IJPSR (2024), Volume 15, Issue 6 **(Review Article)**

INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH

Received on 31 October 2023; received in revised form, 09 January 2024; accepted, 05 April 2024; published 01 June 2024

MYRICA ESCULENTA: A COMPREHENSIVE REVIEW ON PLANT PROFILE, PHYTOCHEMISTRY, ETHNOBOTANICAL AND PHARMACOLOGICAL USES

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Keywords:

Bayberry, *Myrica esculenta*, Ethnobotanical, Phytoconstituents, traditional

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ABSTRACT: Medicinal plants usage has been continued since olden times for treatment of illness and various diseases internationally. They contain substances which have therapeutics activities and further study of these substances has led to discovery of new drugs. In present days, the medicinal plants play a significant role in the development of plant-based medicines. *Myrica esculenta* is a plant which belongs to family myricaceae and is found in foothill tracks of Eastern Himalayas, Meghalaya, Nepal, China and Pakistan. *Myrica esculenta* are rich in flavonoids, tannins, steroids, terpenes. Various parts of this plant are used in Ayurveda and other folk medicines for the treatment of different ailments and skin diseases and pharmacologically used as anti-bacterial, anti-inflammatory, anti-diabetic, anthelmintic, antioxidants, antipyretics, and wound healing. Research carried out using different *in-vitro* and *in-vivo* techniques of biological evaluation support most of these claims. This review presents the botany, chemistry, traditional uses and pharmacology of this medicinal plant.

INTRODUCTION: The medical sector is pushing the use of plant products due to the fact that they have few side effects, are completely in tune with one's natural self, and have a wide range of therapeutic applications. According to various research, the majority of people worldwide rely on plant extracts for their medical needs. According to WHO, some 21,000 plant species have the potential to be employed as medicines [1]. *Myrica esculenta* is a big shrub or a tree that belongs to the family Myricaceae. Other common names for it include box myrtle, bayberry, and kaphal.

QUICK RESPONSE CODE

DOI: 10.13040/IJPSR.0975-8232.15(6).1572-80

This article can be accessed online on www.ijpsr.com

DOI link: https://doi.org/10.13040/IJPSR.0975-8232.15(6).1572-80

It is indigenous to the eastern Himalayan region, the hills of northern India, including the states of Meghalaya and Arunachal Pradesh and southern Bhutan and Nepal [2]. *M. esculenta* is a medicinal plant that is economical and has a variety of uses [3]. *M. esculenta* is famous for its edible fruit and other by-products. Indeed, its fruits have the potential to be a source of revenue for the indigenous communities of Meghalaya and the sub-Himalayan region.

In both traditional medicine and ethnomedicine, the herb is used in a variety of ways. The *M. esculenta* plant has enormous medicinal and nutritional value in all of its components. Fruits can be eaten, and the indigenous tribes use them to prepare pickles, syrups, jams, and drinks [4]. Its leaves, roots, and bark have historically been used to cure a variety of diseases and conditions, including cough, asthma,

fever, chronic bronchitis, diarrhoea, rheumatism, inflammation, earache, paralysis, and more [5]. In addition to its traditional applications, bark is also used in preparation of paper and ropes [6]. Furthermore, *M. esculenta* fruits and roots are an active botanical component in a variety of ayurvedic preparations. The plant includes a number of bioactive phytoconstituents, including volatile oils, phenolic compounds, alkaloids, glycosides, and triterpenoids [7].

The herb has additionally demonstrated important pharmacological properties in numerous animal models, including analgesic, anxiolytic, antiallergic, antidiabetic, antimicrobial, antihypertensive, antiulcer, antioxidant, and anti-inflammatory effects [8]. Indigenous peoples utilise trees for building materials, firewood, food, wood, tanning, and the production of yellow dye [9]. Despite being a beneficial tree, *M. esculenta* is not easily grown, and the majority of its traditional and commercial applications rely completely on collections made by indigenous people from the plant's wild sources [10]. Thus, due to increased urbanization, overharvesting, disregard for sustainable usage, and over-exploitation of forests and wastelands for industrial purposes, the species faces an impending threat of extinction from wild sources. Due to extensive anthropogenic activity, natural habitats are unable to regenerate this plant and therefore affect the natural population of this plant species [11].

Myrica esculenta is a significant medicinal plant with a long history and a promising future in modern medical science. To fully understand the plant's potential and advantages for human health and wellbeing, more study and focus should be given to it. In order to recognize the medicinal properties of this plant in the contemporary medical system, the present review article aims to summarize the ethnomedical uses, phytochemistry, and therapeutic potential of *M. esculenta* for its future prospects, such as conservation, cultivation, and sustainable use.

Distribution: According to reports, *Myrica esculenta* is found extensively around the world in both temperate and subtropical climates [12]. In addition to southern Bhutan and Nepal, it is widely distributed in the hills of northern India, the eastern Himalayan states like Arunachal Pradesh, Assam, and Meghalaya, as well as the northern hills of northern India. It is acknowledged to be widely dispersed throughout the entire Indo-Malesian region [13]. It can also be found outside of India in places like Nepal, China, Japan, Pakistan, Singapore, and the Malayan Islands [14]. In Australia, there is only one species known as *Myrica australiasica* F. Muell [15]. Other Myrica species, such as *M. rubra*, also known as the Chinese bayberry, are found in China and Japan only [16]. Other species of the Myrica genus include *M. adenophora* hance, *M. caroliniesis* (evergreen bayberry), *M. cordifolia* (waxberry/candle berry), *M. californica* (Californian bayberry), *M. dentulata* Baill., *M. heterophylla* Raf. (swamp bayberry), and *M. inodora*. *M. integra* (A. chev.) Killick, *M. nana* A. Chev., *M. quercifolia* L.[17], *M. faya* Ait., *M. gale* L. (bog-myrtle/sweet gale), and *M. hartwegi* S. Watson (Sierra babyberry/mountain wax myrtle) are examples of plants that belong to this genus [18]. *M. esculenta* is a plant that originated in India and is typically found in countries such as Nepal, China, Vietnam, Sri Lanka, Sylhet (Bangladesh), Pakistan, Japan, Asian nation islands, the Himalayas, and the hills of Burma [19].

Taxonomy:

Taxonomical Classification:

TABLE 1: TAXONOMICAL CLASSIFICATION OF *MYRICA ESCULENTA*

Common names [21, 22]	
English	Box myrtle, Bayberry,
Assami	*Ajooree*, *Nagatenga*, *Vdulbark*,
Bengali	*Kayachhal*, *Kaiphal*, *Satsarila*,
Gujrati	*Kariphal*,
Hindi	Kapha, Kaiphal,
Sanskrit	Kathphala, Aranya, Krishnagarba, Mahavalkala
Nepali	*Kobuli*, *Katphala*,
Kannada	*Kandujai kai*, *Kirishivani*, *Kirishivane*,
Punjabi	*Kaiphal*, *Kahela*, *Kahi*,

Botanical Description: The tree produces drupaceous fruit, one of the best wild fruits in the sub-Himalayan region. It is a 12 to 15 m tall, medium to large, strong, evergreen, dioecious tree with a 92.5 cm trunk diameter and light brown to black bark. The male and female trees seem practically identical to one another. The inner bark is dark brown in colour with a smooth surface, extremely hard, bitter in taste, and unpleasant in

odour [23]. The outside bark is greyish dark in colour, rough, and vertically wrinkled. The majority of the leaves are clustered toward the ends of branches and are lanceolate with an entire or serrated border, pale green on the underside, and dark green on the upper side [24]. Pistillate flowers are small in size, sessile, isolated, and bracteate; calyx and petals are either missing or not visible; inflorescence (catkin), 4.2 cm long, axillary, holding approximately 25 flowers in a thread-like style. Around 12 stamens, each with a short filament, are present on each staminate sprout. The seed weight about 165 mg and is about 9 mm in length and 5 mm wide [25].

While the fruiting season began in the first week of May and lasts until the end of May, the flowering season begins in February and lasts until the second week of April, with the first week of March marking its peak [26]. The tree produces drupe fruits that range in color from red to dark brown, are ellipsoidal or oval in shape, and measure approximately 2 to 7 millimeters in diameter Fig. 1D. These fruits have a sweet and sour flavor and contain ovoid-shaped, smooth-surfaced, light-brown seeds that are roughly 1-6 millimeters in diameter and have a viscous taste [27].

Ethnomedicinal uses: The majority of people who lived in rural Uttarakhand utilized stem bark to treat persistent coughs, asthma, and ulcers, and they inhaled bark powder to relieve headaches [28]. Locals in the Sub-Himalayan region utilize bark decoction to treat toothaches and freshen the breath [29] while bark paste is used to treat bruises, joint problems, paralysis, colds, and headaches [30]. Different ethnic communities in the rural area of Orissa also use bark to cure mental disease [31]. Fruit juice is utilized by Meghalaya tribal people to treat bacterial diarrhoea, and it is either consumed raw or used to make cool drinks [32]. Local tribes of Uttaranchal used the paste of leaves as an exterior treatment to cure headache [33].

Ayurvedic Formulations: *Myricaesculenta* are used to prepare different types of Ayurvedic formulations which are beneficial for treatments of various ailments. The different types of Ayurvedic preparations are shown in **Table 2.**

TABLE 2: DIFFERENT TYPES OF AYURVEDIC PREPARATIONS OF *MYRICA ESCULENTA*

Formulation	Uses	References
Chwayanprash"	Enhance digestion, memory, intelligence, concentration and physical strength	34, 35
"KatphaladiChurna"	Treatment of fever, throat infection, respiratory disorders, and abdominal pain	34, 35
"PushyanugaChurna"	Treatment for bleeding disorders and candidiasis	34, 35
"Katphala Taila"	Treatment of joint pain	34, 35
"Arimedadi Taila"	Helps to relieve tooth decay and breath problem	34, 35
"Mahavisagarbha Taila"	Used for vata imbalance, neuromuscular conditions	34, 35
"Bala Taila"	Treatment of vata disorders, respiratory infections and weakness	34, 35
"KhadiradiGutika"	Treatment of dental, oral, throat and tonsillar infections	34, 35
"Maha Vatagajankusa Rasa"	Rheumatoid arthritis, Migraine, Paralysis, Cough, Cold, Asthma	34, 35
"Brihat Phala Ghrta"	Treatment of infertility	34, 35

Traditional uses:

Fruits: According to some reports, the fruits of *Myrica esculenta*was found to possess sedative, carminative, stomachic, and antiulcer properties [36]. The fruit is also used for tumours in the abdomen, respiratory conditions, fever, piles, erratic bowel movements, anaemia, nausea, oral health issues, cough, and dyspnea. It is also useful for preserving bone fracture and placenta. Fruit wax or oil is used to treat bleeding piles, toothaches, menorrhagia, and other menstrual diseases. Unripe fruit juice is used as an anthelmintic [37].

Bark: According to reports, the bark of *Myrica esculenta* is used as an astringent, stimulant, antibacterial, carminative, and antirheumatic. Additionally, it was suggested that it could help with the management of abdominal tumours, chronic bronchitis, respiratory conditions, fever, piles, ulcer, anaemia, diarrhoea, dysentery, nausea, oral disorders, cough, dyspnea, indigestion, anorexia, and ear, nose, and throat conditions [38].

Bark powder combined with ginger is used as a rubefacient in the treatment of cholera. Bark extract combined with *Quercus lanata* bark is employed for the therapy of dysentery and in the form of a gelatinous mass it can be utilized as a plaster on sprains [39].

Flowers: It has been discovered that floral oil is effective for inflammation, paralysis, earaches, and diarrhea [40].

Nutritional Value: The proximate analysis of *M. esculenta* fruits' mineral contents, including Na, K, Ca, Mg, Fe, Zn, Mn, and Cu, as well as nutrients like natural fiber, amino acids, crude fatty acids, crude dietary fiber, ash value, and moisture content, were assessed [41].

The findings presented in **Table 3** validated the use of fruit for nutritional use and suggested that if ingested in sufficient quantities, adequate protection may be acquired against diseases resulting from malnutrition.

TABLE 3: NUTRITIONAL VALUE OF *MYRICA ESCULENTA*

Parameters	Value
Ash (%)	2.18±0.02
Moisture content (%)	72.33±0.23
Crude fat (%)	4.93±0.06
Crude fibre (%)	5.22±0.08
Crude protein (%)	9.62±0.03
Carbohydrates (%)	78.03±0.14
Energy (Kcal/g)	395.04±0.54
Minerals (mg/g):	
Calcium	4.63±0.06
Magnesium	8.4±0.20
Potassium	7.75±0.11
Phosphorus	0.24±0.25
Sodium	0.81±0.013
Manganese	0.032±0.0001
Zinc	0.216±0.0016
Iron	0.404±0.0021
Copper	0.004±0.0002

Phytochemistry: The different parts of *M. esculenta* such as fruits, leaves, and bark have been the subject of numerous early phytochemical studies, which revealed the existence of a number of active phyto-constituents with a range of physiological and pharmacological effects. This plant is discovered to be a rich source of flavonoids, flavonols, and phenolic chemicals. The **Table 4** lists the other bioactive substances found in the plant, which include alkaloids, glycosides, diarylheptanoids, steroids, saponins, triterpenoids, and volatile chemicals.

TABLE 4: ACTIVE CONSTITUENTS OF *MYRICA ESCULENTA*

Sl. no.	Plant parts	Phytoconstituents	References
1.	Fruits	Gallic acid, Catechin, Cholorogenic acid, p-coumaric acid, caffeic acid, trans-cinnamic acid, ellagic acid.	42
		Amino acids: L-Hydroxyproline, iso-leucine, valine, 2-aminobutyric acid, L-cystein hydroxyl, L-cysteinhydroxychloride, alanine, leucine, tryptophan, glutamic acid, tyrosine, threonine, lysine monochloride	43
		2-Furancarboxyaldehyde, 2,5-furandionedihydro-3-methylene, furfural, oxirane, myo-inositol, 1-ethyl-4-methylcyclohexane, methyl-d-lyxofuranoside	44
2.	Leaves	Ethyl-β-D-glucopyranoside; 3-hydroxybenzaldehyde, isovanillin, 4-(hydroxymethyl) phenol, 4-methoxybenzoic acid	46
		Myricetin, Quercetin, Myricitrin (myricetin 3-O-rhamnoside)	47
		Flavone 4'-hydroxy-3',5,5'-trimethoxy-7-O-β-D-glucopyranosy (1→4)-α-L-rhamnopyranoside; flavone 3',4'-dihydroxy-6-methoxy-7-O-α-L-rhamnopyranoside	
		4-hydroxy-1,8-cineole 4-O-_-dapiofuranosyl (1!6)-_-D-glucopyranoside	48
		β-rosasterol, daucosterol, β-sitosterol-β-D-glucopyranoside	46, 44
		Myricanol, Myricanone, 5-O-β-D-glucopyranosylmyricanol	49, 50, 51
		3-epi-ursolic acid, Arjunolic Acid,	52
3.	Bark	Gallic acid, Castalagin, epigallocatechin-3-O-gallate; epigallocatechin-(4β→8)-epigallocatechin- 3-O-gallate; 3-O-galloylepigallocatechin-(4β→8)-epigallocatechin-3-O-gallate	53, 54
		Myricetin, Myricitrin (myricetin-3-O-(3"-Ogalloyl)-α-L-rhamnoside; myricetin-3-O-	44

		(2"-Ogalloyl)-α-L galactopyranosideside; myrecetin 3-O-(2"-O-galloyl)-α-L-rhamnopyranoside,	
		β–sitosterol, Taraxerol, stigmasterol,	55, 56
		Myricanol, Myricanone 16 bromomyricanol	57, 58
		Lupeol; oleanolic acid; BarkTriterpene diol (3β,28-dihydroxytaraxerane), 3β,30-dihydroxy-taraxerane-23-oic acid; 3β,28,30-trihydroxy- taraxara-23-oic acid; 3β,12α,28,30-tetrahydroxytaraxeran-23-oic acid	48,52,54
		Proanthocyanidin acetate, proanthocyanidin methyl-ether Bark	57, 59
		n-Hexadecanol; eudesmol acetate; n-octadecanol	52
4.	Roots	13-Oxomyricanol	51

Pharmacological Actions:

Analgesic Activity: It has been reported that *M. esculenta* fruit has analgesic properties. Using Eddy's hot plate method, a considerable analgesic action in a dose-dependent manner was seen after oral administration of the fruit methanol extract when paw licking and jumping times were prolonged on a hot plate in comparison to the control group [60]. The acetic acid-induced writhing assay and the tail immersion assay both revealed a considerable analgesic effect from leaf methanol extract [61].

Anti-asthmatic Activity: The ethanol extract of bark was administered by oral route and found to exhibit exceptional anti-asthmatic activity through several mechanisms which include: anti-anaphylactic activity in guinea pigs induced by egg albumin, spasmolytic activity by relaxation of guinea pig smooth muscle in histamine and acetylcholine (Ach)-induced contraction [62], bronchodilator activity by protecting against Ach- and histamine aerosol-induced bronchospasm in guinea pigs [63]. The bark's water extract, however, was discovered to have stronger anti-asthmatic properties than the ethanol extract by significantly preventing histamine aerosol-induced broncho-spasm in guinea pigs and by relaxing histamine-induced tracheal chain contraction [64].

Anticancer Activity: In a methylthiazolyltetrazolium (MTT) experiment, Hep G2, Hela, and MDA-MB-231 cancer cell lines were inhibited by a fruit extract prepared in methanol. The animal investigations of acetone and acid-methanol extracts of *M. esculenta* fruits shown powerful anticancer proliferative effects that led to a 70–92% reduction in the viability of C33A, SiHa, and HeLa cancer cells while demonstrating virtually no cytotoxicity towards regular epithelial cell lines [65]. Because the extract contains bioactive substances including ferulic acid and gallic acid, it has been found that increasing the dose of the extract causes an increase in the inhibition of cancer cell proliferation [66].

Antidiabetic Activity: It was discovered that the methanol extract of leaves possesses anti-diabetic properties. In comparison to streptozotocin-induced diabetic rats, the methanol extract of *M. esculenta* demonstrated considerable hypoglycaemia in a dose-dependent manner. When methanol extract was administered orally, blood sugar, cholesterol, and body weight levels all significantly decreased. The extract-treated group lipid profile has improved in comparison to the vehicle-treated group [67].

Antihelmintic Activity: The evaluation of the ethanol extract of *M. esculenta* bark revealed that it exhibited anthelmintic effect against the Indian earthworm *Pheretima posthuman.* Both paralysis and death of the helminth were demonstrated by the crude extract at insignificant doses. The effectiveness of the extract increases in a dose-related manner [68].

Antihypertensive Activity: Angiotensin I-converting enzyme inhibition research revealed that the phytoconstituents extracted from *M. esculenta* leaves are beneficial in treating hypertension. While myricanol and myricetin had only moderate hypotensive effects, corchoionoside C and roseoside were shown to be the most effective ACE inhibitors [69].

Anti-inflammatory Activity: *M. esculenta* leaf methanol extract has demonstrated its capacity to reduce acute inflammation, and this ability was comparable to that of the group that received diclofenac [70]. When tested on the ears of Swiss albino mice, the essential oil extracted from *M. esculenta* bark demonstrated considerable topical anti-inflammatory activity [71].

Antimicrobial Activity: Gram-positive and Gram-negative bacteria are both effectively inhibited by a volatile oil that was extracted from *M. esculenta* bark [72]. Fruits from *M. esculenta* exhibited antibacterial action against *S. aureus* and *S. epidermis* when extracted with methanol. The presence of dodecanol, phytol, furfurals, and 4-H-pyran-4-one, which have been documented to have antibacterial activity which attribute to the antimicrobial effects [73]. Additionally, methanol, ethanol, and aqueous fruit extracts were said to exhibit strong antifungal activity [74].

Antioxidant Activity: Anti-oxidant properties were discovered in the methanol extract of *M. esculenta* fruits and fruit pulp. Due to the presence of phenols, flavonoids, and flavonols, both extracts demonstrated high antioxidant activity [75].

The *M. esculenta* fruit's acetone extract, which had a significant concentration of phenolic compounds, had the greatest capacity to scavenge DPPH radicals. The aqueous extract of *M. esculenta* bark demonstrated considerable DPPH scavenging action, complex metal ions (Fe2+), and a marked reduction of lipid peroxidation in a preliminary study on antioxidant and radical scavenging activity [76]. Furthermore, fresh fruit juice from *M. esculenta* shown significantly greater DPPH and nitric oxide scavenging activity. These findings confirmed the usage of the *M. esculenta* plant as a natural antioxidant source[77].

Antiulcer Effect: Oral treatment of ethanol extract of *M. esculenta* bark at various doses protected against pylorus ligated ulcer in rats significantly by lowering gastric secretions, acidity, lipid peroxidation, and myeloperoxidase enzyme levels in comparison to control. The catalase activity, nitrite levels, and glutathione levels were significantly increased, supporting the theory that the bark antiulcerogenic potential is related to antioxidant mechanisms [78]. Thus, the study offered empirical support for *M. esculenta* conventional use in ulcer treatment.

Hepatoprotective Activity: *M. esculenta* was one of the ingredients in a polyherbal traditional formulations that showed hepatoprotective properties against carbon tetrachloride (CCl4)-induced hepatotoxicity in Wistar rats by significantly lowering the concentrations of thio-barbituric acid reactive substance and hydroperoxides and significantly raising the antioxidant enzyme activities of superoxide dismutase, catalase, glutathione peroxidase, and thelevels of reduced glutathione in tissues of CCl4-induced rats [79].

Wound Healing Activity: The wound excision and incision models were used to scientifically validate the ethnotherapeutic claim that *M. esculenta* bark promotes wound healing. As evidenced by a significant increase in tensile strength, hydroxyproline content, faster wound contraction, and a decline in the tissue epithelization period, the application of an ointment made from an aqueous bark extract accelerated up the recovery process in the treated animals. These changes were comparable to those seen with the standard medication, 0.2% w/w nitrofurazone. As a result, an ethanol extract of bark could be used to treat wounds [80].

CONCLUSION: *Myrica esculenta* is mainly available in the month of April and May and considered as underutilised fruit with high nutritive value and are used in many ayurvedic preparations for treatment of different ailments. The different parts of the tree are found to contains phytoconstituents which possess medicinal activities. Therapeutically it can be used as antimicrobial, antioxidants, anti-ulcers, anthelmintic, anti-inflammatory, wound healing and antidiabetic activity. The chemical components that are present in *Myrica esculenta* are alkaloids, steroids, glycosides, flavonoids. Apart from these researches there are still many possible scientific studies that can determined its medicinal and pharmacological activities. Thus, we can conclude that *Myrica esculenta* is nutritionally and medicinally important fruits in all aspects. However, it is highly recommended to further the research in this regard for the isolation and characterization both chemically and biologically to discover the safe and effective pharmaceutical agents from this source of the nature.

ACKNOWLEDGEMENT: Acknowledged by Author.

Source of Funding: Nil

CONFLICTS OF INTEREST: Nil

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How to cite this article:
Lyngkhoi MM and Mondal A: *Myrica esculenta*: a comprehensive review on plant profile, phytochemistry, ethnobotanical and pharmacological uses. Int J Pharm Sci & Res 2024; 15(6): 1572-80. doi: 10.13040/IJPSR.0975-8232.15(6).1572-80.