Elaeocarpus spp.: A threatened power generating plant, its geographical distribution, propagation through in vivo condition and its medicinal aspects

Babita Kumari, Apurva Srivastava and Santosh Kumar Tiwari

Abstract
The word Elaeocarpus is derived from Greek work Elaeo means olive and carpus means fruit (referring to olive like fruits produced by the genus). The threatened species of Elaeocarpus generally prefer a warm humid climate and usually occurs between 400 and 1000 m amsl. Elaeocarpus is also part of floral community of the Shola forests found in Nilgiri hills, where it is considered sacred by some tribal communities. Natural E. sphaericus beads are usually traded from Nepal where it grows in Central and Eastern Nepal; 550-1600 m altitude. Originally, the tree was widely distributed across Tarai, Shivaliks and Middle Himalayas. Rudraksha beads are sourced from various species of genus Elaeocarpus. The Rudraksha tree is found in tropical evergreen forests, which are characterized by three-tier forest structure. Rudraksha is usually present in the second storey. In north and central India the beads are sourced from Elaeocarpus ganitrus (syn E.sphaericus) which was once distributed across evergreen forests from sea coast to Himalayan foothills upto 2000m. Rudraksha evokes power in the body, which fights against diseases hence improving health. As per Ayurveda, Rudraksha strengthens the body constitutions. It removes the blood impurities and strengthens the body substance. It removes the bacteria inside as well as outside the Human Body, Rudraksha is said to be a natural tranquilizer and has magnetic properties that control heart rate and blood pressure. Drinking water soaked in beads overnight is also believed to have healing properties. However, due to extensive habitat destruction and over extraction of seeds, the threatened species is needed to be study extensively. The objective of this study related to in vivo propagation, Geographical Distribution, medicinalvalue, issues related to natural regeneration, trade - supply and demand and presents recommendations for conservation action. Further studies are required to answer this anomaly and formulate conservation action in consultation with local populations.

Keywords: Elaeocarpus spp., rudraksha, Medicinal use, Threatened Species, Beads, In vivo propagation

Introduction
Elaeocarpus had been an associated species in mixed broad-leaved forests of Himalayas and Himalayan foothills and was found associated with species like Sal (Shorea robusta) and Oak (Quercus spp.). Extensive deforestation of mixed broad-leaved forests for railways, timber extraction and large-scale conversion of Oak forests into Pine (Pinus roxburghii) in Himalayas has led to loss of native species from the region. The deteriorating situation is worsened by the fact that the germination rate for Rudraksh is very low and erratic due to its hard seed coat. Elaeocarpus sphaericus has been reported to contain alkaloids, glycosides, steroids, flavonoids, tannins, fatty acids, carbohydrates and proteins that have been used for making different medicinal extracts. (Rastogi et al. 1991, Lal 1975) [10, 9]. Fruit extract of Elaeocarpus ganitrus was found analgesic in mice and is tested to be used as painkiller tested extracts from dried E.sphaericus fruit against gram-positive and gram-negative bacteria. The effect of extracts was found to have antidepressant properties. Some extracts of E. sphaericus fruits were found to be effective against bronchial asthma (Singh et al. 2000) [20, 21, 16] while methanolic extract of the of E. sphaericus fruits were found anti-anxiety properties. (Shah et al. 2010) [14].

Geographical Distribution of Elaeocarpus spp. in India and Asia
Today the species is threatened and is grown on hill slopes and on farms for its commercial (including poverty alleviation) and religious values in Nepal (MFSC 2013), whereas such plantations or conservation efforts are not known from India. Commercially there are three types of Rudraksha available: Nepalese, Indonesian and Indian.
Of these 75% of Rudraksh in world market are of Indonesian origin, 20% Indian and other countries and 5% Nepalese. The
Nepal Rudraksh is hard, compact, heavy, and lustrous and considered more powerful due to the environment they grow
in, and hence expensive. Indonesian Rudraksh are smaller, Mukhs or faces are inconspicuous and are cheaper. The Indian
round Rudraksh generally lacks lustre and are commonly known as Indian rough beads. These beads are treated with oil
and dye to increase their market prices. Some species like E. bascoi is endemic; only three individuals of E. bascoi are
surviving in the present. It is a strict endemic species to Palni Hills of Western Ghats, found on the fringes of the moist
evergreen forest at 2011 mansl, and included under ‘endangered’ category by IUCN. After the rediscovery of E. bascoi, no
effective conservation strategies have been undertaken to increase their numbers, and this shows that the tree has been facing many problems in its regeneration. The tree is usually found upto 2000 meters above mean sea level.
The genus Elaeocarpus is spread over distinct regions in Himalayan foothills, South East Asia, Nepal, Indonesia, New
Guinea to Australia, Guam, and Hawaii (Map 2). In Asia, the genus Elaeocarpus consists of 120 species, of which 25 have
been reported from India. Most of the species of Elaeocarpus are confined to the North East and southern India, and a few
species to Andaman and Nicobar Islands. Eleven species were reported from the Western Ghats of Tamil Nadu, including
the recently reported Elaeocarpus aristatus. Rudraksha bead is obtained from seeds of several species of genus of the
Elaeocarpus, with Elaeocarpus ganitrus being the principle species. The genus Elaeocarpus has more than 360 known
species worldwide (Coode, 2007). Storrs et al. in their book ‘Trees and Shrubs of Nepal and Himalayas’ have recorded 26
species of Elaeocarpus from Himalayan region. Another publication of Botanical Survey of India titled ‘Floristic
Diversity of Arunanchal Pradesh’ (Upper Subansiri District) has recorded 7 species of Elaeocarpus from Arunanchal
Pradesh (Map 1). Commonly found associated species growing with Elaeocarpus in its natural habitat are Pterocarpus,

Cycle of Germination of seeds to Complete Tree through in Vivo Propagation
The natural regeneration of Elaeocarpus sp. (Rudraksha) is a slow process due to poor germination rate because of
hard seed coat. Natural germination of Elaeocarpus is less than five percent. The seeds take upto one year for sprouting depending upon the humidity of the soil. In this method, the seeds are collected and the pericarp is left for rotting (in case of matured fruits). After removing the pulp, the seeds are given various treatments like mechanically breaking the endocarp or treating with 1% H2SO4. In some cases, the seeds are also boiled in water to soften the endocarp. After this treatment, the seeds are sown in regular soil conditions hospitable for growth of the plant (Figure 1). The Seed germinate after 40 days of sowing and grows upto baby plant (Figure 2 & 3). Accordingly, The Survival and growth of seedlings of Rudraksh (Elaeocarpus ganitrus) under varied canopy conditions after transplant (Khan et al. 2004) [3]. The flowers are ovoid, conical and elongated. The tree usually flowers during April- June. The flowers of Rudraksha are white with fringed petals and they come into view in April- May (Figure 4 & 5). The fruits of Rudraksha come in June and ripen by August-October. Rudraksha are bulbous in shape with a fat outside. The fruits are covered by a blue colour outer covering when fully ripe, thus the tree is also known as the blue berry tree. This colour is due to micro-structural character of the cuticle and light interference. As the fruit matures the blue colour changes to deep brown/grey/black. Rudraksha beads are enclosed by outer shell of blue/green in color on fully ripening (Figure 6 &7). Rudraksha beads are also called as blueberry beads. This Bead is hard and tubercles inside it. The tree starts giving fruit after 8 years and fruits for a long time after the 8 year period A single Rudraksha tree bears beads in all different faces or mukhils at the same time. The tree is a medium sized evergreen broad-leaved tree, which grow up to the height of 200 ft and about 4 feet in girth. The trunk is roughly circular and mature trees are usually buttressed at the base. The bark is greyish-white in colour and has a rough texture. The leaves of the tree are shiny green. The tree bears fruits that are globose, varying in size from about 30 mm. The Tree of Rudraksha is about 100-150 feet high. It may be 14 meters to 20 meters tall depending on the area and the climate. The diameter of trunk is upto 1 meter. The main trunk of the Rudraksha tree is cylindrical with a grayish white and rough textured bark (Figure 8). In Nature, leafy crown of a Rudraksha tree takes a pyramidal shape. The leaves of Rudraksha tree are shining green on the upper side with a dull leathery dorsal side. In the beginning these leaves are light green in colour and turn into deep green at the time of maturity and changes into yellowish red before turning grey coffee colour and falling. This cycle of leaves continues all over the tree throughout the year (Khan et al. 2004) [3]. The seeds are also prone to fungal rotting. Being insect pollinated, Elaeocarpus supports a large pollinator population. The plantation of tree is promoted on farm lands both for its commercial value as well as for improving soil fertility. On hill slopes, it prevents soil erosion.

Medicinal Uses (Hardainiyan 2015) [2].
The medicinal uses of E. sphaericus are summarized as follows:

<table>
<thead>
<tr>
<th>Extracts used</th>
<th>Properties</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petroleum/ether/benzene/chloro form/acetone/ethanol</td>
<td>Antiblastimatic</td>
<td>Singh et al. (2000) [20, 21, 14]</td>
</tr>
<tr>
<td>Petroleum/ether/methanol/chloro form/water</td>
<td>Analgesic</td>
<td>Naina et al. (2012)</td>
</tr>
<tr>
<td>Petroleum ether/benzene/chloroform/acetone ne/ethanol</td>
<td>Anticonvulsant</td>
<td>Dasgupta et al. (1984) and Asolkar et al. (1992)</td>
</tr>
<tr>
<td>Petroleum ether/ethanol</td>
<td>Antidepressant</td>
<td>Singh et al. (2000) [20, 21, 14]</td>
</tr>
<tr>
<td>Water</td>
<td>Antiabetic</td>
<td>Hule et al. (2011)</td>
</tr>
<tr>
<td>Chloroform/ethanol/Water</td>
<td>Antifungal</td>
<td>Singh et al. (2010, 2008) [17, 14]</td>
</tr>
<tr>
<td>Petroleum ether/benzene/chloroform/acetone ne/ethanol</td>
<td>Anti-inflammatory</td>
<td>Singh and Pandey (1999) [18, 19]</td>
</tr>
<tr>
<td>Water/ethyl acetate</td>
<td>Antihypertensive</td>
<td>Sarkar et al. (1972) [13], Asolkar et al. (1992), Sakat et al. (2009) [12] and Lakshmi et al. (2011) [16]</td>
</tr>
<tr>
<td>Petroleum ether/benzene/chloroform/acetone ne/ethanol</td>
<td>Antimicrobial</td>
<td>Singh and Nath (1999) [18, 19]</td>
</tr>
<tr>
<td>Ethanol</td>
<td>Antioxidant</td>
<td>Kumar et al. (2008) [15]</td>
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Threatened Condition of Endangered *Elaeocarpus sp.*
The species is increasingly threatened day by day and are under threatened and endangered category already.
The reduced rates of natural seed banks along with poor germination rate facilitated by harness of seed coat which excists the water absorption by seed has resulted into significant reduction in the no. of unprotected trees. The delayed fruiting, poor seed viability, poor seed germination rate along with unsustainable collection of seeds impedes regeneration of tree via seeds. This has endangered the existing population of Rudraksh as well. Khan *et al.* (2004) [3] reported the decline in population of Rudraksh trees in North East India due to deforestation. The ethnic importance of the bead has been documented as a principle reason for decline in population.
The major threats related to Rudraksh tree in India has been listed as follows:

**Frugivory**
The frugivorous fauna help seed dispersal but in case of Rudraksh this has proved detrimental for natural regeneration of the tree. Unripe fruits are removed from the tree by the animals before seed formation, which lead to decline in natural seed bank. Lower seed production, unsustainable seed collection coupled with damages due to animals has led to low populations of Eleocarpus in its natural habitat.

**Lack of imports from other countries**
India is the largest market for Rudraksh and related products but most of these demands are fulfilled through imports not benefitting the rural communities which otherwise can earn handsome revenue through cultivation of the tree commercially.

**Lack of knowledge about the tree and the species**
Lack of awareness and rising market prices due to religious belief fuelled demand has led to sever loss of species from the natural habitat of the tree (Dafni 2006) [1]. As a result seeds of many other species are now disguised as Rudraksh and sold to customers.

**Lack of historic and present data regarding the species**
The specie is not listed in the NTFP list of forest products and thus has no data related to it, leading to an opaque picture about the trade.

**Unsustainable collection**
The unchecked collection of beads has reduced the number of trees and natural regeneration in the forests, leading to decrease in the number of trees in the wild (Khan 2005) [4].

Map 1: Geographical Distribution of *Elaeocarpus* Species in India

Map 2: Geographical Distribution of *Elaeocarpus* in Asia

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<table>
<thead>
<tr>
<th>Petroleum ether/benzene/chloroform/aceton/ethanol</th>
<th>Antiulcerogenic</th>
<th>Singh <em>et al.</em> (2000) [20, 21, 16]</th>
</tr>
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<tbody>
<tr>
<td>Methanol</td>
<td>Antixyolytic</td>
<td>Shah <em>et al.</em> (2011) [15]</td>
</tr>
<tr>
<td>Water</td>
<td>Cardiac stimulant</td>
<td>Asolkar <em>et al.</em> (1992)</td>
</tr>
<tr>
<td>Water</td>
<td>Bronchodilatory</td>
<td>Asolkar <em>et al.</em> (1992)</td>
</tr>
<tr>
<td>Methanol</td>
<td>Immunomodulatory</td>
<td></td>
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</table>
Fig 1: Germination of Seeds of *Elaeocarpus recurvatus*

Fig 2: Several Baby Plants of *Elaeocarpus recurvatus* emerging out from seeds

Fig 3: A growing plant of *Elaeocarpus recurvatus*

Fig 4, 5: *Elaeocarpus recurvatus* - Inflorescence Branch

Fig 6: *Elaeocarpus recurvatus* - Green Seeds

Fig 7: *Elaeocarpus recurvatus* - Blue & Black Seeds

Fig 8: *Elaeocarpus recurvatus* - A Mature Tree
Conclusions
The consequence of ignorance and exploitation has resulted in a severe loss of trees from Indian forests. It is found that the spread and distribution of this culturally significant tree has shrunk remarkably. Therefore, it is necessary to locate remaining clusters, identify threats and reverse the declining trend. Further, due to ethno-religious importance the seeds are collected in large number from forest floor causing a depletion of the natural seed bank. The prolonged germination period for the species along with poor germination rate and commercial collection of seeds has led to significant reduction in the number of trees in the wild. In spite of its great importance, the renewal of the population has remained unaddressed as most of the market demands are fulfilled by Nepal and other countries that commercially export the beads.

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References