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Baccaurea courtallensis (*Phyllanthaceae*): A Potential Underutilized Tree from Westernghats

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Review Article

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ABSTRACT

Baccaurea courtallensis (*Phyllanthaceae*), a medium-sized tree, is endemic to South Western Ghats. All the plant parts of *B. courtallensis* are documented to possess varied medicinal properties and used to treat diseases by folk medicine practitioners. In the recent years, this plant has been investigated scientifically for supporting its traditional claims. Biological activities like anti-bacterial, anti-fungal, antioxidant, anti-hyperlipidemic and anti-inflammatory are also been reported in *B. courtallensis*. The fruit of the plant is under-utilized, but are highly nutritional. The present review is an attempt to compile the scientific information on botanical characteristics, ethnobotany, phytochemistry and pharmacological activities of *B. courtallensis* and to assess its bioprospection.

INTRODUCTION

Baccaurea courtallensis (Phyllanthaceae) is a medium-sized tree, is endemic to South Western Ghats. Ahmedullah and Nayar (1986) included the plant in their book, Endemic plants of the Indian region Vol-I. International Union for Conservation of Nature and Natural recourses (IUCN) has listed this as a threatened species in its Red Data Book, and the tree requires special conservation measures [1]. It is usually seen in evergreen and semi-evergreen forests in Western Ghats from South Canara southwards and adjoining western parts of Tamil Nadu up to 914 m and also reported in Sri Lanka [2]. In Kerala, the tree is found in all districts except Alappuzha. It is christened variously as Kolikukke (Kannada), Mootalpazham, Mootikaippan, Moottithuri (Malalyalam), Maraootipazham (Tamil).

As for the etymology, generic name *Baccaurea* is a latine derived "*bacca-aurea*" referring to the golden yellow colour of the fruits, and the specific epithet courtallensis is a geographic indication to its type locality Courtallum in Thirunelveli district, Tamil Nadu by Wight in 1836 (Royal Botanic Garden Edinburgh-Herbarium). The fruits of the plant are edible [3]. The leaves, fruits, seeds and stem bark of *B. courtallensis* are documented to possess varied medicinal properties and are used to treat diseases by folk medicine practitioners. The plant is also used in the treatment of diarrhea, diabetes,

dysentery, and mouth cancer [4]. 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 out of which *B. courtallensis* and B. sapida are the only plants reported from India [5]. B. sapida is native to the Southeast Asia region 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 [6]. The majority of other Bacacurea species belong to the Malayan region [7].

Scientific validation of phytochemicals and biological activities of different parts of *B. courtallensis* was rarely evaluated and summarized. However recent studies focus more on pharmacological activities and reported significant biological properties. In this context, ethnomedicine gain a status equal to modern medicine and amalgamation of both has been recommended by World Health Organization [8]. It is therefore necessary to assess the relationship between claims on traditional medicinal uses with its phytochemical constituents and biological activity. The present review is an attempt to gather various studies on B.courtallensis with respect to taxonomy, traditional medicinal uses, phytochemistry and pharmacological activities. This may count on the possible area of research and development of new drugs.

LITERATURE REVIEW

Taxonomy

Baccaurea courtallensis (Wight) Mull. Arg. is validly published by Müller Argoviensis in Prodromus Systematis Naturalis Regni Vegetabilis (1866) with earlier author Wight in the parenthesis. It was earlier included under *Euphorbiaceae* according to the Bentham and Hooker classification (1862-1883). Pierardia courtallensis Wight, *P.* macrostachya Hook f. and *Baccaurea macrostachya* Wight and Arn. Are the synonyms [9]. The earliest report of *B. courtallensis* in an Indian flora is in the Flora of British India by Hooker. He noted it as an abundant species in all moist forests of the Western Ghats from Canara to South Travancore. Rao included it in the Flowering plants of Travancore mentioning its uses as edible and referring to its fruit acid. Gamble in his Flora of Presidency of Madras included *B. courtallensis* mentioning its distribution. The species could be seen in several other floras published after Gamble including, The genus *Baccaurea Euphorbiaceae*, The Flora of Kerala, Flora of Western Ghats, Flora of Cannanore, Flora of Palghat District, Flowering plants of Thrissur Forests, Flora of Calicut, Flora of Quilon District, Flora of Kasaragod Division, Cannanore District , Flora of Pathanamthitta District, Flora of Thiruvanathapuram District (Mohanan and Henry, Flora of Periyar Tiger Reserve, Flora of Thenmala Division, Flora of Nilambur, Floristic Studies of Agasthyamala, Floristic studies in Aralam Wildlife Sanctuary and Floristic Studies in Parambikulam Wildlife Sanctuary [10-12]. The species is included in checklists of Endemic plants of Waynad district, Endemic trees of Peppara wildlife sanctuary, Flowering plants of Kerala and Tree Species Conserved in the Thiruvananthapuram Napier Museum and Zoological Park Garden. Ayyanar and Ignacimuthu 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. in 2016 documented that the tree is at low risk category for conservation. Yogeesha et al. Mentioned the plant as under-utilized fruit species of Western Ghats [13].

Baccaurea courtallensis is a monoecious tree of 7-18 m tall with grayish bark. Flowers are crimson red and are born on the main trunk of the tree. 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 has describes the possibility of less regeneration of *B. courtallensis* dues 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 [14]. The fleshy aril around the seed is consumed as raw. Joseph et al. 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. reported variation in flower colour in *B. courtallensis*.

Botanical description

Trees 15-18 m tall; bark greyish; branchlets rough. Leaves 10-18 x 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 are unisexual, crimson red, in densely clustered slender racemes forming rings around on tree trunk. Male flowers; bracts, 1.40-1.49 mm long, lanceolate, linear-lanceolate or triangular, free, conduplicate, encircling the base of lateral branches; tepals 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 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 [15]. Capsule 1.2-4.5 x 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.

Ethnobotany

Baccaurea courtallensis is an underutilized forest tree species used as medicine by folk practioners. The plant is commonly used to treat diarrhoea, dysentery and skin infections. 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. Fruit of B.courtallensis is used by Kani tribes of Kalakad Mundanthurai Tiger Reserve to induce fertility in men and women [16-18]. Kani healers of Thirunelveli Hills use the plant in herbal preparations. Kani tribes of Thachamali Hills of Kanyakumari District consume the fruit to cure mouth and stomach ulcers. Kani tribes inhabiting in areas of Kanyakumari wildlife sanctuary consume the raw fruit of *B. courtallensis* to cure constipation.The pericarp of tender fruit is consumed as antipyretics by the Kani Tribes of Agasthyamalai Hills. 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 grind together are taken internally as antidote. Paniya tribes of Wayanad District, Kani tribes of Agasthiayamalai Biosphere Reserve, Muthuvan Tribes of Idukki District, Kadar Tribes of Vazhachal forest division, Thrissur district and folks belonging to Malampandarangal tribal group consume the fruit, and the rind is pickled [19,20].

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 [21]. *B Courtallensis* has been documented by Nazarudeen 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 (102.43 mg/100 gm), sodium (1.01 mg/100 gm) and iron (1.56 mg/100 gm) 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. 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/100 gm ascorbic acid, 16.50 mg/100 gm flavanoid, 34.40 mg/100 gm tannin, 390 mg/100 gm phenol and 1.54 gm/100 gm 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 [22].

Phytochemical profile

A majority of the ascribed biological effects of *B.courtallensis* extracts have been attributed to their primary and secondary metabolite composition [23]. 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. 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 and tannins. The methanol and benzene extracts of the fruit rind showed the presence of steroids, coumarins, tannins, flavonoids, phenols, quinones, and volatile oils. 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 (83.5 mg/g), terpenoids (530.6 mg/g) and phenols (7.4 mg/g) [24]. Root extract showed the presence of alkaloids, flavonoids, carbohydrates, saponins, proteins, amino acids, steroids, phenols, tannins, glycosides, coumarins, gums and mucilages. 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+0.35˚ at 589 nm wavelength. Total Phenolic and flavonoid content in leaves of *B.courtallensis* extract was found to be 131 mg GAE/g and 72.2 mg Rutin Equivalent/g respectively (Table 1) [25-29].

RESULTS AND DISCUSSION

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 [30].

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 value of leaves extract against *S. aureus*, *B. subtilis, E. coli* and *P. Aeruginosa* were found to be 2.36 µg/ml, 1.6 µg/ml, 4.68 µg/ml and 37.5 µg/ml respectively and are comparable with that of the standard drug Amoxicillin [31-36]. 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 60 µg/ml against *E. coli* and 70 µg/ml against *S. aureus*, 70 µg/ml and 80 µg/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 [37]. 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 (50 mg/ml) against *Aspergillus niger* and *Aspergillus oryzae* showed zone of inhibition of 2.1 cm [38-40].

Antihyperlipidemic activity

Sreelakshmi et al. examined the anti-hyperlipidemic effect of methanolic fraction of *B. courtallensis* leaf in wistar rats 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 [41].

Antioxidant activity

Jasim et al. have studied antioxidant property of ethanolic leaf extracts of *B. courtallensis* using the DPPH method and total antioxidant capacity by the Phosphomolybdenum method [42-46]. Different concentrations of the leaf extract, ie 20 µg/ml, 25 µg/ml, 40 µg/ml, 50 µg/ml, 60 µg/ml, 80 µg/ml, 100 µg/ml, 150 µg/m and 200 µg/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 43.60 µg/ml. The total antioxidant activity of the extract at 200 µg/ml dosage was found to be equivalent to the activity exhibited by 238 µg/ml of ascorbic acid. Maharani et al. reported that the ethanol extract of *B. courtallensis* leaves performed a concentration-dependent free radical scavenging activity against DPPH with an IC50 value of 24.41 µg/ml and ascorbic acid with IC50 value 14.19 µg/ml [47-50].

Blessy and Surekha have documented the antioxidant activity of crude aqueous extract of leaf and root of *B. courtallensis* by five *in-vitro* radical scavenging assay: DPPH, Nitric oxide, ABTS, FRAP and Hydroxyl radical scavenging activity. The results showed statistically significant difference for DPPH and FRAP. The DPPF free radical scavenging activity of leaf and root extract with IC50 value 1.5 µg/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. In this context leaf and root of *B.courtallensis* can act as a natural antioxidant [51-55].

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 [56]. 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 (Table 1). Non steroid anti- inflammatory drugs causes adverse effect to kidney function. Hence leaves of *B. courtallensis* can be used as potent anti-inflammatory drug [57-61].

Table 1. Phytochemical analysis of different parts of B.courtallensis.

Part Used	Extraction solvent	Primary metabolite	Reference
Leaf		Alkaloids, Flavanoids, Phenols, Saponins, Tannins, Carbohydrates, Anthraquinones, Coumarins, Glycosides, Steroids	Jasim et al. (2019)
	Methanol	Saponins (61 mg/g) Tannins (20 mg/g) Phenolic compounds (16.6 mg/g)	Aiswarya et al. (2016)
	Hexane	Tannins (19.4 mg/g) Saponins (37.5 mg/g) Terpenoids (506.6 mg/g) Phenolic compounds (5.6 mg/g)	

	Ethanol	Glycosides, Carbohydrate, Alkaloids, Phenols, Phytosterols, Proteins, Flavonoids, Saponins, Tannins	Maharani and Anna (2019)
Fruit	Water	Alkaloids, Flavonoids, Terpenoids, Saponins, Phlobatannins, Coumarins, Anthocyanins, Leucoanthocyanins, Phenols, Carbohydrates.	Jose et al. (2017)
Rind	Methanol	Tannins, Falavonoids, Phenols, Volatile Oil, Quinones	Abhishek et al. (2011)
	Benzene	Steroids, Coumarins, Volatile oil	
	Methanol	Tannins (4.6 mg/g) Phenolic compounds	Aiswarya et al. (2016)
	Hexane	Saponins (54 mg/g) Terpenoids (620.6 mg/g)	
	Nil	Phenols (237 mg/100 gm) Flavonoids (93 mg/100 gm)	Yogesh et al. (2016)
Bark	Methanol	Tannins, Saponins, Terpenoids, Flavonoids	Sujatha et al. (2009)
	Petroleum ether	Steroids , Tannins	Sujatha et al. (2009)
	Chloroform	Tannins, Flavonoids	
	Ethyl acetate	Steroids, Tannins, Flavonoids	
	Methanol	Saponins (83.5 mg/g) Terpenoids (530.6 mg/g)	Aiswarya et al. (2016)
	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%)	Mohan (2009)

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 to 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.

CONCLUSION

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 profusely during the fruiting season, it is possible to make value added products like wine, pickles, and dry fruits from the fruit.

REFERENCES

1. Ahmedullah M, et al. (1986) Endemic plants of the Indian region. Calcutta, botanical survey of India, India. 2:173.
2. Anil KN, et al. (1994) Floristic study of Pathanamthitta District, Kerala, PhD. Thesis. Calicut University, Kerala, India. 589.
3. Aiswarya KP, et al. Phytochemical analysis of leaf, bark and fruit extracts of *Baccaurea courtallensis* Muell. Arg. J Pharmacogn Phytochem. 2016;5:196.
4. Ajesh TP, et al. Ethnobotanical documentation of wild edible fruits used by Muthuvan tribes of Idukki, Kerala, India. Int J Pharma Bio Sci. 2012; 3:479–487.
5. Awang K, et al. Diversity, distribution, and conservation of *Baccaurea* species in the home gardens and orchards in Malaysia. Malayan Nat J. 2018;70:333-339.
6. Ayyanar M, et al. Diversity, conservation status and medicinal plants of the family *Euphorbiaceae* in

Tirunelveli hills, Southern India. J Exp Sci. 2010;1:12-16.
7. Ayyanar M, et al. Ethnobotanical survey of medicinal plants commonly used by Kani tribals in Tirunelveli hills of Western Ghats, India. J Ethnopharmacol. 2011; 134:851–864.
8. Binu S, et al. Wild edible plants used by the tribals in Pathanamthitta district, Kerala, Indian. J Tradit knowl. 2009;9:309–312.
9. Blessy Sharon B, et al. Phytochemical screening of primary and secondary metabolites of leaf and root Extracts of *Baccaurea courtallensis* (Wight) Muell.-Arg., an Evergreen Tree. IJSRR. 2019;8:884–885.
10. Blessy Sharon B, et al. Antioxidant activity of leaf and root extracts of *Baccaurea courtallensis* (Wight) Muell.-Arg, *Euphorbiaceae*. Int J Sci Res Rev. 2019;8:112-121.
11. Britto AJD, et al. Evolutionary medicine of Kani tribal's botanical knowledge in Agasthiayamalai biosphere reserve, South India. Ethnobot leafl. 2007;11:280-290.
12. Celin Pappa Rani J, et al. Ethnomedicinal plants used for gastro-intestinal ailments by Kani Tribes of Kanyakumari wildlife sanctuary in Tamilnadu, India. Int J Curr Adv Res. 2017;6:7995-8000.
13. Chaithanya VV, et al. Wild edible plants traditionally used by Kadar tribes of Vazhachal Forest Division, Thrissur, Kerala. J Glob Sci. 2015;4:3344-3349.
14. Chakrabarty T, et al. The genus *Baccaurea (Euphorbiaceae)* in the Indian subcontinent. J Econ Taxon Bot. 1997;21: 525–534.
15. Charu TK, et al. Traditional and Pharmacological Reports of the Genus *Baccaurea* a Review. Am J Biomed Sci. 2021;11:494-508.
16. Daniel P, et al. (2005) The Flora of Kerala. Botanical Survey of India, India. 1:96.
17. Devi Prasad AG, et al. Plants used by the tribes for the treatment of digestive system disorders in Wayanad district, Kerala. J Appl Pharm Sci. 2013;3:171-175.
18. Divya VV, et al. Ethnopharmacological studies on the medicinal plants used by Kani tribes of Thachamalai hill, Kanyakumari, Tamil Nadu, India. Int J Adv Biol. 2013;3:384-393.
19. Gamble JS, et al. (1936) Flora of the Presidency of Madras. Adlard and Son, London. 2:916.
20. Goyal AK, et al. Antioxidant profiling of Latkan (*Baccaurea ramiflora Lour.*) wine. Indian J Biotechnol. 2013;12:137–139.
21. *Hooker JD, et al. The Flora of British India. London. 1887;5:367-368*.
22. Jasim MA, et al. Analysis of anti-oxidant and anti-inflammatory potential of *Baccaurea courtallensis* (Wight) Mull. Arg. J Pharmacogn Phytochem. 2019;8:3994-4000.
23. Joseph JK, et al. A Note on *Baccaurea courtallensis* (Muell.) Arg., (Moottipotti) A wild edible fruit of Western Ghats. Indian J Genet Plant Res. 2003;16:114-116.
24. Jothish PS, et al. A Report on flower colour variation in *Baccaurea courtallensis*. Indian For. 2019;145:295-296.
25. Khadijah A, et al. (2014) Cultivation method of *rambai* family BuletinTeknilogi MARDI. 5:45-49.
26. Maharani R, et al. Preliminary Phytochemical Analysis and *In vitro* Antioxidant Activity of *Baccaurea courtallensis*. Res J Pharm Technol. 2019;12:4397-4399.
27. Manilal KS, et al. (1982) Flora of Calicut. Bishen Sigh Mahendra Pal Sigh, Dehra Dun. 260.
28. Maroyi A, et al. Ethnopharmacological uses phytochemistry and pharmacological properties of croton macrostachyus Hochst Ex Delile: a comprehensive review. Evid based Complement Alter Med. 2017;20: 1-17.
29. Mohanan M, et al. (1994) Flora of Thiruvananthapuram. Botanical Survey of India, Kerala. 407.
30. Mohanan CN, et al. (1984) Studies on the flora of Quilon District, Kerala PhD. Thesis, Madras University, Madras. 358.
31. Mohanan N, et al. (2002) Flora of Agasthyamala. Western Ghats. Bishen Singh Mahendra Pal Singh, Dehra Dun. 599.
32. Müller Argoviensis, et al. (1886) Prodromus Systematis Naturalis Regni Vegetabilis (Prodr.). 15:459.
33. Namitha LH, et al. Tree species conserved in the Thiruvananthapuram Napier Museum and Zoological park garden. Plant Arch. 2019;19:4553-4558.
34. Nair NC, et al. The floristic diversity of the Western Ghats and its conservation: A review. Proc Indian Acad Sci Suppl. 1986;127-163.
35. Nayar TS, et al. (2006) Flowering plants of Kerala. Trivandrum, Tropical Botanic Garden and Research Institute, India. 235.
36. Nazarudeen A, et al. Nutritional composition of some lesser known fruits used by the ethnic communities and local folks of Kerala. Indian J Tradit knowl. 2010;9:398-402.
37. POWO, et al. (2021) "Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew.
38. Jose PV, et al. Phytochemical analysis of fruit extracts of *Baccaurea courtallensis* and evaluation of cholesterol lowering property. GRIN Verlag, Munich. 2017;1-25.

39. Rama Rao M, et al. (1914) Flowering plants of Travancore. Trivandrum, Government press Trivandrum, India. 363.
40. Remesh M, et al. Ethnobotanical aspects of trees of Palakkad District, Kerala, India. Devagiri J Sci. 2016;2:32-51.
41. Raoul Martin APH, et al. (2000) Taxonomy, Phylogeny and Biogeography of *Baccaurea*, *Distichirhops* and *Nothobaccaurea (Euophorbiaceae)*. National Herbarium Nederland, Universiteit Leiden branch. 106-107.
42. Ratheesh Narayanan MK, et al. Wild edible plants used by the Kattunaikka, Paniya and Kuruma tribes of Wayanad District, Kerala, India. J Med Plant Res. 2011;5:3520-3529.
43. Sivarajan VV, et al. (1997) Flora of Nilambur. Dehra Dun, Bishen Singh Mahendra Pal Singh, Uttarakhand. 606.
44. Sasidharan N, et al. (1996) Flowering plants of Thrissur forests. Western Ghats, Kerala, India, Jodhpur. 393.
45. Sasidharan N, et al. (1998) Studies on the flora of periyar tiger reserve. KFRI Research, 150. Kerala Forest Research Institute, Peechi. 365.
46. Sasidharan N, et al. (2002) Floristic Studies in Parambikulam Wildlife Sanctuary. KFRI Research, 246. Kerala Forest Research Institute, Peechi. 282.
47. Sasidharan N, et al. (2013) Floristic studies in Aralam Wildlife Sanctuary. KFRI Research, 467. Kerala Forest Research Institute, Peechi. 365.
48. Sharmila G, et al. Ultrasound-assisted extraction of total phenolics from *Cassia auriculata* leaves and evaluation of its antioxidant activities. Industrial Crops and Products. 2016;84:13-21.
49. Sreelakshmi AG, et al. Antihyperlipidemic and Antibacterial Activities of *Baccaurea Courtallensis* Leaves. J Pharm Res. 2017;1:000116.
50. Sreelakshmi S, et al. An overview of phytochemical and Pharmacological potential of *Baccaurea* Species. J CR. 20207:2354-2362.
51. Subramaniyan KN. (1995) Flora of Thenmala Division. International Book Distributors, Dehra Dun. 339.
52. Srinivasa Mohan, et al. Fatty Acid Composition of *Baccaurea courtallensis* Muell. Arg Seed Oil: an Endemic Species of Western Ghats India. J Am Oil Chem Soc. 2009;86: 1017-1019.
53. Sujatha ML, et al. Investigation on phytochemical screening and antibacterial potential of methanol extract of Baccaurea *courtallensis* Muell. Arg and Prosopis juliflora DC. Biotech Ind J. 2009;3:161-164.
54. Sujatha ML, et al. Successive solvent extraction and phytochemical profile of *Baccaurea courtallensis* Muell. *Arg* and *Prosopis juliflora* DC. Nat Prod Ind J. 2009 5:81-84.
55. Vajravelu E, et al. Flora of Palghat District, includes Silent Valley National Park, Kerala. Indian J Biotechnol. 1990;421.
56. Vardhana R, et al. (2006) Floristic Plants of the World, Sarup and Sons. 101.
57. Varghese AO, et al. Ecological niches and amplitudes of rare, threatened and endemic trees of Peppara Wildlife Sanctuary. Curr Sci. 1999;76:1204-1208.
58. Ramachandra VS, et al. (1988) Flora of Cannanore. Calcutta, Botanical Survey of India, India. 3:409.
59. Volga VR, et al. Endemic Trees of Western Ghats–A Check list from Wayanad District, Kerala, India. Int J Plant Animal Env Sci. 2013;3:197-202.
60. Walter H Horl, et al. Nonsteroidal Anti-Inflammatory Drugs and the Kidney. Pharmace (Basel). 2010;3:2291–2321.
61. Yogeesha HS, et al. Fruit/Seed Morphology, seed drying and germination studies in *Baccaurea courtallensis* (Muell.) *Arg.*, a Threatened under-utilized fruit species of Western Ghats in India. J Hortic Sci. 2016;11:76-79.