

Antimicrobial, Antifungal and Medicinal Properties of *Anthocephalus cadamba*: A Review

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Abstract *Anthocephalus cadamba* commonly known as Cadamb belongs to the family Rubiaceae is widely used in various parts of India. This holy plant is closely associated with the life of Lord Krishna (Hindu Deity). The plant Cadamba enjoys a holy position in Ayurveda, an Indian indigenous system of medicine due to its ability to cure various diseases like diabetes, diarrhoea, fever, cough, inflammation, vomiting, wound healing, ulcer etc. There is the presence of saponins, terpenes, sesquiterpenes glycosides, alkaloids and absence of anthraquinones and flavonoids in this plant and probably due to the terpenes this plant shows antimicrobial property. Leaves, twig and root extract of the plant also shows antibacterial, antioxidant, anti inflammatory activity and antifungal activity against strains of *Aspergillus fumigatus* and *Candida albicans*. So the present paper was undertaken to review various antimicrobial, antifungal and medicinal properties of this plant.

Keywords: Antimicrobial, antifungal, medicinal, *Anthocephalus cadamba*

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1. Introduction

There are a number of plants used in the treatment of various kind of ailments. One such plant is *Neolamarkia cadamba*. It is also known as *Anthocephalous cadamba*. This plant is also known as "Kadamba" in Hindi and Sanskrit and as Kodom in Bengali, burflower-tree in English, Rudraksamba in Telugu, Katampu and Attutek in Malayalam. Other names of this plant are *Neolamarckia cadamba*, *Anthocephalus cadamba* (Roxb.) Miq., *Samama cadamba* (Roxb.) Kuntze, *Anthocephalus morindifolius* (Korth.), *Nauclea cadamba* (Roxb.), *Nauclea megaphylla* (S. Moore), *Neonauclea megaphylla* (S. Moore). [1] In Hindu mythology this tree was the favourite of Lord Krishna. *A. cadamba* is also known as Haripriya or God's favourite [2]. Various religions in India have strongly believed that God lives inside *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 [3]. This is a sunlight growing plant with flowering season from June to September. The optimum temperature for the growth of this plant is 32°C to 40°C. The average required rainfall is 1500 mm to 5000 mm. *Anthocephalus cadamba* is very fast growing tree and in favourable condition the tree can attain a diameter of 50cm in about 12 to 15 years and due

to this nature this plant is good for productivity and carbon sequestration. [4]

The leaves of the Kadam tree (*Anthocephalus cadamba*), scientifically known as *Anthocephalus cadamba* (Roxb.) Bosser, with synonyms including *Anthocephalus cadamba* (Roxb.) Miq. and *A. chinensis* (Lamk.) A. Rich. ex Walp., have been traditionally employed as a gargle for the management of stomatitis disease, as documented by [5] Asolkar et al (1992).

Kadam is renowned as one of the most prominent fast-growing tree species. Its natural habitat spans the tropical and sub-tropic regions, encompassing South China, Southeast Asia, and the Pacific. The geographical distribution and ecological significance of Kadam are emphasized in scholarly works, notably by [6] Jøker (2000) and [7] Wei and Zhu (2019), underlining its prevalence and importance in these regions.

The utilization of Kadam leaves for gargling in the context of stomatitis reflects a traditional medicinal practice. It's important to recognize that such traditional remedies often have cultural and historical roots, and while they may be interesting, consulting with healthcare professionals and considering scientific validation is crucial for comprehensive health guidance. Preliminary phytochemical screening of *A. cadamba* showed the presence of saponins, terpenes, sesquiterpenes glycosides, alkaloids and absence of anthraquinones and flavonoids. The antimicrobial activity could be due to the presence of terpenes [8]. The wound healing activity results showed

that upon application of *Anthocephalous cadamba* extract ointment there was an increase in tensile strength, decrease in the epithelisation period, along with a visibly decreased scar area [9]. Ripened cadamba fruit shows more antimicrobial activity with ethanolic extract whereas unripened fruit shows more antimicrobial activity with ethyle acetate extract. [9,10]. Sanjay *et al.*, 2007 used disc diffusion method for determining MIC of organic and aqueous extracts of *A. cadamba* and concluded that the leaves of the plant showed both antibacterial and antifungal activity against almost all microorganisms studied. They also found higher antimicrobial activity against a dermatophyte *Trichophyton rubrum* followed by *Staphylococcus aureus*, *Proteus mirabilis*, *Escherichia coli*, *Micrococcus luteus*, *Aspergillus niger*, *Klebsiella pneumonia*, *Pseudomonas aeruginosa*, *Candida albicans*, *Aspergillus nidulans*, *Aspergillus flavus* and *Bacillus subtilis* subsequently. They also concluded that the petroleum ether extract of the plant shows low antimicrobial activity than ethanolic and aqueous extract. *A. cadamba* is also an economically important plant. High pulping capacity makes it useful for paper making industry [11]. The fast growing properties of plant make it suitable for reforestation program. Its low alleopathic and shade effect and easy decomposition of leaf make it very suitable for agroforestry programme [4]. Due to its low weight it is used in light construction material. It is well suited for different climatic and soil condition. Their seed germination capacity in different climatic condition is studied by [12] Matra N. *et al.* 2011. Their high productivity and adaptability make it suitable for plantation for local wood demand in place of eucalyptus which is a low productive plant and been used for a long time for plantation [7].

2. Antibacterial Activity

Antibacterial activities of some local medicinal plants were studied using Disc. Diffusion method by [13] Zaidan *et al.* 2005. [3] Dwevedi A. *et al.* 2015 studied the antibacterial, antifungal, antivenom, antihelminthic and other activity of *A. cadamba*. [6] Mishra *et al.* 2011 states that *Cadamba* fruits showed greater antibacterial activity against various microorganisms-*Staphylococcus aureus*, *Micrococcus luteus*, *Bacillus subtilis*, *Candida albicans*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Klebsiella pneumonia*, *Proteus mirabilis*. Almost all part of *A. cadamba* shows antimicrobial activity against all microorganism specially *E. coli* [15] (Mishra R.P. 2013). [16] Bhardwaj *et al.*, 2007 while working on the antimicrobial properties of some plants- extracts against plant pathogens concluded that the aqueous extract of this plant was found to be effective against *Rathyibacter tritici*, causing agent of Tundu disease of wheat. They found that the activity against the test bacteria of various plants in the following order *Cuscuta reflexa* > *Anthocephalus cadamba* > *Azadirachta indica* > *Capparis decidua* > *Cassia fistula* > *Cannavis sativa* > *Brassicae jaunca* > *Clerodendron inerme*. [17] K.S. Chandrashekar *et al.* 2009 worked on antimicrobial activity of *Anthocephalus cadamba* using Gentamycin and Ketoconazole medicine as positive control on *Aspergillus*

niger, *candida albicans*, *Pseudomonas aeruginosa*, *Salmonella typhi*. They found that Chloroform and acetone extract shows more activity than petroleum ether. Similar study was done by [9] Sanjay P.U. *et al.* 2007 and they also obtained approximately same result while working on antibacterial and antifungal activity of the same plant. They used Gentamicin, streptomycin and tetracycline as standard antibiotic against *Micrococcus luteus*, *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumonia*, *Proteus mirabilis*, *Pseudomonas aeruginosa*. They found that Petroleum ether extract showed less antibacterial activity than ethanolic and aqueous extract. [18] Khandelwal *et al.*, 2016 studied the antimicrobial and antioxidant efficacy of hot aqueous extract of *Anthocephalus cadamba* leaves against gram positive (*Bacillus cereus* and *Staphylococcus aureus*) and gram negative (*Escheria coli* and *Pseudomonas aureginosa*) bacteria and found out significant activity against all organism. The sensitivity of *S. aureus* is greater than *E. coli* and *P. aeruginosa*. [19] Jain *et al.*, 2018 studied the antimicrobial activity of some plant including *Anthocephalus cadamba* against *B. subtilis*, *E. coli*, *K. pneumonia*, *P. vulgaris* and *S. typhi*. Significant antimicrobial activity in both methanolic and aqueous extract of *Anthocephalus cadamba* were found only against *B. subtilis* and *K. pneumonia* in comparison to other plant.

Donpaul A.M. *et al.* 2015 [20] studied the antimicrobial, antifungal and antioxidant activities of leaf, twig and calli extract of *A. cadamba*. He revealed that leaf calli and internode calli develop by using hormonal combination of NAA which is more impressive than other. Secondary metabolites responsible for antibacterial and antioxidant activity of leaf calli and internode calli extract produce in culture media but very lesser quantity in comparison to naturally growing plant extract and according to the literature by [21] Indu *et al.* 2013 suggest that if calli grow in stressful condition such as salinity, water stress, electric stimulation etc. then they produce more secondary metabolites and then responsible for antibacterial and antifungal activity.

Investigation regarding antibacterial activity of the plant was done by [22] Vrinda Sharma and Garima Mathur, 2021 on the fruits, leaves and stem of *A. cadamba* and it was found that the antifungal activity of leaves extract was and significantly higher followed by stems extract and then the fruit extract. [23] Acharyya *et al.* 2011 studied in some gram positive and gram negative organisms for antimicrobial and anthelmintic activity and found that methanolic and aqueous extract shows significant antimicrobial activity. Chloroform fraction of alcoholic extract of leaves of *Anthocephalus cadamba* shows highest antimicrobial and antifungal activity followed by petroleum ether fraction. [24]

3. Antifungal Activity

Patel *et al.* 2011 [25] found that the leaf extract of this plant shows more antifungal activity against the strains of *Aspergillus fumigates* and *Candida albicans* than bark extract but according to [20] Donpaul A.M. *et al.* 2015 the twig extract shows more antifungal activity than that of the leaf extract. He found that twig extract shows more

antifungal activity against *Trichoderma* sp. than *candida* sp. and there is no antifungal activity shown in methanolic extract of calli of leaves and internodes. [26] Patil et al. 2013 also studied antibacterial, antioxidant and anti-inflammatory activity of leaves and root extract of *A. cadamba* and found that leaf extract shows more antifungal activity against *Aspergillus fumigatus* than *candida albicans*. Aqueous and alcoholic extract of *Cadamba* leaves shows antibacterial and antifungal activity. [25] Patel et al, 2011 found that all extract of *A. cadamba* shows antifungal activity against *Aspergillus fumigatus* and *Candida albicans*. They also found that leaves extract shows higher activity than bark extract.

4. Medicinal Value

Munira et al. (2020) [27] found that phenolic and flavonoids content of *Anthocephalus cadamba* reduce free radicals. He also found that flower extract of *A. cadamba* reduce blood glucose level. [28] Win K.C. et al 2020 studied the anti-arthritis activity of aqueous and ethanolic extracts of bark of *A. cadamba*. They found that ethanol extract are more anti-arthritis activity than aqueous extract. [29] Bhardwaj S.k. et al 2007 studied the medicinal properties of *A. cadamba* plant and found that the bark is used to reduce fever and serve as a tonic and root is used as to relieve irritation and to treat dysentery and are also diuretic. [30] Dubey et al 2011 reviewed the medicinal properties of *A. cadamba* and found their application on diabetic patient, anti-diarrhoea, fever, cough, inflammation, vomiting, wound healing, ulcer, and anti bacterial activity. They mention their various constituents such as triterpenes, triterpenoid glycosides, flavanoids, cadambine, cadamine, indole alkaloids, isocadambine, saponins etc. [31] Patel et al. 2008, reported that the leaves of *A. cadamba* possess various phytoconstituents like saponins, steroids, alkaloids and carbohydrates. [32] Verma et al. 2018 reviewed the medicinal value of *N. cadamba* including diabetes, fever, diarrhoea, inflammation, cough, vomiting, ulcer and antibacterial activity. [2] Mondal S. et al 2020 reviewed the pharmacological and phytochemistry of *A. cadamba* includes antitumor, antioxidant, antifilarial, antimalarial, antivenom, gastroprotective, antimicrobial along with phytoconstituents. [33] Kader S. A. 2022 reviewed the phytochemical, pharmacological and antimicrobial use of plant constituents of *N. cadamba*. They found that different parts of plant have various phytochemical which used to cure large range of disease. [34] Islam T. et al 2015 studied the antioxidant, anthelmintic and phytochemical screening of methanolic extract of *N. cadamba* including evaluation of membrane stabilizing activity and found that their extract act as membrane stabilizer and can protect against harmful substances and hence use as a anti-inflammatory properties. [35] Ahmad F. et al 2011 studied that methanolic extract of *A. cadamba* has the properties to lowering the blood glucose level in hyperglycemic mice. Hydroethanolic extract of the *A. cadamba* floral top has the antidiarrhoeal properties against castor oil induced diarrhea in mice is due to the presence of indole alkaloids, secoiridoids, triterpenes and saponins etc. is studied by [36] Alam A.M. et al 2008. [37] Ganjewala D. et al. 2013, studied the phyto-constitution

and antioxidant properties of *A. cadamba* with methanolic and hexane extract of leaves and fruit. [38] Chandel M. et al. 2011 found that methanol extract of *A. cadamba* has antioxidant properties and this property has potential that it can repair damaged DNA. This experiment carried out by using pBR322 plasmid DNA. [39] Sanadhya I. and Durve A. 2014 reported that *A. cadamba* belonging to the family Rubiaceae has eriodoid glycosides compound which has antimicrobial activity against gram negative and gram positive bacteria and they insisted that different types of chemicals found in the plant are capable of killing different types of bacterial diseases and it is much more effective and better than chemically prepared medicine. Phytochemicals obtained from different parts of the plant of *A. cadamba* especially leaf shows chemopreventive potential [40]. So it is a boon to the human health and pharmacy industry.

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