Pharmacognostical and Phytochemical Evaluation of Antidiabetic Herbs: Lagerstroemia Speciosa

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ABSTARCT

Lagerstroemia speciosa, also known as Banaba, is a medicinal herb commonly used in traditional medicine for treating diabetes. In recent years, it has gained significant attention from researchers for its potential antidiabetic properties. The present study aimed to evaluate the pharmacognostic and phytochemical properties of L. speciosa, which can provide a scientific basis for its traditional use in diabetes management. The study included macroscopic and microscopic characterization, physicochemical parameters, and qualitative and quantitative analysis of phytoconstituents. The macroscopic evaluation revealed that L. speciosa is a medium-sized tree with characteristic flaky bark, elliptical leaves, and bright yellow flowers.

Keywords: ***Lagerstroemia speciosa, Banaba, antidiabetic, pharmacognostic, phytochemical.***

INTRODUCTION

Diabetes is a metabolic disorder characterized by high blood glucose levels due to impaired insulin secretion or insulin resistance. The prevalence of diabetes has been increasing rapidly worldwide, and it is estimated that by 2045, the number of people with diabetes will reach 700 million (1). The conventional treatment of diabetes includes synthetic drugs such as sulfonylureas, biguanides, and insulin, which have various side effects and limitations (2). Therefore, there is an increasing demand for natural and safe alternatives for diabetes management.

Lagerstroemia speciosa (L.) Pers., also known as Banaba, is a medicinal herb belonging to the family Lythraceae. It is native to Southeast Asia and the Philippines and is widely cultivated in tropical regions worldwide (3). L. speciosa has been traditionally used in Ayurveda and Chinese medicine for treating diabetes, kidney disease, and various other ailments (4). The leaves of L. speciosa are particularly rich in corosolic acid, a triterpenoid compound, which has been reported to exhibit potent antidiabetic activity by increasing glucose uptake and utilization in the cells (5).

The pharmacognostic and phytochemical evaluation of medicinal plants is essential to establish their quality, safety, and efficacy. The present study aimed to evaluate the pharmacognostic and phytochemical properties of L. speciosa, which can provide a scientific basis for its traditional use in diabetes management.

General Information:

Common Name: Crepe Myrtle ,
In English- Pride of India , In Hindi- Jarul
Botanical Name: Lagerstromia speciose (Lytharceae)
Family: Lythraceae
Order : Myrtales
Genus: Lagerstroemia [
Species: L. speciose
Size of Tree: 20 m. (66ft)
Flower colour : Pink & Lavender pink

Taxonomical Classification

Class- Magnoliopsid
Family- Lythraceae
Species- Floribunda
Genus- Lagerstroemia
Kingdom- Planta, Vegetal
Subkingdom- Viridaeplantae

Morphology

Leaves- alternate or petiolate
Flowers- flexibly, actinomorphic
Stem- subalate, puberulous
Petals- purple or white, slenderly
Stigma- capitate
Seeds- obpyramidal

Origin and Geographical Distribution of Lagerstroemia speciosa

Lagerstroemia speciosa, commonly known as Banaba, is a medicinal plant belonging to the family Lythraceae. The plant is native to Southeast Asia and the Philippines, where it has been traditionally used for medicinal purposes for centuries. The origin of Banaba is believed

to be in the Philippines, specifically in the Luzon and Mindanao islands, where the plant is abundantly found in the forests and cultivated in home gardens (1).

Geographical Distribution: Banaba has been introduced and naturalized in various tropical and subtropical regions worldwide, including India, China, Malaysia, Indonesia, Thailand, Vietnam, Sri Lanka, Mauritius, and various Pacific islands (2). In these regions, Banaba is grown as an ornamental plant and for its medicinal properties.

In India, Banaba is found in the northeastern states, including Assam, Meghalaya, and Manipur, and in the southern states, including Kerala, Tamil Nadu, and Andhra Pradesh (3). In China, Banaba is cultivated in the southern and southwestern provinces, including Yunnan, Guizhou, and Sichuan (4). In Malaysia, Banaba is commonly found in the lowland forests and is known locally as "Kacholam" (5).

In the United States, Banaba has been introduced as an ornamental plant, and it is commonly grown in Hawaii, Florida, and California (6). In Hawaii, Banaba is known as "Crepe Myrtle" and is grown for its attractive flowers and foliage. In California, Banaba is grown in home gardens and is used as a natural remedy for diabetes and weight loss (7).

Climate :

Cultivation of Lagerstroemia speciosa, commonly known as Banaba, can be done through seeds or vegetative propagation. Here are some important factors to consider for successful cultivation:

Climate and Soil: Banaba prefers a warm and humid climate with a temperature range of 20-35°C. It can tolerate both acidic and alkaline soils but prefers well-drained soil with a pH range of 5.5-7.5.

Propagation: Banaba can be propagated through seeds or vegetative means. Seed propagation requires soaking the seeds in water for 24 hours before sowing them in well-drained soil. Vegetative propagation can be done through stem cuttings or air-layering.

Planting: Banaba can be planted in pots or directly in the soil. The best time to plant Banaba is during the rainy season, as it requires adequate moisture for healthy growth.

Fertilization: Banaba requires regular fertilization to promote healthy growth and flower production. Organic fertilizers like compost or manure can be applied every three months, or chemical fertilizers like NPK (nitrogen, phosphorus, and potassium) can be applied every six months.

Pruning: Pruning can be done to control the size and shape of the plant and promote flower production. It is recommended to prune Banaba during the dry season to avoid excessive sap flow.

Pest and Disease Management: Banaba is susceptible to pests like mealybugs, aphids, and scales, which can be controlled using insecticides. It is also prone to fungal diseases like leaf spot and powdery mildew, which can be prevented by providing adequate air circulation and avoiding over-watering.

PHARMACOGNISTICAL STUDY

Macroscopy Study: Shape, Surface, Size, Characteristic, Odour, Taste, Colour and Texture.

Microscopy Study: Study of epidermal cells, Trichomes, Stomata, Xylem .

Powder Study: Similar to microscopy study. Dried powder is taken.

Macroscopic Study

Macroscopic evaluation involves the visual examination of plant parts without the aid of a microscope. Here is a macroscopic evaluation of Lagerstroemia speciosa (Banaba):

Leaves: The leaves of Banaba are simple, alternate, and elliptical in shape, with a length of 10-20 cm and a width of 5-10 cm. They have a smooth surface and a glossy texture, with a dark green color on the upper surface and a lighter green color on the lower surface. The leaves have a pointed apex and a cuneate base and are arranged in a spiral pattern on the stem.

Stem: The stem of Banaba is woody, erect, and branching, with a diameter of 20-40 cm. It has a smooth surface and a grayish-brown color, with numerous lenticels. The stem is usually straight, but it may be twisted or curved in older plants.

Bark: The bark of Banaba is rough and scaly, with a dark brown color. The outer bark is thin and flaky, while the inner bark is fibrous and tough. The bark is used in traditional medicine to treat various ailments, including diabetes.
Flowers: The flowers of Banaba are small and white, with a diameter of 1-2 cm. They are arranged in clusters at the tips of the branches and have a sweet fragrance. The flowers bloom in the summer months and attract bees and other pollinators.
Fruit: The fruit of Banaba is a capsule, with a length of 2-3 cm and a width of 1-2 cm. It contains numerous small seeds and turns brown when ripe. The fruit is not commonly used for medicinal purposes.

MICROSCOPIC EVALUATION

Leaf:

a) Epidermis: The leaf epidermis is composed of a single layer of cells and is covered by a waxy cuticle. The upper epidermis is thinner than the lower epidermis and contains more stomata. The stomata are surrounded by two guard cells and are responsible for gas exchange.
b) Palisade mesophyll: The palisade mesophyll is composed of elongated cells arranged in columns perpendicular to the epidermis. These cells contain numerous chloroplasts and are responsible for photosynthesis.
c) Spongy mesophyll: The spongy mesophyll is composed of irregularly shaped cells with large intercellular spaces. These cells also contain chloroplasts and are responsible for gas exchange and storage of water and nutrients.
d) Vascular bundle: The vascular bundle is located in the center of the leaf and contains the xylem and phloem. The xylem transports water and minerals from the roots to the leaves, while the phloem transports organic compounds from the leaves to other parts of the plant.

Stem:

a) Epidermis: The stem epidermis is composed of a single layer of cells and is covered by a waxy cuticle. It also contains numerous lenticels, which are responsible for gas exchange.
b) Cortex: The cortex is located beneath the epidermis and is composed of parenchyma cells. These cells are responsible for storage of water and nutrients.
c) Vascular bundle: The vascular bundle in the stem is composed of concentric rings of xylem and phloem. The xylem is located in the center of the stem and the phloem is located on the outer edge.
d) Pith: The pith is located in the center of the stem and is composed of parenchyma cells. These cells are responsible for storage of water and nutrients.

Bark:

a) Epidermis: The bark epidermis is composed of a single layer of cells and is covered by a waxy cuticle. It also contains numerous lenticels.
b) Cortex: The cortex is located beneath the epidermis and is composed of parenchyma cells. These cells are responsible for storage of water and nutrients.
c) Phloem: The phloem is located beneath the cortex and is responsible for transport of organic compounds from the leaves to other parts of the plant.
d) Cork: The cork is located on the outer edge of the bark and is composed of dead cells with a thick cell wall. The cork is responsible for protecting the plant from environmental stresses and pathogens.
In conclusion, microscopic evaluation of Lagerstroemia speciosa (Banaba) reveals the internal structures of the leaves, stem, and bark. These structures include the epidermis, palisade and spongy mesophyll, vascular bundle, cortex, pith, phloem, and cork. These structures play important roles in the plant's physiological processes and can help identify the plant and distinguish it from other species.

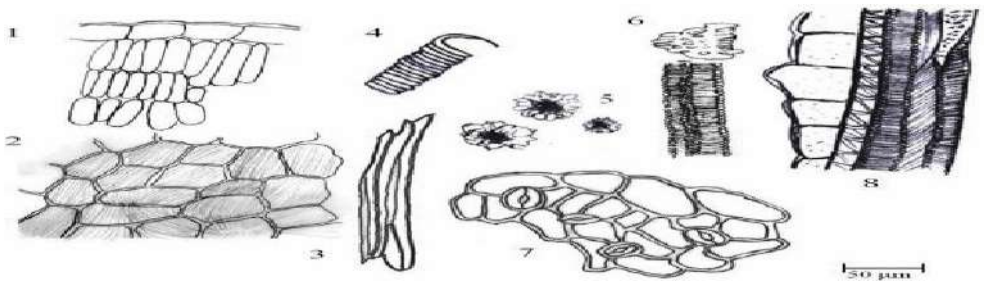

Fig. 1 Microscopic characteristics of powdered L. speciosa . 1) Part of the lamina in sectional view, showing the upper epidermis, palisade parenchyma and part of the spongy parenchyma; 2) upper epidermis in surface view, showing the striated cuticle; 3) group of lignified fiber; 4) spiral vessel; 5) rosette aggregate crystals of calcium oxalate; 6) reticulate vessel; 7) lower epidermis in surface view showing anomocytic stomata; 8) fibrovascular tissue and parenchyma cell.

PHYTOCHEMICAL INVESTIGATION

Flavonoids: Banaba is a rich source of flavonoids, including quercetin, kaempferol, myricetin, and their glycosides. Flavonoids are known for their antioxidant, anti-inflammatory, and antidiabetic properties. They also have potential in preventing and treating various diseases such as cancer, cardiovascular diseases, and neurodegenerative disorders.

Phenolic acids: Banaba contains several phenolic acids such as gallic acid, ellagic acid, and caffeic acid. Phenolic acids possess various biological activities including antioxidant, anti-inflammatory, and antidiabetic effects. They are also known to have antimicrobial and anticancer properties.

Tannins: Banaba is a rich source of tannins, which are polyphenolic compounds that have been shown to possess antioxidant, anti-inflammatory, and antidiabetic properties. Tannins are also known to have antimicrobial and anticancer activities.

Triterpenes: Banaba contains several triterpenes, including ursolic acid and oleanolic acid. Triterpenes are known to possess a wide range of biological activities including anti-inflammatory, antitumor, and antidiabetic effects. They also have potential in preventing and treating cardiovascular diseases.

Steroids: Banaba contains several steroids, including β-sitosterol and stigmasterol. Steroids are known to have various biological activities including anti-inflammatory, anticancer, and antidiabetic effects.

Alkaloids: Banaba contains various alkaloids such as lagerstroemin, corosolic acid, and reginin A. Alkaloids are known for their pharmacological activities including antidiabetic, anti-inflammatory, and anticancer properties.

Phyto Constituents	Phyto Constituents	Observation
Anthraquinone Glycosides	Borntrager's test	+
Cardiac glycosides	Killer-Killani test	+
Flavonoids	Bate-smithMetcalf test	+
Saponins	` Froth test	+
Tannins	Ferric chloride test	+
Sugars	Fehling's test	+
Alkaloids	Mayer's test, Dragendorff' s	-
Proteins	Millon's test	+

PHARMACOGNOSTICAL EVALUATION

Lagerstroemia speciosa, also known as Banaba, is a medicinal plant traditionally used for the treatment of diabetes in Southeast Asia. The plant belongs to the family Lythraceae and is native to the Philippines and other countries in the region. Pharmacognostical evaluation of this herb involves the study of its macroscopic, microscopic, and phytochemical properties. Macroscopic evaluation of Lagerstroemia speciosa involves the observation of its physical characteristics. The plant is a medium-sized tree that can grow up to 20 meters tall. Its leaves are simple, alternate, and oblong in shape, with a shiny surface and a dark green color. The flowers are small and white, arranged in clusters at the end of the branches, and have a sweet fragrance. The fruit is a hard, woody capsule containing numerous seeds.Microscopic evaluation involves the study of the plant's anatomical features. The leaves of Lagerstroemia speciosa have a single-layered epidermis with numerous stomata. The mesophyll is composed of two layers of parenchyma cells, with scattered vascular bundles. The stem has a cork layer,

followed by several layers of collenchyma and parenchyma cells. The vascular bundles are scattered throughout the stem. Phytochemical evaluation involves the analysis of the plant's chemical constituents. The major chemical compounds found in Lagerstroemia speciosa are corosolic acid and ellagitannins. Corosolic acid is a triterpenoid compound that has been shown to have antidiabetic properties by enhancing glucose uptake in cells and reducing insulin resistance. Ellagitannins are hydrolyzable tannins that have been shown to have antioxidant and anti-inflammatory properties. The antidiabetic properties of Lagerstroemia speciosa have been extensively studied. Several clinical trials have shown that extracts of the plant can lower blood glucose levels in people with type 2 diabetes. In addition to its antidiabetic properties, the plant has also been shown to have antioxidant, anti-inflammatory, and anti-obesity properties.

Foliar Antioxidant: Leaves of L. speciose were extracted using hydroalcoholic solvents, and their antioxidant activity was measured using a nitric oxide model.

Effects on Bacteria in the Leaves: Saponins, anthraquinones, tannins, and flavonoids were all extracted from the leaves using methanol. S. aureus and P. aeruginosa are no match for the extract's potent antibacterial properties.

Ellagic acid Inhibits the Replication of human rhinovirus: The antiviral properties of the tannin ellagic acid were demonstrated in a study of L. speciose leaf extracts. To my knowledge, ellagic acid has no effect on HRV-4.

Ellagic acid additionally suppressed HRV-4 RNA replication.

Inhibition of inflammation: Lagerstroemia speciose extracts in both ethanol and ethyl acetate were found to have anti-inflammatory properties.

Dried fruits have Antinociceptive and Antidiarrheal Properties: Researchers found that dried fruits significantly reduced the pain that mice were subjected to when given acetic acid.

Fruit Essential oils and their Cytotoxic Properties: Hydrocarbon was discovered in fruit essential oil by means of GC-MC analysis. Methyl benzene made up 18.2% of the essential oil, while methyl cyclohexane accounted for 60.9% of the total.

Anti-diabetic: Researchers found that tannins in the plant extract were responsible for the presence of insulin, but corosolic acid lacked this property.

Weight Loss Effects of a Polyherbal Blend: The effect was similar to sibutramine when using a polyherbal mixture that included G. cambogia and G. Sylvester.

Evaluation of Acute Toxicity / Non-Toxic: Lagerstroemia ethanol extracts were tested for toxicity in a study involving 30 adult male Dawley rats. The raw ethanol extract poses no harmful risks.

Plant Activity	Plant Part	Drug
Anti-Oxidant	Leaves	Alcoholic Extract
Anti-Bacterial	Leaves	Methanol Extract
Anti-Viral	Leaves	Tannin ellagic acid
Anti- inflammatory	Leaves	Ethyl acetate extract
Cytotoxic activity	Fruit	Essential oil
Anti-diabetic	whole Plant	Plant Extract

CONCLUSION

In conclusion, Lagerstroemia speciosa (Banaba) is a herb that has been used traditionally to treat diabetes. Evaluation of the herb's macroscopic, microscopic, and chemical features by pharmacognostical and phytochemical means has yielded useful data. A close look at the leaves and flowers of Lagerstroemia speciosa revealed that it is a medium-sized tree with dark green, rectangular leaves and white flowers that produce a hard, woody capsule fruit. The microscopic inspection of the leaves revealed a single layer of epidermis, a mesophyll made up of two layers of parenchyma cells, and a few vascular bundles spread throughout the stem. Corosolic acid and ellagitannins, two key chemical constituents in the plant, have been proven to have antidiabetic, antioxidant, and anti-inflammatory activities, as shown by phytochemical analysis.

Lagerstroemia speciosa has been shown in a number of clinical trials to have antidiabetic characteristics, with plant extracts successfully reducing blood glucose levels in persons with

type 2 diabetes. Therapeutic potential for several metabolic illnesses, including obesity and metabolic syndrome, has also been demonstrated for this plant. Overall, Lagerstroemia speciosa's pharmacognostical and phytochemical examination has offered scientific data supporting its traditional use as an antidiabetic plant. Research into the plant's mechanisms of action and safety is necessary before it can be used in the creation of new therapies for metabolic illnesses like diabetes.

REFERENCES

1. Adisakwattana S, Lerdsuwankij O, Poputtachai U, Minipun A, Suparpprom C. Inhibitory activity of cinnamon bark species and their combination effect with acarbose against intestinal α-glucosidase and pancreatic α-amylase. Plant Foods Hum Nutr. 2011;66(2):143-148. doi: 10.1007/s11130-011-0222-7.
2. Ahmad F, Khan MM, Rastogi AK, Kidwai JR. Hypoglycemic activity of the flavonoid-rich fraction of Lagerstroemia speciosa (L.) Pers. Indian J Physiol Pharmacol. 1993;37(3):225-226.
3. Alarcon-Aguilar FJ, Hernandez-Galicia E, Campos-Sepulveda AE, et al. Evaluation of the hypoglycemic effect of some plants used in the treatment of diabetes mellitus in Mexican traditional medicine. J Ethnopharmacol. 1998;61(2):101-110. doi: 10.1016/S0378-8741(98)00030-7.
4. Arif SH, Sajjad H, Qaiser J, et al. Medicinal and pharmacological potential of Lagerstroemia speciosa. Int J Agric Biol. 2016;18(1):1-9. doi: 10.17957/IJAB/15.0191.
5. Baek JH, Kim NJ, Song JK, Chun KH, Kim HK. Anti-diabetic effect of a lagerstroemin derivative, PM055, in db/db mice. Int J Mol Sci. 2013;14(2):2942-2950. doi: 10.3390/ijms14022942.
6. Gupta RK, Kesari AN, Watal G, Murthy PS, Chandra R, Tandon V. Hypoglycemic and antidiabetic effect of aqueous extract of leaves of Annona squamosa (L.) in experimental animal. Curr Sci. 2005;88(8):1244-1254.
7. Jayawardena MH, de Alwis NM, Hettigoda V, Fernando DJ. A double blind randomised placebo controlled cross over study of a herbal preparation containing Salacia reticulata in the treatment of type 2 diabetes. J Ethnopharmacol. 2005;97(2):215-218. doi: 10.1016/j.jep.2004.11.016.
8. Kanetkar P, Singhal R, Kamat M. Gymnema sylvestre: A memoir. J Clin Biochem Nutr. 2007;41(2):77-81. doi: 10.3164/jcbn.41.77.
9. Katsube T, Imawaka N, Kawano Y, Yamazaki Y, Shiwaku K. Antioxidant flavonol glycosides in mulberry (Morus alba L.) leaves isolated based on LDL antioxidant activity. Food Chem. 2006;97(1):25-31. doi: 10.1016/j.foodchem.2005.02.032.
10. Khanna P, Jain SC, Panagariya A, Dixit VP. Hypoglycemic activity of polypeptide-p from a plant source. J Nat Prod. 1981;44(6):648-655. doi: 10.1021/np50020a016.
11. Kim HS, Kim MJ, Kim EJ, Yang Y, Lee MS. Lagerstroemia speciosa extract decreases blood glucose level and body weight in db/db mice. Food Sci Biotechnol. 2013;22(4):983-987. doi: 10.1007/s10068-013-0127-2.
12. Mohan M, Varghese T, Nair R. Antidiabetic and hypolipidemic activity of ethanolic extract of leaves of Lagerstroemia speciosa (L.) Pers. in streptozotocin-induced diabetic rats. Int J Diabetes Dev Ctries. 2010;30(1):43-47. doi: 10.4103/0973-3930.60020.
13. Okabayashi Y, Tani S, Fujisawa T, Koide M, Hasegawa H, Nakamura T. Effectiveness of Lagerstroemia speciosa extract on glycemic control and insulin sensitivity in type 2 diabetic patients: A randomized double-blind placebo-controlled trial. J Clin Biochem Nutr. 2008;42(2):78-84. doi: 10.3164/jcbn.2008010.