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SEA BUCKTHORN (*HIPPOPHAE SP.*): HIGHLY POTENTIAL UNDERUTILISED PLANT IN SIKKIM: A REVIEW

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ABSTRACT
Seabuckthorn (SB) has gained tremendous importance as a multi utility plant. SB products include foodstuffs, healthcare products, cosmetics, medicine and many more. Countries like China, Russia, and Canada exploited the plant with immense commercial success. Seabuckthorn grow in Lachung and Lachen area of North Sikkim. The berries were mainly use as dye and meat tenderiser and leaves as fodder in Sikkim. SB holds the potential of changing the socio economic status of rural Sikkim if the plant is exploited like China and elsewhere but government must have proper policy and R&D backup to realised the potential.

INTRODUCTION

Seabuckthorn(SB) is a hardy shrub with tremendous economic potential, highly nutritious, medicinal plant. It is known to have extremely high adaptability and grows on harsh environment. SB (*Hippophae* sp.), is an economically important plant belonging to Elaeagnaceae family. The scientific name "*Hippophae*" was derived from Greek words 'Hippo' meaning horse and 'phoas' meaning shine (Rousi, 1971). The SB is a hardy deciduous shrub with narrow leaves, reaching 2 to 4 meters in height and develops a tree-like appearance since usually only the upper buds sprout and branch. Common sea-buckthorn has branches that are dense and stiff, and very thorny. The leaves are a distinct pale silvery-green, lanceolate, 3-8 centimetres long and less than 7 millimetres broad.The male produces brownish flowers which produce wind-distributed pollen. The female plants produce orange berry-like fruit 6-9 millimetres in diameter, soft, juicy and rich in oils. The roots distribute rapidly and extensively, providing a non-leguminous nitrogen fixation role in surrounding soils.SB is native of Asia and Europe and known to humans for centuries. The plant was mentioned in various ancient writings including Greek scholars such as Dioscorides and Therophas. In Asia records of the use of this plant in ayurvedic medicine and many oriental medicines such as *rGyudbzi*, the Tibetan medical classic (Li and Guo, 1989) were mentioned.

Forests have been providing the need of rural people for income, social and cultural benefits while being sustainable. Himalayas are atreasure house of medicinal plants of significant uses (Kumar *et al.*, 2009b). The significance of the biodiversity in human welfare with respect to environmental and developmental context has necessitated in assessment of plant, animal and microbial resources of most part of the world (Kumar *et al.*, 2009a). In recent times SB has attracted special attention as multi utility plant as environmental and unique functional food. It grows in cold regions of Asia, Europe, and North America. It is distributed i n Himalayan regions including India, Nepal, Bhutan, Pakistan and Afghanistan, China, Mongolia, Russia, Kazakhstan, Hungary, Romania, Switzerland, Germany, France, Britain and northwards to Scandinavian countries (Fig.1, Bernath and Foldesi 1992). The wide distribution of SB is reflected in its habited-related variation not only in morphology, yield, growth rhythms and cold hardiness, but also in berry related characters such as fresh weight, chemical and sensory attributes (Alam, 2004).

This wild plant(Fig. 2) has been a good subject for domestication in many countries including non traditional countries like Canada in North America. Due to its immense potential the plant attracted attentions of researchers in Asia, Europe and more recently in North America. In India, SB is found in Himalayan regions of Himachal Pradesh, Ladakh (J&K), Uttaranchal, Sikkim and Arunachal Pradesh (Ali and Kaul 2011). The plant is mainly concentrated in the cold deserts of Trans-Himalayas at an altitude from 2500 m to 4500 m. Indian Himalayas host world's second or third largest area under SB (30,000 ha). In Ladakh it grows approximately 12,000 hectare area and covers major part of the forest area in the region. In Sikkim, it is categorise under NTFP and found

exclusively in North Sikkim district of the state where naturally and abundantly available. The plant density in the natural environment is very less (200 plants per hectare) as compare to plant density of planted orchards (1600 plants/hac.). A natural SB plant can yield 750 to 1500 kg fruit/ha (Li and Schroeder 1996). In a season a fruiting plant gives approximately 6 - 7 Kg of berries (4-5 litres of juice).

SB is known in different names as *Chharma* (Hindi), *Shaji* (Chinese) *Sanddrome* (German) and *Tarubo* (Sikkim). SB includes 5 or more species namely *H. rhamnoides*, *H. salicifolia*, *H. tibetana*, *H. neurocarpa* and *H. goniocarpa*. Mainly three species of SB viz; *H. rhamnoides* var. *turkestanica*, *H. salcifolia* and *H tibetana* are found in India. Among these *H. rhamnoides* var. *turkestanica* is the most common in India.

The SB-growing areas in the Trans-Himalaya host unique geoclimatic conditions of high altitude coupled with extreme temperature variations (-30 to 30ºC), low precipitation, low oxygen in air and arid soil. Seabuckthorn is a hardy plant and survive in most soil types though sandy loam is preferred. SB is adapted to cold, drought as well as saline and alkaline soils. Like other members of the Elaeagnaceae family, SB is also a nitrogen fixer (Annonymous, 2000). Its vigorous production of vegetation and its strong and complex root system with nitrogen-fixing nodules make SB an optimal pioneer plant for water and soil conservation in eroded land.

Phytohemical compositions of SB berries

SB berry (Fig.3, 4) is recognized for its nutritional benefits, being rich in amino acids, carbohydrates, organic acids, protein, vitamins and phenolic compounds. A number of studies have shown that the chemical composition of the fruit varies greatly according to the species, and climatic and geological conditions of the areas where the plant is grown (Zhao *et al.,* 1991). The moisture content of SB fruit has been reported to range from 74.0 to 86.7%; Carbohydrate content in the fresh berries of Chinese origin varies between 8.0 - 14.0% with glucose and fructose as the major carbohydrates and are present in approximately equal amounts. The protein content of the fruit varies with the variety and geographical location and is reported to vary from 0.79 to 3.11% on fresh weight basis. SB is reputed to be an excellent source of vitamin C, although a wide concentration range (200 to 2500 mg/100 g juice) has been reported (Bal *et al.,* 2011, Kallio *et al.,* 2002). SB berries are highly acidic in nature (pH 2.7-3.5). Malic acid was the major organic acid along with citric and tartaric acid reported in minor quantities. The whole berry oil content of Chinese SB was 2.1% and 1.7% of the seed and pulp/peel respectively (Parimelazhagan *et al.,* 2005) whereas the whole berry oil content of Finnish SB was reported to be 3.5% with an oil content of 11.3% of the seed and 2.8% of the pulp/peel. Linoleic (18:2 n-6) and linolenic acids (18:3 n-3) comprise about 70% of seed oil Fatty acid. Palmitoleic acid (16:1 n-7) comprised 12.1-39.0% of oil in pulp/peel. Palmitoleic acid is practically absent in seed The polar lipids included 61% phospholipids and 39% galactolipids, which contained mainly 16:0, 16:1 (n-7), 18:1 (n-9), 18:1 n-7 and 18:2 (n-9, 6) Fatty acid. Galactolipids were shown to be rich in 18:1 (n-9) and 18:3 (n-9, n-6, n-15) Fatty acid, while phospholipids contained higher concentrations of 16:0 and 18:1 (n-9) Fatty acids (Yang and Kallio 2002). The total sterol content was found to range from 1200 to 1800, 240 to 400 and 340 to 520 mg/kg in the oils from seeds, fresh pulp/peel and whole berries, respectively (Mironov 1989). Sitosterol constituted 57 to 76% and 61 to 83% of the seed and pulp/peel sterols, respectively. The presence of D-Sitosterol, 24-methylene-cycloartanol, citrostadienol, and uvaol in the unsaponifiable part of a pentane extract of the fruit pulp of common SB was also reported (Beverridgew *et al.,* 1999). Among the Phytosterols in SB (*H. rhamnoides* L.) seed oil, *sitosterol* and [-5-*avenasterol* were, quantitatively, the most important phytosterols (Oomah and Mazza, 1999). The carotenoid content of SB fruit varies with the geoclimatic conditions but typically ranges from 30 to 40 mg/100g fruit (Lu, 1993) with D- carotene accounting for approximately 45% of the total carotenoids. The total phenolic content of SB fruit was reported to range from 114 to 244 mg/ 100 g fruit. Phenolic compounds such as quercetin 3-O-glycosides, catechins, and hydroxybenzoic acids with a catechol structure exhibited good antioxidant capacities. These phenolic compounds account for less than 5% of the total antioxidant activity of the filtered juice and ascorbic acid is shown to be the major antioxidant in SB juice .The flavonoid content in the leaves and fruit of SB has been reported to range from 310 to 2100 mg/100g dried leaf and 120 to 1000 mg/100g fresh fruit, respectively (Hardy, 2000). Phytopharmaceuticals in SB includes *quercetin*, *kaempherol*, and *isorhamnetiz*.

Uses of SB berries

SB fruit has attracted considerable attention, mainly for its medicinal value and great economic potential. The fruit and leaves have been used for more than one thousand years in traditional medicines in India, China, Mongolia and Tibet. In Asia and Russia fruit and seed extracts have been used for the treatment of burns, cancer, CVD, gastric ulcers and oral inflammation. SB oil is approved for clinical use in hospitals in China and Russia, where, in 1977, it was formally listed in the Pharmacopoeia.Being a good source of bioactive phytochemicals, SB berries have been processed by hundreds of industries in China and Russia for nutraceuticals and cosmaceutical products. More than ten different drugs have been developed from SB in these countries (Menrad 2003).

It is widely use as functional food, nutraceuticals and cosmaceutical in modern days. A wide spectrum of physiological effects of SB berries and berry products has been reported, including high antioxidant, radio-protective, anti tumor, inhibition of LDL cholesterol oxidation and platelet aggregation, anti-hypertensive, immunomodulation and cytoprotectiveeffects, protection from gastric ulcer, reduction of atopic dermatitis and wound healing (Lanev, 1995).

Traditional uses of SB in Sikkim

Though the SB is highly versatile, multi-utility plant with huge commercial potential, it is relatively unknown and unexplored. No authentic scientific report on SB in Sikkim as of now is available. Little mention in earlier studies cited its importance as a useful NTFP. Traditionally, the leaves of SB are used as fodder and woody parts as firewood and fruits were used as tonic. SB is mention in traditional medicine preparations also. The juice extracts were applied to minor burns. There is also a belief that the juice is useful in treatment of mentally unstable people. The juice is given to feral horses as it is believe to tame

Figure1: Field showing seabuckthorn shrubs

Figure 2: A Seabuckthorn shrub

Figure 3: Seabuckthorn branches bearing berries

Figure 4: Seabuckthorn berries

the animal. The most widely use of SB juice in ancient times by the Bhutia people of the area was to dye cloths. It gives a good orange colour finish cloth that fetch higher price. The juice was routinely put into the meat broth particularly pork meat. The juice acts as tenderising agent as well as it give a unique pleasant flavour to the soup. This is still very much in practice in the Lachung and Lachen area. It is also given to people who are recovering from high fever and other diseases.

Harvest and postharvest management

Sea buckthorn berries when overripe carry a strong musky odour with rancid taste, detectable even in thefield. Washing may reduce or change the odour (Bevveridge, 19999). To avoid this problem, berries must beharvested at the correct stage, quickly transported to the processing plant, and be cooled immediately to temperaturesaround 4° to 6°C to retard growth of microorganismsIf the berries are to be stored more than a few days, they should be frozen, preferably by individual quickfreezing techniques. The berries were thawed and processed to products as required on demand. Juice extractedby pressing or centrifugal techniques must be stored under refrigeration and requires pasteurizationand freezing for long term storage. Alternatively fruit may be processed into pasteurized or sterilized finished products and stored in that form at room temperature. The shelf life even of sterilized product is limited but improved in refrigerated storage.Maturity indices were bright orange colour and soft texture of the berries. Harvesting is done manually either by shaking the tree or by cutting the branches bearing the berries and hand plucking it from the cut branches.

Processing of SB berries

At present, the largest producers and consumers of sea-buckthorn products are China, Russia, and Mongolia. They all have large scale processing facilities. Processed products include: oil, juice, alcoholic beverages, candies, ice-cream,

tea, jam, biscuits, vitamin C tablets, food colors, medicines, cosmetics and shampoos. Reports describing the processing of SB berries are rather limited. Juice, pulp oil, seed oil, cream and pigments are the main commercial products from SB berries. Normally the processing begins with the harvesting of berries. The diseased and damaged berries and stems, leaves and other debris are removed as a part of cleaning. Washing the berries with luke warm water or with mild detergents or wetting agents are suggested to increase the juice yield. Pressing techniques such as screw pressing, cloth pressing or serpentine pressing etc are being utilized for the separation of juice from berries. Juice obtained by the conventional processing techniques reported to be turbid, with a high content of suspended solids and pulp oil. Juice with pulp oil leads to the formation of an undesirable oily layer on the top during storage. Centrifugation of unheated juice causes rapid separation into a floating cream phase, an opalescent clear juice in the middle and sediment. The use of a stalk centrifuge or a cream separator to separate the cream from the juice (Zhang et al 1989) and Fatty acid removal in low temperature were suggested. Solvent extraction has been tried for oil recovery, but it is not recommended for nutraceutical applications owing to the residual solvents and the destruction of bioactive phytochemicals during desolventisation. Fresh pressed juice separates into three phases when allowed to stand overnight in the refrigerator: an upper cream phase, juice in the middle portion, and sediment at the bottom. Enzymatic hydrolysis with commercial, broad spectrum carbohydrate hydrolyzing enzyme preparations reduces the juice viscosity, assists juice separation, and provides an opalescent juice. SC-CO2 extraction has been suggested for superior quality, solvent free oils but the berries must be dried before supercritical extraction, resulting in a loss of juice and phytonutrients during drying.

Status and potential of Seabuckthorn production and processing in Sikkim

SB (*H. salicifolia*) is naturally and abundantly available in mountainous regions particularly in Lachung and Lachen areas in North Sikkim. The species available in Sikkimhas, however, never been claimed scientifically and needs validation. The epicentre of SB in Lachungis in and around the Lachung bridge riverbed comprises of long stretches of SB bushes(N-27°41.424′ and E-88°44.772′) at an altitude of 8680 ft from msl and TemchiZema area in Lachen(N-27°43.162′ and E-88° 33.479′) with an altitude of 8460 ft from msl. SB is a non timber forest product and the product is handled by the forest department and the local people through Joint Forest Management Committees (JFMC). Forest department of the Sikkim state has planted SB in about 800ha in Lachung area and another 1000ha at Lachen and adjoining areas with suitable altitudes (7000ft to 10000ft) other than naturally occurring plants. These new plants have successfully adapted to the environment and growing healthily. The present overall potential of 5000- 6000 litres of SB juice in the area will be improved to 15-20 thousand litres by 2016 as new plants gives fruit after 4 years.

The locals, particularly Bhutia's harvest the berries by chopping the branches and hand plucking it from the cut branches. They also used a globe made of thick cloth in plucking the berries from the twigs. They made make juice from the berries by crushing discarded the seeds after extracting juice of the fruit thus 6-10 MT of SB seed is thrown out as waste in a season. This wastecan be a good resource as the oil extracted from it is still very rich source of essential Fatty acid and vitamins. There huge scope of expanding the SB area in Sikkim Highlands where no other plant can sustain particularly in West and North Sikkim.

As mentioned earlier Seabuckthorn is well adapted in Sikkim highland particularly North Sikkim at an altitude of 2500 msl to 4000 msl (or 8000ft – 10,000 ftmsl).It has tremendous potential for commercial production of SB in that area. As the plant itself is hardy and survived in most soil types it can be expanded many fold. Sikkim is a hilly state with major part of the area lack habitation and having the favourable altitude for the plant. In a season a fruiting plant gives approximately 6-7 Kg of berries (4-5 litters of juice). Rough estimate show that a hactre of seabuckthorn will give atleast 5-6 MT of seabuckthorn berries. The seabuckthorn area in Sikkim is exclusively in North Sikkim at Lachung and Lachen areas though there is high probability that it may be growing in other hilly areas of North and West Sikkim as unknown weed plant. The potential seabuckthorn production, at present is about 65,000 Kg of berries per season. But unfortunately this unique food is not exploited in Sikkim as it should be. Cost of production of this plant in Sikkim is almost nil as no inputs such as irrigation, weeding fertilisers, manures etc are not required. Hand harvesting is commonly performed by the collector/farmer themselves. The market potential in Europe was increasing in recent times. Current market price of Seabuckthorn in Europe is 240 USD/litre though it varies seasonally. There is huge scope of socio-economic development of the people in North Sikkim in particular and Sikkim as a whole through Seabuckthorn production with the intervention of State and Central Government in promoting Seabuckthorn in Sikkim.

The advantages of establishing Seabuckthorn production and processing industry in Sikkim are favourable soil and climate, vast land which cannot be use for any other agricultural crops, relatively cheap labour, water and power at reasonable price and enthusiastic people who already have utilised the plant and posses indigenous knowledge of the plant and its uses. Ready consumer will be available for the products developed from the plant.

The Sikkim Government, tried to promote the SB by selling the juice as health promoting drink by the commercial name "Kanchan Berry" which unfortunately could not be materialised after initial one season. One of reason may be due to lack of R&D support. As the places where the plant is abundant lies in restricted and remote areas, R&D personnel also faces problems which may be another reason that the plant hasn't been studied as much it should be. The export of Seabuckthorn juice was also tried by *Medevir*, one of the companies from Sikkim but again due to lack of processing protocol / facilities and R&D backup the project could not be a success.

There are numerous constraints in establishing viable seabuckthorn based industry. Perhaps the foremost is lack of R&D support as well as the prevailing forest and other laws of the state. Also, there is no definite technology for the Sikkim

berry and the available technology is not tested in Sikkim conditions. As it is observed there is varietal and geographical differences in nutritional qualities of seabuckthorn (Yao and Tigerstedt, 1995), nobody is sure of the quality of the Sikkim variety. No suitable seabuckthorn cultivar, thus, is identified for Sikkim condition. If these issues are addressed Sikkim may be one of the major havens for seabuckthorn in India.Based on the information it is found that the SB needs some R&D for its commercialization. The various researchable issues includes establishing the species available in Sikkim; bio chemical and phytonutrient profile of the berries; animal model experiments to establish the various medicinal properties of the berries; commercially successful value added products and waste utilization.

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