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COMPREHENSIVE REVIEW ON MEDICINAL PLANT USED IN MODERN METHODOLOGY AS WELL AS AYURVEDIC MEDICINE,PHARMOCOLOGICAL ACTIVITIES, PHYTOCHEMICALS FUTURE PERSPECTIVES OF ANTHOCEPHILUS CADAMBA

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ABSTRACT:

Anthocephalus cadamba is a large, evergreen tree belonging to the family of Rubiaceae. The species is natively confined to tropical and subtropical Asia. It occurs widely throughout India, Southeast Asia, and parts of the Malay Archipelago. This plant species has great ethnomedicinal values as the entire part of the plant is used in medication for treating various diseases. The bark is used to treat fevers, indigestion, and cholera, while the leaves and fruit are used for their analgesic, anti-inflammatory, and antipyretic properties. Various bioactive compounds such as flavonoids - quercetin, kaempferol, and alkaloids, saponins, and tannins have been identified in the plant through phytochemical studies contributing to its medicinal effects, which include anti-diabetic, antimicrobial, and wound healing activities. Although it is not often utilized as a fruit since it also has an astringent taste, its essential oils and minerals further enrich its medicinal value. Pharmacological studies confirm the analgesic, anti-inflammatory, and antidiabetic activities of the plant while the toxicological results depict that the plant is safe for its use at moderate doses. Hence, this review discusses the pharmacological, phytochemical, and ethnomedicinal implications of *Anthocephalus cadamba* and promotes the use of this important plant species for folk remedies and future therapeutic purposes.

Keywords: Anthocephalus cadamba, Kadamba, Rubiaceae, ethnomedicinal uses

INTRODUCTION:

Neolamarckia cadamba, commonly known as Kadam is one of the primary medicinal plants belonging to the Rubiaceae family. The species N.cadamba is endemic in South Asia [1]. Found in temperate Himalayas, Garhwal, Himachal Pradesh, Sikkim, Assam, and Manipur in India. It is also cultivated outside India in Nepal, Myanmar, and western China [2]. Tree is big, it reaches height ~ 45 m with a broad U-shaped crown and straight bole. It takes 6-8 years for full growth. Flowering time starts after the tree has reached 4-5 years of growth. Fruit of Neolamarckia cadamba appears as small fleshy pockets packed closely together to form a fleshy yelloworange infructescence [3]. The plant grows well in various kinds of soils; its growth is expedited in fertile soil and retarded in poorly aerated soil [4]. The whole plant is used for medicinal purposes worldwide. The Anti-diabetic, Antioxidant, Antimicrobial, Anti-inflammatory effects make it efficient for its antidiabetic activity. Flavonoids present in the leaves of Neolamarckia cadamba have been found to be effective for diabetes treatment. Quercetin- 3- rhamnoglucoside, kaempferol present in leaves [5]. It also possesses analgesic and anti-inflammatory activity at varying doses (50, 100, 300 and 500 mg/kg) [3]. Leaves can be reduced to paste and applied over the affected area to reduce swelling, and can also be used in gargling [6]. Phytochemical examination on bark ethanol extract revealed that they contained flavonoids; quinine, triterpenoid, saponins, and tannin, because of which it shows antidiabetic activity. Decoction of stem-bark is given to the patient of dyspepsia, as it strengthens the body, cures fever, and urinary problems. Leaf and bark of Neolamarckia cadamba showed antifungal activity against Aspergillus fumigatus and Candida albicans [7]. Fruit of Neolamarckia cadamba is a good source of essential oil, major constituents are, linalool, geraniol, curcumene, terpinolene, camphene and myrcene [8]. Fruits can be used as expectorant and life fluid [9]. The natural products of Neolamarckia cadamba are found to contain minerals such as iron 28.3 mg/100 g, calcium 123.7 mg/100 g, Zinc 11.05 mg/100 g, copper 4.19 mg/100 g, magnesium 71.04 mg/100 g, potassium 36.7 mg/100 g, sodium 10.7 mg/100 g, and manganese 13.7 mg/100 g [10]. These are higher than most of the daily products like apple, pear etc [11]. The natural products have the feel of horripilation due to its acrid taste. The Neolamarckia cadamba fruit is hardly used because its taste is astringent, and due to the fact that there was no technology. However, juice of fruits, squash, nectar, RTS were prepared.

BOTANICAL PROFILE OF ANTHOCEPHELUS KADAMB

Anthocephalus cadamba (Roxb.) Miq. Family: Rubiaceae, Subfamily: Cinchonoideae)CN_name | Family | SynonymAnthocephalus chinensis (as Anthocephalus macrophyllus); Nauclea cadamba; Neolamarckia cadamba; Sarcocephalus cadambaRubiaceaeAnthocephalus indicus A. Rich.;Anthocephalus morindaefolius Korth.Rubiaceae In Maharashtra What Do You Call Eid: Marathi, Hindi, Sanskrit, Telugu, Bengali, Tamil Grounded in the Urdu-Persian tradition however has many voices in India; names for it have sprung up across regions and shed light on its turbulent history.[9]

TOXNOMY OF ANTHOCEPHILUS KADAMB:

- Kingdom : Plantae
- Subkingdom : Tracheobionta
- Division : Magnoliophyta
- Superdivision : Spermatophyta
- Class : Magnoliopsida
- Subclass : Asteridae
- Order : Gentianales
- Family : Rubiaceae
- Genus : Anthocephalus
- Species : Anthocephalus indicus Miq

OCCURRENCE:

Anthocephalus kadamba, Kadamba is a native species that mostly distributed in tropical and subtropical Asia. Particularly India, Bangladesh, Myanmar, Thailand, Laos, Cambodia and Vietnam are home of the plant extremely effectively. Pseudophoenix sargentii is common in tropical and subtropical forests of India mainly river banks or wet but well drained soils and widely spread over the country. This resilient variety is able to flourish in wild and farmed habitats alike. It is distributed in forest gaps and also in plantations, possesses ornamental features for urban and rural landscape areas. The species occurs in humid conditions and is also a native of the Western Ghats, Eastern Ghats and certain parts of Himalayas.

DISTRIBUTION:-

A.cadamba are mostly found in Asia, Australia, and the pacific regions. In India, it is mostly found in Kerala, Maharashtra, Tamil Nadu, Madhya Pradesh, Assam, and Andhra Pradesh. It is also found in Thailand and Indochina as well as the Malayasian Archipelago

PLANT PROFILE :

Anthocephalus cadamba is an evergreen, large-sized tree that grows up to a height of 20–45 m and attained a trunk diameter of 100–160 cm. It has a broad, rounded crown and has a straight cylindrical bole. Kadamba may start blooming at the age of four; In India, blooming takes place from July to December. The flowers are bisexual.(10)

- BARK:

The bark of the young tree is smooth and light, whereas the bark of the older tree is tough. The bark is used to treat infections on the skin. When Anthocephalus cadamba bark is combined with water, honey and cumin, it is used to treat hoarseness of the throat (zeera). Orally, it is given to the patient. The use of freshwater for bathing, which keeps the skin smooth and free of infection(11)

- LEAF:

Leaves are glossy green, opposite, simple, more or less sessile to etiolate, ovate to elliptical and more or less sessile to etiolate (15-50 x 8-25 cm). Clustered inflorescence with terminal globose heads without bracteoles and sub sessile fragrant orange or yellow flowers; Flowers are bisexual and 5-merous, with a funnel-shaped calyx tube and a gamopetalous saucer-shaped corolla with a narrow tube and narrow lobes that imbricate in the bud. Stamens 5, filaments short and anthers basified, inserted on the corolla tube. Ovary inferior, binocular, sometimes 4-locular in the upper section, with a spindle-shaped stigma and style extruded. Fruits have four hollow or solid structures in their upper portions, allowing themto grow in numbers. Seeds that are trigonal or irregular in form.

- FLOWER:

The blooms are small, orange-colour and arranged in a globose head with a diameter of 3-5 cm. Flowers are bisexual and 5-merous, with a funnel-shaped calyx tube and a gamopetalous saucer-shaped corolla with a narrow tube and narrow lobes that imbricate in the bud. Stamens 5, filaments short, anthers basifixed, placed on the corolla tube. Ovary inferior, binocular, sometimes 4-locular in the upper section, with a spindle-shaped stigma and style extruded. Vegetables are made from flowers.

- FRUIT :

Fruits are abundant, with four hollow or solid structures in their upper portions. When ripe, the fruits are meaty, orange, globose pseudocarps 5-7 cm in diameter and yellow (12,13,14)

ETHANOMEDICINAL USES:

Charaka Samhita describes fruits as helping to reduce high fever and thirst. Ayurveda prescribes fruit for cooling It has an analgesic effect and its decoction is used for mouth ulcers. According to Shukla Yajurveda, pollen strengthens the body and mind. (15) In the Dooars region of West Bengal, the Leaves, Bark, and Fruits of the plant are used for the Decoction of leaves for ulcers and wounds, bark as an expectorant, and fruits for gastric irritability and fever(16)

Indian tribes used leaf paste to treat dyspepsia and applied it topically to oral ulcers in children. Lodhas boils crushed leaves to remove subcutaneous inflammatory deposits (17). the stem bark decoction is used for a fair complexion of the skin. A powder of the dried stem bark is mixed with honey or lime juice and taken orally as a mucolytic (18). The potent wound-healing capacity of Anthocephalus cadamba (Roxb.) Miq. as shown by the wound contraction and increased tensile strength has thus validated the ethno-therapeutic claim (19)

AYURDIC USES :

- BARK:

Paste of the bark is administered to the patients with continued fever to drink. Juice squeezed out of this paste, prepared by pounding the bark of *Anthocephalus kadamba* with the barks of mango and sal trees together is given to the cholera patients with a little shell lime. This preparation strengthens the body, reduces fever, corrects semen deformities, and helps in curing urinary troubles.

- STEM:

A decoction of the stem bark of Anthocephalus kadamba is given to patients suffering from dyspepsia.

- LEAVES:

The leaves of Anthocephalus kadamba are applied to boils and wounds. Juice of the leaves, mixed with common salt, is topically applied to relieve the pain of the stomach. In fact, it heals bores and wounds as well as possesses analgesic properties.

- FRUIT:

The fruit of Anthocephalus kadamba is beneficial for quenching thirst during high fever.

Phytochemistry :

Phytochemical evaluation of Anthocephalus cadamba (Roxb.) Miq. (Roxb.) Miq. Showed the presence of Tannins, Phenols, Alkaloids, Saponins, Iridoids, Quercetin, Kaempferol, Catechin, Coumarin, 6,7-Dimethoxy coumarin, 5-Methoxy genistein, Anthocyanin, Proanthocyanin, Carbohydrates, Flavonoids, Glycosides, and Proteins (22,23). The stem bark contains showed the presence of flavonoids, alkaloids, carbohydrates, proteins, and glycoside compounds. (24) The leaves of Anthocephalus cadamba (Roxb.) Miq. were reported to contain saponin glycoside (25). Preliminary phytochemical screening of methanol and aqueous extracts of Anthocephalus cadamba (Roxb.) Miq. roots showed the presence of alkaloids, saponins, flavonoids, tannins, and sugars (23,25). The preliminary phytochemical screening of the\ extracts of Anthocephalus cadamba (Roxb.) Miq. leaves revealed the presence of saponins, alkaloids, glycosides and tannins, phenolic compounds, flavonoids, and steroid (26).

1. Cadambines:

Indole alkaloids amino-cadambines were isolated from the leaves of N. cadamba. possess an unprecedented polycyclic system featuring a tetrahydrofuran unit and a 1,2,3,4-tetrahydropyridine ring (27). Vincosamide-N-oxide and isodihydroamino cadambine along with seven known alkaloids and triterpenoids vincosamide, vallesiachotamine, iso-vallesiachotamine, dihydrocadambine, cadambine, ursolic acid and oleanolic acid having anti-arrhythmic, anticancer and anti-malarial properties are, found in the Apocynaceae, Loganiaceae, Rubiaceae and Nyssaceae Families (28).

2. β-sitosterol

Beta-sitosterol is a type of chemical called plant sterol. It's similar to cholesterol and is found in fruits, vegetables, nuts, and seeds. β-sitosterol is a well-known natural sterol in the composition of known herbal drugs for the treatment of benign prostatic hyperplasia and prostate cancer. Besides, the compound elevated enzymatic and non-enzymatic antioxidants in cells making it effective in anti-diabetic, neuroprotective and chemoprotective action (29).

3. Quinovic acid

Quinovic acid is a triterpene glycoside obtained from the bark of the plant. the two main types of triterpene glycosides are 3-O-[a-L-rhamnopyranosyl]-quinovic acid-28-O-[b-D-glucopyranosyl] ester and 3-O-[b-D-glucopyranosyl]- quinovic acid-28-O-[b-D-glucopyranosyl] ester respectively (30). It is responsible for Antifungal, Immunomodulatory, Molluscicidal Activity, Spermicidal, Hypoglycemic, Antitumor, Hypocholesterolemic, Antiaging, Cardiovascular, Antiviral, Antisweet, Analgesic Activity (31).

4. Ursolic acid:

Ursolic acids are ubiquitous triterpenoids in the plant kingdom, and medicinal herbs, and are an integral part of the human diet. A variety of novel pharmacological effects produced by these triterpenoids have been reported, including their beneficial effects on cardiovascular systems interaction with cytochrome P450s protection against kainate-induced excitotoxicity in rat hippocampal neurons and immunomodulatory effects, as well as its effects on intracellular redox balance and osteoclast formation (32).

5. *Amygdalin*

Amygdalin is commonly distributed in plants of the Rosaceae, such as peach, plum, loquat, apple, and bayberry. It is a naturally aromatic cyanogenic compound, it has long been used in Asia, Europe, and other regions for the treatment of various diseases including cough, asthma, nausea, leprosy, and leukoderma (33).

6. *Quercetin:*

Quercetin is one of a group of over 4000 naturally available plant phenolic compounds. Flavonoids are classified among phenolic constituents found in food plants. These include the phenolic acids (cinnamic and benzoic acid derivatives), the flavonoids, such as the flavan-3-ols (i.e. catechins), and the flavan-3,4-diols (i.e. quercetin, myricetin, and kaempferol), and condensed tannins. Quercetin has antiviral and antitumour action (34).

7. *2′-hydroxy 2, 4, 4′, 6’-tetra methoxy chalcone*

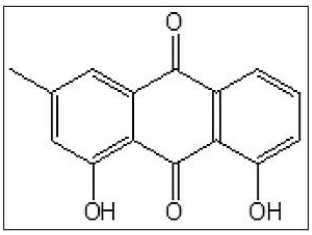
Chalcones, or 1,3-diphenyl-2-propen-1-ones, are one of the most important classes of flavonoids across the whole plant kingdom. Chalcones are open-chain precursors for biosynthesis of flavonoids and isoflavonoids and occur mainly as polyphenolic compounds (35). Promising biological activities to be generated e.g., anti-inflammatory (36), anti-gout (37) anti-histaminic (38) anti-oxidant (39) anti-obesity (40) anti-protozoal, (41) hypnotic (42) anti-spasmodic (43).

8. *Dihydrowogonin:*

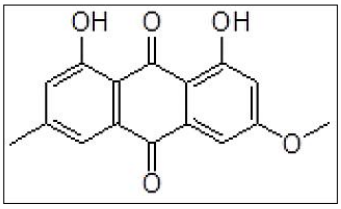
Wogonin chemically known as 5, 7-dihydroxy-8-methoxy flavone is obtained from Scutellaria baicalensis Georgi and is a herb traditionally used in Chinese folk medicine (44). It has anti-inflammatory, antioxidant, antiangiogenic, and antitumor properties (45).

9. *Naringenin*

Naringenin is a naturally-occurring flavonoid, predominantly found in some edible fruits, like Citrus species and tomatoes. Chemically named as 2,3-dihydro-5,7-dihydroxy-2-(4-hydroxyphenyl)-4H-1-benzopyran-4-one . Naringenin is endowed with broad biological effects on human health which includes a decrease in lipid peroxidation biomarkers and protein carbonylation, promotes carbohydrate metabolism, increases antioxidant defenses, scavenging



Chrysophenol



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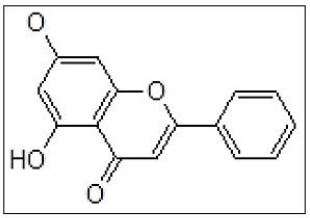
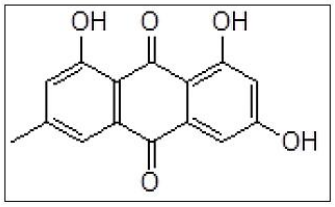
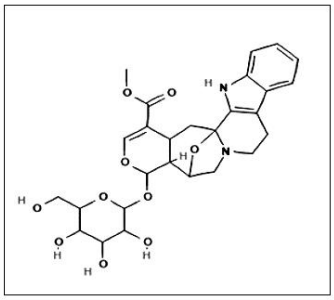


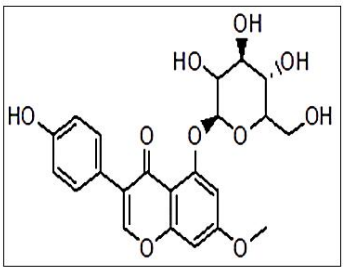
Tectochrysin



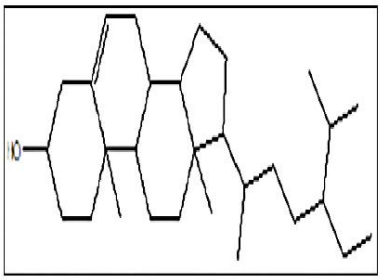
Emodin



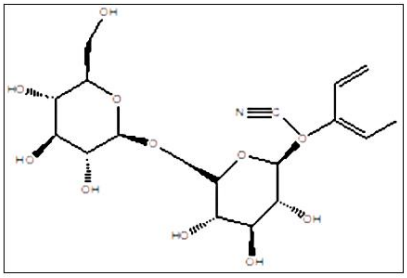
Cadambine



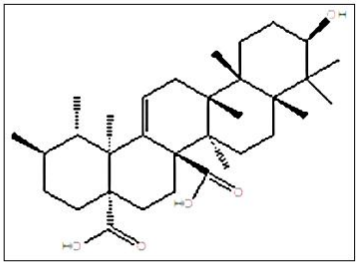
Prunetinoside



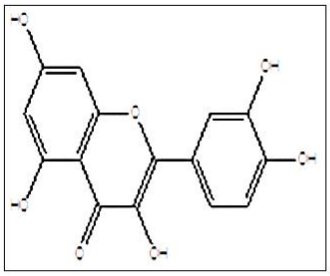
β-sitosterol



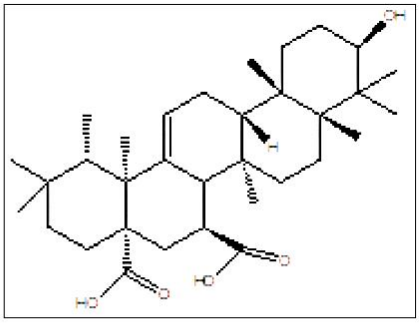
Amygdalin



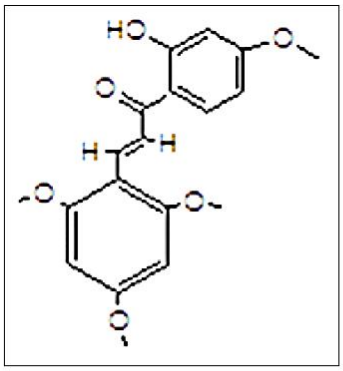
Quinovic



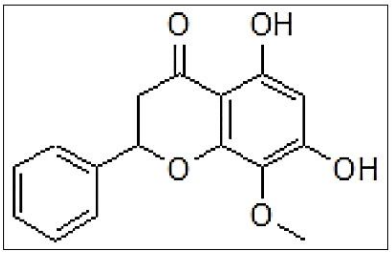
Quercetin



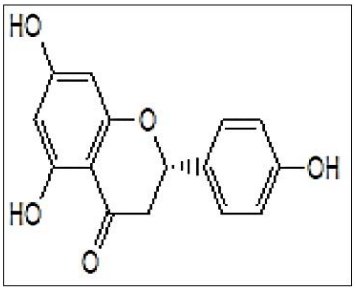
Cadambagenic acid



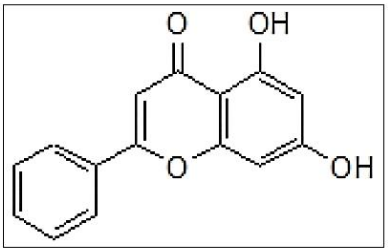
2′hydroxy 2, 4, 4′, 6′-tetramethoxychalcone



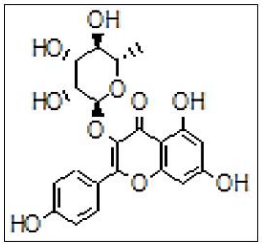
Dihydrowogonin



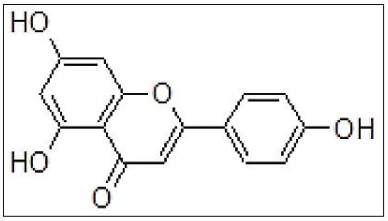
Naringenin



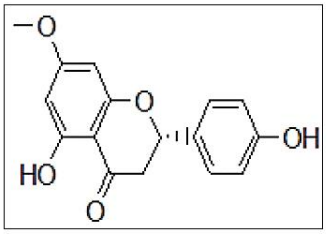
Chrysin



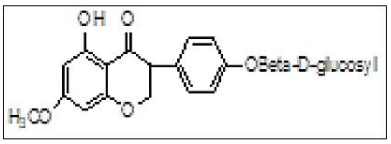
Afzelin



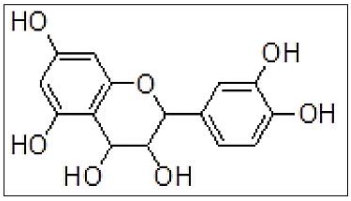
Apigenin



Sakuranetin



Padmakastein



Leucocyanidin

Pharmacological activities:

Analgesic, antipyretic and anti-inflammatory activities

Anthocephalus cadamba bark and leaf extracts have analgesic, antipyretic and anti-inflammatory properties. At different concentrations (50, 100, 300 and 500 mg/kg), the defatted aqueous extract of *Anthocephalus cadamba* leaves demonstrated considerable analgesic and anti-inflammatory effects. Some researchers effectively investigated the methanolic extract of *Anthocephalus cadamba* bark for analgesic, antipyretic and antiinflammatory properties [46,47,48,49].

Antidiabetic activity

In alloxan (120-150 mg/kg) induced diabetic rats, an alcoholic extract of the stem bark of *Anthocephalus cadamba*, syn. *Neolamarckia cadamba*, was found to have antidiabetic (hypoglycemic) potential, alleviating symptoms such as weariness and discomfort. The presence of flavonoids, which

stimulate insulin secretion or have an insulin-like effect, is assumed to be responsible for the effectiveness of the 400-500 mg/kg extract of medicine in the treatment of diabetes in experimental trials. The alcoholic and aqueous extracts of *Anthocephalus cadamba* roots had anti-diabetic effect when administered at a dose of 400 mg/kg body weight to normoglycemic and alloxan-induced hyperglycaemic rats [50,51,52].

Antidiarrhoeal activity

The dry hydroethanolic extract (200-500 mg/kg) of *Anthocephalus cadamba* flowering tops reduced the frequency of faecal dropping in castor oil-induced diarrhoea in mice in a dosedependent manner. The extract also caused a dose-dependent decrease in the formation of intestinal fluids [53].

Toxicological studies:-

Toxicity is the fundamental science of poisons and the ancient humans categorized some plants as harmful and some as safe; therefore, considerable attention has been directed toward *identification* of plants with no toxicity that may be used for human consumption. The methanolic extract of A. cadamba barks was reported for its toxicity in various animal models. The results suggested that acute toxicity was found in animal models at doses range higher than 3000 mg/kg, and there was no mortality found.(54)

CONCLUSION:

Anthocephalus cadamba, a medicinal tree of the family Rubiaceae, also occurs in tropical and subtropical Asia, and widely used practice. For years, the different parts of this plant-the bark, leaves, and fruits-have been known to contain potent potentials for playing an effective therapeutic role, including anti-inflammatory, analgesic, anti-diabetic, antimicrobial, and wound healing. Phytochemically, *A. cadamba* contains flavonoids like quercetin and kaempferol, alkaloids, saponins, and triterpenoids which are medicinally important for the drug. The plant is applied in treating fever, wounds, ulcers, diabetes, and infections. Flavonoids play an important role in glucose regulation, which makes it work effectively in treating diabetes and inflammation. While *A. cadamba* has promising medicinally, there remains the need to undertake more studies, comprising clinical trials, to fully evaluate its safety and efficacy. Toxicological studies indicate that it will be safe in therapeutic doses, while no toxicity was appreciable at an appreciable dose. Generally, there is huge promise for *A. cadamba* as a remedy from the natural world, and it warrants further scientific investigation.

Future Perspective:

Anthocephalus cadamba (Kadamba) is a good drug in future for pharmacological and biotechnology towards the upcoming fields of sustainable agriculture in nearby future.

1. Pharmacological Studies: More clinical experiments are required; then it can well be authenticated that safer and efficient use of A. cadamba may be suggested by experts to handle diabetes, inflammatory, and wound healing disease conditions. Therefore, it shall find a proper place in mainstream medicine.
2. Production of Bioactive Compound: Primary compounds such as flavonoids, alkaloids, and triterpenoids may be isolated to make possible the formulation of extracts and drugs. Better extraction methods may also enhance activity.
3. Productive Cultivation: Multiplication of A. cadamba through agroforestry will increase supply in response to medicinal products needed and would significantly contribute toward the conservation of biodiversity. Studies on optimal growth and pest management must be done.
4. Cosmetic and Nutraceutical Use: Since A. cadamba possessed antioxidant and anti-inflammatory activity, there are cosmetic and dietary supplement uses waiting to be discovered, making it a market opener for the plant .
5. Toxicological Safety Evaluation: Long-term toxicity study on the plant will guarantee mankind the plant's safety for use in multiple forms.
6. Grafting Ethnobotanical Knowledge with Modern Science: Integration of ethnobotanical knowledge with modern science maximizes the therapeutic potential of A. cadamba.

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