



Phytochemical and Pharmacological Attributes of Ashtonishing Kadamba Tree (*Neolamarckia cadamba* (Roxb.) Bosser) for Integrated healthcare

S. Abdul Kader¹, MM Abid Ali Khan², Niyaz Ahamad³, Komal³, Shristi Singh⁴, Raaz K. Maheshwari⁵

1. Department of Plant Biology & Plant Biotechnology, Presidency College, Chennai, Tamil Nadu, India

2. Department of Botany, Shia College, Lucknow, Uttar Pradesh, India

3. Department of Plant Molecular Biology & Genetic Engineering, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

4. Department of Agronomy, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

5. Department of Chemistry, SBRM Govt PG College, Nagaur, Rajasthan, India

ABSTRACT

The Kadamba tree (*Neolamarckia cadamba* (Roxb.) Bosser) is crucially significant as it has the largest number of phytochemicals and secondary metabolites. The Kadamba is one of the ornamental plants with religious significance. Many phytoconstituents were isolated using various solvents and obtained compounds, such as cadamine, quinovic acid, cadambine, cadambagenic acid, α -dihydrocadambine, isodihydrocadambine, β -sitosterol, amygdalin, phelasin, ursolic acid, linalool, and geraniol that belong to alkaloids, coumarins, terpenoids, diterpenoids, triterpenes glycosides, sterols, flavonoids, amides, and fatty acids. There are number of traditional applications for treating humanity, which includes mouth ulcer, sub dermal inflammatory deposits, stomatitis, fever, gastric disturbance, astringent, febrifuge, antiseptic, diuretics, anemia and. uterine complaints. This review has showcased various pharmacognosical and phytochemical aspects of bark and leaves of Kadamba tree.

Keywords: Antioxidant, Antihelminthic activity, anti-inflammatory activity, Hyperimmune antivenom, Penta cyclic terpenes.

INTRODUCTION

The Cadamba [*Neolamarckia cadamba* (Roxb.) Bosser] Syn. *Anthocephalus cadamba* (Roxb.) Miq.] (Family: Rubiaceae), commonly known as Kadam (Hindi), distributed all over India. The species have been widely but incorrectly called *Anthocephalus chinensis* as it has scented orange flowers present in dense globe-shaped clusters, which are used in the preparation of perfumes. In India, it is found in the temperate Himalayas (which extend from Kashmir to Bhutan), Garhwal, Himachal Pradesh, Sikkim, Assam, and Manipur. In Garhwal, it is particularly distributed in the temperate zones of Pauri, Tehri, Chamoli, and Uttarkashi districts, while in Himachal Pradesh it is prevalent in the districts of Chamba, Kangra, Manipur, Bilaspur, Kullu, Sirmour, and Simla. [1-3] Besides India, the Cadamba is found in Nepal, Myanmar, and western China⁷. The Kadam tree is highly regarded as religiously and culturally in India being sacred to Lord Krishna, and hence, the tree is also known as Haripriya, God's favorite. Kadamba tree is an evergreen, tropical tree that can reach up to 148 ft. in height. It is a large tree with a broad crown and straight cylindrical bole. It is quick growing, with broad spreading branches and grows rapidly in the first 6–8 years. Bark is dark grey in color, rough and frequently longitudinally fissured, exfoliating in thin scales. Leaves are glossy green, opposite, simple more or less sessile to petiolate, ovate to elliptical, 30 cm long 10-15 cm broad with prominent veins. [4-7].



Kadamba Trees

Flowering usually begins when the tree is 4–5 years old. Kadam flowers are sweetly fragrant, red to orange in color, occurring in dense, globular heads of ~5.5 cm diameter. Fruits are round like small balls, hard containing approximately 8000 seeds and are green when young turning to yellow when ripe. Seeds are trigonal or irregularly shaped. Flowering usually begins when the tree is 4-5 years old. [5,7-8] The fruits of the Cadamba are small, containing fleshy capsules packed closely together to form a yellow-orange infructescence. It is an ornamental plant that is also used for timber and paper-making. It has crucial significance in Indian mythology and religion. Various religions in India have strongly believed that God lives inside a Cadamba tree based on its enormous significance to humankind. It has been said in the Sanskrit shloka, “Ayi Jagadamba Mad-Amba Kadamba Vana-Priyavaasini Haasa-Rate,” that is, Goddess Durga likes to live in the forest of Cadamba trees. The Cadamba has been known to cure a number of diseases; particularly, the extract prepared from the bark and leaves is crucial. Various researchers across the world have focused their studies on discovering a number of phytochemicals as well as secondary metabolites (saponins, indole and quinoline alkaloids, secoiridoids, and triterpenes) with pharmacological significance from the Cadamba.

The present review is based on the significance of the Cadamba and its derived products to humankind. [6,8,9-11]

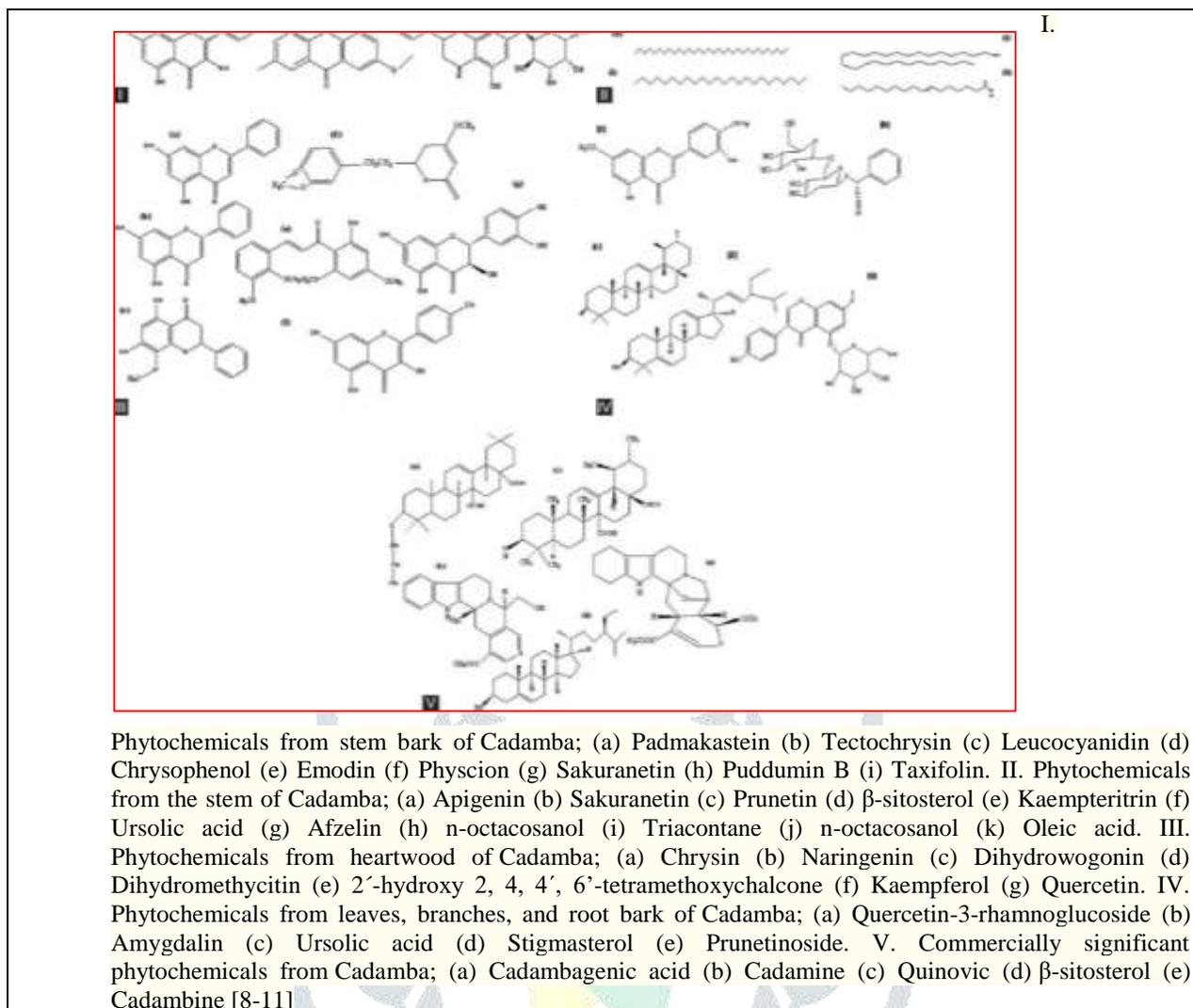


Flowers, fruits, seeds and bark of Cadamba Tree

This article provides a concise review of *Anthocephalus cadamba* (Roxb) Miq. (family – Rubiaceae) that covers ethnobotanical information, pharmacological studies, and phytochemistry.

Phytochemical constituents

Different parts of Cadamba have shown to contain various groups of chemical constituents viz. alkaloids, saponins, terpenoids, flavonoids, triterpenoid glycosides-selinene, 2-nonalol, α -phellandrene, α -steroids, fats and reducing sugars. Recently, the presence of indole alkaloids, phytoesters other glycosides have been identified as a major constituents from various parts of A cadamba. Tannin and an astringent principle which is due to the presence of an acid similar to cincho-tannic acid and α -sitosterol has also been isolated from the bark of the tree. Cadambine ($C_{27}H_{32}N_2O_{10}$), 3 α -dihydrocadambine ($C_{27}H_{34}N_2O_{10}$), iso dihydrocadambine ($C_{37}H_{44}N_2O_{15}$) and 2 non glycosidic alkaloids isocadamine and cadamine were isolated from leaves of the tree. Three terpenoids viz. α -amyryncaprylate, lupeol and nor α -amyryn were first time purified from the petroleum ether fraction of bark ethanolic extract. Two novel triterpenoids saponin, phelasin A and phelasin B were isolated from the bark of cadamba tree. Linalool, geraniol, geranyl acetate, linalyl acetate, α -selininene, 2-nonanol, α -phellandrene, α -bergamottin, p-cymolmcurcumene, terpinolene, camphene and myrcene were isolated from the flowers of C cadamba. Structure of major chemical constituents are shown in the given figure.



PHARMACOLOGICAL ATTRIBUTES

It has been found that methanolic extract of the root bark of the Cadamba can be used as an antidote against snakebite. It is used in neutralizing *Vipera russellii* and *Naja kaouthia* venom, which can induce hemorrhage, cardiotoxicity, neurotoxicity, defibrinogenation, and inflammation. The pentacyclic triterpenes (free or as glycosides) have a crucial significance in providing ~20% protection against snake venom. The Cadamba is a medicinal plant known to have antioxidant properties that are found particularly in its leaves. Recently, the antihelminthic activity of the Cadamba has been elucidated. Some researchers have demonstrated the antifungal property of the Cadamba. They have reported that the extract of the bark and leaf of the Cadamba showed antifungal activity against *Aspergillus fumigatus* and *Candida albicans*. They have also found that the Cadamba leaf extract shows higher antifungal activity than the bark extract. [12-14] Recently, it was reported that Cadamba leaf extract has excellent larvicidal and pupicidal activities against the filarial vector, *Culex quinquefasciatus*, even at low concentrations. The alcoholic and aqueous extracts of Cadamba fruits have shown significantly higher antibacterial activity against microorganisms (*Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Micrococcus luteus*, *Bacillus subtilis*, *Staphylococcus aureus*, *Pseudomonas*

aeruginosa, Salmonella typhi, Klebsiella pneumonia, Proteus mirabilis, Candida albicans, Trichophyton rubrum, Aspergillus niger, Aspergillus flavus, and Aspergillus nidulans). Researchers demonstrated an experiment to determine the antidiabetic study of Cadamba in which they have used the Cadamba stem bark powder. [5,7,13-16] The phytochemical screening of Cadamba has revealed the presence of lupeol and betulinic acid-type triterpene which have antineoplastic activity. Flavonoids in Cadamba like quercetin, silymarin apigenin, daidzein, and genistein are known to have analgesic and anti-inflammatory activities. Research is being done to identify more and more active constituents in Cadamba having anti-inflammatory activity. The Cadamba has been reported to be used for its hepatoprotective activity. The hepatoprotective activity is due to the presence of chlorogenic acid isolated from the Cadamba plant. The methanol extract of Neolamarckia cadamba barks showed significant analgesic, anti-inflammatory and antipyretic activity. [17-19]

Traditional therapies

The paste of the leaves of kadamba are tied over the wound or area affected with localized pain and swelling to reduce the complaints. The decoction of the bark of kadamba is used to wash the infected wound. The decoction of the bark of the plant is used for gargling to treat mouth ulcers and inflammation of the gums. The decoction of kadamba is taken in a dose of 30-40 ml to treat diarrhea and irritable bowel syndrome. The powder of the bark of the tree is given with sugar candy in a dose of 5-6 g to treat nausea and vomiting. The juice of the fruit of kadamba is given in a dose of 40-50 ml to treat excessive sweating, thirst and burning sensation of the body. The decoction of the root is taken in dose of 30-40 ml to treat urinary tract infection and renal calculi. The decoction of the bark of the tree is consumed in a dose of 30-40 ml to treat fever. The paste of the bark of kadamba is applied over black spots and pimples. The fresh juice of the leaf is consumed in a dose of 10-15 ml to treat leucorrhoea and increased menstrual flow. The fresh juice of the fruit is useful to increase the breast milk in lactating women. The paste prepared from the bark of stem and leaf of kadamba is useful to treat pain, redness and itching due to insect bite. The roots, fruits, leaves, bark skin is used from medicinal purposes. Externally, the wounds and ulcers are dressed with its leaves slightly warmed to alleviate the pain, swelling and for cleansing and better healing of wounds. The decoction of the leaves is also used for this purpose. The paste of its bark skin is benevolent in conjunctivitis, as an external application. Internally, the decoction of bark skin is an effective remedy for diarrhea, dysentery and colitis. The juice of bark skin combined with cumin seeds and sugar alleviates vomiting. The excessive thirst in fevers is quenched with its fruit juice. Kadamba is the best panacea for raktapitta, edema and cough. The decoction of roots is salutary in urinary ailments like dysuria, urinary calculi and glycosuria. Menorrhagia is effectively controlled with the fresh juice of its leaves or their decoction. The fruit juice augments the quantity of breast milk in lactating mothers and also works well as a lactodepurant. Kadamba is rewarding in skin diseases as it improves the complexion of the skin. In burning sensation of the body and fever, the bark skin is commonly used. The bark skin and the fruits are salubrious in general debility. [20-29]

CONCLUSION

The Cadamba is one of the important medicinal plant which is crucially significant as it has the largest number of phytochemicals and secondary metabolites (viz., cadambagenic acid, cadamine, quinovic acid, β -sitosterol, cadambine, etc.) having pharmacological and pharmacognosical properties. Cadamba is one of such ayurvedic remedy that has been mentioned in many Indian medicinal literatures. In this article authors have discussed about phytochemistry of *Anthocephalus cadamba* and its application in the treatment of various ailments like diabetes mellitus, diarrhoea, fever, inflammation, haemoptysis, cough, vomiting, wounds, ulcers, debility and antimicrobial activity. The major constituents of the plant are triterpenes, triterpenoid glycosides, flavanoids, saponins, indole alkaloids; cadambine, cadamine, isocadambine, isodihydrocadambine.

REFERENCES

1. Alekhya V, Deepan T, Sahoo S, Dhanaraju MD. Preliminary phytochemical screening and evaluation of in vitro antioxidant activity of *Anthocephalus cadamba* by using solvent extracts. *Eur J Biol Sci.* 2013;5:34–7.
2. Umachigi SP, Kumar GS, Jayaveera K, Kishore KD, Ashok KC, Dhanapal R. Antimicrobial, wound healing and antioxidant activities of *Anthocephalus Cadamba*. *Afr J Tradit Complement Altern Med.* 2007;4:481–7.
3. Alam MA, Akter R, Subhan N, Rahman MM, Majumder MM, Nahar L, Sarker SD. Antidiarrhoeal property of the hydroethanolic extract of the flowering tops of *Anthocephalus cadamba*. *Rev Bras Farmacogn.* 2008;18:155–9.
4. Banerji N. Structure of two new saponins from stem bark of *Anthocephalus cadamba* MIQ. *J Indian Chem Soc.* 1978;55:275–8.
5. Brown RT, Chapple CL. *Anthocephalus* alkaloids: Cadamine and isocadamine. *Tetrahedron Lett.* 1976;19:629–30.
6. Shantha TR, Vasanthakumar KG, Gopakumar K. Pharmacognostical studies on the leaf of *Neolamarckia cadamba* (Roxb.) Bosser, Rubiaceae. *J Econ Taxon Bot.* 2008;32:128–48.
7. Dwevedi A, Sharma K, Sharma YK. (2015). Cadamba: A miraculous tree having enormous pharmacological implications *Pharmacogn Rev.* 29(18): 107–113. doi: 10.4103/0973-7847.162110
8. Dubey A, Nayak S, Goupale DC. *Anthocephalus cadamba*: A Review. *Pharmacog J.* 2011;2:71–6.
9. Ganjewala D, Tomar N, Gupta AK. Phytochemical composition and antioxidant properties of methanol extracts of leaves and fruits of *Neolamarckia cadamba* (Roxb.) *J Biol Act Prod Nature.* 2013;3:232–40.

10. Brown RT, Fraser SB, Banerji J. Heart wood of cadamba contains glucoalkaloids of isodihydrocadambien. *Tetrahedron Lett.* 1974;29:3335.
11. Brown RT, Fraser SB, Chapple LC. Anthocephalus alkaloids: 3 β -dihydrocadambine and 3 β -isodihydrocadambine. *Tetrahedron Lett.* 1976;17:2723–4.
12. Banerji N. New saponins from stem bark of Anthocephalus cadamba MIQ. *Indian J Chem B.* 1977;15:654–5.
13. Mondal S, Dash GK, Acharyya A, Acharyya S, Sharma HP. Studies on diuretic and laxative activity of bark extracts of Neolamarckia cadamba (roxb.) bosser. *Drug Invent*
14. Gupta A, Anand M, Yadav S, Gautam J. Phytochemical studies and antioxidant activity of different leaves extracts of A. cadamba. *Int J Futur Sci Engg Technol.* 2013;1:21–5..
15. Acharyya S, Rathore DS, Kumar HK, Panda N. Screening of Anthocephalus cadamba (roxb.) miq. root for antimicrobial and anthelmintic activities. *Int J Res Pharm Biomed Sci.* 2011;2:297–300.
16. Patel DA, Darji VC, Bariya AH, Patel KR, Sonpal RN. Evaluation of antifungal activity of Neolamarckia cadamba (roxb.) bosser leaf and bark extract. *Int Res J Pharm.* 2011;2:192–3.
17. Mishra RP, Siddique L. Antibacterial properties of Anthocephalus cadamba fruits. *Asian J Plant Sci Res.* 2011;1:1–7.
18. Chandrashekar KS, Prasanna KS. Antimicrobial activity of Anthocephalus cadamba Linn. *J Chem Pharm Res.* 2009;1:268–70.
19. Bussa SK, Pinnapareddy J. Antidiabetic activity of stem bark of Neolamarckia cadamba in alloxan induced diabetic rats. *Int J Pharm Technol.* 2010;2:314–24.
20. Devgan M, Bhatia L, Kumar H. Anthocephalus cadamba: A comprehensive review. *Res J Pharm Technol.* 2012;5:1478–83.
21. Dolai N, Karmakar I, Suresh Kumar RB, Kar B, Bala A, Haldar PK. Evaluation of antitumor activity and in vivo antioxidant status of Anthocephalus cadamba on Ehrlich ascites carcinoma treated mice. *J Ethnopharmacol.* 2012;142:865–70.
22. Ambujakshi HR, Antony ST, Kanchana Y, Patel R, Thakkar H. Analgesic activity of Anthocephalus cadamba leaf extract. *J Pharm Res.* 2009;2:1279–80.
23. Pant K, Agarwal K, Saini P. To study in vitro anti-inflammatory activity of Anthracephalus cadambaleaves extract. *DHR Int J Pharma Sci.* 2012;3:55–60.
24. Kapil A, Koul IB, Suri OP. Antihepatotoxic effects of chlorogenic acid from Anthocephalus cadamba. *Phytother Res.* 1995;9:189–93.
25. Razafimandimbison, Sylvain G. A Systematic Revision of Breonia (Rubiaceae-Naucleeae). *Annals of the Missouri Botanical Garden. Pharmacog Rev.* 2002; **89** (1): 1–37. doi:10.2307/3298655

26. Mondal S, Bhar K, Mahapatra A, Mukherjee J, Mondal P, Tazib S, Nair AP. "Haripriya" god's favorite: Anthocephalus cadamba (Roxb.) Miq. - At a glance. Pharmacog Res. 2020 12(1):1 doi:10.4103/pr.pr_102_19
27. Palshikar G, Firake B, Pranav Parekh P. Pharmacognostic evaluation and phytochemical screening of Anthocephalus cadamba. Asian J Res Biol Pharmaceu Sci. 2013 1(2):86 - 96.
28. Acharyya S, Dash GK Mohd. Abdullah S. Antihyperglycemic and antilipidemic activity of Anthocephalus cadamba (roxb.) Miq. Roots. Euro J Exp Biol, 2013; 3(3):116-120.
29. Sanjay PU, Kumar GS, Jayaveera KN, Kishore KDV, Kumar CKA, Dhanapal R. Antimicrobial, Wound Healing and Antioxidant Activities of Anthocephalus Cadamba. Afr J Tradit Complement Altern Med. 2007; 4(4): 481–487.

