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A Review On Assessment Of Pharmacological Activity Of Anthocephalus Cadamba Base Extract In Phenylhydrazine-Induced Anemia

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Abstract
Neolamarckia cadamba (synonym Anthocephalus cadamba), commonly known as Kadamba, is a premier medicinal plant in traditional Indian medicine (Ayurveda). This review compiles the botanical characteristics, phytoconstituents, and therapeutic potentials of the plant to serve as a comprehensive reference for M.Pharm research. Deep scientific evaluation validates its traditional use as an antimicrobial, antidiabetic, antioxidant, and anti-inflammatory agent & Hematinic property.
Keywords: Anthocephalus cadamba Hematinic, phytoconstituents, Anemia

1.Introduction

1.1 Anemia is a major global health concern:

Anemia is a major global health concern characterized by a decrease in red blood cell (RBC) count or hemoglobin concentration, leading to reduced oxygen-carrying capacity of the blood. The condition can result from nutritional deficiencies, chronic diseases, or drug-induced oxidative stress. Phenylhydrazine (PHZ) is widely used to induce experimental hemolytic anemia by generating free radicals that damage erythrocyte membranes and hemoglobin, thereby mimicking oxidative stress-related anemia in humans.[1]

Anemia remains a major global health concern due to its high prevalence, multifactorial etiology, adverse effects on maternal and child health, and its substantial impact on productivity and economic development, particularly in resource-limited settings.

"Neolamarckia cadamba bark was selected for the present study due to its rich content of indole alkaloids such as cadambine, along with flavonoids and phenolic compounds that exhibit hematinic and antioxidant properties. Its traditional use in treating blood-related disorders, combined with limited scientific validation in iron deficiency models, provides a strong rationale for investigating its potential as a safe and cost-effective anti-anemic agent.

1.1.1. High Global Prevalence

Affects ~1.9 billion people worldwide
Most common among:
Women of reproductive age

Pregnant women
Infants and children
Elderly population
Particularly prevalent in South Asia and Sub-Saharan Africa

1.1.2. Multiple and Interrelated Causes

Anemia is not a single disease but a multifactorial condition, caused by:
Nutritional deficiencies (iron, folate, vitamin B12)
Chronic infections (malaria, tuberculosis, HIV)
Parasitic infestations (hookworm)
Genetic disorders (thalassemia, sickle cell anemia)
Chronic inflammatory diseases
Blood loss (menstruation, gastrointestinal bleeding)

1.1.3. Severe Health Consequences

Reduced oxygen-carrying capacity of blood
Leads to:
Fatigue and weakness
Impaired cognitive development in children
Reduced immunity
Increased maternal and neonatal mortality
Poor pregnancy outcomes (low birth weight, preterm birth)

1.1.4. Impact on Child Growth and Development

Causes irreversible cognitive and physical impairment
Affects school performance and learning ability
Reduces future earning capacity

1.1.5. Economic and Productivity Loss

Decreases work capacity and productivity
Causes significant economic losses at both individual and national levels
Increases healthcare expenditure

1.1.6. Indicator of Underlying Disease

Often reflects poor nutrition, infection burden, and socio-economic inequality
Serves as a marker of population health status

1.1.7. Public Health Challenge

Despite being preventable and treatable, anemia remains underdiagnosed and undertreated
Requires integrated strategies:
Nutritional supplementation
Infection control
Health education
Food fortification programs

1.2 Significance of Anthocephalus cadamba:

Anthocephalus cadamba (Roxb.) Miq., commonly known as Kadamba, belongs to the family Rubiaceae. It is a traditional medicinal plant used in Ayurveda and folk medicine for its hepatoprotective, antioxidant, and hematinic properties. The bark and leaves are rich in bioactive constituents such as alkaloids, flavonoids, phenolic compounds, saponins, and glycosides, many of which exhibit strong antioxidant and cytoprotective effects.[2]
Given its antioxidant potential, A. cadamba extract may counteract oxidative hemolysis and improve hematological parameters. Therefore, the present study aims to evaluate the pharmacological activity of Anthocephalus cadamba base extract in phenylhydrazine-induced anemic rats.

1.2.1 Part usage of anthocephalus cadamba:

Different parts of Anthocephalus cadamba are used for medicinal and therapeutic purposes: [3]
Bark: Used for its anti-inflammatory, antimicrobial, and hepatoprotective properties.
Leaves: Known for antioxidant, analgesic, and wound healing effects. Flowers: Traditionally used in treating fever, infections, and as an aphrodisiac.
Fruits: Beneficial for digestive disorders and have potential antidiabetic properties. Roots: Used in treating skin diseases and gastrointestinal issues. Significance of kadamba tree Anthocephalus cadamba is a bigger tree with a height of 20-45metres and a trunk diameter of 100-160 cm. It has a broad crown and a straight cylindrical bole. At the age of four, kadam may begin

to flower. It blooms in India from July to December. Flowers are bisexual.

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.

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 them to 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.

Cadambine is the key alkaloid present in A. cadamba bark, typically ranging from 0.05–0.25% w/w in crude bark and 0.5–2.5 mg/g in methanolic extract, while isocadambine is present in relatively lower concentrations."

1.2.2 Need for the Study:

Synthetic hematinic agents are often associated with adverse effects and limited efficacy in oxidative stress–related anemia. Natural plant extracts with antioxidant and erythropoietic potential offer safer and more sustainable therapeutic options. However, limited scientific evidence is available on the hematinic potential of Anthocephalus cadamba in experimentally induced anemia. This study will bridge that gap and provide pharmacological justification for its traditional use in anemia management.

The hematological assessment of Anthocephalus cadamba is necessary to scientifically validate its traditional use as a blood tonic and to explore its potential as a safe, effective, plant-based therapeutic agent for the management of anemia.

The scientific evaluation of Anthocephalus cadamba for hematological activity is needed due to the following well-justified reasons:

1.2.2.1. High Global Burden of Anemia

Anemia remains a major global public health problem, particularly in developing countries like India, where nutritional deficiencies and chronic infections are prevalent. Existing iron therapies often cause gastrointestinal side effects, poor compliance, and limited long-term effectiveness. This creates a strong need for safer, plant-based hematinic agents.

1.2.2.2. Strong Traditional Claim Related to Blood Disorders

In Ayurveda and folk medicine, Anthocephalus cadamba bark has been traditionally used as:

- A blood purifier
- A tonic for weakness and debility
- A remedy for conditions associated with fatigue and low vitality, which are classical symptoms of anemia
- However, these traditional claims lack sufficient experimental hematological

validation, necessitating systematic scientific investigation.

1.2.2.3. Rich Phytochemical Composition Supporting Hematopoiesis

Anthocephalus cadamba is reported to contain:

- Flavonoids
- Phenolic compounds
- Tannins
- Alkaloids
- Glycosides

These phytoconstituents are known to:

- Enhance iron absorption
- Protect erythrocytes from oxidative damage
- Stimulate erythropoiesis

Thus, hematological assessment can help correlate phytochemistry with biological activity.

1.2.2.4. Antioxidant and Anti-Inflammatory Potential

Oxidative stress plays a crucial role in hemolytic anemia, including phenylhydrazine-induced anemia. A. cadamba has demonstrated:

- Significant antioxidant activity
- Anti-inflammatory properties

This supports its evaluation for restoring hematological parameters such as Hb, RBC count, and hematocrit.

1.2.2.5. Limited Experimental Evidence on Hematinic Activity

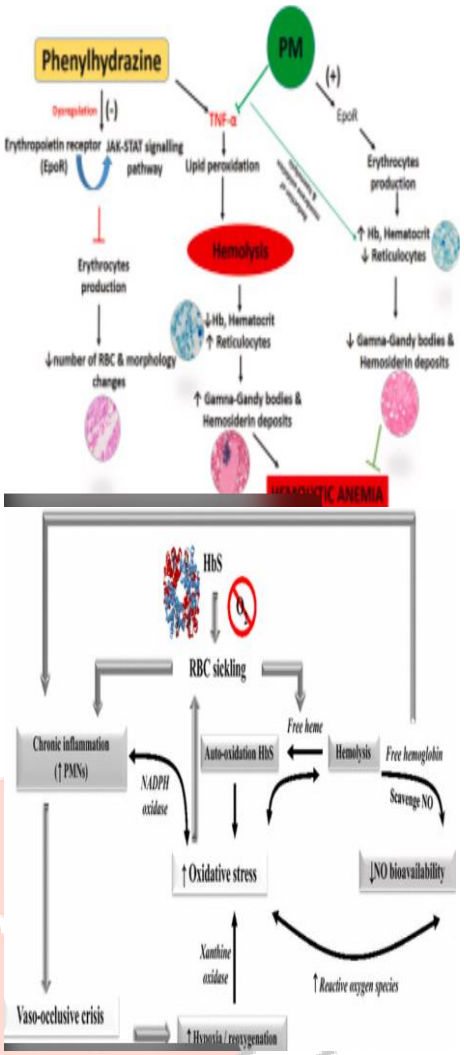
Although A. cadamba has been extensively studied for antimicrobial, antidiabetic, hepatoprotective, and anti-ulcer activities, very limited studies exist on its hematological or anti-anemic potential, highlighting a clear research gap.

1.2.2.6. Validation of Ethnomedicinal Knowledge

Scientific hematological assessment helps:

- Validate traditional medicinal claims
- Support evidence-based herbal drug development
- Promote A. cadamba as a potential natural hematinic agent

Fig.1- Mechanistic Correlation: How A. cadamba Treats PHZ-Induced Anemia[4]



1.3 Skin Parameters for Iron Deficiency

1. Pallor (Skin Paleness)

Important indicator

- Ear pinna
- Footpads
- Tail
- Conjunctiva (eye)

Reason: Reduced hemoglobin → less oxygen → pale appearance

2. Skin Dryness & Roughness

- Iron deficiency affects epithelial cell turnover

Skin becomes:

- Dry
- Rough
- Flaky

Method for assessment:

- Touch/visual inspection
- Compare with control group

3. Hair Loss (Alopecia)

- Poor oxygenation → weak hair follicles

Observe:

- Patchy hair loss
- Thinning fur

4. Delayed Wound Healing

Iron is required for:

- Collagen synthesis
- Tissue repair
- Deficiency → **slow healing**

Method:

- Create standardized incision (ethical approval required)
- Measure:
- % wound contraction
- Healing time

Indicator:

- Slower closure = higher deficiency

5. Skin Thickness & Elasticity

- Iron deficiency → reduced collagen

Skin becomes:

- Thin
- Less elastic

Method:

- Skin fold (pinch test)
- Vernier caliper measurement

1.3.1 Combined Skin assessment probability in case of iron deficiency

Parameter	Observation Method	Expected i
Pallor	Visual (ear, eye)	↑ Pale colo
Dryness	Touch + visual	↑ Rough/dr
Hair loss	Visual	↑ Alopecia
Wound healing	Experimental	↓ Healing r
Skin thickness	Caliper/pinch	↓ Thickness

Skin evaluation is supportive, not confirmatory

Always correlate with:

- Hemoglobin (Hb)
- RBC count
- Serum ferritin

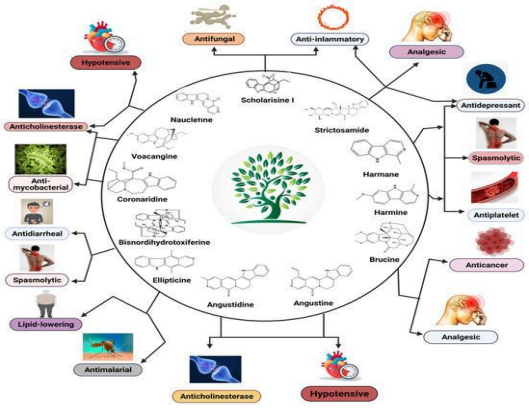
Skin evaluation helps in early detection and progression monitoring of iron deficiency. The most reliable visible sign is pallor, while wound healing delay and hair loss strengthen the diagnosis.

1.4 Reason behind the selection of A.cadamba

In Neolamarckia cadamba (A. cadamba) bark, the anti–iron deficiency (anti-anemic) effect is not due to a single compound, but a combination of phytochemicals that work together to improve hematological parameters.[7]

Fig 2:-Key Chemical Constituents Responsible

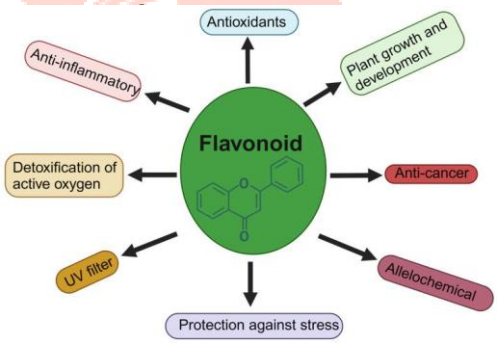
1. Alkaloids (Major Active Group)



- Important compounds:
  Cadambine & Isocadambine
- Role in iron deficiency:
  Stimulate erythropoiesis (RBC formation)
  Improve hemoglobin synthesis indirectly
  Considered the primary active constituents

Fig 3:-Flavonoids role

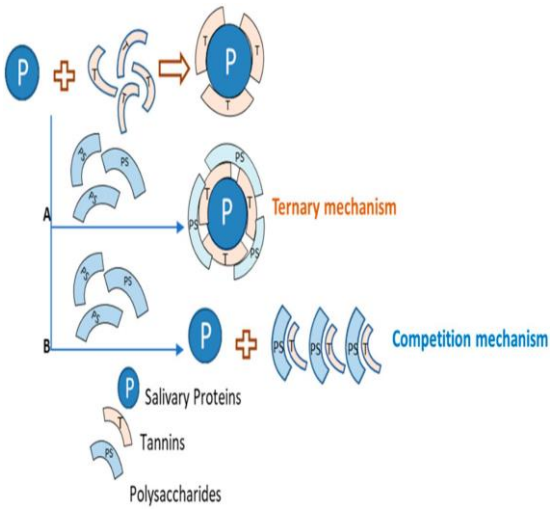
2. Flavonoids



- Quercetin-like compounds
- **Mechanism:**
  Strong antioxidant activity
  Protect RBCs from oxidative damage
  Enhance iron absorption in intestine
  Very important supportive role

Fig 4:-Tannins role

3. Tannins



Action:

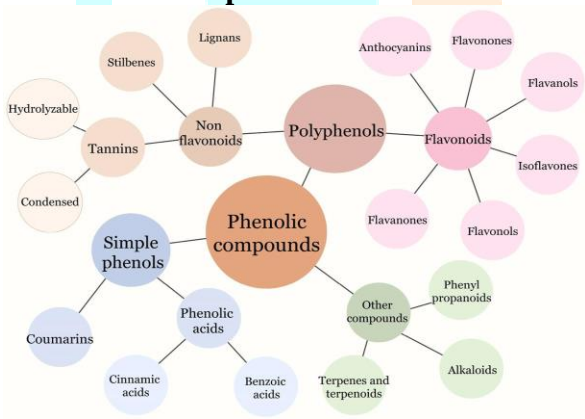
- Improve gut health
- Mild hematinic effect

4. Saponins

- Enhance nutrient absorption
- May stimulate hematopoietic system

Fig 5:- Phenolic Compounds role

5. Phenolic Compounds



Role:

Reduce oxidative stress
Protect bone marrow cells
Support RBC production

Most Responsible Constituents

Primary active:
Alkaloids (Cadambine) → Direct hematinic effect
Supportive contributors:
Flavonoids → Antioxidant + iron absorption
Phenolics → RBC protection
Saponins → Nutrient uptake

- ↑ Erythropoiesis → (Alkaloids)
- ↑ Iron absorption → (Flavonoids, Saponins)
- ↓ RBC destruction → (Antioxidants)
- ↑ Overall hematological profile → Combined effect

A. cadamba bark shows anti-anemic activity mainly due to its indole alkaloids (cadambine), supported by flavonoids and phenolic antioxidants that enhance iron utilization and protect erythrocytes.

2. Future Perspectives and Conclusion

Neolamarckia cadamba possesses verified therapeutic potential that aligns with modern drug discovery needs. Future M.Pharm research should focus on the bio-guided isolation of minor indole alkaloids and the formulation of nano-emulsions or phytosomes to enhance the bioavailability of hydrophobic triterpenoid fractions.

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