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Research Review

Elaeagnus latifolia (Linn), An Underutilized Fruit of North-East India: A Comprehensive Review

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ABSTRACT

Elaeagnus latifolia Linn, a large woody scandent shrub belongs to family Elaeagnaceae and is found in wild as well as semi wild habitat of South East Asia, extending up to Middle East and Europe. Its fruits are rich in vitamins, minerals, essential fatty acids and other bioactive compounds such as phenolics, flavonoids. They have been used in many traditional medicines by the various ethnic communities of the region as hepatoprotective, anti-inflammatory and antipyretic agents. Due to the presence of high antioxidant lycopene in the fruit pulp, this fruit is believed to have anticancer property and also shows tyrosinase inhibitory activity. The extracts of leaves and fruits have antibacterial property against some gram-positive and gram-negative bacteria. Though these fruits have many nutritional benefits, it is considered as an underutilized fruit of North East India, due to lack of knowledge of locals and not grown commercially. Due to over exploitation and loss of natural habitat, the plant is facing a threat to exist in the wild. Hence, proper scientific intervention is required for the conservation and sustainable utilization of the plant for future improvement programs.

***Key words*:** *Elaeagnus latifolia*, Hepatoprotective, Anti-inflammatory, Antipyretic, Tyrosinase inhibitory activity

India's north-eastern region is considered as one of the mega plant biodiversity hotspots. It falls under Indo-Burma biodiversity hotspot which ranks among top 10 biodiversity hotspots of the world [1]. Due to the variability in the nature of soil, climate and topography, North-east region harbors a tremendous amount of endemic plant species including fruit crops, medicinal and aromatic plants, fodder plants and ornamental plants, particularly orchids [2-4]. Apart from the commercially cultivated fruits, the region is very rich in diversity of under-utilized and under-exploited fruits which remained scattered in semi-wild or semi-domesticated conditions throughout the region [5]. Although these fruits are not appropriately exploited, since time immemorial they are found to play a significant role in the food and nutritional supplement of the local people, particularly for the rural communities [6]. Most of these underutilized fruits are a good source of vitamins, minerals, carbohydrates, fats, proteins and other bioactive compounds. Besides providing nutritional benefits, these fruits are used in the traditional system of medicines and folklore [7].

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Fruits of *Elaeagnus latifolia*, commonly known as bastard oleaster, is one such underutilized fruit of North-East region. It belongs to the family Elaeagnaceae and is locally known as 'Mirika-tenga' or 'Bon-Jora' in Assam, 'Solengi-arikong' in Karbi, 'Beerai-esing' in Mishing, 'Heyai' in Manipur, 'Soh-shang' in Khasi hills, 'Slangi' in Jaintia hills, 'Sokua' in Garo hills and Muslerhi in Sikkim [8]. The species is widely distributed from the Northern regions of Asia to the Himalayas and Europe [9]. Among the North-eastern states, this species has been reported in the Dikhow valley of Sivasagar (Assam), Naga hills of Nagaland, Khasi and Jaintia hills of Meghalaya, Diwang and Tawang area of Arunachal Pradesh [10].

Botanical description

Elaeagnus latifolia is a large woody, much-branched, evergreen, fast-growing, scandent shrub with rust color shining scales which often have thorns throughout the body. The leaves are alternate, pinnately compound, acute or rounded at the base and silver speckled over green colour. In general, it flowers in September-December, and the fruits are harvested during the month of March-April. The flowers are hermaphrodite, white in colour, delightfully fragrant and are often pollinated by bees. The fruit is oblong in shape with a single large seed. At early stage, fruits are green in colour but at the time of ripening its pericarp turns into an attractive pink colour. Fully ripen fruits are very delicious, taste sweet with hints of sourness or acidic and pleasantly refreshing. The

fruits are quite perishable and cannot be stored for more than 3-4 days at room temperature.

Ecology of the plant

The genus *Elaeagnus* has been reported to be found in many parts of the world, viz. China, Japan, Korea, Taiwan, India, Pakistan, Iran, Turkey and Europe to the USA and Canada [11]. *E. latifolia* grows mostly in swamps, and have been reported growing at an elevation of 1500 and 2600m above mean sea level in the Himalayas [12-14]. There has also been report of this species growing in subtropical and warm temperate zones [15-16]. In semi-wild conditions, the plant is commonly found in the backyard garden of many local people of the region. It can tolerate a wide range of habitats and environmental stresses like high salinity, extreme pH, heavy metal etc. It can grow even in nutrient-poor condition soil. *E. latifolia* is an actinorhizal plant and forms symbiotic association with the nitrogen-fixing bacterium Frankia, which plays a crucial role in fixing of atmospheric nitrogen to the soil and restoring the degraded environmental conditions [17-19].

Nutritional value of the fruit

The genus *Elaeagnus* contains mono- and disaccharides in the leaves; fructose, carotenoids and L-ascorbic acid in the fruits; and fatty acids and phytosterols in the seeds, leaves and stems [20].

Fruits of *Elaeagnus latifolia* are nutritionally very rich in vitamins, especially vitamin A, C and E. They are also rich in various macroelements such as calcium, magnesium, potassium, sodium, nitrogen phosphorous and microelements like zinc, copper, ferric, manganese etc. [21-23]. The major carbohydrates present in the fruits are fructose and glucose [24]. They also contain a good amount of essential fatty acids such as oleic acid, stearic acid, linoleic acid and palmitic acid, which are not typically found in any fruits [25-26]. Besides these, the fruits have been reported to contain a significant amount of phytochemicals such as phenolics (such as purpurin, gallic acid, anthraquinone), flavonoids (such as rutin, catechin, quercetin), ascorbic acids, carotenoids, tannins (such as tannic acid), terpenes (such as terpenoids, triterpenoids), alkaloids (such as reserpine) and other bioactive compounds like 1-Chloroflouoethane, Cyclopentanone, 2-Methyl nhexadecanoic acid, 9-Octadecenoic acid, Octadecanoic acid, E-11-Hexadecenal, Hexadecanoic acid-2-hydroxy1-(hydroxymethyl) ethyl ester, 1,2-Benzenedicarboxylic acid, dioctyl ester, 9,10 antracenedione, 1,8 dihydroxy3-methoxy-6-methyl (Parietin) [27-30] Anthocyanins, proanthocyanins, catechins and flavonols as the major flavonoid groups and hydroxylated derivatives of cinnamic acid (p-coumaric, ferulic acid) and benzoic acid (4-hydroxybenzoic acid, vanillic acid, protocatechuic acid) as the major phenolic acids are also present in the fruits [31-32]. Hydroxybenzoic acid derivatives are responsible to enhance the nutritional value of food by reducing the oxidation of nutrients. The fruit pulp contains an abundance of lycopene reserve in it [33]. The seeds of the fruits are found to contain a profuse amount of fats and proteins (albumin and globulin). Previous work on HPTLC fingerprinting analysis of *E. latifolia* flowers, reported the presence of phytosterols, glycosides and saponins in them [34]. Physio-chemical property in the fruits of *Elaeagnus latifolia* at various maturity stage and stated that with the advancement of maturity and ripening of *Elaeagnus* fruit, the tannin content, fiber content and ascorbic acid present in them gradually diminishes, while total soluble sugar and carotenoid content significantly increases [35].

Antioxidant property

The compound viz. purpurins, tannic acid, rutin, catechin, quercetin and reserpine present in *Elaeagnus latifolia* were previously reported to have antioxidant property [36-40]. Free radical scavenging activity of methanolic extract of the fruits as well as leaves of *Elaeagnus latifolia* by DPPH and hydrogen peroxide in terms of inhibitory concentration (IC_{50}) against a standard ascorbic acid [41]. DPPH scavenging activity of the methanolic extract of fruits and leaves exhibited an IC_{50} value of 144.64±0.25µg mL^{-1} and 200.39±5.44µg mL^{-1} respectively as compared to standard ascorbic acid of IC_{50} value 29.39±7.11µg mL^{-1}. Whereas hydrogen peroxide scavenging assay of the methanolic extract of fruits and leaves was found to be showing an IC_{50} value of 487.31±6.17µg mL^{-1} and 444.59±3.77µg mL^{-1} respectively, in comparison with standard ascorbic acid of IC_{50} value 279.89±1.81µg mL^{-1}. This shows that methanolic extract of the leaves and fruits of *Elaeagnus latifolia* act as strong antioxidants as well as DNA protection from oxidative degradation. In another work, it was found that 70% methanol extract of *E. latifolia* fruit contains small amounts of phenols, flavonoids, ascorbic acid, carbohydrates and tannins [42]. Due to the presence of these phytochemicals, *E. latifolia* possesses moderate antioxidant activity which can be helpful in preventing the oxidative damages of cells in the human body. In 2019, Meeploy and Niwaspragrit investigated that fruits of *E. latifolia* contain high phenolic compounds which could be one of the main contributors for the antioxidant property of the fruit. This is due to the redox properties of phenolic compounds for which they can act as reducing agents, hydrogen donors, singlet oxygen quenchers or metal chelators [43]. In a more recent report, a comparative study was carried out on the pulp extracts of *E. latifolia* for the analysis of total phenolic content, carotenoids, ascorbic acid and antioxidant activity by using 5 different environmentally friendly methods viz. agitation, percolation, Soxhlet, ultrasound assisted extraction with ethanol and hydro distillation. Of all these methods, Soxhlet showed highest extraction efficacy and antioxidant property was almost similar in all the methods [44].

Inhibition of tyrosinase activity

Fruits of *Elaeagnus latifolia* contain at least three classes of compounds including ascorbic acid, carotenoids, and phenolic compounds, which can inhibit tyrosinase activity [45]. Tyrosinase, also known as polyphenol oxidase (PPO), is a multifunctional copper-containing enzyme widely distributed in nature, including bacteria, fungi, higher plants and animals [46-47]. In case of mammals, tyrosinase causes pigmentation of the skin, eyes and hair [48]. In plants, it is responsible for undesired enzymatic browning of farm products, such as bruised or cut fruits and vegetables, which ultimately leads to a significant decrease in nutritional and market values [49-50]. The tyrosinase inhibitory activity of fruit flesh extracts of twelve *Elaeagnus latifolia* trees were determined at a concentration of 6.00 mg/mL using the dopachrome method with L-DOPA as a substrate. It was observed that all the flesh extracts exhibited inhibitory activity against mushroom tyrosinase ranging from 72.41 ± 2.42% to 15.99 ± 3.29%. Also, color alteration from colorless to reddish brown colored dopachrome was observed in the reaction mixture containing the fruit flesh extracts [51].

Antimicrobial property

A study by Roza *et al*. [52] using paper disc diffusion method and microdilution method revealed that the leaf extracts of *E. latifolia* have antimicrobial property against both gram-positive bacteria (*Staphylococcus saprophyticus*) and gram-negative bacteria (*Salmonella enterica*). Paper disc diffusion of the leaf extract showed better inhibitory effect against *S. saprophyticus* than *S. enterica*, but the inhibition was very weak. On the other hand, the microdilution method showed good inhibition against *S. saprophyticus* in comparison to a standard drug chloramphenicol with MIC and MBC values of 1250µg/ml respectively. Furthermore, there is another report in which methanolic extracts of leaves and fruits of *E. latifolia* were tested against some pathogenic microorganisms considering ofloxacin as standard drug [53]. In this experiment it was revealed that the leaf extract of *E. latifolia* showed an inhibition against *B. subtilis*, *S. aureus*, *S. faecalis* and *P. mirabilis*, but no inhibition against *E. coli* was observed. The fruit extract of the plant showed inhibition only against the gram-positive bacteria and not against the gram-negative bacteria. From the results, it is clear that the plant is potent against the tested microorganism.

Anti-cancerous property

Oxidative stress and reactive oxygen species (ROS) are responsible for aging and many other diseases such as cancer, cardiovascular diseases, and diabetes type of dysfunction [54]. Studies have showed that the fruits of *E. latifolia* helps in prevention of cancer as well as reversing the growth of cancer. This might be due to the presence of high concentration of antioxidant lycopene in the pulp of the fruit. Lycopene has been reported to have inhibitory effect against both in vitro and in vivo cancerous cells. The anti-cancerous activity of lycopene is mediated through reactive oxygen species (ROS) scavenging, removal of toxic substances, inhibition of malignant cell proliferation and increase in gap junction communication, which remains suppressed during carcinogenesis [55-56].

Hepatoprotective property

WU *et al*. [57] studied the effect of dried powdered fruit of *E. latifolia* (ECR) on blood alcohol clearance. The activities of hepatic alcohol dehydrogenase (ADH) and aldehyde dehydrogenase (ALDH) was determined by inducing acute alcohol intoxication in mice with Hongxing liquor containing 65% v/v ethanol orally. These mice were pretreated with ECR at 200, 400 and 800 mg/kg 30-mins prior to administration of alcohol. It was found that the concentration of blood alcohol at 4 h after alcohol ingestion, pretreated with 800 mg/kg ECR, decreased by 21.2%. The activities of hepatic alcohol dehydrogenase (ADH) and aldehyde dehydrogenase (ALDH) were enhanced by ECR. Therefore, it possesses the potential to ameliorate the damage to human health that high alcohol intake often causes.

Traditional uses of the plant

Traditionally, *E. latifolia* is famous for its fruits in the north-eastern region of India. The fruits are harvested from the wild for some local use as food or sometimes for medicinal purposes. Its fruits are edible, juicy and can be eaten raw with salt or used to prepare chutneys. The fruit pulp is used in making varieties of sauces, pickles, jams, jellies and pies. Sometimes the fruits are also used in preparing herbal tea, refreshing drinks, wine, ice cream topping, dessert etc. [58]. In Meghalaya, fresh fruits of *E. latifolia* are mixed with sugar and fermented for 5 months for the preparation of wine [59]. Apart from enjoying it as a fresh fruit, other parts of the plant such as its leaves are used as fodder for cattles and its wood as a source of fuel [60]. The plant parts of *E. latifolia* have also been used in folklore medicines, particularly its flowers are considered to have astringent, analgesic, muscle relaxant, hepatoprotective, anti-inflammatory and antipyretic properties. It is also used to prepare some laxative herbal medicines [61]. In Vietnam and Thailand, *Elaeagnus latifolia* is used for the treatment of diarrhea, dysentery, asthma and bleeding [62]. In some parts of Mizoram, the root juice is taken orally (5-10ml, 1-2times daily) to remove retained placenta and root decoction (10-15ml orally, 3times daily) is used for the treatment of threatened abortion [63]. In Meghalaya, the Garo tribes uses *E. latifolia* fruits (two spoonful of fruit juice taken twice daily) for the treatment of Anemia [64]. The fruit has been also reported to have the ability to reduce the occurrence of cancer or it can reverse or halt cancerous growth [65]. In a study conducted on the ecological significance of actinorhizal plants of Kumaun range of Himalayas, it was found that *Elaeagnus latifolia* has land reclamation property. They are widely planted in these regions by the locals to prevent soil erosion [66].

(a) (b) (c)

Fig 1 (a) Dorsal view of leaf of *Elaeagnus latifolia* (b) Ventral view of leaf of *Elaeagnus latifolia* (c) Ripe fruit of *Elaeagnus latifolia*

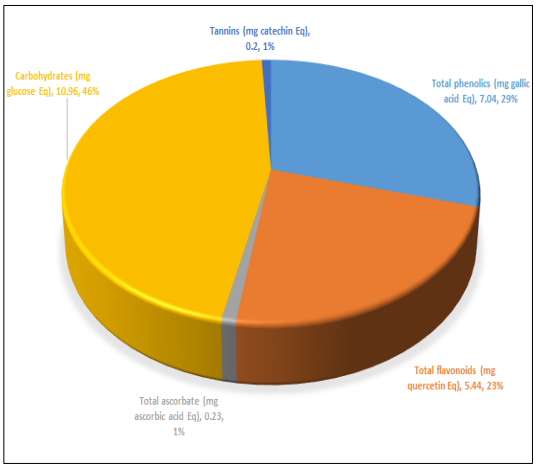

Fig 2 Quantitative phytochemical analysis of 70% methanol extract of *Elaeagnus latifolia* Linn

Source: Panja *et al*. [69]

Other uses

Among the ethnic communities in Vietnam, leaves of *E. latifolia* have been used as a natural colouring agent for colouration of rice, thus replacing the artificial colour and lessening the health risk [67]. The insecticidal properties of extracts from leaves and fruits of *E. latifolia* against the nymph of mealybug (*Phenacoccus manihoti*) by using leaf dipping method [68]. He found out that ethanolic extract from bastard oleaster fruits by Soxhlet method and leaves by percolation method at 5% concentrations were highly effective in killing the nymph of mealybug with the LC_{50} at 48 h for 2.64 and 2.83%, respectively.

Table 1 Quantitative morphological property of fruit of *Elaeagnus latifolia* Linn collected from Meghalaya, India

Fruit weight (g)	14.06
Fruit length (cm)	3.3
Fruit diameter (cm)	2.39
Pulp recovery (%)	70.24
Seed weight/fruit (g)	3.19
Seed length (cm)	2.8
Seed diameter (cm)	1.29

Source: Patel *et al*. [70]

Table 2 Antibacterial property of 70% methanolic extract of fruits and leaves of *Elaeagnus latifolia* Linn

Methanolic extract and standard drug	Zone of Inhibition in mm (Mean ± SD)				
	Gram positive bacteria			Gram negative bacteria	
	B. subtilis	*S. aureus*	*S. faecalis*	*E. coli*	*P. mirabilis*
Leaf Extract (250µg)	10 ± 1.00	12 ± 1.52	11 ± 1.60	–	10 ± 2.08
Leaf Extract (500µg)	12 ± 1.00	11 ± 2.10	14 ± 1.52	–	13 ± 1.51
Leaf Extract (1000µg)	15 ± 1.52	17 ± 2.51	19 ± 1.52	–	18 ± 1.52
Fruit Extract (250µg)	10 ± 1.00	12 ± 1.52	13 ± 1.52	–	–
Fruit Extract (500µg)	13 ± 1.10	15 ± 2.51	16 ± 2.51	–	–
Fruit Extract (1000µg)	18 ± 1.00	17 ± 1.52	17 ± 2.10	–	–
Ofloxacin (standard)	28 ± 1.57	35 ± 2.00	27 ± 1.52	29 ± 2.51	25 ± 1.0
DMSO	–	–	–	–	–

Source: Dutta *et al*. [41]

CONCLUSION

This review aims to provide a comprehensive data on the traditional uses, phytochemistry and pharmacological properties of *E. latifolia*, which is an underutilized fruit plant. It also includes the botanical description and ecology of the plant. The study reveals that the plant contains a fairly good amount of phytochemicals which are responsible for different biological and pharmacological activities like antioxidant, analgesic, anti-microbial, anti-inflammatory etc. The fruits of this plant have a great potential in food processing industries due to its higher fruit yielding capacity. The plant possesses immense medicinal properties and other benefits, but a very limited number of research work has been carried out till date. This might be due to lack of knowledge of people about the potential, bio prospecting, value addition and market demand of the plant. Steps should be taken for mass cultivation of the plant with proper horticulture techniques along with cost-effective methods for post harvesting of the fruits. However, with the recent change in climate, topography, urbanization, developmental projects and changing lifestyles of people, this plant is facing a great threat and is gradually diminishing from its wild habitat. Therefore, for sustainable genetic conservation, advanced studies should be conducted and proper exploration is needed in order to utilize the plant for future improvement programs.

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