Advances in Zoology and Botany 11(2): 112-120, 2023
DOI: 10.13189/azb.2023.110203 http://www.hrpub.org

A Review on Taxonomy, Anatomy, Ethnobotany and Pharmacology of *Baccaurea courtallensis* (Phyllanthaceae) from Westernghats

Sreeshma P. S.*, Joby Paul

Department of Botany, St. Thomas' College (Autonomous), Thrissur District, Kerala- 680001, India

Received July 27, 2022; Revised September 1, 2022; Accepted October 25, 2022

Cite This Paper in the Following Citation Styles

(a): *[1] Sreeshma P. S., Joby Paul, " A Review on Taxonomy, Anatomy, Ethnobotany and Pharmacology of Baccaurea courtallensis (Phyllanthaceae) from Westernghats," Advances in Zoology and Botany, Vol. 11, No. 2, pp. 112 - 120, 2023. DOI: 10.13189/azb.2023.110203.*

(b): *Sreeshma P. S., Joby Paul (2023). A Review on Taxonomy, Anatomy, Ethnobotany and Pharmacology of Baccaurea courtallensis (Phyllanthaceae) from Westernghats. Advances in Zoology and Botany, 11(2), 112 - 120. DOI: 10.13189/azb.2023.110203.*

Abstract Ethnic communities are traditionally using wild plants in their day to day life for nutrition and medicinal requirements. *Baccaurea courtallensis* (Moottipazham *Mal*., family Phyllanthaceae) is one such wild plants used by tribals from different parts of westenghat region. It is a medium-sized endemic tree found in semi- evergreen and evergreen forests of Western Ghats, India. All parts of the *B. courtallensis* are documented to possess varied medicinal properties and used to treat stomach and mouth ulcer, diarrhoea, piles and dysentery by traditional healers. In the recent years, this tree has been analysed scientifically for supporting its traditional claims. The present review is an effort to revisit to scientific information on botanical characteristics, anatomy, ethnobotany, phytochemistry and pharmacological activities of *B. courtallensis* based on research papers from portals including Web of Science, Google scholar and Scopus. People belonging to Paniya, Kani and Kurichya tribal groups of different forest regions are the important payees of the plant. Both primary and secondary metabolites are present in leaves and roots of the plant. Various bioassays conducted in the leaves of *B. courtallensis* show that the plant has anti-bacterial, anti-fungal, anti-hyperlipidemic, antioxidant, and anti-inflammatory activity. The fruit of the plant shows significant antioxidant properties. This data compilation supports the basic perceptive of *B. courtallensis* and opens up new horizon for future research.

Keywords Antidote, Antipyretic, Bioprospection, Endemic Plant, Moottipazham, Underutilized Fruit

1. Introduction

Baccaurea courtallensis (Phyllanthaceae) is an endemic medium-sized tree, found in Western Ghats and included the plant in *Endemic plants of the Indian region Vol-I*, by Ahmedullah and Nayar [1]. International Union for Conservation of Nature and Natural resources (IUCN) has enlisted this species as a threatened in its Red Data Book [2]. It is frequently seen in evergreen and semi-evergreen forests in Western Ghats of India from South Canara southwards and adjoining western parts of Tamil Nadu up to 914 m [3] and also reported from Sri Lanka [4]. In Kerala, the tree is naturally distributed in all districts except Alappuzha.

It is vernacularly known as Kolikukke (Kannada), Mootalpazham, Mootikaippan, Moottithuri (Malalyalam), and Maraootipazham (Tamil). The generic name Baccaurea is a Latin derived “bacca-aurea” referring to the golden yellow colour of the fruits [5], and the specific epithet “courtallensis” is the geographic indication of its type locality Courtallum in Thirunelveli district, Tamil Nadu, collected by Wight in 1836 (Royal Botanic Garden

Edinburgh - Herbarium). The fruits of the plant are edible [6,7] and food for many wild animals. The leaves, fruits, seeds and stem bark of *B. courtallensis* are documented to possess varied medicinal properties and are used to treat diseases by ethnomedicine practitioners. The plant is also used in the treatment of diarrhea, diabetes, dysentery, and mouth cancer [8,9]. Recent studies focus on validation of nutritional analysis and medicinal properties of indigenous underutilized trees species which were formerly known only to the local community. This in turn helps in enhancing its commercial value and better utilization of nature and natural resources.

A total of 100 species under the genus Baccaurea are enlisted, of which *B. courtallensis* and *B. sapida* are the only species reported from India [10]. *B. sapida* is native to the Southeast Asia, distributed along the sub-Himalayan tract, mostly from Nepal to Sikkim, Darjeeling hills, Arunachal Pradesh, Tripura, Assam, Bhutan, Burma, Penninsular Malaysia, Tibet, and Andaman Islands [11]. The majority of other Baccaurea species belong to the Malayan region [12].

Recent studies focus more on pharmacological activities and validated many of the ethnomedical properties of plants using advanced protocols and techniques. Thus, the ethnomedicine gains a status equal to modern medicine and amalgamation of both has been recommended by World Health Organization [13]. It is therefore necessary to assess the relationship between claims on traditional medicinal uses with its phytochemical constituents and biological activity. However, scientific validation of phytochemicals and biological activities of different parts of *B. courtallensis* was rarely evaluated and summarized. The present review is on the taxonomy, anatomy, ethnomedicinal uses, phytochemistry and pharmacological activities of *B. courtallensis*. This may enable a potential area of research and drug development from the *B. courtallensis*.

2. Methodology

Based on the underlying principle, an online search was performed using various bibliographical databases: Google Scholar, Web of Science, Scopus using the scientific names *B. courtallensis*, synonyms, vernacular names as key words along with antioxidants, anti-inflammatory, anti-fungal, anti-bacterial, cytotoxic, chemical constituents, etc. To ensure the scientific name with respect to the accepted name, synonyms, family, author citations, we searched plant database such as "International Plant Names Index" (www.ipni.org). Hundreds of articles were reviewed for this purpose, but only relevant papers were screened for extracting the related information.

3. Results and Discussion

3.1. Taxonomy

Baccaurea courtallensis (Wight) Müll. Arg. is validly published by Müller Argoviensis in Prodromus Systematis Naturalis Regni Vegetabilis [14] with earlier author Wight in the parenthesis. It was earlier included under the family Euphorbiaceae according to the Bentham and Hooker classification (1862-1883). *Pierardia courtallensis* Wight, *P. macrostachya* (Wight & Arn.) Hook f. and *Baccaurea macrostachya* Wight & Arn. are the synonyms [15] to this species. The earliest report of *B. courtallensis* was in the Flora of British India by Hooker [16] and described as an abundant species in all moist forests of the Western Ghats from Canara to South Travancore. Rao [17] included it in the Flowering plants of Travancore citing its uses as edible and referring to its fruit acid. Gamble [3] included *B. courtallensis* in his Flora of Presidency of Madras and mentioning its distribution. The species could be seen in several other floras and revisions published after Gamble including, The genus Baccaurea (Euphorbiaceae) [5], The Flora of Kerala [18], Flora of Western Ghats [19], Flora of Cannanore [20], Flora of Palghat District [21], Flowering plants of Thrissur Forests [22], Flora of Calicut [23], Flora of Quilon District [24], Flora of Kasaragod Division, Cannanore District [25], Flora of Pathanamthitta District [26], Flora of Thiruvanathapuram District [27], Flora of Periyar Tiger Reserve [28], Flora of Thenmala Division [29] Flora of Nilambur [30], Floristic Studies of Agasthyamala [31], Floristic studies in Aralam Wildlife Sanctuary [32] and Floristic Studies in Parambikulam Wildlife Sanctuary [33]. The species is included in checklists of Endemic plants of Waynad district [34], Endemic trees of Peppara wildlife sanctuary [35], Flowering plants of Kerala [36] and Tree Species Conserved in the Thiruvananthapuram Napier Museum and Zoological Park Garden [37]. Ayyanar and Ignacimuthu [38] studied the diversity and conservation status of medicinal plants of the family Euphorbiaceae in Tirunelveli hills and reported *B. courtallensis* to be endemic and vulnerable. But Ramesh et al. [39] documented that the tree is at low risk category for conservation. Yogeesha et al., [40] mentioned the plant as under-utilized fruit species of Western Ghats.

B. courtallensis is a monoecious tree of 7-18 m height with grayish bark. Flowers are crimson red and are born on the main trunk of the tree as a cauliflorous species. At full bloom condition, the tree appears to be a crimson mass. During the time of anthesis, the flower emits a pleasant smell to attract the pollinators. Mohan [41] has described the possibility of less regeneration of *B. courtallensis* due to consumption of fruits by local residents and tortoise. The cauline nature of the plant is very much important for the ecological community where it grows. The fleshy aril around the seed is consumed as raw. Joseph et al., [42]

reported that preliminary observation of *B. courtallensis* on its natural populations and their fruit characters indicate the existence of a good amount of genetic heterogeneity within the population. Jyothish et al., [43] reported variation in flower colour in *B. courtallensis*.

3.2. Botanical Description

Trees, 15-18 m tall; bark greyish; branchlets rough. Leaves 10-18 × 1.5-8 cm, simple, alternate, often clustered towards the tip of branchlets; Petiolate, cuneate to attenuate base with acuminate apex; margin entire, sometimes crenulate, lanceolate; petiole 0.5-5.5 cm long, slender, glabrescent or puberulous; lateral nerves 4-7 pairs, pinnate, slender, brochidodromous nerve endings. Flowers unisexual, crimson red, in densely clustered slender racemes forming rings around on tree trunk. Male flowers; single bract with hirsute hairs, 1.40-1.49 mm long, lanceolate, linear-lanceolate or triangular, free, conduplicate, encircling the base of lateral branches; tepals 4-6, 2.17-2.24 mm long, linear, oblong, elliptic, suborbicular or oblanceolate, glabrous or sparsely puberulous. Stamens 4-8, free; anthers 0.51-0.52 mm long basifixed; filaments 0.45-0.47 mm; pistillode clavate. Female flowers; bracts, 0.55-0.60 mm, lanceolate; tepals 5-6, 4.25-4.70 mm, oblong or oblong-elliptic, sparsely puberulous to glabrous, ciliate. Ovary 3.01-3.17 mm long, superior, ovoid or subglobose, 3-locular, ovules 2 in each cell, 3-angled, tomentose. Stigmas 3, flabellate. Capsule 1.2-4.5 × 8.5-12 cm, 11-28 gms, subglobose, ovoid, ellipsoid or obovoid, 3 locular, thick walled, pinkish red when ripe, brown when dry, often pubescent, dehiscent. Seeds 3, oblong, flat, leathery outer coat, inner coat brown, aril white.

3.3. Anatomy

3.3.1. Stem

In the cross section, the single-layered epidermis was found with a very thin cuticle on the outside. The surface is glabrous without hairs. Anisocytic type of stomata was present on the epidermis. Peripheral cortex consists of wavy patches of collenchymas followed by thin walled parenchyma of 3-4 layers with regularly oval or round shaped cells. Underneath cortex parenchyma, there is a single layered rectangular or oval shaped endodermis. Pericycle is underneath endodermis. It was usually sclerenchymatic and surrounding on vascular bundles or cup-like 1-2 layers. Just below the bundle cap is the primary phloem followed by secondary phloem. The number of vascular bundles arranged in a ring is ±34. Interfascicular region was located in between vascular bundles with narrow medullary rays. Cambium cells are clear with thin elongated cells with 2-3 layers forming a continuous layer between xylem and phloem. Pith region at the center of the stem is composed of large orbicular or polygonal parenchymatic cells (Fig. 1B)

3.3.2. Petiole

Outline is boat shaped, slightly concave at the adaxial surface, convex on the abaxial surface. Epidermis is uniseriate with very thin cuticle. Cortex is composed of 1-2 layers of polygonal angular collenchyma cells and ±15 layers of thin walled parenchyma cells. The number of vascular bundles arranged in a ring is ±12 with two leaf traces. Pith is composed of thin walled parenchyma cells (Fig. 1D).

3.3.3. Leaf

In the cross section of the leaf, there was a thin cuticle on the upper and lower epidermis. Both epidermal cells were isodiametric and rectangular, oval or cubic in shape. Surface of epidermis is glabrous without hairs. Anisocytic stomata were present on lower surfaces of the leaf (Fig. 1C). These were located on the same level as epidermal cells. Mesophyll consisted of palisade and spongy parenchyma cells. Palisade parenchyma cells were 2 layered, cylindrical whereas spongy parenchyma cells ±7 layered and round or oval in shape. Vascular bundles were embedded in mesophyll forming a ring and are collateral type. They were surrounded by parenchymatic bundle sheath. A ring of sclerenchymatic tissue around the bundles was present. The xylem faces inner surface as phloem faces the outer side. Sclerenchyma on phloem tissue was present (Fig. 1A).

3.4. Ethnobotany

B. courtallensis is an underutilized forest tree species used as medicine by folk practitioners. The plant is commonly used to treat diarrhoea, dysentery and skin infections [2]. The bark of the plant is used as a tonic in disorders of mucous membrane and to heal wounds and its root is used in controlling diabetes [44]. Fruit of *B. courtallensis* is used by *Kani* tribes of Kalakad Mundanthurai Tiger Reserve [38] to induce fertility in men and women. *Kani* healers of Thirunelveli Hills use the plant in herbal preparations [45]. *Kani* tribes of Thachamali Hills of Kanyakumari District consume the fruit to cure mouth and stomach ulcers [46]. *Kani* tribes inhabiting in areas of Kanyakumari wildlife sanctuary consume the raw fruit of *B. courtallensis* to cure constipation [47]. The pericarp of tender fruit is consumed as antipyretics by the *Kani* Tribes of Agasthyamalai Hills [48]. *Kurichia* tribes of Wayanad District use root paste and leaf paste of *B. courtallensis* mixed with required quantity of hot water and taken internally in the form of tablets to treat piles. Leaves, fruits and stem ground together are taken internally as antidote [49]. *Paniya* tribes of Wayanad District [50], Kani tribes of Agasthiayamalai Biosphere Reserve [48], *Muthuvan* Tribes of Idukki District [51], *Kadar* Tribes of Vazhachal forest division, Thrissur district [52] and folks belonging to *Malampandarangal* tribal group consume the fruit, and the rind is pickled [53].

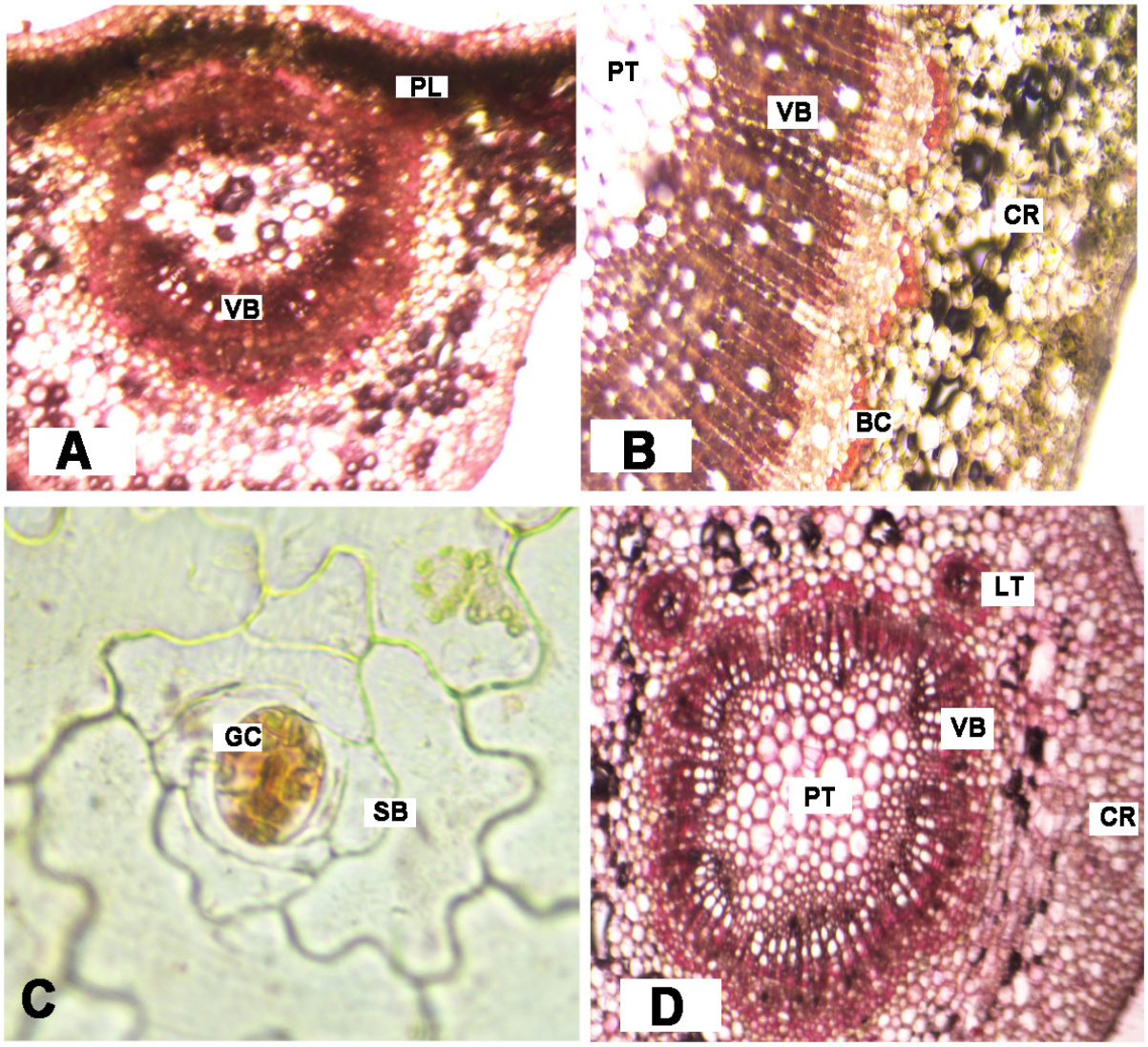

Figure 1. A - C.S. of leaf vascular bundle, B - C.S. of Stem, C - Stomata, D - C.S. of petiole (VB - vascular bundle, PL - Palisade tissue, PT - Pith, BC - Bundle cap, GC - Guard cell, SB - Subsidiary cell, CR - Cortex, LT - Leaf trace)

3.5. Nutritional Composition

Wild fruits even though not much tasty as other cultivated fruits, they possess a good nutritional wealth and show healthy biological activities which are known less to the world. Nowadays people choose for healthy and quality plant-based food products. The nutritional composition of fruit of *B. courtallensis* has been documented by Nazarudeen [53] and compared it with that of cultivated jackfruit. The fruit is rich in moisture content (87.33%), fat (2.09%), dietary fiber (1.89%), non-reducing sugar (2.47%), reducing sugar (4.92), and a good profile of mineral elements like potassium (102.43mg/100g), sodium (1.01 mg/100g) and iron (1.56 mg/100g) are also being reported. Fresh rind was found to be rich in antioxidants, with 237 mg of total phenols and 93 mg of flavonoids per 100-gram fresh weight [40]. Studies have been carried out on the physicochemical properties of the *B. courtallensis* fruit rind. It was determined by a proximal analysis of fruit rind with 88.56% moisture content, 1.26% ash, 4.75% crude fiber, 1.86% fat, 58.53 mg/100g ascorbic acid, 16.50mg/100gm flavanoid, 34.40 mg/100g tannin, 390 mg/100g phenol and 1.54g /100g carotenoid. Being an excellent source of nutritional components, *B. courtallensis* fruit can help to rectify the ill effects of under nutrition in humans if incorporated into the diet.

3.6. Phytochemical Profile

A majority of the biological effects of *B. courtallensis* extracts are due to their primary and secondary metabolite composition. Primary metabolite analysis has essentially been focused on the leaves and root of *B. courtallensis* and secondary metabolites on the leaf, root, bark, whole fruit, and fruit rind. Leaf was ground to crude leaf powder and extracted in ethyl acetate, iso-butanol, n-butanol,

cyclohexane, acetone, petroleum ether, benzene, ethanol, methanol, n-hexane and aqueous solvents and showed the presence of tannins, saponins, terpenoids and phenolic compounds, alkaloids, flavonoids, carbohydrates, proteins, amino acids, steroids, glycosides, emodins, coumarins, gums and mucilages, and anthraquinones [44-55]. The *B. courtallensis* fruits were subjected to preliminary phytochemical analysis and they showed the presence of alkaloids, flavonoids, terpenoids, saponins, phlobatannins, coumarins, anthocyanins, leucoanthocyanins, phenols, and carbohydrates [56], and tannins [44]. The methanol and benzene extracts of the fruit rind showed the presence of steroids, coumarins, tannins, flavonoids, phenols, quinones, and volatile oils [57]. The phytochemical screening of n-hexane and methanolic bark extract revealed the presence of tannins, terpenoids, saponins, and flavonoids. Quantitative analysis was also done to determine the total saponins (83.5mg/g), terpenoids (530.6mg/g) and phenols (7.4mg/g) [44]. Root extract showed the presence of alkaloids, flavonoids, carbohydrates, saponins, proteins, amino acids, steroids, phenols, tannins, glycosides, coumarins, gums and mucilage [58]. The seed of *B. courtallensis* was analyzed for oil content. Fatty acid composition revealed the presence of 22.5% oil on a dry kernel weight basis. The composition includes 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%). Physicochemical properties of the oil showed an acid value of 1.402, saponification value of 166.89, the refractive index of 0.4239, specific gravity of -0.938, and an optical rotation of α at 29°C is 0.35° at 589 nm wavelength [41]. Total Phenolic and flavonoid content in leaves of *B. courtallensis* extract were found to be 131mg GAE/g and 72.2 mg Rutin Equivalent/g respectively [54] (Table 1).

Table 1. Phytochemical analysis of different parts of *Baccaurea courtallensis*

Part Used	Extraction solvent	Primary metabolite	Reference
Leaf		Alkaloids, Flavanoids, Phenols, Saponins, Tannins, Carbohydrates, Anthraquinones, Coumarins, Glycosides, Steroids	[54]
	Methanol	Saponins (61mg/g), Tannins (20 mg/g), Phenolic compounds (16.6mg/g)	
	Hexane	Tannins (19.4 mg/g), Saponins (37.5 mg/g), Terpenoids (506.6 mg/g), Phenolic compounds (5.6mg/g)	[44]
	Ethanol	Glycosides, Carbohydrate, Alkaloids, Phenols, Phytosterols, Proteins, Flavonoids, Saponins, Tannins	[2]
Fruit	Water	Alkaloids, Flavonoids, Terpenoids, Saponins, Phlobatannins, Coumarins, Anthocyanins, Leucoanthocyanins, Phenols, Carbohydrates	[56]
Rind	Methanol	Tannins, Falavonoids, Phenols, Volatile Oil, Quinones	[57]
	Benzene	Steroids, Coumarins, Volatile oil	
	Methanol	Tannins (4.6 mg/g), Phenolic compounds	[44]
	Hexane	Saponins (54 mg/g), Terpenoids (620.6 mg/g)	
		Phenols (237 mg/100g), Flavonoids (93 mg/100g)	[40]
Bark	Methanol	Tannins, Saponins, Terpenoids, Flavonoids	[60]
	Petroleum ether	Steroids, Tannins	
	Chloroform	Tannins, Flavonoids	[60]
	Ethyl acetate	Steroids, Tannins, Flavonoids	
	Methanol	Saponins (83.5 mg/g), Terpenoids (530.6 mg/g)	[44]
	Hexane	Saponins (46 mg/g)	
Seed	Hexane	Palmitic acid (42.59%), Oleic acid (36.15%), Stearic acid (16.20%), Myristic acid (4.28%), Lauric acid (0.40%), Linoleic acid (0.38%)	[41]

3.7. Pharmacological Activities

Various parts of *B. courtallensis* show a wide range of pharmacological activities such as antibacterial, antifungal, anti-hyperlipidemic, anti-oxidant, and anti-inflammatory. These activities might probably be due to the coactions of various phytochemicals found in the plant.

3.7.1. Antimicrobial Activity

The anti-bacterial efficiency of methanolic extract of leaves of *B. courtallensis* was tested against gram-negative bacteria: *Bacillus subtilis*, *Pseudomonas aeruginosa*; and gram positive bacteria: *Staphylococcus aureus* and *Escherichia coli* using well diffusion method. The MIC values of leaves extract against *S. aureus, B. subtilis, E. coli and P. aeruginosa* were found to be 2.36µg/ml, 1.6µg/ml, 4.68µg/ml and 37.5µg/ml respectively and are comparable with that of the standard drug Amoxicillin [59]. Ten different concentrations of fruit rind extract of *B. courtallensis* were tested for their antibacterial activities against different pathogenic bacteria viz., *E.coli, S. aureus, P. vulgaris, Klebsiella pneumoniae and P. aureginosa*. The MIC value of methanol extract was 60µg/ml against *E. coli* and 70µg/ml against *S. aureus*, 70µg/ml and 80µg/ml for benzene extract against *E.coli* and *S.aureus* respectively. *P. vulgaris* and *P. aeruginosa* did not show inhibition and were found to be resistant with micro concentration [57]. The bacteria *S. aureus, Bacillus cereus, E. coli*, and *Salmonella typhi* were selected for antibacterial assay using methanolic bark extract (50 mg/ml) of *B. courtallensis*. Of the four bacteria selected, *E. coli* showed a greater zone of inhibition (1.9 cm) followed by *S. typhi* (1.8 cm), *S. aureus* (1.7 cm) and *B. cereus* (1.5 cm). The antibiotic Chloramphenicol (10 mg/ml) was used as standard. The antifungal activity of methanol extracts of bark (50mg/ml) against *Aspergillus niger* and *A. oryzae* showed zone of inhibition of 2.1 cm [60].

3.7.2. Antihyperlipidemic Activity

Sreelakshmi et al., [59] examined the anti-hyperlipidemic effect of methanolic fraction of *B. courtallensis* leaf in Wistar outbred albino rat using Triton WR-1339 induced hyperlipidemia and high-fat diet-induced hyperlipidemia. The methanol fraction exhibited significant anti-hyperlipidemic activity at 200 mg/kg and 400 mg/Kg which is evident by the lowered levels of total cholesterol (TC), triglycerides (TG), and low-density lipoprotein cholesterol (LDL-C) and increased level of high-density lipoprotein cholesterol (HDL-C) to near normal.

3.7.3. Antioxidant Activity

Jasim et al., [54] have studied antioxidant property of ethanolic leaf extracts of *B. courtallensis* using the DPPH method and total antioxidant capacity by the Phosphomolybdenum method. Different concentrations of the leaf extract, ie 20µg/ml, 25µg/ml, 40µg/ml, 50µg/ml, 60µg/ml, 80µg/ml, 100µg/ml, 150µg/ml and 200µg/ml were used for DPPH assay. The ethanol leaf extract of 50 µg/ml dosage exhibited 86.34% of significant free radical scavenging activity and IC50 at a concentration of 43.60µg/ml. The total antioxidant activity of the extract at 200µg/ml dosage was found to be equivalent to the activity exhibited by 238 µg/ml of ascorbic acid. Maharani and Anna [2] reported that the ethanol extract of *B. courtallensis* leaves performed a concentration-dependent free radical scavenging activity against DPPH with an IC50 value of 24.41µg/ml and ascorbic acid with IC50 value 14.19µg/ml.

Blessy and Surekha [58] have documented the antioxidant activity of crude aqueous extract of leaf and root of *B. courtallensis* by five in-vitro radical scavenging assays: DPPH, Nitric oxide, ABTS, FRAP and Hydroxyl radical scavenging activity. The results showed statistically significant differences for DPPH and FRAP, the DPPF free radical scavenging activity of leaf and root extract with IC50 value 1.5µg/ml and 1 µg/ml respectively. The IC50 values of leaf and root crude aqueous extracts of *B. courtallensis* are 201. 24 µg/ml and 383.1 µg/ml respectively in FRAP analysis. Currently the need for natural antioxidants is rising due to the ill effects of synthetic antioxidants [61]. In this context, leaf and root of *B. courtallensis* can act as a natural antioxidant.

3.7.4. Anti-inflammatory Activity

The anti-inflammatory activity of ethanol extract of *B. courtallensis* leaves was studied by carrageenan-induced rat paw oedema test in groups of three rats. The activity of the plant extract was calculated as the degree of oedema inhibition. After three hours of carrageenan injection, the plant extract at 150 mg/kg dose showed 68.18% inhibition and at 450 mg/kg dose, 86.36% inhibition was reported. No mortality was recorded for the oral administration of graded doses of ethanolic plant extract even after 24 hours [54]. Non steroid anti- inflammatory drugs cause an adverse effect to kidney function [62]. Hence leaves of *B. courtallensis* can be used as potent anti-inflammatory drug.

4. Conclusions

4.1. Ethnobotany and Future Bioprospection

The scientific validation of the ethnobotany uses of *B. courtallensis* can be done by conducting various experimentations. Further documentation if biological activities and bioactive compounds can be used to analyze the bioprospecting of *B. courtallensis*. Then, it can be continued to further research for commercialization of the products. Herbal medicines are always an inevitable part of the health care of Indian tradition. The use of herbal remedies is more prevalent in people with asthma, jaundice, sinusitis, etc. Today plenty of herb-based drugs are available in the market and most of them are known to have

little side effects. From various studies, it is evident that *B. courtallensis* is a potent herb with antibacterial, antifungal, antioxidant, and anti-inflammatory properties. The fruit is rich in nutrition with a significant amount of antioxidants. Till date no compound has been isolated from this plant. At the same time from *B .ramiflora*, another species of the same family, a total of thirty compounds have been isolated and characterized so far from different parts of the plant. The present review summarizes important pharmacological studies on *B. courtallensis* and serves as the baseline information to carry out further studies at the molecular level. It opens up a new area of research for the scientific world to identify and extract the bioactive compounds, and to conduct tests on toxicity level, clinical trials, and thereby designing of novel drug. Since the tree fruits are profuse during the fruiting season, it is possible to make value added products like wine, pickles, and dry fruits from the fruit.

REFERENCES

[1] M. Ahmedullan and M. P. Nayar, Endemic plants of the Indian region, Botanical Survey of India, Calcutta, Vol. 2,173, 1986.

[2] Maharani and S. L. Anna, Preliminary Phytochemical Analysis and In vitro Antioxidant Activity of *Baccaurea courtallensis*, Research Journal of Pharmacy and Technology, Vol. 12, No. 9, 4397-4399, 2019.

[3] J. S. Gamble, Flora of the Presidency of Madras, Adlard and Son, London, Vol. 2, 916, 1921.

[4] A. P. H. Raoul Martin, Taxonomy, Phylogeny and Biogeography of Baccaurea, Distichirhops and Nothobaccaurea (Euophorbiaceae), National Herbarium Nederland, Universiteit Leiden branch, 106-107, 2000.

[5] T. Chakrabarty and M. Gangopadhyay, The genus Baccaurea (Euphorbiaceae) in the Indian subcontinent. The Journal of Economic and Taxonomic Botany, Vol. 21, 525–534, 1997.

[6] R. Vardhana, Floristic Plants of the World, Sarup & Sons, 101, 2006.

[7] S. Binu, Wild edible plants used by the tribals in Pathanamthitta district, Kerala, Indian, Journal of Traditional Knowledge, Vol. 9, 309–312, 2009.

[8] A. Khadijah, M. Mohd Khairulazhar, A. R. Razali and A. Rusli, Cultivation method of rambai family, Buletin Teknilogi MARDI, Vol. 5, 45-49, 2014.

[9] S. Sreelakshmi, M. Subathra, P. Deepthi, R. Maharani, M. Jayalakshmi and P. Amudha, An overview of phytochemical and Pharmacological potential of Baccaurea Species, Journal of critical reviews, Vol. 7, No. 10, 2354-2362, 2020.

[10] T.K. Charu, S. C. Nargis and B. F. Ismat, Traditional and Pharmacological Reports of the Genus Baccaurea. A Review, American Journal of Biomedical Science and Research Vol. 11, No. 6, 494-508, 2021.

[11] A. K. Goyal, T. Mishra and A. Sen, Antioxidant profiling of Latkan (*Baccaurea ramiflora* Lour.) wine, Indian Journal of Biotechnology, Vol. 12, 137–139, 2013.

[12] K. Awang, M. Shukri and M. Ali, Diversity, distribution, and conservation of Baccaurea species in the home gardens and orchards in Malaysia, Malayan Nature Journal, Vol.70, No. 3, 333 -339, 2018.

[13] A. Maroyi, Ethnopharmacological Uses Phytochemistry and Pharmacological properties of Croton macrostachyus Hochst Ex Delile: a comprehensive review, Evidence-based Complementary and Alternative Medicine, Vol. 20, 1-17, 2017.

[14] Müller Argoviensis, Prodromus Systematis Naturalis Regni Vegetabilis (Prodr.), Vol. 15, No. 2, 459, 1866.

[15] POWO. (2021) "Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. Published on the Internet; http://www.plantsoftheworldonline.org/. Retrieved 14 October 2021.

[16] J. D. Hooker, The Flora of British India. London, Vol. 5, 367-368, 1887.

[17] M. Rama Rao, Flowering plants of Travancore, Government Press Trivandrum, 363, 1914.

[18] P. Daniel, G. V. S. Murthy and P. Venu, The Flora of Kerala, Botanical survey of India, Vol. 1, 96, 2005.

[19] N. C. Nair and P. Daniel, The floristic diversity of the Western Ghats and its conservation: A review, Proceedings of the Indian Academy of Sciences (Animal Science/Plant Science) Supplement, 127-163, 1986.

[20] V. S. Ramachandra and V. J. Nair, Flora of Cannanore, Botanical Survey of India, Vol. 3, 409, 1988.

[21] E. Vajravelu, Flora of Palghat District, including Silent Valley National Park, Kerala, Botanical Survey of India, Howrah, 421, 1990.

[22] N. Sasidharan and V. V. Sivarajan, Flowering plants of Thrissur forests, Western Ghats, Kerala, India, Jodhpur, 393, 1996.

[23] K. S. Manilal and V. V. Sivarajan, Flora of Calicut. Bishen Sigh Mahendra Pal Sigh, Dehra Dun, 260, 1982.

[24] C. N. Mohanan, Studies on the flora of Quilon District, Kerala Ph. D. Thesis, Madras University, Madras, 358, 1984.

[25] R. Ansary, Studies on the vascular floral of Kasaragod division Cannanore district, Kerala State, Ph. D. Thesis, Botanical Survey of India, 333, 1985.

[26] K. N. Anil, Floristic Study of Pathanamthitta District, Kerala. Ph. D. Thesis, Calicut University, Kerala, India, 589, 1994.

[27] M. Mohanan and A. N. Henry, Flora of Thiruvananthapuram, Kerala. Botanical Survey of India, Coimbatore, 407, 1994.

[28] N. Sasidharan, Studies on the flora of Periyar Tiger Reserve. KFRI Research Report No. 150. Kerala Forest Research Institute, Peechi, 365, 1998.

[29] K.N. Subramaniyan, Flora of Thenmala Division,

International Book Distributors, Dehra Dun, 339, 1995.

[30] V. V. Sivarajan and P. Mathew, Flora of Nilambur. Bishen Singh Mahendra Pal Singh, Dehra Dun, 606, 1997.

[31] N. Mohanan and M. Sivadasan, Flora of Agasthyamala, Western Ghats. Bishen Singh Mahendra Pal Singh, Dehra Dun, 599, 2002.

[32] N. Sasidharan, Floristic studies in Aralam Wildlife Sanctuary, KFRI Research Report No. 467, Kerala Forest Research Institute, Peechi, 365, 2013.

[33] N. Sasidharan, Floristic Studies in Parambikulam Wildlife Sanctuary, KFRI Research Report No. 246, Kerala Forest Research Institute, Peechi, 282, 2002.

[34] V. R. Volga, M.K. Ratheesh Narayanan, and N. Anil Kumar, Endemic Trees of Western Ghats–A Check list from Wayanad District, Kerala, India, International journal of plant, animal and environmental sciences, Vol. 3, No. 2, 197-202, 2013.

[35] A. O. Varghese and A. R. R. Menon, Ecological niches and amplitudes of rare, threatened and endemic trees of Peppara Wildlife Sanctuary, Current Science, Vol. 76, No. 9, 1204-1208, 1999.

[36] T.S. Nayar, B.A. Rasiya, N. Mohanan and G. Rajkumar, Flowering plants of Kerala. TBGRI, Trivandrum, 235, 2006.

[37] L.H. Namitha and A. Gangaprasad, Tree Species Conserved in the Thiruvananthapuram Napier Museum and Zoological Park Garden, Plant Archives Vol. 19, No. 2, 4553-4558, 2019.

[38] M. Ayyanar and S. Ignacimuthu, Diversity, conservation status and medicinal plants of the family Euphorbiaceae in Tirunelveli hills, Southern India, Journal of Experimental Sciences Vol. 1, No. 6, 12-16, 2010.

[39] M. Remesh, K. S. Manilal and K.M.S.Muktesh, Ethnobotanical aspects of trees of Palakkad District, Kerala, India, Devagiri Journal of Science, Vol. 2, No. 1, 32-51, 2016.

[40] H. S. Yogeesha, S. Ganeshan, K. S. Shivashankara, D. L. Shetty and C. Anil Kumar, Fruit/Seed Morphology, Seed Drying and Germination Studies in *Baccaurea courtallensis* (Muell.) Arg., a Threatened Under-Utilized Fruit Species of Western Ghats in India, Journal of Horticultural Sciences, Vol. 11, No. 1, 76-79, 2016.

[41] Srinivasa Mohan, Fatty Acid Composition of *Baccaurea courtallensis* Muell. Arg Seed Oil: an Endemic Species of Western Ghats India, Journal of the American Oil Chemists' Society 86, 1017 -1019, 2009.

[42] J. K. Joseph, M. A. Nizar, K. C. Velayudhan, M. Unnikrishnan and Z. Abraham, Note on *Baccaurea courtallensis* (Muell.) Arg., (Moottipotti) A Wild Edible Fruit of Western Ghats, Indian Journal of Plant Genetic Resources, Vol. 16, No. 2, 114-116, 2003.

[43] P.S. Jothish, M. Ajeesh, J. Rahul and C. Anilkumar, A Report on Flower Colour Variation in *Baccaurea courtallensis*, The India Forester, Vol. 145, No. 3, 295-296, 2019.

[44] K.P. Aiswarya, N. Sruthi Unnikrishnan, S. Mahesh and Laija Nair, Phytochemical analysis of leaf, bark and fruit extracts of *Baccaurea courtallensis* Muell. Arg., Journal of Pharmacognosy and Phytochemistry Vol. 5, No. 3, 196, 2016.

[45] M. Ayyanar and S. Ignacimuthu, Ethnobotanical survey of medicinal plants commonly used by Kani tribals in Tirunelveli hills of Western Ghats, India, Journal of Ethnopharmacology Vol. 134, 851–864, 2011.

[46] V.V. Divya, N. Karthick and Umamaheswari, Ethnopharmacological studies on the medicinal plants used by Kani tribes of Thachamalai hill, Kanyakumari, Tamil Nadu, India, International Journal of Advanced Biological Research, Vol. 3, No. 3, 384-393, 2013.

[47] Celin Pappa, J. Rani and S. Jeeva, Ethnomedicinal Plants Used For Gastro-Intestinal Ailments by Kani Tribes of Kanyakumari Wildlife Sanctuary in Tamilnadu, India, International Journal of Current Advanced Research Vol. 6, No. 12, 7995-8000, 2017.

[48] A. J. D. Britto and R. Mahesh, Evolutionary medicine of Kani tribal's botanical knowledge in Agasthiayamalai Biosphere Reserve, South India, Ethnobotanical Leaflets Vol. 11, 280-290, 2007.

[49] G. Devi Prasad, T.B. Shyma and Raghavendra, Plants used by the tribes for the treatment of digestive system disorders in Wayanad district, Kerala, Journal of Applied Pharmaceutical Science, Vol. 3, No. 8, 171-175, 2013.

[50] M.K. Ratheesh Narayanan, N. Anilkumar, V. Balakrishnan, M. Sivadasan, H. Ahmed Alfarhan and A.A. Alatar, Wild edible plants used by the Kattunaikka, Paniya and Kuruma tribes of Wayanad District, Kerala, India. Journal of Medicinal Plants Research, Vol. 5, No. 15, 3520-3529, 2011.

[51] T.P. Ajesh, A. A. Naseef and R. Kumuthakalavalli, Ethnobotanical documentation of wild edible fruits used by Muthuvan tribes of Idukki, Kerala, India, International Journal of Pharma and Bio Sciences, Vol. 3, No. 3, 479 – 487, 2012.

[52] V.V. Chaithanya, N. Sugiya, and K.S, Aneesh, Wild edible plants traditionally used by Kadar tribes of Vazhachal Forest Division, Thrissur, Kerala, Journal of Global Sciences Vol. 4, No. 9, 3344-3349, 2015.

[53] A. Nazarudeen, Nutritional composition of some lesser known fruits used by the ethnic communities and local folks of Kerala, Indian Journal of Traditional knowledge 9(2): 398-402, 2010.

[54] M. A. Jasim, S. R. Suja, S. Anusha and R. N. Rakesh, Analysis of anti-oxidant and anti-inflammatory potential of *Baccaurea courtallensis* (Wight) Mull. Arg., Journal of Pharmacognosy and Phytochemistry Vol. 8, No. 3, 3994-4000, 2019.

[55] Blessy Sharon and K. Surekha, Phytochemical Screening of Primary and Secondary Metabolites of Leaf and Root Extracts of *Baccaurea courtallensis* (Wight) Muell.-Arg., an Evergreen Tree, International Journal of Scientific Research and Reviews, Vol. 8, No. 1, 884 – 885, 2019.

[56] P.V. Jose, M. Jiby John, N. K. Sajeshkumar and G. Esther Elsa, Phytochemical analysis of fruit extracts of *Baccaurea courtallensis* and evaluation of cholesterol lowering

property, GRIN Verlag, Munich, 1-25, 2017.

[57] R.U. Abhishek, R. Ashwin and T.P. Mahesh, Phytochemical analysis and antibacterial efficacy of fruit rind of *Baccaurea courtallensis* Muell. Arg., Medicinal Plants - International Journal of Phytomedicines and Related Industries, Vo. 3, No. 4, 327-330, 2011.

[58] Blessy Sharon and K. Surekha, Antioxidant activity of leaf and root extracts of *Baccaurea courtallensis* (Wight) Muell.-Arg., Euphorbiaceae, International Journal of Scientific Research and Reviews, Vol. 8, No. 5, 112-121, 2019.

[59] A. G. Sreelakshmi, N. Thomas, B. Carla and C. Sunil, Antihyperlipidemic and Antibacterial Activities of *Baccaurea Courtallensis* Leaves, Journal of Pharmacy Research, Vol. 1, No. 3, 000116, 2017.

[60] M. L. Sujatha, C. N. Yadav, S. H. Jain, S. Mohan and T.R. Kekuda, Investigation on phytochemical screening and antibacterial potential of methanol extract of *Baccaurea courtallensis* Muell. Arg and *Prosopis juliflora* DC. Biotechnology an Indian Journal Vol. 3, No. 3, 161-164, 2009.

[61] G. Sharmila, V.S. Nikitha, S. Ilaiyarasi, K. Dhivya, V. Rajasekar, N. M. Kumar, K. Muthukumaran and C. Muthukumaran, Ultrasound-assisted extraction of total phenolics from *Cassia auriculata* leaves and evaluation of its antioxidant activities., Industrial Crops and Products 84, 13-21, 2016.

[62] H. Walter Horl, Nonsteroidal Anti-Inflammatory Drugs and the Kidney, Pharmaceuticals (Basel), Vol. 3, No. 7, 2291–2321, 2010.