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

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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 mamsl. *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, Shiwaliks 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, flavinoids, 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.

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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 at present in the world. It is a strict endemic species to Palni Hills of Western Ghats, found on the fringes of the moist evergreen forest at 2011 mamsl, 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 Arunachal Pradesh' (Upper Subansiri District) has recorded 7 species of *Elaeocarpus* from Arunachal Pradesh (Map 1). Commonly found associated species growing with *Elaeocarpus* in its natural habitat are *Pterocarpus*, *Chukrasia* spp., *Dipterocarpus*, *Grewia*, *Artocarpus*, *Kydia* spp. *Terminalia*, *Pongamia* (Noatay 2002)^[8] and other tropical species.

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 to 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 mukhis 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 1: Table Showing Medicinal Properties of *E. sphaericus*

Extracts used	Properties	References
Petroleum/ether/benzene/chloro form/acetone/ethanol	Antiasthmatic	Singh <i>et al.</i> (2000) ^[20, 21, 16]
Petroleum/ether/methanol/chloroform/ water	Analgesic	Naina <i>et al.</i> (2012)
Petroleum ether/benzene/chloroform/acetone/ethanol/	Anticonvulsant	Dasgupta <i>et al.</i> (1984) and Asolkar <i>et al.</i> (1992)
Petroleum Ether/ethanol	Antidepressant	Singh <i>et al.</i> (2000) ^[20, 21, 16]
Water	Antidiabetic	Hule <i>et al.</i> (2011)
Chloroform/ethanol/Water	Antifungal	Singh <i>et al.</i> (2010, 2008) ^[17, 14]
Petroleum ether/benzene/chloroform/acetone/ethanol	Anti-inflammatory	Singh and Pandey (1999) ^[18, 19]
Water/ ethyl acetate	Antihypertensive	Sarkar <i>et al.</i> (1972) ^[13] , Asolkar <i>et al.</i> (1992), Sakat <i>et al.</i> (2009) ^[12] and Lakshmi <i>et al.</i> (2011) ^[6]
Petroleum ether/benzene/chloroform/acetone/ethanol	Antimicrobial	Singh and Nath (1999) ^[18, 19]
Ethanol	Antioxidant	Kumar <i>et al.</i> (2008) ^[5]

Petroleum ether/benzene/chloroform/aceto ne/ethanol	Antiulcerogenic	Singh <i>et al.</i> (2000) ^[20, 21, 16]
Methanol	Antixyolytic	Shah <i>et al.</i> (2011) ^[15]
Water	Cardiac stimulant	Asolkar <i>et al.</i> (1992)
Water	Bronchodilatory	Asolkar <i>et al.</i> (1992)
Methanol	Immunomodulatory	

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 exciscnds the water absorption by seed has resulted into signifciant 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 frugivorus 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

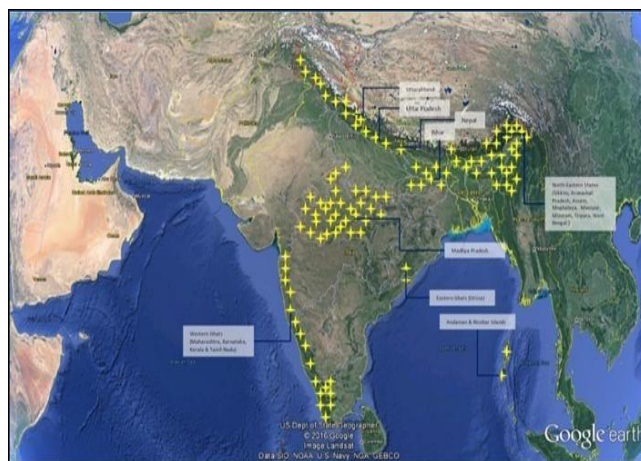
Lack of awareness and rising market prices due to religious belief fuelled demand has led to sever loss of species from the natural habitat of the tree (Dafni 2006) ^[1]. As a result seeds of many other species are now disguised as Rudraksh and sold to customers.

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



(1)



(2)



(3)



(4)



(5)



(6)



(7)



(8)

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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