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AN INTEGRATIVE REVIEW OF *BACCAUREA COURTALLENSIS MUELL. ARG.:* TRADITIONAL USES, PHYTOCHEMISTRY, PHARMACOLOGICAL ACTIVITIES, AND BOTANICAL FEATURES

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ABSTRACT

Baccaurea courtallensis Muell. Arg., is a perennial plant species, found exclusively in the Western Ghats and classified under the family Phyllanthaceae, has been traditionally utilized by tribal groups such as the Paniya, Kani, and Kurichya for the treatment of conditions including ulcers, diarrhea, dysentery, hemorrhoids, and diabetes. Current scientific investigations affirm these traditional medicinal uses, showcasing the pharmacological promise of this plant. Phytochemical evaluations of methanol and hexane extracts derived from the leaves, bark, and fruit identified the presence of tannins, saponins, terpenoids, and phenolic substances. The leaves demonstrate antibacterial, antifungal, anti-inflammatory, antihyperlipidemic, and antioxidant properties. This review consolidates existing studies on the botanical characteristics, ethnobotanical uses, phytochemical properties, pharmacological effects, and therapeutic potential of *B. courtallensis*, promoting further investigation for medicinal and conservation purposes.[1,2]

KEYWORDS: *Baccaurea courtallensis*, phytochemistry, pharmacological activities, antioxidant activities, antibacterial, review.

INTRODUCTION

Baccaurea courtallensis (Wight) Müll. Arg, A tree of medium size that belongs to the Phyllanthaceae family, it is an evergreen species native to the Western Ghats of India and is occasionally noted in Sri Lanka. The species is predominantly found in evergreen

and semi- evergreen forests at elevations ranging from 700 to 1000 meters, extending from the South Konkan region through South Kerala and the western parts of Tamil Nadu. It has been recognized as a threatened species and is included in the IUCN Red Data Book as well as the Endemic Plants of the Indian Region compiled by Ahmedullah and Nayar. In Kerala, it is naturally distributed across all districts except Alappuzha.

Locally, the tree is known by various vernacular names such as Kolikukke (Kannada), Mootalpazham and Moottikaippan (Malayalam), and Maraootipazham (Tamil). The genus name *Baccaurea* is derived from Latin meaning "golden berry," referring to the fruit's yellowish to crimson color. The fruits are edible and consumed primarily by tribal communities such as the Muthuvan, Kani, Kadar, and Kurichya, who harvest them for both food and traditional medicinal purposes. The aril is sweet-sour, while the rind is often used for pickling. Despite its ethnobotanical importance, the fruit remains largely unknown to the wider population.

B. courtallensis is highly valued in traditional medicine for treating a range of ailments including stomach ulcers, mouth ulcers, diarrhoea, dysentery, diabetes, piles, skin infections, and infertility. Different parts of the plant—roots, leaves, bark, seeds, and fruits—are used in indigenous healing practices. Recent scientific studies have begun validating these traditional claims, with extracts showing antibacterial, antifungal, anti-inflammatory, antihyperlipidemic, and antioxidant activities.[1]

Phytochemical screenings of methanol and hexane extracts have revealed the presence of important bioactive compounds such as flavonoids, tannins, saponins, terpenoids, phenolic compounds, steroids, coumarins, quinones, and volatile oils. The seed oil, comprising about 22% of the dry seed content, contains major fatty acids like palmitic acid and oleic acid, with minor components including lauric, linoleic, linolenic, stearic, and myristic acids.[3]

Given its limited distribution, threatened status, and high medicinal and nutritional potential, *B. courtallensis* is a valuable but underexplored species. The current review aims to synthesize available information on its taxonomy, distribution, ethnobotanical relevance, phytochemistry, and pharmacological properties, thereby promoting further research, conservation, and sustainable utilization of this important native tree.

Botanical characteristics

Scientific Classification of *Baccaurea courtallensis*

- Kingdom: Plantae
- Clade: Tracheophytes
- Clade: Angiosperms
- Clade: Rosids
- Order: Malpighiales
- Family: Phyllanthaceae
- Genus: *Baccaurea*
- Species: *Baccaurea courtallensis*

Binomialname

Baccaurea courtallensis (Wight) Müll. Arg. Synonyms

- *Baccaurea macrostachya* (Wight & Arn.) Hook.f.
- *Pierardia courtallensis* Wight
- *Pierardia macrostachya* Wight & Arn.

Fig. 1: *Baccaurea courtallensis* (Wight) Müll. Arg.

***Baccaurea courtallensis* in Folklore Practice**

Herbal medicine continues to be commonly used in developing nations due to its lower cost in comparison to contemporary pharmaceutical treatments. In several Asian countries, approximately 80% of the population depends on herbal solutions for their health needs. One notable plant, Baccaurea courtallensis, which is typically found in the Western Ghats of India, has a traditional use in treating ailments such as diarrhea, dysentery, skin infections, diabetes, hemorrhoids, and inflammation. Despite its therapeutic importance, the International Union for Conservation of Nature (IUCN) has categorized B. courtallensis as a threatened species, indicating the necessity for its preservation.[4]

Root and leave	A mixture of the paste made from roots and leaves is combined with hot water and ingested to address piles and serve as an antidote. It is utilized in managing diabetes and alleviating headaches.
Fruit and Fruit rind	Local indigenous groups like the Kanikkar, Malampandarangal, and Paniyar eat ripe fruit due to its health benefits. It is used to treat conditions such as sterility, mouth and stomach ulcers, and to regulate serum cholesterol levels. In Kerala, the rind of the fruit is pickled for everyday consumption. The pericarp of the young fruit is taken as a remedy for fever.
Bark	The bark is utilized as a remedy for issues related to mucous membranes and for promoting wound healing and antibacterial effects.

Phytomorphology

Stem

In the cross-section, a single-layered epidermis was observed, featuring a very thin cuticle on its outer surface. The surface appears smooth and devoid of hairs. The epidermis contained anisocytic stomata. The peripheral cortex is made up of wavy patches of collenchyma, followed by 3-4 layers of thin-walled parenchyma composed of regularly oval or round cells. Beneath the cortex parenchyma lies a single layer of rectangular or oval-shaped endodermis. The pericycle is situated just under the endodermis and is typically sclerenchymatic, encircling the vascular bundles in 1 -2 layers. Directly below the bundle cap, the primary phloem is found, followed by the secondary phloem. Approximately 34 vascular bundles are organized in a ring formation. The interfascicular region is located between the vascular bundles and is characterized by narrow medullary rays. The cambium cells are distinct, consisting of thin elongated cells forming 2 -3 layers that create a continuous layer between the xylem and phloem.

Fig. 2: stem of *Baccaurea courtallensis.*

Leaves

In the leaf's cross section, a thin cuticle covered both the upper and lower epidermis. The cells in both epidermal layers were isodiametric and could be rectangular, oval, or cubic in shape. The epidermis appeared smooth and lacked hairs. Anisocytic stomata were found on the lower leaf surfaces, aligned with the epidermal cells. The mesophyll was made up of both palisade and spongy parenchyma cells. The palisade parenchyma consisted of two layers of cylindrical cells, while the spongy parenchyma comprised around seven layers of round or oval cells. Vascular bundles were situated within the mesophyll in a ring formation and were of the collateral type. They were encased in a parenchymatic bundle sheath. Surrounding the bundles was a layer of sclerenchymatic tissue. The xylem was oriented towards the inner side, while the phloem was positioned on the outer side.

Fig. 3: leaves of *Baccaurea courtallensis.*

Fruits

The fruits are spherical and have a vibrant crimson-red skin, with an average diameter of 2.5 cm. They are categorized as berries, featuring a semi-hard yet fleshy outer rind that is 2-3 mm thick and used for making pickles. Inside the rind, there is typically a single arillate seed occupying the cavity. In some larger fruits, it is possible to find two seeds.

Fig. 4: Fruits of *Baccaurea courtallensis.*

Seeds

The seed is wide and flat, oval in form, and has a white hue. It features a resilient outer seed coat along with a fragile brown inner seed coat. The outer layer is surrounded by a fibrous fuzz that can be easily removed by rubbing it against a rough surface. The inner seed-coat encloses a thick and fleshy endosperm. The embryo is surrounded by the endosperm, which features two delicate, paper-like cotyledons and a short embryonic axis.[5,6]

Floral morphology

The inflorescence exhibits cauliflory, with a significant number of trees generating dark crimson flowers in densely packed slender racemes on the mature stem. Female flowers tend to be larger than male flowers, and the tepals of the female are also bigger than those of the male. Both male and female flowers release a faint musky scent.

The male inflorescence forms in clustered racemes on short tubercles scattered across the trunk, displaying a red hue. The bracts are either linear, lance-shaped, or triangular, remaining free and folded inwards, surrounding the base of the lateral branches; the tepals number 4–5, measuring 1.5–2 x 1 mm, and can be linear, oblong, elliptical, nearly round, or inverted lance-shaped, with a smooth surface or sparsely pubescent; there are 6–7 stamens that are free and fertile; the anthers are basifixed, and the pistillode has a club-like shape.

Female inflorescences develop on clustered racemes predominantly located at the trunk's base. Small bumps were noted on the trunks where the female inflorescences emerge. Each cluster contained between 6 to 19 female inflorescences, with an average of 10.56. The bracts are lanceolate, measuring 1–1.5 mm in length; there are 4–5 tepals that range from 2.5–3 x 0.6–1.5 mm, which can be linear, oblong, or oblong-elliptic, and are either sparsely hairy or hairless, and have fringed hairs; the ovary is located superiorly and is woolly. The ovule structure of B. courtallensis is anatropous with amphistomal tissue forming the micropyle, it is crassinucellate, originates from axile placentation, has bitegmic integuments, and features an obturator that creates a nucellar beak. The ovule is positioned ventral epitropous. Typically, the ovary contains two ovules per locule. The embryo is green due to chlorophyll, and the endosperm is cellular.[5]

Fig. 5: Male and Female *Baccaurea courtallensis* flowers.

Distribution of *Baccaurea courtallensis*

The tree species Baccaurea courtallensis, which belongs to the Phyllanthaceae family, is native to the Indian peninsula. The reproductive biology of this plant is unknown, even though it naturally reproduces by seeds. Local tribes eat the ripe fruits, which are referred to as mootilpazham (clusters of fruits located at the foot of tree trunks). Protein, potassium, reducing and non-reducing sugars, carbs, total phenols, antioxidants, and flavonoids are all abundant in these luscious fruits.

This tree species also has ornamental appeal, and its vibrant inflorescences provide a stunning visual treat when fully in bloom. The tropical evergreen forests of the southern Western Ghats, Eastern Ghats, and Odisha serve as the natural habitat for this evergreen tree. It can be found in areas of evergreen and semi-evergreen forests throughout the Western Ghats, particularly in the southern and central regions of the Sahyadri, extending up to the Coorg area. This species typically exists as an understory tree in low to medium-elevation evergreen forests located at altitudes of up to 1,000 meters. B. courtallensis is recognized as an underutilized fruit tree. Generally, the phrase "underutilized fruit tree" describes a category of fruit trees that are presently found in scattered and neglected conditions along roadsides, on homestead properties, and in wastelands, even though they possess the potential for more extensive use. The tree also interacts biotically with birds and mammals that eat its fruits. Bioactive substances of therapeutic significance are present throughout the entire plant.

Flowering takes place from February to May, while fruit development and maturation occur between June and September. The flowers are unisexual and the species is

dioecious; however, this study highlights the unusual appearance of monoecious flowers in several inflorescences of a handful of trees. The crimson red fruits are grouped in a racemose type of inflorescence and dangle in symmetrical clusters. These inflorescence clusters can be found extending from the base of the trunk upward. During field observations, both wind and insect pollination were noted, with honey bees and black ants identified as the primary visitors to the flowers.[4,5]

Phytochemical Composition

Baccaurea courtallensis Muell. Arg demonstrated the existence of phytoconstituents. A qualitative analysis of the phytochemical active compounds was conducted separately for the leaves, stem, and fruits. The analysis of the leaf, bark, and fruit extracts for phytochemicals showed varying results depending on the solvents employed. The qualitative analysis of the fruit indicated the presence of tannins, saponins, terpenoids, and phenolic compounds. However, the plant extracts did not show the presence of glycosides and flavonoids. The leaf also indicated the presence of tannins, saponins, terpenoids, and phenolic compounds. In contrast, the bark extract contained only saponins and terpenoids. The plant extract revealed that saponins are known to have an inhibitory effect on inflammation.

The fruits of *B. courtallensis* underwent initial phytochemical analysis, revealing the presence of alkaloids, flavonoids, terpenoids, saponins, phlobatannins, coumarins, anthocyanins, leucoanthocyanins, phenols, carbohydrates, and tannins. The methanol and benzene extracts from the fruit rind displayed the presence of steroids, coumarins, tannins, flavonoids, phenols, quinones, and volatile oils. Phytochemical screening of the n-hexane and methanolic bark extracts showed the existence of tannins, terpenoids, saponins, and flavonoids. Additionally, quantitative analysis was performed to measure total saponins (83.5 mg/g), terpenoids (530.6 mg/g), and phenols. The root extract identified alkaloids, flavonoids, carbohydrates, saponins, proteins, amino acids, steroids, phenols, tannins, glycosides, coumarins, gums, and mucilage.

The oil content of *B. courtallensis* seeds was evaluated. Analysis of fatty acid composition indicated that the oil comprises 22.5% based on dry kernel weight. The fatty acids identified include palmitic acid (42.59%), oleic acid (36.15%), stearic acid (16.20%), myristic acid (4.28%), lauric acid (0.40%), and linoleic acid (0.38%). The physicochemical characteristics of the oil displayed an acid value of 1.402, a

saponification value of 166.89, a refractive index of 0.4239, a specific gravity of -0.938, and an optical rotation of α at 0.35° at 29°C and 589 nm wavelength. The total phenolic content and flavonoid content in the leaves of *B. courtallensis* extract were determined to be 131 mg GAE/g and 72.2 mg Rutin Equivalent/g, respectively.[8]

Pharmacological Activities

Different components of *B. courtallensis* exhibit a broad spectrum of pharmacological properties, including antibacterial, antifungal, anti-hyperlipidemic, antioxidant, and anti-inflammatory effects. These activities are likely a result of the interactions among various phytochemicals present in the plant.

Antioxidant Activity

The ethanolic extract from the leaves of *Baccaurea courtallensis* demonstrates notable antioxidant properties, as shown by the DPPH free radical scavenging assay. At a concentration of 50 µg/ml, it exhibited a scavenging activity of 86.34%, with an IC_{50} value of 43.60 µg/ml. Prior research indicated even higher activity with an IC_{50} of 24.41 µg/ml, whereas ascorbic acid presented an IC_{50} of 14.19 µg/ml. Through the phosphomolybdenum method, the total antioxidant capacity of the extract at 200 µg/ml was found to be equivalent to 238 µg/ml of ascorbic acid. Furthermore, aqueous extracts from both the leaves and roots demonstrated strong antioxidant effects across various assays. In the DPPH assay, the leaf and root extracts had IC_{50} values of 1.5 µg/ml and 1.0 µg/ml, respectively, while in the FRAP analysis, their IC_{50} values were 201.24 µg/ml and 383.1 µg/ml. These results indicate that *B. courtallensis* possesses robust, dose-dependent antioxidant capabilities and shows potential as a natural source of antioxidants.

Anti-inflammatory Activity

The ethanolic leaf extract of *Baccaurea courtallensis* was assessed for its anti-inflammatory properties using the carrageenan-induced rat paw edema model. The extract exhibited significant, dose-dependent reduction of inflammation, showing 68.18% inhibition at 150 mg/kg and 86.36% at 450 mg/kg after a three-hour period. No mortality or signs of toxicity were noted following oral administration of the extract, even at higher doses 24 hours later. Considering the negative effects linked to traditional non-steroidal anti-inflammatory drugs (NSAIDs), *B. courtallensis* appears to be a promising and safe natural alternative for anti-inflammatory treatment.

Antihyperlipidemic Activity

The methanolic leaf extract of *Baccaurea courtallensis* has demonstrated notable anti-hyperlipidemic effects in experimental models of Triton WR-1339 and high-fat diet-induced hyperlipidemia in Wistar albino rats. At doses of 200 mg/kg and 400 mg/kg, the extract significantly lowered total cholesterol, triglycerides, and LDL-C levels, while elevating HDL-C levels toward a normal range. This indicates that *B. courtallensis* possesses not only antioxidant and anti-inflammatory characteristics but also shows promise as a natural option for controlling hyperlipidemia.

Antimicrobial Activity

A prior study highlighted the antibacterial capabilities of methanolic extracts from the leaves, fruit rind, and bark of *Baccaurea courtallensis* against different pathogenic bacteria. The leaf extract demonstrated potent activity against both gram-positive and gram-negative bacteria, with minimum inhibitory concentration (MIC) values of 1.6 µg/ml for Bacillus subtilis, 2.36 µg/ml for Staphylococcus aureus, 4.68 µg/ml for Escherichia coli, and 37.5 µg/ml for Pseudomonas aeruginosa, showing effectiveness comparable to the standard antibiotic Amoxicillin. Both methanolic and benzene extracts of the fruit rind exhibited antibacterial effects against E. coli and S. aureus, with MIC values between 60–80 µg/ml, while P. vulgaris and P. aeruginosa demonstrated resistance. Furthermore, the methanolic bark extract (50 mg/ml) produced inhibition zones against E. coli (1.9 cm), S. typhi (1.8 cm), S. aureus (1.7 cm), and B. cereus (1.5 cm), using Chloramphenicol as the standard comparator. The bark extract also displayed antifungal properties, yielding inhibition zones of 2.1 cm against Aspergillus niger and A. oryzae, which signifies the broad-spectrum antimicrobial characteristics of *B. courtallensis*.[7]

Ethnobotanical uses

B. courtallensis is a medicinal plant highly valued in Indian traditional medicine, particularly among indigenous populations. Its various parts, including leaves and fruits, are utilized to treat numerous health issues. Historically, it has been employed to address ailments like asthma, jaundice, sinusitis, cough, and digestive problems. The fruit is ingested for its nutritional value and antioxidant properties, while leaf extracts are frequently used in treatments for inflammation and infections. These applications demonstrate the plant's significant role in folk healing traditions and underscore its potential for further scientific investigation and pharmaceutical advancement.

CONCLUSION

Baccaurea courtallensis Muell. Arg. is a species that is endemic to the region and holds significant ethnobotanical value, having a lengthy history of traditional application among the tribal populations of the Western Ghats. Scientific investigations increasingly support its various medicinal uses, which include treating ulcers and diabetes as well as serving as an anti- inflammatory and antimicrobial agent. Phytochemical analyses have identified the presence of bioactive compounds such as tannins, saponins, terpenoids, and phenolics, all of which enhance its extensive pharmacological capabilities. Nonetheless, there is a notable lack of research focused on the isolation and characterization of specific bioactive compounds. As a result, thorough studies in pharmacology, phytochemistry, and conservation are crucial to fully explore the therapeutic benefits of *B. courtallensis*, facilitating its incorporation into contemporary medicine and ensuring sustainable utilization.

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