

MYRICA ESCULENTA: A HEALTH PERKS

Abstract

Our research delves into the multifaceted nature of *Myrica esculenta*, commonly known as the Bayberry or Box Myrtle. By conducting an extensive review of literature, including research articles, ethnobotanical surveys, and environmental studies, we have gathered valuable insights into various aspects of this botanical species. Our focus lies in understanding the taxonomy, morphology, habitat preferences, and distribution patterns of *M. esculenta*. Additionally, the phytochemical analysis revealed to identify bioactive compounds and explore their therapeutic applications. Furthermore, we have explored the ethnobotanical significance of *M. esculenta*, shedding light on its cultural roles and traditional practices within different communities. Overall, our findings emphasize the plant's pharmacological versatility, ecological importance, and cultural value, contributing to a comprehensive understanding of *Myrica esculenta* for future scientific and cultural endeavors.

Keywords: *Myrica esculenta*, Taxonomy, Morphology, Distribution, Phytoconstituents, Pharmacological properties

Authors

Mr. Mohidul Islam

Faculty of Pharmaceutical Science,
Assam down town University, Panikhaiti,
Guwahati 781026, Assam, India.

Dr. Faruk Alam

Faculty of Pharmaceutical Science,
Assam down town University, Panikhaiti,
Guwahati 781026, Assam, India.

Mr. Rajat Das

Department of Pharmacognosy,
Himalayan Pharmacy Institute, Majhitar,
Rangpo, East Sikkim, India, 737136.

Ms. Kumudini Sahoo

School of Pharmacy,
Driems University. Tangi, Cuttack,
Odisha.754022.

I. INTRODUCTION

India is home to four of the 34 global biodiversity hotspots, namely the Himalayas, the Western Ghats, the Nicobar Islands, and the Northeastern rainforests. The Himalayan region in India is particularly known for its diverse range of edible plants, with over 670 different species. These plants are valued for their health perks and nutritional worth. One such plant is *Myrica esculenta* Buch-Ham. Ex D. Don from the Myricaceae family, which is valued for its medicinal properties. Multiple other names for it exist as well, including "Katphal" in Sanskrit, "Kaiphala" in Urdu, "Nagatenga" in Assam, "Soh-phi" in Khasi, and "Box myrtle" in English [1]. It is a valuable medicinal tree found in Jaintia, Khasia, Shimla, Naga, Bengal, and Lushai hills at elevations of 900-2100 meters [2]. It is scattered all over the outer Himalayas from Ravi (Punjab) eastward to Assam. Within the Myricaceae family, the Genus *Myrica* is a broad group that includes over 97 species [3]. It has been stated that *Myrica Esculenta* is the only species found in India; [4] other species are found all over the world, such as *M. Rubra* in China and Japan, *M. Australiasica* F. Muell in Australia, and *M. persylvanica* Mirb in North America. This plant also has other synonyms, such as *Myrica sapida* Wall. And *Myrica farqhariana* Wall [5]. *Myrica Esculenta* bark decoction is thought to help with diuresis, asthma, dysentery, fevers, lung infections, diarrhea, antioxidant [6], antibacterial [7], and chronic bronchitis. The bark is chewed to ease toothaches, and it is made into a lotion that is used on festering sores. Even the bark's extracted yellow color is being used as a medicinal coloring agent [8, 9]. Additionally, bark is used to make ropes and paper [10]. Fruit is regarded as a pectoral, stomachic, sedative, and carminative [11]. Because it is actinorhizal, it also helps soils that are low in nitrogen regenerate [12]. The plant is mostly harvested for its delicious fruits and has been shown to have nutritional and medicinal value [13]. The plant's fruits are also used for producing pickles, jams, syrups, and cool drinks [14].

Table 1: Botanical classification [15]

Kingdom: plant	Order: Fagales
Division: Spermatophyta	Series: Unisexuale
Sub-division: Angiospermeae	Family: Myricaceae
Class: Dicotyledonae	Genus: <i>Myrica</i>
Sub-class: Monochlamydeae (Incompletae or Apetalae)	Species: <i>esculenta</i> Buch – Ham

Table 2: Vernacular names [5, 16, 20]

Sanskrit	Aranya, Kathphala, Mahavalkala Krishnagarba	Kannada	Kirishivani, Kandujai kai, Kirishivane,
Assamese	Ajooree, Vdulbark, Nagatenga	Marathi	Kayaphala
Bengali	Kayachhal, Satsarila, Kaiphala	Malayalam	Maruta
English	Bayberry, Box myrtle	Telugu	Kainaryamu
Gujrati	Kariphala	Hindi	Kaiphala, Kapha
Punjabi	Kahela, Kaiphala, Kahi	Nepali	Katphala, Kobuli

II. MORPHOLOGICAL CHARACTERISTICS OF MYRICA ESCULENTA

Myrica Esculenta is a deciduous tree that remains green throughout the year. It is a medium-to-large tree, reaching a height of 12 to 15 meters. Interestingly, both male and female trees have a very similar appearance. The bark of the tree can vary in color, ranging from light brown to black. The leaves are densely packed at the tips of the branches and have a lanceolate, ovate shape with serrated edges. The tree bears succulent drupe fruits that come in various shapes, such as small ellipsoidal or ovoid to globose. Initially, the fruits are green but gradually turn reddish-purple as they mature. Due to their perishable nature, these fruits have a relatively short shelf life of two to three days. The flowering season of *Myrica Esculenta* begins in October and continues until the end of December. Following this, the fruit-setting season commences in November, and mature fruits can be harvested from April to June [17]. The inner bark of the tree is dark brown, smooth, and hard, emitting an unpleasant fragrance and having a bitter taste. On the other hand, the outer bark appears greyish-dark in color, rough, and vertically wrinkled. The tree produces drupe fruits that range in color from red to dark brown. These fruits are ellipsoidal or oval-shaped and have a diameter ranging from 2 to 7 mm. Inside the fruits, there is an ovoid-shaped, smooth-surfaced, light brown seed that measures between 1 and 6 mm in diameter and has a greasy taste [5,13].

III. HABITAT

Myrica esculenta is a plant species that can be found in the Himalayan region of India, specifically in areas such as Jammu & Kashmir, Uttarakhand, Himachal Pradesh, Assam, Naga, Jaintia, and the Lushi Hills. It thrives at altitudes ranging from 900 to 2100 meters. Interestingly, this species is not limited to India alone, as it can also be found in other countries such as China, Japan, Myanmar, Singapore, Malaysia, and China [18].

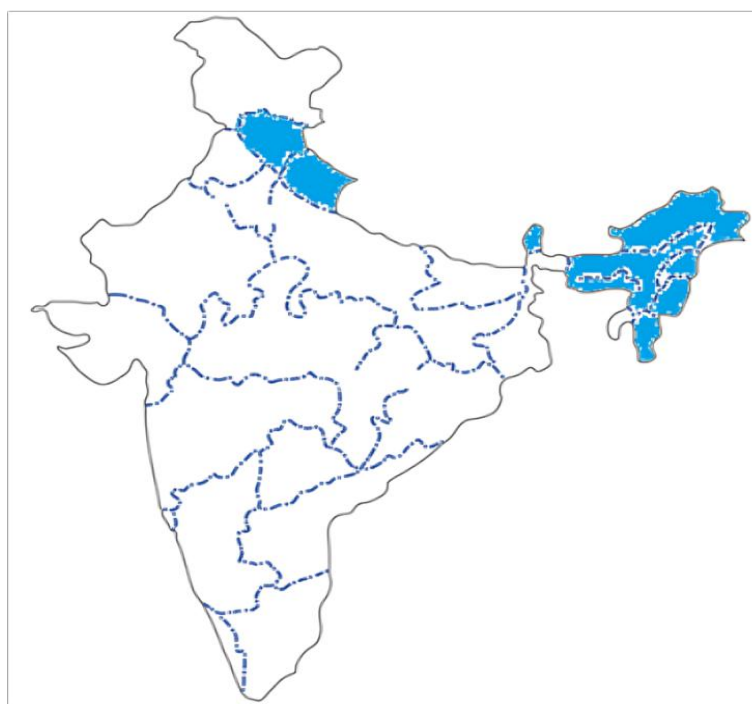


Figure 1: Distribution of *Myrica esculenta* in India [19]

IV. MORPHOLOGICAL AND MICROSCOPICAL CHARACTERISTICS

The morphological analysis of the *M. esculenta* plant and its components (Figure 2A-2D) reveals that it is a compact medium-sized perennial tree that can reach heights ranging from 3 to 15 meters. The leaves of this plant are described as lanceolate and obovate, measuring approximately 9 by 3 centimeters in diameter. Additionally, the lower surface of the leaves displays a light green color, while the upper surface appears dark green.



Figure 2: Myrica esculenta A: Whole plant, B: Leaf, C: Bark, D: Fruit.

V. PHYTOCHEMISTRY

Analysis of phytochemicals conducted on the leaves, stem bark, bark, and seeds of *M. esculenta* unveiled numerous potent phytoconstituents including alkaloids, tannins, phenols, flavonoids, phytosterols, glycosides, and saponins as indicated in Table 3. These bioactive compounds have demonstrated a diverse range of therapeutic effects and could be utilized in the development of new drugs or natural remedies. Further research and studies on the phytochemical composition of *M. esculenta* could lead to the discovery of novel bioactive compounds with significant health benefits and therapeutic applications.

Table 3: Phytoconstituents of various extracts of different parts of *M. esculenta*

Phytoconstituent	Leaf	Stem	Bark	Seed	Root	Ref.
Alkaloid	Present	Absent	Absent	Absent	Absent	[21, 22]
Glycosides	Present	Absent	Absent	Absent	Absent	[21, 22]
Saponins	Present	Present	Present	Present	Absent	[21, 22]
Phytosterols	Present	Present	Present	Absent	Absent	[21, 22]

Phenols	Present	Present	Absent	Absent	Absent	[21, 22]
Flavanoids	Present	Present	Present	Present	Absent	[21, 22]
Tannins	Present	Absent	Absent	Present	Absent	[21, 22]

Some bioactive compounds were reported in the plant belong to the class of alkaloids, glycosides, diarylheptanoids, ionones, steroids, saponins, triterpenoids, volatile compounds (**Table 4**). The structures of some important bioactive phytoconstituents reported in *M. esculenta* plant is presented in **Figure 3**.

Table 4: List of major phytoconstituents from different parts of *Myrica esculenta*

Plant part	Reported compound	Reference
Leaves	Flavone 4'-hydroxy-3',5,5'-trimethoxy-7-O- β -D-glucopyranosyl) (1 \rightarrow 4)- α -L-rhamnopyranoside; Flavone 3',4'-dihydroxy-6-methoxy-7-O- α -L-rhamnopyranoside; Myricetin; Quercetin; Myricetin 3-O-rhamnoside; Ethyl- β -D-glucopyranoside; 3-hydroxybenzaldehyde; Isovanillin; 4-(hydroxymethyl)-phenol; β -sitosterol; 4-methoxybenzoic acid; Oleanolic acid	19, 23, 25, 26, 27, 29, 30
Bark	Myricetin-3-O-(2''-Ogalloyl)- α -L-rhamnopyranoside; Gallic acid; Epigallocatechin 3-O-gallate; 3-O-galloyl-epigallocatechin-(4 β \rightarrow 8)-epigallo-atechin3-O-gallate; Myricetin; Quercetin; Myricetin 3-O-rhamnoside; Oleanolic acid; β -sitosterol; Stigmasterol; Myricanone	24, 25, 26, 27, 30, 31
Fruits	Tannin, Ascorbic acid, Myricetin, Quercetin, Gallic acid, Ferulic acid	25, 28, 29

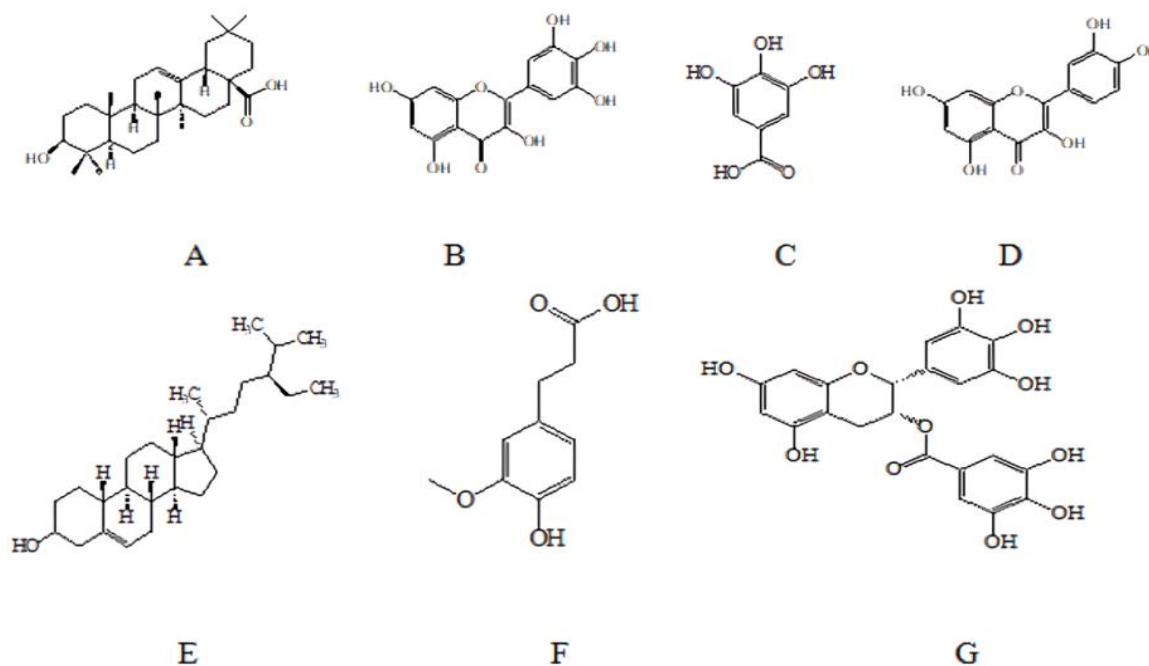


Figure 3: Structures of some important bio active molecules present in *Myrica esculenta*: A. Oleanolic acid; B. Myricetin; C. Gallic acid; D. Quercetin; E. β -sitosterol; F. Ferulic acid; G. Epigallocatechin 3-O-gallate

VI. AYURVEDIC FORMULATION

Various Ayurvedic formulations like Chwayanprash and Brahmarasayan are created using fruits and roots to improve digestion, memory, intelligence, concentration, and physical strength. The bark of *M. esculenta* is a key component in the Ayurvedic formulation Visweshwara rasa, which is specifically designed to address fevers originating from kapha and pitta imbalances. Additionally, other Ayurvedic remedies that utilize fruits or bark of *M. esculenta* as a significant ingredient include Katphaladi churna, Kaas-har churna, Katphala taila, Katphala kvatha, Khadiradi gutika, Maha vatagajankush rasa, Brihatphala ghrita, Pusanuga churna, Arimedadi taila, Bala taila, and Mahavisagarbha taila. These formulations are commonly used in the treatment of various conditions such as rheumatoid arthritis, diarrhoea, dysentery, headache, menorrhagia, and other menstrual disorders, showcasing the diverse therapeutic applications of *M. esculenta* in Ayurvedic medicine.

VII. ETHNOMEDICINAL USES

The plant is commonly utilized in both the Yunani and Ayurvedic medical traditions due to its various parts such as the bark, flowers, fruits, and roots. In Ayurveda, the bark is characterized as having a bitter, caustic, and pungent taste, making it a valuable component in medicinal preparations. Apart from its use in traditional medicine, this tree serves multiple purposes as it is considered a potent remedy for a wide range of health issues including anaemia, bronchitis, asthma, piles, sore throats, fever, liver problems, chronic dysentery, cough, sores, and urinary discharges. However, according to the Ayurvedic Samhita, *Myrica esculenta* is not recommended for individuals with spleen and liver issues. On a different note, the oil extracted from the flowers of this tree acts as a tonic and has been proven effective in the treatment of paralysis, headaches, earaches, and diarrhea [2]. This showcases the diverse range of benefits that this plant offers in the field of traditional medicine.

VIII. PHARMACOLOGICAL PROFILE

Myrica esculenta extracts possess a broad spectrum of pharmacological effects. Previous research has highlighted the remarkable efficacy of phenolic compounds as antioxidants, indicating that plants abundant in antioxidants hold great promise for the treatment of degenerative diseases. The antioxidant potential of *Myrica esculenta* extracts has been attributed to the presence of flavonoids and phenolic acids, as indicated by earlier investigations [32-34]. Furthermore, these extracts have demonstrated analgesic, antiasthmatic [35], anticancer [36], antidepressant [37], antidiabetic [38], antidiarrheal [39], antihypertensive [40], anti-inflammatory [40], antimicrobial [40], antipyretic [5,33], antiulcer [5,41], chemo-preventive, hepatoprotective, and wound healing [5] properties, as documented in various studies.

1. Antimicrobial Activity

The oil extracted from the *Myrica esculenta* plant has been found to possess antimicrobial and anti-inflammatory properties. It is effective against a range of microorganisms, including *Saccharomyces cerevisiae*, *Bacillus pumilus*, *Candida albicans*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Aspergillus niger*, and *Staphylococcus aureus*. Additionally, it has demonstrated antifungal activity against *Sclerotium rolfsii*, *Rhizoctonia solani*, and *Fusarium oxysporium*, as reported in a study [42].

2. Analgesic Activity

Myrica esculenta fruits exhibited notable pain-relieving properties in a dosage-dependent fashion when extracted using methanol. On the other hand, the leaf extract demonstrated a substantial analgesic impact [5].

3. Antidiabetic Activity

The administration of *Myrica esculenta* leaf extracts in the form of methanol has shown significant effects on reducing blood glucose levels, blood cholesterol levels, and body weight in diabetic rats induced with streptozotocin. These effects were observed to be dependent on the dosage of the extracts used in the study, as higher doses resulted in greater reductions. The findings suggest that *Myrica esculenta* leaves may hold potential as a natural remedy for managing diabetes and associated metabolic disorders. This study provides valuable insights into the therapeutic properties of *Myrica esculenta* and its potential application in the treatment of diabetes [38].

4. Anti-Hypertensive Activity

To study the impact of phyto-constituents from *Myrica esculenta* leaves on hypertension management, researchers decided to inhibit the angiotensin I-converting enzyme. 2. The study revealed that Corchoionoside C and (6S,9R)-roseoside were the most effective ACE inhibitors among the compounds tested. 3. On the other hand, myricanol, 5-O- β -D-glucopyranosyl myricanol, and myricetin exhibited only minimal hypotensive effects in the experiment [25].

5. Antioxidant Activity

The antioxidant capacity of the methanol extract derived from the fruit of *Myrica esculenta* was evaluated through three separate in vitro tests that measure radical scavenging activity: the 1,1-diphenyl-2-picrylhydrazyl (DPPH) assay, the 2,2-azinobis (3-ethylbenzothiazoline-6-sulphonic acid) assay, and the ferric reducing antioxidant power (FRAP) assay. These assays provide valuable insights into the ability of the extract to neutralize free radicals and exhibit antioxidant properties. The results obtained from these tests contribute to our understanding of the antioxidant potential of *Myrica esculenta* fruit extract and its potential applications in various fields [24].

6. Anticancer Activity

The MTT assay was employed to investigate the impact of bayberry fruit extracts on three distinct cell types: non-transformed PBMCs, transformed normal HEK293 cells, and cervical cancer cells (C33A HeLa and SiHa). The results revealed that the extracts exhibited a dose-dependent suppression of cancer cell lines, while demonstrating no cytotoxic effects on non-cancerous cells. This finding highlights the potential of bayberry fruit extracts as a promising therapeutic agent for cancer treatment [36].

7. Hepatoprotective Activity

The hepatoprotective effects of the Ayurvedic polyherbal formulation Herbitars, containing 50 and 100 mg/kg doses along with 5 mg/g of *Myrica esculenta*, were demonstrated in Wistar rats exposed to carbon tetrachloride (CCl₄)-induced hepatotoxicity. This study revealed a significant reduction in the levels of thiobarbituric acid reactive substance and hydroperoxides in the liver and kidney of rats treated with Herbitars, indicating its potential in combating oxidative stress. Moreover, the antioxidant enzyme activities of glutathione peroxidase, superoxide dismutase, catalase, and reduced glutathione were found to be increased in the liver and kidney tissues of CCl₄-induced rats treated with Herbitars, suggesting a protective mechanism against liver and kidney damage induced by CCl₄ [43].

IX. TOXICOLOGICAL STUDIES

M. esculenta, a commonly consumed plant, is generally regarded as safe with limited research conducted on its toxicity. Rawat et al. conducted a study to investigate the potential toxic effects of the methanol extract derived from *M. esculenta* leaves. Interestingly, their findings revealed no signs of toxicity when administering the extract orally at a dose of 300 mg/kg over two weeks. However, when the dose was increased to 2000 mg/kg, toxic effects were observed in Wistar rats [44]. Furthermore, another study focused on assessing the acute toxicity of ethyl-acetate and water extracts derived from *M. nagi* bark. The extracts were administered intravenously at three different doses: 100, 200, and 1000 mg/kg. The results indicated that the LD₅₀ (lethal dose for 50% of the population) of both the ethyl-acetate and water extracts in mice was 1000 mg/kg [45]. These findings shed light on the potential toxicity of *M. esculenta* and *M. nagi* extracts, emphasizing the importance of further research in this area to ensure their safe usage.

X. SUMMARY

The examination of leaves at both macroscopic and microscopic levels revealed several characteristics. The leaves were lanceolate in shape, thin, and arranged in a spiral pattern. They had a dark green color and astringent taste. The apex of the leaves was acute, and the epidermis had a cuticularized surface with polygonal cells. On each surface of the leaves, there were single-layered palisade mesophyll cells. The spongy parenchyma, which consisted of 2-3 layers, was also observed. The leaves had unicellular and uniseriate hollow trichomes, and the stomata were of the anomocytic type. In the mid-rib portion, a bowl-shaped vascular bundle was present. Additionally, the leaves contained alkaloids, carbohydrates, flavonoids, glycosides, phenolic compounds, and tannins. *M. esculenta*, a plant species with therapeutic and nutritional potential, has been used in ancient Ayurveda and Unani systems of medicine. The plant contains various phytoconstituents that contribute to its medicinal value. However, further research is needed to identify the active therapeutic compound and understand its specific mode of action. *M. esculenta* has shown promising pharmacological effects in the treatment of asthma, diabetes, cancer, ulcers, and anxiety. Given its rich content of vitamin C and polyphenolic compounds, exploring its potential for immunomodulatory, cardioprotective, nephroprotective, and neuroprotective activities is crucial.

REFERENCES

- [1] Macdonald AD. The morphology and relationships of the Myricaceae. Evolution, systematics, and fossil history of the Hamamelidae. 1989; 2:147-65.
- [2] Panthari PR, Kharkwal HA, Kharkwal H, Joshi DD. Myrica nagi: A review on active constituents, biological and therapeutic effects. Int. J. Pharm. Pharm. Sci. 2012; 4(Suppl 5):38-42.
- [3] Yanthan M, Misra AK. Molecular approach to the classification of medicinally important actinorhizal genus Myrica.
- [4] Haridasan K, Rao RR. Forest flora of Meghalaya. Dehra Dun India; 1985.
- [5] Sood P, Shri R. A Review on Ethnomedicinal, Phytochemical and Pharmacological Aspects of Myrica esculenta. Indian Journal of Pharmaceutical Sciences. 2018 Jan 1;80(1).
- [6] Chen JH, Wang YM, Wu DM, Wu ZS. Preliminary study on antioxidative and radical scavenging activities of extracts from Myrica esculenta Buch-Ham. Bark. Chem Ind For Prod. 2007:1-7.
- [7] Suryawanshi JS, Karande KM, Udugade BV. Antibacterial activity of bark and fruits of Myrica nagi. Indian Journal of Natural Products. 2009;25(3):21-3.
- [8] Kumar JK, Sinha AK. Resurgence of natural colourants: a holistic view. Natural product research. 2004 Feb 1;18(1):59-84.
- [9] Semwal RB, Semwal DK, Kapoor P. Dyeing properties of Berberis aristata DC with natural and synthetic mordants. Trends in Applied Sciences Research. 2012 May 1;7(5):392.
- [10] Bhatt ID, Dhar U. Factors controlling micropropagation of Myrica esculenta buch.–Ham. ex D. Don: a high value wild edible of Kumaun Himalaya. African Journal of Biotechnology. 2004;3(10):534-40.
- [11] Thote PS, Mishra BR. Myrica Esculenta and it's Anti-Asthmatic Property with Ayurvedic approach: A Review. Journal of Ayurveda and Integrated Medical Sciences. 2019 Dec 31;4(06):216-9.
- [12] Yanthan M, Misra AK. Molecular approach to the classification of medicinally important actinorhizal genus Myrica.
- [13] Dhani A. Major wild edible fruits used by locals of Garhwal Himalaya. International Journal of Advanced Life Sciences (IJALS). 2013;6(3):145-9.
- [14] Makdoh K, Lynser MB, Pala KH. Marketing of indigenous fruits: a source of income among Khasi Women of Meghalaya, North East India. Journal of Agricultural Sciences. 2014 Jul 1;5(1-2):1-9.
- [15] Thote PS, Mishra BR. Myrica Esculenta and it's Anti-Asthmatic Property with Ayurvedic approach: A Review. Journal of Ayurveda and Integrated Medical Sciences. 2019 Dec 31;4(06):216-9.
- [16] Nadkarni KM, Nadkarni AK. Indian Materia Medica. 3rd eds. This is the publisher. Bombay, India. 1982;3:1138.
- [17] Gusain YS, Khanduri VP. Myrica esculenta wild edible fruit of Indian Himalaya: need a sustainable approach for indigenous utilization. Eco Env Cons. 2016 Apr;22:267-70.
- [18] Shankhwar R, Bhandari MS, Meena RK, Shekhar C, Pandey VV, Saxena J, Kant R, Barthwal S, Naithani HB, Pandey S, Pandey A. Potential eco-distribution mapping of Myrica esculenta in northwestern Himalayas. Ecological engineering. 2019 Mar 1;128:98-111.
- [19] Kabra A, Martins N, Sharma R, Kabra R, Baghel US. Myrica esculenta Buch.–Ham. ex D. Don: A natural source for health promotion and disease prevention. Plants. 2019 May 31;8(6):149.
- [20] <http://www.ayurveda.hu/api/API-Vol-3.pdf>
- [21] Shah H, Naseer A, Pandey AK, Upadyay P. Physiochemical and Phytochemical Screening of Various Extracts of Myrica esculenta Linn. Himalayan Plant. Seed.;6(2.4):1-3.
- [22] Kabra A, Sharma R, Singla S, Kabra R, Baghel US. Pharmacognostic characterization of Myrica esculenta leaves. Journal of Ayurveda and integrative medicine. 2019 Jan 1;10(1):18-24
- [23] Bamola A, Semwal DK, Semwal S, Rawat U. Flavonoid glycosides from Myrica esculenta leaves. Journal of the Indian Chemical Society. 2009;86(5):535-6.
- [24] Mann S, Satpathy G, Gupta RK. In vitro evaluation of bio-protective properties of underutilized Myrica esculenta Buch.–Ham. ex D. Don fruit of Meghalaya.
- [25] Nhiem NX, Van Kiem P, Van Minh C, Tai BH, Cuong NX, Thu VK, Anh HL, Jo SH, Jang HD, Kwon YI, Kim YH. A new monoterpene glycoside from Myrica esculenta and the inhibition of angiotensin I-converting enzyme. Chemical and Pharmaceutical Bulletin. 2010 Oct 1;58(10):1408-10.
- [26] Anjum N, Tripathi YC. Evaluation of total polyphenols, flavonoids and antioxidant activity of Myrica esculenta buch-ham. ex d. don fruits. World Journal of Pharmaceutical and Medical Research. 2021;7(2):186-92.
- [27] Singh N, Khaton S, Srivastava N, Rawat AK, Mehrotra S. Qualitative and quantitative standardization of Myrica esculenta Buch.–Ham. Stem bark by use of HPTLC. JPC–Journal of Planar Chromatography–

- Modern TLC. 2009 Aug;22:287-91.
- [28] Kumar JK, Sinha AK. Resurgence of natural colourants: a holistic view. *Natural product research*. 2004 Feb 1;18(1):59-84.
- [29] Yang W, Tang CM, Li X, Zhou Y, Wang L, Li L. Study on the chemical constituents of *Myrica esculenta*. *J Yunnan Univ (Natural Sciences)*. 2011;33:453-7.
- [30] Agnihotri S, Wakode S, Ali M. Triterpenoids from the stem bark of *Myrica esculenta* Buch Ham. *World J. Pharm. Pharm. Sci*. 2016 Jan 21;5:1319-27.
- [31] Begley MJ, Campbell RV, Crombie L, Tuck B, Whiting DA. Constitution and absolute configuration of meta, meta-bridged, strained biphenyls from *Myrica nagi*; X-ray analysis of 16-bromomyricanol. *Journal of the Chemical Society C: Organic*. 1971:3634-42.
- [32] Pant G, Prakash O, Chandra M, Sethi S, Punetha H, Dixit S, Pant AK. Biochemical analysis, pharmacological activity, antifungal activity and mineral analysis in methanolic extracts of *Myrica esculenta* and *Syzygium cumini*: the Indian traditional fruits growing in Uttarakhand Himalaya. *Indian Journal of Pharmaceutical and Biological Research*. 2014 Jan 1;2(1):26.
- [33] Middha SK, Usha T, Babu D, Misra AK, Lokesh P, Goyal AK. Evaluation of antioxidative, analgesic and anti-inflammatory activities of methanolic extract of *Myrica nagi* leaves-an animal model approach. *Symbiosis*. 2016 Jun;70:179-84.
- [34] Goyal AK, Mishra T, Bhattacharya M, Kar P, Sen A. Evaluation of phytochemical constituents and antioxidant activity of selected actinorhizal fruits growing in the forests of Northeast India. *Journal of Biosciences*. 2013 Nov;38:797-803.
- [35] Patel T, Rajshekar C, Parmar R. Mast cell stabilizing activity of *Myrica nagi* bark. *J Pharmacogn Phytother*. 2011 Sep;3(8):114-7.
- [36] Saini R, Garg V, Dangwal K. Effect of extraction solvents on polyphenolic composition and antioxidant, antiproliferative activities of Himalyan bayberry (*Myrica esculenta*). *Food Science and Biotechnology*. 2013 Aug;22(4):887-94.
- [37] Syed S, Ahmad M, Fatima N, Jahan N. Neuropharmacological studies of *Myrica nagi* bark. *International Journal of Biology and Biotechnology (Pakistan)*. 2013;10(4).
- [38] Rawat S, Kumar N, Kothiyal P. Evaluate the antidiabetic activity of *Myrica esculenta* leaves in streptozotocin induced diabetes in rat. *Int J Univ Pharm Bio Sci*. 2013;2:510-25.
- [39] Nayak BK, Deka P, Eloziia N. Assessment of phytochemical & pharmacological activities of the ethanol leaves extracts of *Myrica esculenta* Buch. Ham. *J. Pharm. Res*. 2017;11:444-9.
- [40] Prashar Y, Patel NJ. A review on *Myrica nagi* approach in recognizing the overall potential of the plant. *Res J Life Sci Bioinform Pharm Chem Sci*. 2018;4:217-31.
- [41] Swathi DH, Prasad KV. Antioxidant and antiulcer potential of ethanolic extract of bark of *Myrica esculenta* in pyloric ligation ulcer model. *Int J Pharm Sci*. 2015;7:195-8.
- [42] Agnihotri S, Wakode S, Ali M. Essential oil of *Myrica esculenta* Buch. Ham.: composition, antimicrobial and topical anti-inflammatory activities. *Natural product research*. 2012 Dec 1;26(23):2266-9.
- [43] Samundeeswari C, Rajadurai M, Periasami R, Kanchana G. Hepatoprotective effect of Herbitars, A polyherbal against CCl₄ induced hepatotoxicity in rats. *J Pharm Res*. 2011;4:676-9.
- [44] Rawat S, Kumar N, Kothiyal P. Evaluate the antidiabetic activity of *Myrica esculenta* leaves in streptozotocin induced diabetes in rat. *Int J Univ Pharm Bio Sci* 2013;2:510-25.
- [45] Patel T, Rajshekar C, Parmar R. Mast cell stabilizing activity of *Myricanagibark*. *J Pharmacognosy Phytother* 2011;3:114-7.