



17. Seabuckthorn: An Emerging Horticultural Crop of India

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ABSTRACT

Seabuckthorn (*Hippophae* spp. L.) is an ecologically as well as economically wonder plant that is hardy and drought tolerant and can withstand extreme temperatures from 43°C to +43°C. Seabuckthorn berries are among the most nutritious of all fruits. The medicinal property of this magical plant was mentioned in the ancient writings of Greek literature. Seabuckthorn grows naturally in cold and high-altitude areas of India. Berry collection has become an important income-generating source. The period of collection is short but the output is high. Acceptance and marketability of seabuckthorn, as an income-generating source, can be evaluated from the increase in the price of the fresh berry from Rs. 8 per kg in the year 2001 to Rs. 45 per kg in 2017. There are enough opportunities that this hidden treasure of the Himalayas can bring in the livelihoods of the people living in high mountains. Cultivation and commercialisation of seabuckthorn have the budding potential for sustainable development in trans-Himalayan regions of India.

Keywords: Berry, Cultivation, Medicinal, Nutritious, Wonder

1. Introduction

Genus *Hippophae* Linn. also known as Seabuckthorn or magical berry is a shrub that belongs to the family Elaeagnaceae. In ancient Greece, leaves of seabuckthorn were mixed in the fodder and given to the horses which help in their weight gain and a shiny coat also. The generic name *Hippophae* is derived from the Latin word '**Hippo**' means **horse** and '**phaos**' means **toshine** (Rongsen, 1992).

Seabuckthorn is a dioecious and deciduous hardy shrub/tree which is usually spinescent with yellow or orange berries (Bailey and Bailey, 1978). The plant is fast-growing, frost and wind-resistant with brown or black rough bark and a thick greyish-green crown. Leaves are alternate, narrow and lanceolate with a silver-grey colour on the upper side (Synge, 1974). Seabuckthorn can withstand extreme climate including high altitude, drought-resistant salinity

and inundation (Ruan and Li, 2002). Seabuckthorn generally occurs as a wild species distributed widely throughout temperate zones between 27° and 69°N latitude and 7°W and 122°E longitude (Pan *et al.*, 1989; Rousi, 1971) including China, Mongolia, Russia, Great Britain, France, Denmark (Wahlberg and Jeppsson, 1990; Yao and Tigerstedt, 1995). The extensive root system is capable of holding the soil on fragile slopes. Seabuckthorn can be planted in marginal soils on account of its symbiotic association with nitrogen-fixing actinomycetes (Akkermans *et al.*, 1983; Dobritsa and Novik, 1992). Roots of Seabuckthorn are also able to transform insoluble organic and mineral matter in the soil into more soluble states (Lu, 1992). The plant rapidly spreads by rhizomatous roots and quickly colonizes in the adjacent areas. Since the plant is dioecious, the sex of seedlings cannot be ascertained until they start flowering. Flower buds are formed mostly on 3 years old wood, differentiated during the previous growing season (Bernath and Foldesi, 1992). The male inflorescence consists of four to six apetalous flowers. Female inflorescence usually consists of one single apetalous flower with one ovary and one ovule. The plant is anemophilous, therefore, flowers are devoid of nectarines and coloured petals attract insects for pollination (Figure 17.1).



FIGURE 17.1: *Hippophae salicifolia* D. Don (Seabuckthorn)

2. Taxonomic Position

Hippophae is a member of the family Elaeagnaceae. Arne Rousi (1971) classified *Hippophae* into three species based on morphological differences: *Hippophae rhamnoides* L., *H. salicifolia* D. Don, and *H. tibetana* Schlecht. Two taxonomists,

Liu and He (1978) mentioned a fourth species as *H. neurocarpa* from Qinghai-Xizang plateau of China. These classifications were accepted by Lian (1988), but taxonomists are still waiting for a precise classification of Hippophae.

3. Natural Distribution

Seabuckthorn is considered native to Europe and Asia. It is estimated that the total area covered by Seabuckthorn in China, Mongolia and Russia is approximately 810,000 ha of natural stands and 300,000 to 500,000 ha as planted ones (Sun, 1995). Natural Seabuckthorn plantations are abundant in Europe along the river banks and coastal dunes along the Baltic Coast of Finland, Poland and Germany (Biswas and Biswas, 1980; Kluczynski, 1989; Rousi, 1971). In Asia, Seabuckthorn stands are distributed in the trans-Himalayan regions of Nepal, India and Bhutan. The plant is also prevalent in the northern parts of Afghanistan and Pakistan (Lu, 1992).

There are five species of Seabuckthorn viz., *H. rhamnoides*, *H. salicifolia*, *H. neurocarpa*, *H. tibetana* and *H. goniocarpabased* on differences in their morphology. The major species of the plant distributed in India are *H. salicifolia*, *H. tibetana* and *H. rhamnoides*. Out of three species, only two species i.e., *H. salicifolia* D. Don and *H. tibetana* S. are reported in Uttarakhand (Yadav, 2006). In India, distribution is limited to high altitudes of IHR- Himachal Pradesh, Uttarakhand, Jammu and Kashmir, Arunachal Pradesh and Sikkim (Stobdan *et al.*, 2008; Yadav *et al.*, 2009). In Indian Himalayas, it is estimated to cover about 1, 00,000 ha, with the world's second-largest Seabuckthorn resources (Singh *et al.*, 2007).

H. salicifolia D. Don (**Vernacular- Chuk, Tarwa**) is a widely distributed species reported to exist in abundance in Indian Himalayan Region (IHR), between 1500-3500 m.a.m.s.l (Hooker, 1894 and Gaur, 1999). Recently Dwivedi *et al.* (2009) have given the distribution of Seabuckthorn in the different parts of India (Table 17.1). *Hippophae salicifolia* is considered as the best species of genus *Hippophae* which has high-quality fruit, yield and is less thorny (Lu *et al.*, 2001). Flowering in June and fruiting end till October indicating optimum temperature in the high altitudes (Table 17.2).

4. Economic Importance

Seabuckthorn is a valuable multipurpose plant species having great ecological and social values. It is one of the most magical plant resources used as firewood, fodder and also serves as a soil binder in tough and fragile Himalayan terrains. It plays an important role in controlling soil erosion, reclamation of degraded and wastelands, wildlife habitat enhancement, etc. The genus is of great ecological significance as roots show excellent soil binding properties. *Frankia* which is present in its root nodules fixes atmospheric nitrogen, making the soil more fertile. The natural forest of Seabuckthorn can yield 750-1500 kg of berries/ha and seeds also contain high-quality oil which has many bioactive substances (Rongsen, 1992). The plant is tolerant to extreme cold, drought conditions, saline and toxic habitats (Rousi, 1971; Li and Schroeder 1999). The fruits have a distinctive taste of sour and a unique aroma of pineapple reminiscent. *H. salicifolia* berries are used by the local inhabitants in making pickles, strengthening the economy of the poor in rural areas

TABLE 17.1: Distribution of Seabuckthorn species in India

Species (vernacular name)	Ladakh (Tsermang)	Himachal (Chharma)	Uttarakhand (Ames, Chuk, Chu)	North East (Tare, Tarooobo)
Hippophae Rhamnoides	Indus, Nubra, Suru, Changthang valley	Kukumsari, Lakauk, Kaza, Tabo	–	–
Hippophae Salicifolia	–	Lahaul	Yamnotri, Kai, Badrinath, gori, Harindun, Buddi, Dharma, Bagnitiyar	Lachen, Lanchug, Dormang
Hippophae Tibetana	Zanskar	Sangrum, Kibbar, Takcha	Gomukh, Niti, Ranimani, Brtal, Nelong, Shinla, Milan	North Sikkim

(Source: Dwivedi *et al.*, 2009)

Berries are the rich source of carotenoids, minerals, vitamins B, C, E and K. The fruit of seabuckthorn is recorded as a rich source of vitamins and is used in the preparation of various products including local beverages (Gaur, 1999). It has deep roots which make the plant hold soil particles strongly. It acts as a strong soil stabilizer and also helps in the retention of water. It is also called a wonderful plant due to the multifarious benefits it provides (Lu, 1992). Recently, it has attracted considerable attention worldwide mainly for its nutritional, medicinal and environmental values. Pharmacologically, Seabuckthorn is considered significant as an anti-inflammatory, anti-microbial and pain-relieving plant (Li, 1999) (Figure 17.2).

TABLE 17.2: General characteristics of Seabuckthorn species found in India

Species	Distribution	Altitude (m)	Plant height	Flowering time	Fruit ripening time
<i>Hippophae rhamnoides</i>	Tibet, India, Kyrgyzstan, China, Kazakistan, Uzbekistan	600-4200	5-6 m	May	September-October
<i>Hippophae salicifolia</i>	India, Tibet, Bhutan, Nepal	2700-3700	3-10 m	June	October
<i>Hippophae tibetana</i>	India, Tibet, China	3000-5200	0.8-1.2 m	May	August-September

(Source: Dwivedi *et al.*, 2009)

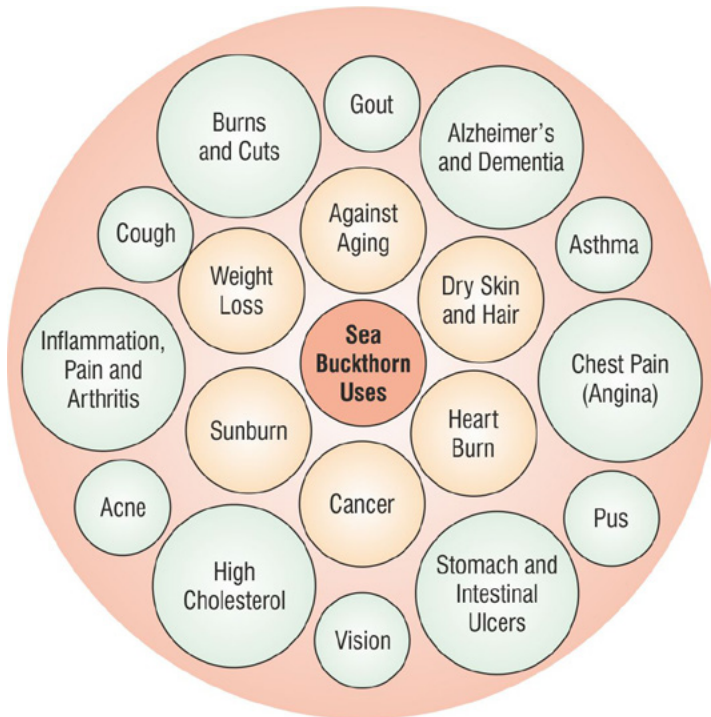


FIGURE 17.2: Multifarious uses of Seabuckthorn

5. Product Development and Income Generation

The total acreage of Seabuckthorn is reported about 3.0 million hectares worldwide (both wild and cultivated cover). Seabuckthorn is found in China, Russia, Mongolia, Canada and Northern Europe. China is the largest producer of Seabuckthorn. The potential of Seabuckthorn as a magical and wonder plant has been acknowledged by several R&D organizations. The Seabuckthorn industry is still in its budding and nascent stages. 13,000 ha of the total area are under Seabuckthorn cultivation. Approximately 600 tons of berries are harvested every year. In the country, Ladakh remains the major site for natural Seabuckthorn resources with over 70% of the total area (13,000 ha). Seabuckthorn has a tremendous potential to lift the socio-economic position of the local populace of the cold desert areas of India. Until August 2001, seabuckthorn was considered a thorny menace, having profuse suckering nature by locals. The plants are being uprooted due to fear of their spread to the fertile soil. In India, seabuckthorn has received increasing attention after the Defence Institute of High-Altitude Research (DIHAR, DRDO) has developed the technology for extracting and manufacturing beverages from its fruit. The patented technology has been transferred to commercial units, NGOs and local entrepreneurs. The industrialists well received the technology and ready-to-serve beverage is currently available in the Indian market under the brand name of 'Ladakh Berry', 'Power Berry'. Tender and healthy leaves from the male plants are mixed with herbs of high elevation like local tea

(*Bidens pilosa*), salam panja (*Dactylorhiza hatigeria*), local caraway (*Carum carvi*), black caraway (*Bunium persicum*), oregano (*Origanum vulgare*), local mint (*Mentha longifolia*), yarrow (*Achillea sp.*) and roseroot (*Rhodiola sp.*) etc. to prepare herbal tea. The herbal tea is bountiful in flavonoids, vitamins along medicinal values (Dwivedi *et al.*, 2006) and has found wide acceptance among the consumers. Several other products such as seapricot beverage, jam, jelly, seabuckthorn oil, soft gel capsule, bakery products, animal feed, etc. are at distinct stages of development and commercialization. Industrialists have shown keen interest in this wonder shrub and its market is expanding day by day. Seabuckthorn fruit worth Rs 1.4 crore has been sold in 2007 from the Ladakh region, which generated employment and rural income. The requirement for fruit is increasing as reflected in the cost of its fruit from Rs 8/kg in 2001 to Rs 22/kg in 2010. The plant is now considered as a potential horticultural crop.

6. Forest Department Initiatives on Seabuckthorn Development

6.1. Jammu and Kashmir

Hippophae spp is found in the Ladakh region i.e., Leh and Kargil District. Two species viz., *H. rhamnoides* and *H. tibetana* are found in the districts but the majority of the area is under *H. rhamnoides*. In the Leh district, the seabuckthorn is naturally found in Nubra and Leh area. Also, the area under seabuckthorn was extended by Forest Department since the 1960s through root suckers. It is found naturally along Zaskar and Suru Valley of Kargil. It is planted by the Forest Department essentially for soil conservation purposes. The Forest department used seabuckthorn in fixing sanddunes in Hunder, Nubra for that more than 70 ha area was planted with seabuckthorn. A total of around 12000 ha is under seabuckthorn (natural as well as planted) in the Ladakh region (satellite imagery-based finding). Presently, it is planted in other ranges/blocks like Durbuk and Nyoma and the results are satisfactory. At present, the Forest Department allows people to collect the fruits during the season by giving permits from forest and community areas. It allots area on a rotational basis. Fruit collection is allowed only up to 10 am as continued collection during the day after 10 am leads to damage to plants (increase temperature leads to loss of turgidity). The present methodology employed is the collection of fruits by beating. There is a detailed regulation on seabuckthorn collection in Leh. Co-operative Dept, Leh collects the fruits from farmers/collectors and pays Rs. 22/kg. The cooperative department makes pulp from fruits and sells it to the industries. As per regulation, Rs. 1000/tonne of pulp is collected and is kept for seabuckthorn development. Forest department is acting as a nodal agency for the Ladakh Autonomous Hill Development Council (LAHDC) for the KVIC-SFURTI (Scheme of Fund for Regeneration of Traditional Industries) Seabuckthorn cluster development programme. The total cost of the project is Rs. 88.5 lakhs in which Implementing Agency contribution. Financial assistance is available for,

1. The creation of Common Facility Centre
2. Product Design and Development
3. Market Promotional Assistance
4. Capacity Building Measures etc.

In the cluster development programme, 500 families and above are enlisted as beneficiaries. It is planned to develop a Common Facility Centre for pulping, product design and packaging. In that, fruit pulping machine, bottle sealing machine, labeller and other instruments so required will be purchased. Training to farmers, uneducated youths in making seabuckthorn juice, jam, sepricot juice, seabuckthorn leaf tea and good management practices have already been started. In the first batch, people from various parts of Leh district were trained in the year 2009 with the help of the Defence Institute of High-Altitude Research (DIHAR). The major aim of the programme is to impart entrepreneurial skills.

6.2. Uttarakhand

Seabuckthorn is wildy found in Uttarakhand Himalaya since time immemorial and its fruit juice was used by the local tribal and ethnic community in districts Uttarkashi, Chamoli and Pithoragarh. However, its use as a medicinal plant and the ecological advantages of sea buckthorn was not known locally. The different species of the wonder plant present in Uttarakhand are *Hippophae salicifolia* and *H. tibetana*. *Hippophae salicifolia* is in abundance in Tons valley, Yamunotri valley above Ranachatti, Alaknanda valley above Hanumanchatti, Bhagirathi above Harsil, Nanadakini above Ghat, Pindar valley above Khati, Saryu above Munnar, Gori Ganga above Lilam, Dhauliganga West above Suraithota, Dhauliganga East above Sobala and Kali valley above Malpa. *Hippophae tibetana* is prevalent in very rare populations, the major ones being a 100ha patch on Burfu glacier and a 20ha patch on Milam glacier. Small populations are also identified at Bedang in Darma valley. The plant is propagated by seeds and by cuttings in many of the high altitude nurseries in Uttarakhand.

A product that has been developed in Uttarakhand is as follows:

6.2.1. Sea Buckthorn Fruit Extract

It is rich in antioxidants, excretes toxins from the body system and is also useful in cancer, diabetes, liver problems etc. This has a good response among the users. After packing, its cost is Rs. 1000/ltr.

6.2.2. Sea Buckthorn Fruit Juice

This product is made from fruit pulp and is good for health but it is not prescribed for patients having diabetes. It is about Rs. 150/ltr.

6.2.3. Sea buckthorn seed powder

It is made by extracting seeds from mature fruits. This is good for cancer and the whole-body system due to its antioxidant property. It is Rs. 500/Kg.

6.2.4. Sea buckthorn seed pickle

The seed powder is also processed into a pickle mixed with salt and other spices. The pickle cost Rs. 600 /Kg.

6.2.5. Himalayan herbal tea

It is prepared from sea buckthorn seed powder, leaves and some other herbs. It is shown in fog 17.3. This herbal tea works as a strong antioxidant and helps

in the treatment of different ailments of the body system which works on the principle of exuding toxins from the body. It cost Rs. 2000/Kg.



FIGURE 17.3: Herbal tea

6.3. Himachal Pradesh

Wild populations of 3 species of Seabuckthorn i.e., *Hippophae rhamnoides*, *H. salicifolia*, and *H. tibetana* have been recorded from Lahaul, Spiti and Kinnaur districts of Himachal Pradesh, the occurrence of natural patches in the state. As per the preliminary assessment, the occupancy of Seabuckthorn in Himachal Pradesh is about 1000 hectares, with a geographical spread extending over about 1000 km² in the districts of Kinnaur, Lahaul & Spiti. More than 80% of the area under Seabuckthorn is a designated forest, with the remaining 20% area being private/community lands.

Seabuckthorn, for departmental plantations, is being currently raised in 8 nurseries in the state with an annual production of about 1.00 lac plants. It is pertinent to mention that the usual technique being followed to raise Seabuckthorn nurseries is from stem cuttings. Cuttings maintained in the nurseries for more than 3 years gave the best survival on planting out. According to studies, Seabuckthorn plantations have been raised over 105 hectares in Lahaul & Spiti district.

6.4. Sikkim

Seabuckthorn is mostly confined to the Lachen and Lachung valleys of north district and few patches are found in the east district. The approximate forest area covered under seabuckthorn is about 800 ha. The species which is most commonly found in Sikkim is *H. salicifolia* and distributed from 8000 to 12000 ft above MSL. The department has initiated harvesting of berries from 2009-10 and about 4000 kgs of raw juice is collected during that year.

7. Seabuckthorn Production and Harvesting

7.1. Soil

Seabuckthorn grows well in a wide range of soil types. It is studied that seabuckthorn profusely grows in soil that is rich in humus, nutrient compounds and a neutral pH. It grows better in well-drained sandy and loamy soil with a high amount of organic matter.

7.2. Irrigation

Seabuckthorn can tolerate drought conditions and is considered a moisture-sensitive plant especially in the spring at the flowering and fruit development stage. Seabuckthorn orchard establishment should be maintained in areas receiving a minimum of 400 mm annual precipitation. The optimum soil moisture content for the mature plants is approx. 70%. Mulching should be practised to reduce the loss of moisture in the soil (Li and McLoughlin, 1997). Black plastic is used during the first 3-4 years to conserve moisture and controlling the weed.

7.3. Manure and Fertilizer

Seabuckthorn has a high requirement of nutrients. The plants require less amount of nitrogen and the requirement of potassium is negligible. Well, rotten dairy manures @45 tonnes/ha should be used depending upon soil condition (Li and McLoughlin, 1997).

7.4. Propagation

The plant can be propagated by various means. The seeds remain viable for more than three years. Fresh seeds do not germinate immediately after harvesting. Seed stratification is performed for 20-25 days in moist sand which makes 85 percent germination possible (Approx.). Cuttings planted in greenhouse/trench/polyhouse result in a higher success rate especially in cold desert areas. Micro-propagation of seabuckthorn has been standardized in Murashige & Skoog media. Defence Institute of High-Altitude Research (DIHAR) has successfully used the soft wood cutting method as a means of asexual reproduction using 200-300 ppm NAA. The technique has yielded 90 percent root ability in cuttings with excellent root quality under mist conditions having coarse sand rooting media. The plantlets get ready for transplantation in poly bags within 90 -100 days after planting of cuttings (Dwivedi *et al.*, 2007). A single seabuckthorn plant produces 13-65 suckers (Dwivedi *et al.*, 2006).

7.5. Nursery Management

Light and well-drained soils are ideal which is at least 1.2 m deep. The site should receive sunlight and irrigation should be assured. The nursery bed should be ploughed deep before sowing. Well, rotten FYM @4kg/m² should be mixed in soil 20-30 days before sowing/planting.

7.6. Orchard Establishment

A single or double hedgerow system of plantation is recommended under the orchard system. In a single hedgerow system, the spacing between rows to row is maintained at 2-4 m for pure cultivation and at 4-5 m for intercropping (Dwivedi *et al.*, 2006). Method and spacing need to be modified based on cultivar, soil fertility status and climatic condition. For economic reasons, the ratio of male to female plants is important as the number of female trees directly affects the total yield. Recommended male plants in an orchard vary from 6 to 12%.

7.7. Cultivar

No recommended cultivar so far is reported for Indian conditions. Production parameters such as yield, ability to harvest, an organoleptic test of fruit, the nutrient profile of fruit and disease resistance need further consideration.

7.8. Harvesting

The process of harvesting seabuckthorn fruit starts soon after ripening and it is considered the most time-consuming operation in growing seabuckthorn. Small fruit size, short pedicel, forces required to pull off each fruit, the density of fruit on the branch and the thorniness of the plant are the major concerns affecting the process of harvesting. In the early morning hours, it is quite easy to harvest the fruits. Fruits are being harvested by beating the bush. Mechanical harvesters and bioregulators need to be used.

8. Post-Harvest and Storage

Seabuckthorn fruits cannot be transported over long distances due to their small size, juiciness and delicacy. Soon after harvesting, the berries should be spread in a shaded area. Pre-cooling is also required and advisable if the temperature during the harvesting period is high. Fruits need to be cleaned and processed as soon as possible for long term storage.

9. Policy Suggestions

There is an urgent call for a National Program on the cultivation of seabuckthorn and, therefore, developmental work needs to be carried on a mission mode. Ladakh is a natural dwelling habitat and over 70% of seabuckthorn is found in Ladakh. Various developmental activities concerning seabuckthorn need to be concentrated and focussed in Ladakh only. Seabuckthorn, till now, is considered a forest menace. It needs to be declared as well as promoted as a horticultural crop which can be a boon to the local populace inhabiting the Trans Himalayan region of India. Hence, the government needs to create a favourable environment for the investors in the form of subsidies, training and skill development on value-added products. Government support is indispensable for the scientific cultivation and propagation of Seabuckthorn. The involvement of private units for large scale cultivation may also be considered. Seabuckthorn varieties from Russia, China, Canada and Mongolia should be imported.

10. Conclusion

Megaprojects on seabuckthorn have been initiated by the Ministry of Environment & Forests as well as by several Research and Developmental organizations given its environmental, biotechnological, nutraceuticals, pharmaceutical and socio-economic potential. Modern scientific research along with traditional use of the wonder plant coupled with commercial value can bring immense benefit to people from the lesser-known magical plant of the Trans Himalayan region *i.e.*, seabuckthorn.

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