was seen that the seed epidermis was surrounded by a thin cuticle, there were upper and lower epidermis. The lower epidermis has many trichomes (uniseriate multicellular, uniseriate unicellular). Collenchyma is present over the lower epidermal region. Palisade cells (like blocks) are present below the upper epidermis. Sclernchymatous sheeth mingles with xylem and phloem, xylem lignified, phloem unlignified. Parenchyma cells occupy the remaining space (King, et al., 2017). The appearance of *L. acutangula* seeds using Scanning electron microscopy (SEM) can be seen in Figure 4.

4. Phytochemical test of *L. acutangula* leaf powder

Phytochemical testing of *L. acutangula* leaf powder can be seen in Table 2.

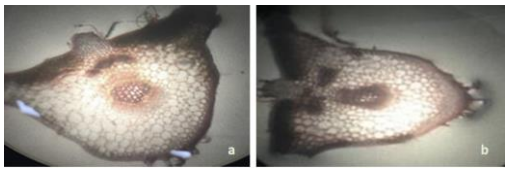

Figure 3. Microscopic observation of transverse pieces of *L. acutangula* leaf. (a) transverse section of midrib (b) transverse section of lamina (Raja et al., 2017)

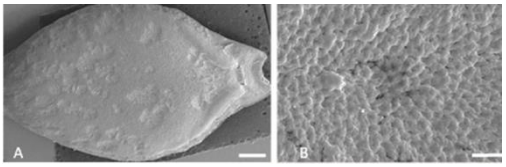

Figure 4. *L. acutangula* seeds under SEM microscopy (Heneidak & Khalik, 2015)

Specific parameters of extract

1. Phytochemical qualitative test of ethanol extract and water extract of *L. acutangula*

Phytochemical testing of *L. acutangula* leaf extract can be seen in Table 3.

2. Quantitative test of methanol extract of *L. acutangula* var. *amara*

The quantitative test method uses *Gas Chromatography-Mass Spectroscopy* (GCMS) to identify and determine the number of chemical compounds contained in a sample of *L. acutangula* fruit methanol extract (Jaysingrao & Sunil, 2019). The quantitative content of *L. acutangula* fruit extract can be seen in Table 4.

Table 2. Photochemical examination of *L. acutangula* leaf powder (Raja, et al., 2017)

Chemical test	Present/Absent
Alkaloids (Dragendroff's test)	Present
Glycosides (Bal jet test)	Present
Saponins (Foam test)	Present
Carbohydrates (Molisch's test)	Present
Proteins (Biuret test)	Absent
Amino acids (Ninhydrin test)	Present
Lipids(fixed oil) (Filter paper test)	Present
Volatile oil (Distillation method)	Absent

Table 3. Phytochemical examination of the ethanol extract and aqueous extract of *L. acutangula* (Tupe et al., 2013; Raja et al., 2017)

Chemical test	Ethanolic extract	Aqueous extract
Alkaloids (Mayer's and Dragendroff's test)	Present	Present
Glycosides (Borntrager's test)	Present	-
Saponins (Foam test)	Present	Present
Carbohydrates (Molisch's test)	Present	Present
Flavonoids (Sinodha test)	Absent	Absent
Steroids (Libermann Burchard's test)	Present	Absent
Terpenoids	-	Present
Triterpenoids	-	Present

Table 4. Phytochemical examination of the ethanol extract and aqueous extract of *L. acutangula* (Jaysingrao & Sunil, 2019)

Name of Compound	Molecular formula	Molecul weight
2-Cyclohexane-1-one,2-methyl-5-(1methylethenyl)-s	$C_{10}H_{14}O$	150
Benzene,1-methoxy-4-(1-propenyl)	$C_{10}H_{12}O$	148
10-Acetoxy-5-Oximino-H-dibenzo(a,d)cycloheptene,o-(2acetylmethylaminoethyl)	$C_{22}H_{22}N_2O_4$	378
3-Dimethylamino-2-(-4-chlorophenyl)thioacrylic acid, thiomorpholide	$C_{15}H_{19}ClN_2S_2$	326
Phenol,2-methoxy-4-(1-propenyl)	$C_{10}H_{12}O_2$	164
(+) salsolidine	$C_{12}H_{17}NO_2$	207
Ethanone,1-(2-(5-hydroxy-1,1-dimethylhexyl)3methyl-2 cyclopropen-1-yl)	$C_{14}H_{24}O_2$	224
9,9-Bi-9-H-fluorene,9,9-dimethoxy	$C_{28}H_{22}O_2$	390
2-Piperidinone,N-(4-bromo-n-butyl)-	$C_9H_{16}BrNO$	233
3-Octyne,7-Methyl	C_9H_{16}	124
3-Methyl-2-Octyl-1H-quinolin-4-one	$C_{18}H_{25}NO$	271
(+) salsolidine	$C_{12}H_{17}NO_2$	207

Name of Compound	Molecular formula	Molecul weight
Ethanone,1-(2-(5-hydroxy-1,1-dimethylhexyl)3methyl-2-cyclopropen-1-yl)	$C_{14}H_{24}O_2$	224
9,9-Bi-9H-fluorene,9,9-dimethoxy	$C_{28}H_{22}O_2$	390
2-Piperidinone,N-(4-bromo-n-butyl)-	$C_9H_{16}BrNO$	233
3-Octyne,7-Methyl	C_9H_{16}	124
3-Methyl-2-Octyl-1H-quinolin-4-one	$C_{18}H_{25}NO$	271
2-(2-Hydroxyethyl)-7,7,9-trimethyl-1,2,4triazospiro (4,5) decane-3-thione	$C_{12}H_{23}N_3OS$	257
9,12-Octadecadienoyl chloride,(Z,Z)	$C_{18}H_{31}ClO$	298
1-Oxacyclopentadecan-2-one,15-ethenyl-15methyl	$C_{17}H_{30}O2$	266

Non specific parameters of extract

Non-specific parameters are all aspects that are not directly related to pharmacological activity but affect the safety and stability aspects of the extracts and the resulting preparations. The data below is a standardization obtained from Ayurvedic pharmacopeia on *L. acutangula* (Jyothi, et al., 2010).

1. Determination of total ash content

   The total ash content of *L. acutangula* is not more than 16%.
2. Determination of acid soluble ash content

   The acid insoluble ash content of *L. acutangula* is not more than 4%.
3. Determintion soluble in water and alcohol

   L. acutangula water-soluble extract is not more than 13%, while the alcohol-soluble extract of *L. acutangula* is not more than 6%.
4. Microbial contamination and determination of total fungi

   Foreign object not more than 2%.

Pharmacological Activities

L. acutangula has been widely used by the community from generation to generation. Almost all parts of the plant can be used, the parts that are widely used are the fruit, seeds, leaves and, roots. The fruit is used in the treatment of the enlarged spleen, helps detoxify the liver, helps with constipation, treats edema from its diuretic effect, anti-diabetes and stomach worm medication. Seeds are used in their oil form for skincare. The fresh leaves are used as a bandage for diseases such as enlarged spleen, ringworm, leprosy. The powdered leaves can be applied topically mixed with garlic to get rid of leprosy. The leaves can also be useful in the treatment of dysentery. While the root with the addition of milk/water can help in removing kidney stones (Shrivastava & Roy, 2013; Raja et al., 2017; Chanda et al., 2019).

Some of the published research results regarding the benefits of published *L. acutangula* can be seen in Table 5.

Table 5. Some pharmacological activities of *L. acutangula*

Pharmacological Activities	Major findings	Reference
Antimicrobial	The antibacterial effect of ethanolic extract of *L. acutangula* was studied against *Pseudomonas aeruginosa, Escherichia coli, Staphylococcus aureus,* and *Candida albicans*. Nanoparticel of *L. acutangula* extract has antibacterial and antifungal activities against *E. coli* and *Saccharomyces cervisiae*	(Menghani et el., 2011; Taruna et al., 2016)
Antiparasitic	The methanolic extract of *L. acutangula* showed moderate anthelmintic activity. At a concentration of 10 mg /ml, it causes paralysis and death of stomach worms after> 90 minutes	(Rahman, 2014)
Anticancer	The anticancer activity of ethanol and water extracts (200 and 400 mg/kg BW, of *L. acutangula* was evaluated in mice for a significant reduction, tumor volume, and tumor weight of Ehrlich ascites carcinoma (EAC) cells.	(Dashora & Chauhan, 2015)
Antioxidant	The methanol extract of *L. acutangula* fruit showed antioxidant activity, which results were higher than that of the hexane and water extracts. The chemical compound content of *L. acutangula* fruit extract has an antioxidant effect	(Suryanti et al, 2015; Jaysingrao & Sunil, 2019)
Hypoglycemic	The ethanol extract of the fruit and seeds of *L. acutangula* significantly reduced blood sugar levels in streptozotocin-induced diabetic rats	(Raj et al., 2013)
Hepatoprotective	The alcohol extract of *L. acutangula* var *amara* fruit showed good hepatoprotective activity	(Abid et al., 2014)
Gastroprotective	Gastroprotective effect of *L. acutangula* methanol extract and water on stomach ulceration of streptozotocin-induced diabetic rats.	(Pimple et al., 2013)
CNS protection	The protective effect of the ethanol extract of *L. acutangula* against Parkinson's disease symptoms and catalepsy by regulation of neurotransmitters and antioxidant properties	(Gandhare, 2012)
Anti-inflammatory	The ethanol seed extract of *L. acutangula* for anti-inflammation using the carrageenan-induced rat foot edema method and analgesic activity using the flick and tail immersion method. The chemical compound content of *L. acutangula* fruit extract has an antiinflammatory effect	(Gill, et al, 2011; Jaysingrao & Sunil, 2019)
Analgesic	The ethanol seed extract of *L. acutangula* as an analgesic in rats using the flick and tail immersion method. The chemical compound content of *L. acutangula* fruit extract has an analgesic effect	(Gill, et al, 2011; Jaysingrao & Sunil, 2019)
Immunomodulator	Fruit wall ethanol extract of *L. acutangula* can increase phagocytosis and neutrophils	(Shendge & Balemkar , 2018)
Antithyroid	The ethanol extract of *L. acutangula* rind can be useful in the regulation of thyrotoxicosis disorders	(Sunhre, Kar, & Panda, 2020)

Toxicity of *L. acutangula*

The LD_{50} value of water and methanol extract from luffa fruit obtained a value of 4 g / kg body weight (Dashora and Chauhan, 2015). While the LD50 value for ethanol extract is 500 mg / kg, and petroleum ether extract 350 mg / kg (Ibrahim et al., 2014).

Conclusion

L. acutangula is a plant originating from India. It is widely grown and found in Indonesia and has been widely used by the Indonesian people both from its fruit, leaves, seeds, and roots. Based on ethnopharmacological studies, *L. acutangula* is often used in traditional medicine in various countries. Phytochemical analysis of *L. acutangula* leaf powder, namely, chemical compounds of alkaloids, glycosides, saponins, carbohydrates, amino acids, and lipids. Analysis of the ethanol extract of *L. acutangula* contained chemical compounds of alkaloids, glycosides, saponins, carbohydrates, and steroids. Analysis of the aqueous extract of *L. acutangula* contained alkaloids, saponins, carbohydrates, terpenoids, triterpenoids. Pharmacological activity in pre-clinical trials showed that *L. acutangula* has the potential to be antimicrobial, anticancer, antioxidant, hypoglycemic, hepatoprotective, gastroprotective, immunomodulatory, antiparasitic, anti inflammatory, analgesic, and anti-thyroid.

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