

Sea buckthorn:

A wonder bush

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Sea buckthorn (Hippophae L.) is a wonderful plant found in the Himalayan region with multiple pharmacological and commercial benefits. This deciduous shrub belongs to the family Elaeagnaceae and has been used over centuries as food and traditional medicine. A unique mixture of bioactive compounds is present throughout the plant, especially in fruits, which are known as sea berry or siberian pineapple. Sea buckthorn is a rich source of both lipophilic and hydrophilic antioxidants. In vitro and in vivo studies have shown a wide range of beneficial anti-inflammatory, anti-carcinogenic, antioxidant and anti-atherosclerotic properties in juices, jams and oil derived from it. It is a valuable, multipurpose plant extensively grown in Asia, Europe and Canada. In order to use it in the best way for products of human nutrition, it is necessary to recognize its positive aspects and to eliminate the negative ones.

Keywords: Bioactive compounds, Himalayan berry, Nutritional and medicinal properties

SEA buckthorn (*Hippophae rhamnoides* L.) is a diploid ($2n = 24$), cross pollinated dioecious shrub, belonging to family Elaeagnaceae. In Himalayan hills, it is locally called as Tsermang while its fruits are named as Tsestalullu. It has got its name from its habit of growing near the vicinity of the sea and possesses many spines or thorns that form a major part of the sea buckthorn species. In the world, its total acreage cover is reported about 3.0 million hectares (both wild and cultivated) and approximately 90% of the world's sea buckthorn is found in China, being the leading producer among all the countries following Mongolia, Russia, Northern Europe and Canada.

In India, it grows naturally in different parts of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh. According to researchers, there are seven species of genus *Hippophae*, out of which three are native to India, viz. *Hippophae rhamnoides*, *Hippophae salicifolia* and *Hippophae tibetana*, where *H. salicifolia*

and *H. tibetana* are lesser exploited species of sea buckthorn. In terms of nutritional component, berries of *H. salicifolia* are of high quality, rich in vitamin C, and also contain all essential polyunsaturated fatty acids (PUFA) particularly omega-3 and omega-6, with late maturing

attribute. Sea buckthorn also offers interest as ornamental bush. This ideal bush is a blessing for the researchers specifically which are in the fields of biotechnology, nutraceutical, pharmaceutical, cosmetic and environment sciences.

Climate and soil

The Trans-Himalayan Ladakh region of Indian continent, is considered as specialized region for its cultivation, which is characterized by extreme climatic conditions like high wind velocity, high rate of soil erosion, and extreme temperatures, i.e. -30°C in winter to $+35^{\circ}\text{C}$ in summer, which serves ideal for this shrub that can tolerate up to -40°C to $+40^{\circ}\text{C}$. Sea buckthorn is a hardy bush with an extensive root system which has the ability to bind soil particles and aids in nitrogen fixation. Plants are suitable for growing in arable and marginal soils, which in turn ameliorates soil health and also becomes a support system for the smooth growth of other plants. It is quite tolerant to salt-spray adjacent near highways.



Sea buckthorn leaves, thorns and berries (Source: https://en.wikipedia.org/wiki/Hippophae_rhamnoides#/media/File:Seabuckthorn_berries,_Nubra_valley,_Ladakh.jpg)

Cultivation practices

Planting and care: Sea buckthorn grows well under sunny, deep soils with assured irrigation facilities and a good drainage system. It has a deep root system (3–5 m) and requires smooth soil surface (stones/hard rocks free) with optimal 2–3 m depth for its proper growth. Hedge row system (single or double) is mostly recommended for its planting that provides more space between rows (1 m) and lesser space between plants so as to approach each plant easily for training, pruning, harvesting and other cultural operations. In single hedge row system, the distance between rows is maintained at 2–4 m for pure cultivation and 4–5 m for intercropping. However, method and distance of planting can vary as per the climatic condition, fertility status of soil, varietal

features, orchard management practices adopted and harvesting requirements.

The most suitable time for digging pits for plantation is autumn (October-end to early November) and spring (March–April) after onset of dormancy and before sprouting of buds, or at least 45 days before planting, where best plant establishment and its survival has been reported in spring planting.

Pits should be 60 cm diameter, 60–80 cm deep and cleaned properly to which well rotten FYM @2 kg per pit should be added before filling them. In areas with heavy soils, sand should also be mixed to balance the soil porosity level. The pits should then be kept open for solarisation for about 10–15 days and thereafter, they should be filled properly with the prepared mixture.

Varieties and propagation methods: High yielding selections, namely FRL Selection-1, FRL Selection-2 and FRL Selection-3 are used most commonly under cultivation. Most favoured less thorny, big-sized fruit and short duration introductions from abroad are being evaluated at Kukumseri, Lahaul valley of Himachal Pradesh. These selections can be propagated by various methods (Table 1).

Training and pruning: Training is an essential operation to provide a desirable shape to the plant to make cultural operations easier and also provides a strong and scientific structure to the plant. It has been observed that sea buckthorn, being a thorny bush should be restricted to a plant height of less than 2 m for ease in harvesting. Properly managed sea buckthorn plants develop a crown of

Table 1. Different propagation methods popularly used for sea buckthorn

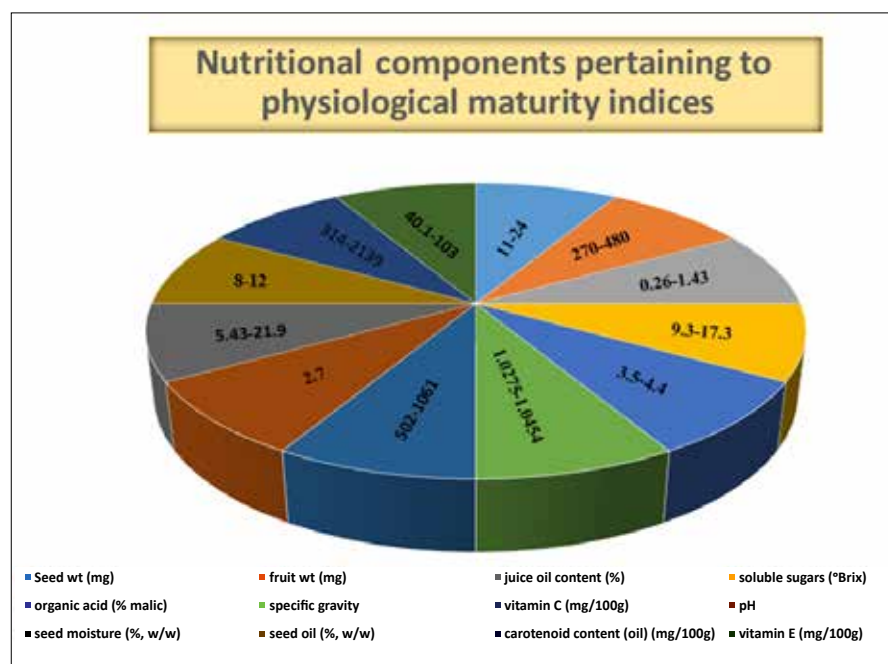
Propagation mode	Procedure
 Seed	- The seeds are brownish-small (4.5 mm) in length with a hard seed coat. One gram may contain about 100–105 seeds. - Seeds remain viable for only a period of 2 years and can be used for successive propagation. - Freshly harvested seeds have a short physiological dormancy and thus, cannot germinate immediately after harvesting.
 Suckers	- Sea buckthorn can also be propagated through its profused suckers that yield about 13–40 suckers per plant depending upon the growing conditions and age of the plants. - These true-to-type suckers are separated along with the roots from the mother plants and planted directly at the planting site. - The optimum time for suckers separation and their planting is in March before bud break.
 Hardwood cuttings	- Stem cutting (1–2 year old) having a pencil thickness is another commercial method recommended ideal for propagation. - The best time for taking cuttings is in March. - The side branches and thorns are removed to make (30 cm) long cuttings which are then washed under running water for a period of 2–3 days. - To ease the rooting initiation in sea buckthorn, indole butyric acid (IBA) @500 ppm before planting is used and it takes 60–75 days for complete rooting. - This method assists in proper development of plant canopy and also maintains appropriate male/female ratio in the orchard.
 Softwood cuttings	- This method is much rapid than hard wood cuttings as it yields over 90% rooting along with excellent root quality specifically under mist condition using coarse sand as a rooting medium. - The softwood cuttings are prepared using NAA @200–300 ppm for propagation. - The plantlets are then transplanted in polybags within 90–100 days after planting of cuttings.

2–3 m diameter at the age of 4 years after planting.

Pruning is essentially required for canopy management, removal of profuse suckers and induction of new growth, which is essential to induce flower buds in next season. The best time of pruning in Ladakh is the month of March before sprouting of the plant in spring. Intensity of pruning depends upon the age and growth of plant, and soil conditions. However, 50% growth of 3–4 year old shoots should be removed.

Harvesting: Vegetatively propagated sea buckthorn plants start bearing fruits early at the age of 3–4 years after plantation than the seedlings that take 5–6 years for fruiting. Their commercial production in orchard starts only after 8 years of plantation.

Yield: The yield of the sea buckthorn plant is dependent on the age, management practices and variety used for cultivation. Cultivated varieties yield about 10–15 tonnes/ha fruit, under properly managed orchard conditions. However, under Ladakh conditions, the yield of the ripe fruits, ranges from 0.6–2.0 kg/plant, since plants are grown in wild and natural conditions. About 200–300 q of the



Nutritional components pertaining to physiological maturity indices

fresh leaves can be harvested/ha/year after 8 years of plantation.

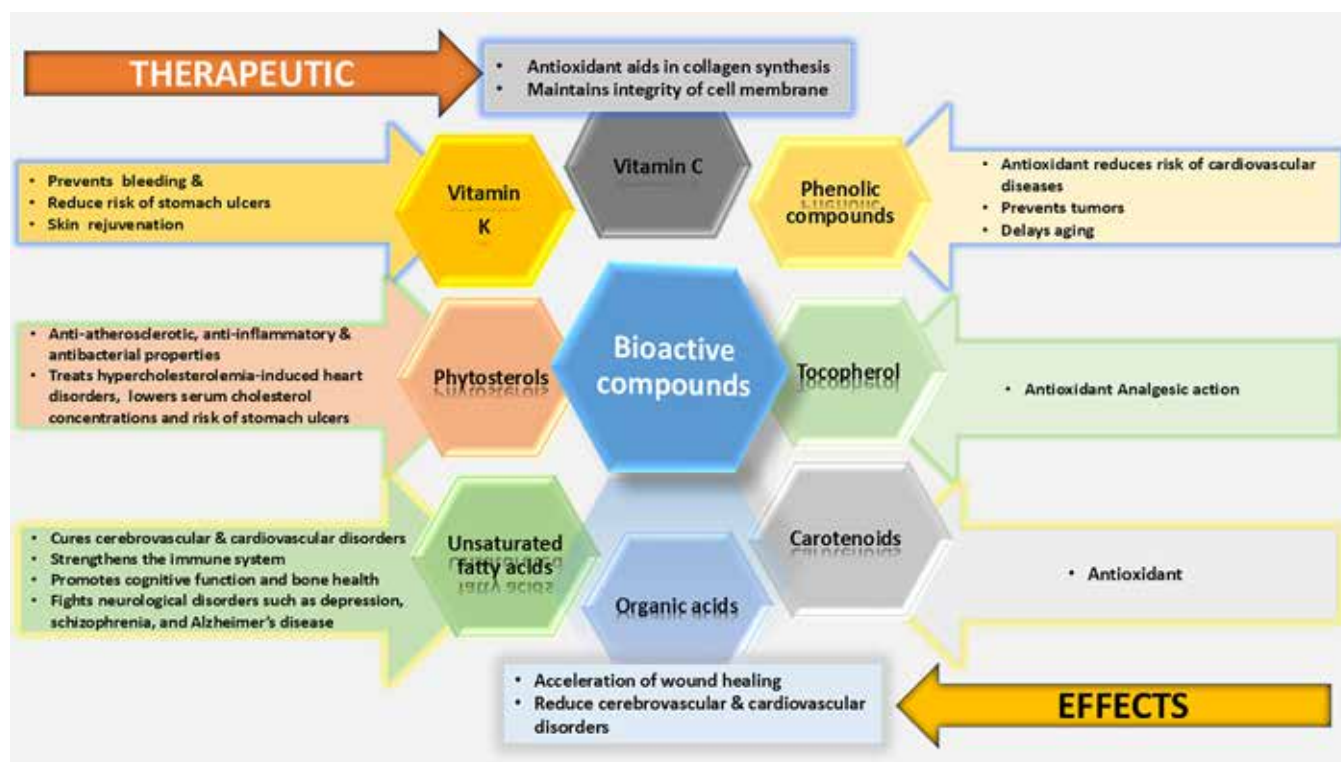
Diseases and insect-pest: About 47 species of pathogen belonging to 42 genera have been reported to affect sea buckthorn in Russia. In India, there are very few reports on its diseases. The major diseases in nurseries namely root-rot caused by *Rhizoctonia solani*, *Verticillium* sp. and *Fusarium* sp. infestations have been

observed at Gangotri and Ranichuri in Uttarakhand.

There are certain pests reported in China and Russia like death-hawk moth (*Acherontia styx*), defoliating beetles (*Brahmina coriacea*), *Holotrichia longipennis* that damage plants at early growth and cause serious threats to them. Indian meal moth, *Plodia interpunctella* is a storage pest that damages sea buckthorn fruits. Aphid attack on



Post-harvest practices used in sea buckthorn and resulting products from their different parts



List of compounds present in sea buckthorn along with their therapeutic effects on human health

sea buckthorn has also been noticed in Uttarakhand.

Post-harvest practices: Sea buckthorn is a non-climacteric fruit which ripens only on the plant and cannot ripen after harvesting. The onset of the fruits ripening generally begins from mid to end August under Ladakh and Lahaul conditions. Their physiological maturity can be judged on the basis of surface colour, texture, juice content and total soluble solids. A sharp increase in the TSS (12° Brix) and juice content (>70%) of the fruits has been recorded after ripening. Ripe fruits can remain on branches of plants, even throughout the winter up to April but, keeping them for a long time can otherwise damage the texture and fruit quality.

Fruits are highly perishable, soft, small, delicate and juicy, and thus, cannot be transported over long distances. Fruits are collected in plastic baskets of 10 kg capacity to avoid damage by pressure. Moreover, the ripe fruits have a musky odour, which is reduced before processing by washing them with cold water. They need immediate processing (within 24 h) after harvesting. However, to reduce the post-harvest losses, fruits

must be stored at the recommended temperature of 4–6°C.

Nutritional profile

A unique mixture of bioactive compounds is present throughout the plant, especially in fruits. *In vitro* and *in vivo* studies, in human and animal models, ought to have a wide range of beneficial anti-inflammatory, anti-carcinogenic, antioxidant and anti-atherosclerotic effects from juices, jams and oil derived from the fruits that show the presence of phenolics, vitamins, minerals, amino acids, fatty acids and phytosterols.

Plant oils are usually lipophilic or hydrophobic materials that can be extracted with the help of non-polar solvents like hexane. The fruit oil consists of a high amount of nutritional and medicinal components. Oil can be extracted from the seeds and the pulp. The mature seeds contain 8–20% oil, the dried fruit pulp (flesh and peel) about 20–25%, and the fruit residue about 15–20% oil after juice extraction.

Hepatoprotective properties

Scientists examined prevention from hepatic damage in mice induced

by carbon tetrachloride (CCl₄) by taking oral supplementation of seed oil from sea buckthorn at several doses of 0.26, 1.3 and 2.6 mg/kg for 8 weeks, which reduced the degree of lipid peroxidation in the liver, and reduced previously elevated levels of cholesterol, triglyceride, alkaline phosphatase, alanine amino transferase and aspartate amino transferase in serum. The activities of various antioxidant enzymes, i.e. catalase, superoxide dismutase, glutathione reductase and glutathione peroxidase, were also found to increase that are likely to have protective effects. In addition, the seed oil has activity similar to a drug silymarin (200 mg/kg), when applied at equal tested doses, aids in preventing and treating liver ailments.

Anti-carcinogenic potential

Though a review is explained about the anti-carcinogenic properties of lipids obtained from sea buckthorn plants, but their medicinal and prophylactic doses are not known and no clinical experiments have yet been performed. Nevertheless, scientists described that sea buckthorn oil plays an important role in

cancer therapy, especially for the treatments based on chemotherapy and radiotherapy regimes. The consumption of seed oil is also associated with other health benefits like increased appetite, restoration of kidney and liver functions, and maintaining the proper health of patients. The sea buckthorn seed oil contains a wealth of vitamins, particularly A, E and beta-carotene, and it may offer protective effects against cervical cancer.

Antioxidant and other biological properties

Sea buckthorn seed oil also constitutes of strong antioxidant and anti-inflammatory properties, that protects against the oxidative stress caused by lipids that have undergone thermal oxidation which in turn improves the immune response. Also, it reduces hepatotoxic effects and liver degeneration in rabbits. The studies have also reported that the sea buckthorn seed oil also bestows protective antioxidant

effect on injuries induced by sulfur dioxide inhalation in mice, and may ameliorate oxidative damage, i.e. lipid peroxidation and protein carbonylation to the colon in rats. A recent study has found that oil extracted from fruit flesh, seeds and peel protects against chronic stress-induced natural killer cells, leading to their inhibition in rats when applied at a dose of 10 ml/kg for 21 days.

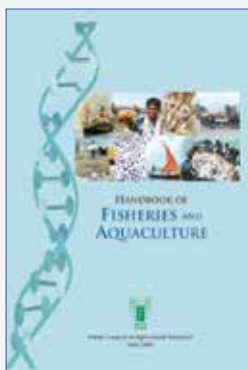
SUMMARY

In India, sea buckthorn has grown naturally since a long period of time in different parts of Himalayan terrains. However, its importance came into limelight only after the Defence Institute of High Altitude Research (DIHAR) transferred sea buckthorn based technology to a private firm in the year 2001, where it proved to be profitable. Since then, Ladakh has remained the leading place with 70% of its total area under sea buckthorn harvest. Although,

the mean annual berry harvest is less than 5% of the total bearing, largely due to short harvesting season (20–30 days), which coincides with the harvesting time of other crops. Since, sea buckthorn is a relative newcomer as a crop, a little is known about its cultivation practices. Due to lack of its appropriate plantation knowledge leading to small berry size, makes harvesting tedious and labour intensive. Furthermore, there are no available high yielding varieties that can be cultivated and propagated on a large scale, depict the need of a good breeding program. The berry is very delicate and highly perishable therefore, long distance transportation is challenging. To prevent further post-harvest losses, there is a need of cold chain facilities to extend its availability and development of value added products.

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HANDBOOK OF FISHERIES AND AQUACULTURE



Fisheries is a sunrise sector with varied resources and potentials. The sector engages 14 million people at the primary level and is earning over ₹10,000 crore annually through exports. Fish consumption has shown a continuous increasing trend assuming greater importance in the context of 'Health Foods'. It is expected that the fish requirement by 2025 would be of the order of 16 million tonnes, of which at least 12 million tonnes would need to come from the inland sector and aquaculture is expected to provide over 10 million tonnes. The domestic market for fish and fishery products is also growing rapidly and necessary models and quality control protocols in this regard need to be developed.

In 2006, the Indian Council of Agricultural Research, brought out the First Edition of 'Handbook of Fisheries and Aquaculture'. The present revised edition comprises 42 updated and six new chapters, viz. Fish physiology; Aquaculture engineering, Fisheries development in India; Fisheries cooperatives; Demand and supply of fish; and Climate change – impact and mitigation. The Handbook would be of great value to students, researchers, planners, farmers, young entrepreneurs and all stakeholders in fisheries and aquaculture.

TECHNICAL SPECIFICATIONS

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