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Current Research On *Myrica esculenta* Buch.-Ham. Ex D. Don And The Need For Its Conservation

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Abstract: *Myrica esculenta* Buch.-Ham. ex D. Don is a dioecious evergreen tree found along the Indian Himalayan region and extends from Himachal Pradesh and Uttarakhand through Assam, Khasi, Jaintia and Naga Hills to Lushai hills of Mizoram and Manipur. The tree has immense importance nutritionally, in traditional medicine and pharmacologically. The species have also found its role in nanoscience and biosorption of heavy metals as established from recent studies. *Myrica esculenta*, being nodulated by *Frankia* can help in regeneration of nitrogen depleted soils which makes it recommendable for afforestation programmes. However, the presence of an impermeable seed coat which imparts physical dormancy and the poor rate of regeneration of the species in their natural habitat combined with the effects of high anthropogenic activity could pose a threat of extinction of the species from the wild. Steps such as micropropagation and germplasm conservation could be employed for propagation along with sustainable utilization by the indigenous people in order to conserve the species. Hence, in this article, the morphology, nutritional values and phytochemistry of the species has been discussed. Also, the studied techniques for increase in germination rate and successful micropropagation have been reviewed.

Keywords: Conservation • Micropropagation • *Myrica esculenta* • phytoconstituents • sustainable utilization

Introduction

Myrica esculenta Buch.-Ham. ex D. Don is included in the genus *Myrica* and family Myricaceae. The family consists of three genera and 97 species are included in the genus *Myrica*. However, *Myrica esculenta* Buch.-Ham. ex D. Don is the only species of the genus *Myrica* which is found in India (Haridasan, 1987). The species is sometimes referred to with the synonyms such as *Myrica sapida* Wall. and *Myrica farqhariana* Wall (Huguet *et al*., 2005). However, the accepted name is *Myrica esculenta* Buch.-Ham. ex D. Don. The species is dioecious in nature. Generally found in the temperate and sub-tropical regions, *Myrica esculenta* is evergreen species (Yantham *et al*., 2013). It is distributed mainly in the foothills of the Eastern Himalayan range including the northeastern states of Assam, Arunachal Pradesh, Nagaland, Manipur, Mizoram along the Khasi, Jayantia, Kamarupan and Luchai Hills (Hooker, 1876; Anonymous, 1962). It is also found in the states of Himachal Pradesh and Uttarakhand and in

Nepal, Sri Lanka, Myanmar, Bangladesh, Vietnam, Singapore, China and Japan (Osmaston, 1927). The species occurs at altitudes of 900-2100m above sea level (Anonymous, 1962). In Assam the species, locally known as Naga tenga is frequently found in the Dikhow valley of Sivasagar.

The species belong to Kingdom: Plantae; Division: Magnoliophyta; Class: Magnoliopsida; Order: Fagales; Family: Myricaceae; Genus: *Myrica;* Species: *Myrica esculenta* Buch.-Ham. ex D. Don.

Myrica esculenta is a medium to large sized tree with a height of about 12-15m; the diameter of the trunk is about 92.5cm (Kritikar and Basu, 1999). The overall appearance wise the male and female trees appear similar. The bark is brown to black in colour; leaves are lanceolate, the upper surface is dark green, and the lower surface is light green in colour and the margins are either entire or serrate and are mostly crowded towards the end of the branches with a width of about 3-3.5cm (Parmar *et al*., 1982). The female flowers are small, pistilate, bracteates and solitary; the inflorescence is catkin and bears about 20-25 flowers in a thread-like style (Kirtikar and Basu, 1988; Sahu *et al*., 2013). The male inflorescence is compound raceme. About 12 stamens, each with a very short filament are borne on a staminate flower (Patel and De, 2006). The fruits are drupe, oval or globose shaped, about 2-7mm in diameter, green in colour when unripe and becomes yellowish to dark red when ripe with a seed of about 1-6mm in diameter (Dhani *et al*., 2013).The shelf life is only about 2-3 days and is perishable in nature (Patel and De, 2006). The flowers start blooming from December to January and the fruiting could be seen starting from February. The ripe fruits are found from April to middle of May.

Nutritional properties

The parts of the plant are nutritionally important. The bark and fruits have been found to be a good source of essential nutrients like carbohydrates, proteins, fats and contains minerals like Na, K, Ca, P, S, Mg, Fe, Zn, Mn, Cu, *etc* (Fig 1). The main amino acids found in the species are glutamine and aspargine (Wheeler and Bond, 1970). The fruits are known for their taste and are either eaten raw or prepared into drinks, jams and pickles. Presence of such microorganisms can promote soil health (Kachari *et al*., 2018).

Table 1: Important minerals in different parts of *Myrica esculenta*

Plant part	Minerals (mg/g)										References
	Ca	K	Na	Mn	Fe	Zn	Cu	Mg	P	S	
Fruits	4.63± 0.06	7.75± 0.11	0.81± 0.013	0.032± 0.0001	0.404± 0.0021	0.216± 0.0016	0.004± 0.0002	8.4± 0.20	0.24± 0.25	-	Seal *et al.* (2011); Chandra *et al.* (2012)
Stem bark	3.155± 0.18	2.939± 0.23	0.06± 0.03	-	0.123± 0.16	0.006± 0.001	-	1.061± 0.4	0.03± 0.01	0.277± 0.34	Patel *et al.* (2017)

Ecological importance

The tree is also important ecologically. The *Myrica* species are capable of nitrogen fixation although being non-leguminous angiosperm (Becking, 1977; Benson and Silverster, 1993; Muckun *et al*., 1993). Arbuscular mycorrhizal fungi such as *Glomus*, *Acaulospora*, *Diversispora*, *Steptoglomus*, *Funneliformis*, *Rhizophagus*, *Entrophospora*, *Scutellospora*and *Gigaspora*, phosphate solubilizing micro-organism (PSM) and plant growth promoting rhizobacteria (PGPR) were also isolated from the rhizophere soils of *Myrica esculenta.*

Medicinal uses

Medicinally, the plant is used since ancient times in Ayurvedic systems (Chatterjee *et al*., 1994) and several formulations are prepared from different parts of the plant. The plant is used in traditional medicine by several tribes in India.

Phytochemistry

Several important phytochemicals are contained in various parts of the plant. The plant contains phenols, flavonoids, flavonols along with alkaloids, steroids, saponins, glycosides, triterpenoids and other volatile compounds.

Table 2: Total phenolic content, total flavonoid content and total flavonol content in different parts of *Myrica esculenta*

Plant part	Total phenolic content	Total flavanoid content	Total flavonol content	Reference
Stem bark	276.78±5.36 mg GAE/g d.w.	121.68±6.81 mg QE/g d.w.	-	Srivastava *et al.* (2016)
Small branches	31.24±2.57 mg GAE/g d.w.	12.94±1.12 mg QE/g d.w.	-	
Fruits	26.21±0.1 µg GAE /mg d.w.	38.00±0.5 µg RE /mg d.w.	122.75±0.1 µg RE /mg d.w.	Mann *et al.* (2015)
Fruit juice	321.68±0.06 mg/g GAE	187.2±0.04 mg/g QE	155.2±0.02 mg/g QE	Goyal *et al.* (2013)
Leaves	88.94 ± 0.24 mg/g GAE	67.44 ± 0.14 mg/g QE	-	Kabra *et al.* (2019)

Table 3: Moisture content, total ash and acid insoluble ash in different parts of *Myrica esculenta*

Plant part	Moisture content (%)	Total ash (%)	Acid insoluble ash (%)	Reference
Leaf	8.72	2.83	0.52	Shah *et al.* (2019)
Stem	9.93	2.47	0.02	
Bark	5	3.4	1.5	
Seed	6.32	2.4	1.3	
Root	4.42	1.3	0.01	
Fruit	72.33	2.18	-	Kabra *et al.* (2018)

Other Applications

Nanoscience

Myrica esculenta bark tannin (BT) was used for the preparation of homogenous Palladium (Pd) nanoparticles as stabilizers. Heterogeneous γ-Al2O3-BT-Pd catalysts were then prepared by the immobilization of the tannin-stabilized Pd nanoparticles (BT-Pd) onto γ-Al2O3. It was found that Pd NPs were well stabilized by the phenolic hydroxyl groups of BT as determined by Fourier Transformation Infrared Spectrum (FTIR) and X-ray Photoelectron Spectroscopy (XPS) analyses. The γ-Al2O3-BT-Pd catalysts were found to exhibit highly for various olefin hydrogenations. The γ-Al2O3-BT-Pd exhibits superior reusability as compared with conventionally prepared γ-Al2O3-Pd catalysts as it was found that it could be reused five times without significant loss of activity (Chen *et al*., 2012).

The leaf extracts of *Myrica esculenta* could be used for the preparation of silver (Ag) nanoparticles within six hours by treating aqueous solutions of 1mM silver nitrate ($AgNO_3$) with leaf extract. The silver nanoparticles ranged in size from 45 to 80 nm, were polydisperse and exhibit a face-centered cubic crystal structure as revealed by their analysis by transmission electron microscope (TEM), X-ray diffraction (XRD) and UV-Vis spectroscopy (Phanjom *et al*., 2012).

Aqueous extracts of *Myrica esculenta* fruits could be employed for the successful synthesis of zinc oxide nanoparticles (ZnO NPs). The fruit extracts acts as reducing and/or capping agent during the process. The characterization of the formation of zinc oxide nanoparticles through X-ray powder diffraction (XRD), X-ray photoelectron spectroscopy (XPS), field emission scanning electron microscope (FESEM) and ultraviolet–visible spectroscopy (UV–vis) revealed the formation ZnO NPs with crystallite size of 31.67 nm. These nanoparticles, so formed, showed antimicrobial, antioxidant as well as photocatalytic activities. Moreover, these particles possess greater antimicrobial activity than that of pure fruit extracts (Lal *et al*., 2022).

Biosorption of heavy metal

The study for the efficiency of *Myrica esculenta* leaf powder as biosorbent for the removal of Cu(II) ions from contaminated wastewater indicated that with higher pH, moderate high temperature, lower metal ion concentration and higher dosage of biosorbents as optimal conditions, the leaf powder could be used for removal of Cu(II) from copper contaminated waste water. Though high regression values were shown in case of all the three isotherm models studied which implies the suitability of copper adsorption on to the leaf powder, the Langmuir isotherm model was found to be most efficient followed by Freundlich and finally Temkin model as indicated by the regression values. Thus, on application of the required conditions, the leaf powder can be used for large scale removal of copper from industrial waste water (Joshi *et al*., 2018).

The waste leaves of *Myrica esculenta* were found to be potential adsorbents of Pb(II), Cd(II) and Zn(II) ions from the waste waters. The efficiency of removal was maximum at a dose of 1g, at pH 6 for 60 min contact time at a temperature of 60^0 C. At pH 6 and contact time 25 minutes, the % adsorption of Pb^{2+}, Cd^{2+} and Zn^{2+} ions was found to be 97.02%, 92.52% and 81.99% respectively. The Langmuir, Freundlich and Temkin isotherm models were used for determination of the equilibrium data of adsorption and it was observed that the adsorption capacity of Pb^{2+}, Cd^{2+} and Zn^{2+} ions were 8.264, 5.617 and 7.751 mgg^{-1} by Langmuir isotherm model. Moreover, Freundlich isotherm is more favourable than the other two models for adsorption of Pb(II), Cd(II) and Zn(II) ions on the surface of leaf powder prepared from *Myrica esculenta* (Joshi *et al*., 2018).

Moreover, the species is used for fuel and fodder (Singh *et al*., 1986; Rastogi and Mehrotra, 1991; Dollo, 2009). On boiling the bark with slake lime a yellow dye is obtained (Kar *et al*., 2008; Kumar *et al*., 2004).

Conservation and sustainable utilization

The species of *Myrica* forms actinorhizal relationship with *Frankia* and so it can lead to the regeneration of nitrogen depleted soil (Yanthan, 2013). Since it can grow in nitrogen depleted soils, the species can be recommended for the various afforestation programmes. In order to meet the requirement of large number of seedlings for carrying out an afforestation programme, the seed germination and viability potential of the species is needed to be evaluated (Wang, 1991).

M. esculenta shows poor germination in their natural habitats because of the presence of an impermeable seed coat which causes physical dormancy. To overcome the poor germination of the seed, presowing treatments can be applied. Prechilling at 4°C for 20 days of mechanically scarified seeds soaked in GA3 (100 ppm) solution may aid in the increase in germination rate (Bhatt *et al*., 2000).

Most of the wild edible species of *M. esculenta* shows poor regeneration in their natural habitats due to high anthropogenic activity as well as biotic pressure which is resulting in a decrease in their population in their native forests (Sundriyal *et al*., 2001). Overexploitation leading to low seedling availability and lack of seeds in the forests may result in threat to extinction of the species from wild (Jeeva *et al*., 2011).

In *M. esculenta,* the male tree density is significantly higher (Rawal *et al.,* 2003). The male and female trees being highly identical in morphology, it becomes difficult for the identification of the economically important female trees until maturity. Therefore, cloning of the mature female trees becomes an effective way for propagation of the preferred specimen. However, trials for propagation using cuttings did not induce rooting (Bhatt *et al.,* 2000).

Steps such as micropropagation may be done for the improvement of growth of the species. However, *M. esculenta* fails to show satisfactory response even in germination trials in nursery conditions. One of the reasons for this could be the production of phenols and other chemical produced by the plants (Sun *et al.,* 1988). These problems can be addressed by applying methods for the manipulation of various factors that play a role in improvement of micropropagation of *M. esculenta* tress.

Bhatt *et al.* (2004) suggested certain factors effective for the micropropagation of *M. esculenta* plants.

- Media additives: Treatment with 0.1% $HgCl_2$ for 10 minutes provides maximum aseptic cultures. Polyvinylpyrollidone (PVP; 0.5%) is an effective media additive and also helps in removal of phenolic compounds.
- Season: The season of collection of explants plays an important role in reduction of browning caused by phenol and bud break induction. Explants collected during winter season *i.e.*

November – December induces maximum bud break.

- Standardization of the media: Woody Plant Medium (WPM) supplemented with 10µM kinetin and 0.1µM naphthalene acetic acid (NAA) is an appropriate media for explants establishment.

- Plant growth regulators: Compared to benzyl amino purine and N6(γ,γdimethylallyamino)purine (2iP), kinetin is an better option for multiplication of explants.

A study on the future distribution pattern of *Myrica esculenta* in response to climate change using Maxent model showed that in the absence of anthropogenic pressure and evolutionary change in the natural zone of distribution, there would be an increase in the environmentally suitable habitats in northwestern Himalayas (Bhandari *et al*., 2020). Thus, efforts to conserve the species might reduce its possibility of extinction.

Certain strategies, as suggested by Gusain and Khanduri (2016) could be adopted for sustainable utilization of the plant species. Selection of high yielding and disease free trees in the wild based on the extent of presence of phenolic compounds and antioxidative properties of the fruits and use of such selected trees for conservation and as a source of seed and cutting material for micropropagation could be implemented. If successful planting material could be prepared then growers should be supplied with it and encouraged to establish orchards of the same.

Conclusion

Myrica esculenta possess several nutritional and medicinal benefits. As the species contains several important phytochemicals, it could be considered for its potential pharmacological aspects. The fruits can be a natural source of antioxidants due to the radical scavenging behaviour of phenolic acids present in them. Also, since the species can be used for afforestation programmes because of its ability to harbour *Frankia* and fix nitrogen, its regeneration rate is needed to be increased. By applying means for breaking of the physical dormancy and by addressing the factors that influence micropropagation such as standardization of the media, collection season, media additives and plant hormones, propagation of the commercially important female plants can be carried out. However, further scientific studies on the extraction of the several bioactive compounds present in different parts of *Myrica esculenta* plants along with their pharmacological effects are needed to be done. Due to anthropogenic activities the species might be facing risk of extinction in the wild in near future and concern needs to be raised for sustainable use and multiplication of the species. Thus, research methodologies for the conservation of the species to limit unsustainable overuse are an immediate need of the hour.

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References

Anonymous. (1962). A dictionary of Indian raw material and industrial products. CSIR Publ., New Delhi, 6(L-M). Pp: 471-472.

Becking JH (1977). Dinitrogen- fixing associations in higher plants other than legume. In: Hardy, R.W.F. and Sibber, W.S. (eds) A treatise on denitrogen fixation, Sec.3 (Biology), Wiley- Inter Science, New York.

Benson DR and Silverster WB. (1993). Biology of Frankia strains, actinomycete symbionts of actinorhizal plants.Microbiol Mol Biol Rev. 57(2): 293-319.

Bhandari MS, Shankhwar R, Meena RK, Pandey S, Kant R, Barthwal S, Ginwal HS and Chauhan JS. (2020). Past and future distribution pattern of *Myrica esculenta* in response to climate change scenario. Model Earth Syst Environ. 1-16.

Bhatt ID, Rawal RS and Dhar U (2000). Improvement in seed germination of *Myricaesculenta*Buch.-Ham. ex D. Don-a high value tree species of Kumaun Himalaya, India. Seed Sci Technol.28(3): 597-605.

Bhatt ID and Dhar U (2004). Factors controlling micropropagation of *Myrica esculenta*buch.–Ham. ex D. Don: a high value wild edible of Kumaun Himalaya. Afr. J. Biotechnol. 3(10): 534-540.

Chandra S, Saklani S, Mishra AP and Badoni PP. (2012). Nutritional evaluation, antimicrobial activity and phytochemical screening of wild edible fruit of *Myrica nagi* pulp. Int J Pharm Pharm Sci. 4(3): 407-411.

Chatterjee A and Pakrashi SC. (1994). The Treatise on Indian Medicinal Plants. New Delhi: Publications and Information Directorate, 1. Pp: 32-33.

Chen C, Lv G, Huang X, Liao XP, Zhang WH and Shi B. (2012). Bayberry Tannin as Stabilizer for the Synthesis of Highly Active and Reusable Heterogeneous Pd Catalysts and Their Application in the Catalytic Hydrogenation of Olefins. Bull Korean Chem Soc.33(2): 403.

Dhani A. (2013). Major wild edible fruits used by locals of Garhwal Himalaya. Int J Adv Lif Sci. 6: 145-149.

Dollo M, Samal PK, Sundriyal RC and Kumar K. (2009). Environmentally sustainable traditional natural resource management and conservation in Ziro valley, Arunachal Himalaya, India. J Am Sci. 5(5): 41-52.

Goyal AK, Mishra T, Bhattacharya M, Kar P and Sen A. (2013). Evaluation of phytochemical constituents and antioxidant activity of selected actinorhizal fruits growing in the forests of Northeast India.J Biosciences. 38(4): 797-803.

Gusain YS and Khanduri VP. (2016). *Myrica esculenta* wild edible fruit of Indian Himalaya: need a sustainable approach for indigenous utilization. Eco Env Cons. 22: S267-S270.

Hooker JD. (1876). Flora of British India. Bishan Singh Mahendra Pal Singh, Dehradun, Vol. V.

Huguet V, Land EO, Casanova JG, Zimpfer JF and Fernandez MP. (2005). Genetic diversity of *Frankia* microsymbionts from the relict species *Myrica faya* (Ait.) and *Myrica rivas-martinezii* (S.) in Canary Islands and Hawaii. Microb Ecol. 49(4), 617-625.

Joshi NC and Bahuguna V. (2018). Biosorption of copper (II) on to the waste leaves of kafal (*Myrica esculenta*). Rasayan J Chem. 11(1): 142-150.

Joshi NC, Singh A and Rajput H. (2018). Utilization of Waste Leaves Biomass of *Myrica esculenta* for the Removal of Pb (II), Cd (II) and Zn (II) ions from Waste Waters. Oriental Journal of Chemistry.34(5): 2548-2553.

Kabra, A., & Baghel, U. S. (2018). Nutritional Value and Elemental Analysis of Katphala (Myrica esculenta Buch-Ham). *J. Biol. Chem. Chron*, *4*(2), 19-25.

Kabra, A., Sharma, R., Hano, C., Kabra, R., Martins, N., & Baghel, U. S. (2019). Phytochemical composition, antioxidant, and antimicrobial attributes of different solvent extracts from myrica esculenta buch.-Ham. ex. D. Don Leaves. *Biomolecules*, *9*(8), 357.

Kachari A, Hazarika P and Dutta D. (2018). Study of Beneficial Microorganisms in the rhizosphere soils of *Myrica esculenta* (Buch.-Ham. ex D. Don.). Life Sciences Leaflets.95: 12-31.

Kar A and Borthakur SK. (2008). Dye yielding plants of Assam for dyeing handloom textile products. Indian J Tradit Know. 7(1): 166-171.

Kirtikar KR and Basu BD. (1988). Indian Medicianl Trees. Allahabad (India): Lalit Mohan Basu publishers, 3. Pp: 2350-2351.

Kirtikar KR and Basu BD. (1999). Indian Medicinal Plants. New Delhi: International book distributors, 3(2). Pp: 1699.

Kumar JK and Sinha AK. (2004). Resurgence of natural colourants: a holistic view. Nat Prod Res. 18(1): 59-84.

Lal S, Verma R, Chauhan A, Dhatwalia J, Guleria I, Ghotekar S, & Kumar P (2022). Antioxidant, antimicrobial, and photocatalytic activity of green synthesized ZnO-NPs from *Myrica esculenta* fruits extract. *Inorganic Chemistry Communications*, *141*, 109518.

Mann S, Satpathy G and Gupta RK. (2015). In vitro evaluation of bio-protective properties of underutilized *Myrica esculenta*Buch.–Ham. ex D. Don fruit of Meghalaya. Indian J Nat Prod Resour. 6(3): 183-188.

Muckun IR, McNaughton SJ, Raynal DJ and Leopold DJ. (1993). Comparative foliage and twig chemistry of co-occurring *Myrica gale* and *Chamaedaphne calyculata*. Can J Bot. 71(1): 129-135.

Osmaston AE. (1927). (Reprinted 1978). Forest Flora for Kumaun. Dehradun: International Book Distributor. Pp: 605.

Parmar C and Kaushal MK. (1982). *Myrica nagi*. In: Wild Fruits of the Sub-Himalayan Region. Eds. Parmar C and Kaushal MK. Kalyani Publishers, New Delhi. Pp: 49-53.

Patel RK and De LC. (2006). Soh-phie (*Myrica* species) an unexploited fruit of the future for Meghalaya. Envis Bulletin Himalayan Ecology. 14(1): 34-37.

Patel VG, Patel KG, Patel KV and Gandhi TR. (2017). Development of Standardisation parameters and Isolation of Phytomarker Myricetin from stem bark of *Myrica esculenta* Buch. Ham. Ex d. Don. J Pharmacogn Phytochem. 6: 29-34.

Phanjom P, Zoremi E, Mazumder J, Saha M and Baruah SB. (2012). Green synthesis of silver nanoparticles using leaf extract of *Myrica esculenta*. Int J Nanosci Nanotechnol. 3(2): 73-79.

Rastogi RP and Mehrotra BN. (1991). Compendium of Indian Medicinal Plants. Lucknow: Central Drug Research Institute (CDRI) and New Delhi: Publications & Information Directorate, 1: Pp: 1960-1969.

Rawal, R. S., Pandey, B., & Dhar, U. (2003). Himalayan forest database–Thinking beyond dominants. *Current Science*, *84*(8), 990-994.

Sahu S, Sahu CR, Yadav A, Rathod P, Chaturvedi S and Tripathi R. 2013. Review on *Myrica esculenta* A popular plant of Himalayan region. J Chem Pharm Sci. 6: 93-97.

Seal T. (2011). Nutritional composition of wild edible fruits in Meghalaya state of India and their ethno-botanical importance. Research Journal of Botany. 6(2): 58-67.

Shah, H., Naseer, A., Pandey, A. K., & Upadyay, P. (2019). Physiochemical and Phytochemical Screening of Various

Extracts of *Myrica esculenta* Linn. Himalayan Plant. *Seed*, *6*(2.4), 1-3.

Singh J, Lal VK and Trivedi VP. (1986). Pharmacognistic evaluation of katphala (The bark of *M. esculenta*).Anc Sci Life. 6(2): 85-87.

Srivastava B, Sharma VC, Pant P, Pandey NK and Jadhav AD. (2016). Evaluation for substitution of stem bark with small branches of *Myrica esculenta* for medicinal use- A comparative phytochemical study. J Ayurveda Integr Med. 7(4): 218-223.

Sun D, Zhao Z, Wong H and Foo LY. (1988). Tannins and other phenolics from *Myricaesculenta* bark. Phytochemistry. 27(2): 579-583.

Sundriyal M and Sundriyal RC. (2001). Wild edible plants of the Sikkim Himalaya: nutritive value of selected species.Econ Bot. 55(3): 377- 390.

Wang BSP. (1991). Tree and shrub seed. In: Advances in Research and Technology of seed. Ed. Bradnock, W.T. International Book Distributors, Dehradun, India. Pp: 34-43.

Wheeler CT and Bond G. (1970). The amino acids of non-leguminous root nodules. Phytochemistry. 9(4): 705-708.

Yanthan M and Misra AK. (2013). Molecular approach to the classification of medicinally important actinorhizal genus *Myrica*. Indian J Biotechnol. 12(1): 133-136.