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A Wellness Shrub — Seabuckthorn (*Hippophae rhamnoides* Linn. subsp. *turkestanica* Rousi)

Author(s):- *Dr. Brahma Singh*

INTRODUCTION

Seabuckthorn or Seaberry, Lehberry (*Hippophae rhamnoides* Linn. subsp. *turkestanica* Rousi), a member of the Family *Elaeagnaceae* is a deciduous, dioecious shrub of alpine, high altitudes and polar regions. In India, its natural growth is prominent in cold arid regions, particularly Ladakh and Lahaul -Spiti area covering several thousand hectares. Its fruits and leaves are store houses of nutrients and pharmaceutical products. They are rich source of.



Hippophae rhamnoides, female plant

vitamins, minerals bioactive substances like flavonoids, carotenoids, sterols, organic acids, phenolics, etc. The fruit pulp and seed are rich in useful oils which are of great importance in preparation of health foods, wellness foods, medicine, and cosmoceuticals

SEABUCKTHORN IN MEDICINE

In India, its importance was realized in 1992 when the author found its wild abundance in the cold desert of Leh /Ladakh, Jammu &Kashmir State and named it Leh Berry. Perhaps the Chinese were the first to use this plant as medicine even before 8th century. In traditional Chinese medicines, seabuckthorn products have been used as health drinks, for cardiovascular and digestive diseases and ailments related to lungs and skin. Chinese Olympic athletes were served seabuckthorn based health drinks to improve their physical performance and endurance. Seabuckthorn figures in folklore medicines of China, Mongolia, Tibet, India, Russia, Pakistan and Afganistan. Before 12th century Ancient Greeks were taken by surprise to find their horses that were let loose to die a natural death, strong and energetic again with a shine on their hair. These horses used wild seabuckthorn growth as their fodder. The shrub was thus named *Hippophae*-Hippo (horse), phaos(shine). Genghis Khan, the Mughal conqueror, who established an Empire from China to Eastern Europe in the 13th Century, relied on three treasures , viz . well organized army, strict discipline and seabuckthorn. Soviet astronauts were given seabuckthorn based health foods as vitamin source and medicine for protection against radiation and improving the body immunity during oxygen deficiency in their space flights. The Russian Cosmonauts used it as space food item. Pulp and seed oil of seabuckthorn made soldiers stronger which has now been proved scientifically. Russian immigrants brought seabuckthorn to America in the beginning of the 20th century. Medicinal values of seabuckthorn are documented by the name “Amlaveda” as well as “tSer-Mang” in Amchi system of medicine, prevalent in Indian Himalayas. In India, this bush has been recorded growing wild in abundance since time immemorial in Himalayan cold deserts in the state of Jammu & Kashmir and Himachal Pradesh covering more than 11500 hectares. The Defense Forces deployed there up to an altitude of 24000 ft have to depend on locally grown fresh food as the area is at a long distance from habitation and totally cut off by road from rest of the world for six to nine months. To develop local agriculture, Defense Research and Development Organisation (DRDO), Ministry of Defense, Government of India established a Field Research Laboratory (FRL), now called as Defense Institute of High Altitude Research (DIHAR*) in this cold desert. While developing appropriate agro-technologies

*The author had an opportunity to head this laboratory from 1991 to 1995 and oversee it till 2001 from DRDO, Headquarters, New Delhi under the guidance of Dr APJ Abdul Kalam, Scientist and Former President of India.

and undertaking massive afforestation, the institute (the author in particular) came across an abundant wild growth of this bush. Local farmers wanted to get rid of it from their fields as it proliferated fast. That created inquisitiveness about this plant and enquiries from local colleagues in FRL about the abundant wild growth of this bush revealed that the plant is not liked here and its dried twigs being thorny are used by farmers as fuel and as fence. Further enquiries by the author disclosed that during recess school children do enjoy its fruits. This indicated its edible nature and was enough for to study this bush extensively from 1992 onwards and efforts have taken Indian seabuckthorn to an International level of research. More than thirty national institutes and laboratories are working now on this plant in India. Its fruitful utilization has created substantial returns to Ladakh and Lahaul Spiti regions in terms of employment, improvement in economy and knowledge about seabuckthorn in a period of less than two decades.

Physico-chemical Constituents of *Hippophae rhamnoides ssp turkestanica*

FRUIT

The fruits are small orange-yellow to red in colour consisting of skin, pulp and seed, all of which are storehouses of rare and useful bioactive substances. They are rich in vitamin C, vitamin E (mixed tocopherols), folic acid, carotenoids, including beta carotene, lycopene, zeaxanthine; (yellow-orange-red colours of the fruit), fatty acids (the main unsaturated fatty acids are oleic acid (omega-9), palmitoleic acid (omega-7), palmitic acid and linoleic acid (omega-6), and linolenic acid (omega-3). There are also saturated oils and sterols (mainly β -sitosterol), organic acids other than ascorbic (quinic acid and malic acid), flavonoids (mainly isorhamnetin, quercetin glycosides and kaempferol). The physico-chemical characters of seabuckthorn fruits are given in Table 1 :

The flavonoids and oil of seabuckthorn are specially extracted for medicinal use. Richness of fruit and leaves in these constituents is evident from data given in Table 2. Main constituents of seabuckthorn oils from seed, fruit pulp (juice), and pomace reported by FRL are presented in Table 3.

Table 1 – Physico-chemical properties of ripe fruits of *H. rhamnoides* ssp *turkestanica* of Ladakh

| Physical Characters | |
|----------------------------------|------------------------------|
| Length (mm) | 7.34 |
| Width (mm) | 5.91 |
| Shape | Round/Oval/ Ovoid/ Oblong |
| Colour | Yellow, Orange to Orange Red |
| Seed (%) | 6.54 |
| Residue/Pomace (%) | 19.45 |
| Juice Yield (%) | 74.5 |
| Average Weight of 100 Fruits (g) | 14.07 |
| Chemical Characters | |
| Total soluble solids (°B) | 14.3 |
| Acidity % (as Malic acid) | 2.54 |
| pH of Juice | 2.15 |
| Total Sugars % | 1.03 |
| Reducing Sugars % | 0.96 |
| Non Reducing Sugars % | 0.07 |
| Moisture % | 74.58 |
| Ash % | 1.8 |
| Crude Protein % | 2.64 |
| Crude Fibre % | 3.54 |
| Total Carbohydrates % | 20.56 |
| β-Carotene (ug/100g) | 12839.67 |
| Vitamin C (mg/100g) | 424.8 |
| Vitamin B ₁ (mg/100g) | 2.664 |
| Vitamin B ₂ (mg/100g) | 6.227 |
| Pectin % | 0.48 |
| Fat % | 1.54 |
| Energy (cal. /100g) | 106.66 |
| Minerals (mg/kg) | |
| Sodium | 41.28 |
| Potassium | 1499.96 |
| Calcium | 383 |
| Iron | 11.68 |
| Magnesium | 47.7 |
| Zinc | 0.94 |
| Phosphorus % | 0.02 |

FRL (DRDO), The Seabuckthorn 2006.

In the oil fraction, the unsaturated fatty acids are of great interest. The unsaturated fatty acids in seed, pulp and pomace are 87, 67 and 70 per cent, respectively. The fruit residue, which includes the outer peel, is rich in the colored carotenoids, flavonoids and vitamin E. The seed has very high level of the unsaturated fatty acids and sterols.

Table 2 – Flavonoids and Other Components of Seabuckthorn Fruits and Leaves

| Component (s) | Content (mg / 100g) | Reference |
|--------------------------|---------------------|---------------------------------|
| Carotene and carotenoids | 16-28 | Kudritskaya <i>et al</i> (1989) |
| Flavonoids (fruit) | 120-2100 | Chen <i>et al</i> (1991) |
| Flavonoids (leaves) | 310-2100 | Chen <i>et al</i> (1991) |
| Volatile oil | 3.6 | Hirvi & Honkanen (1984) |
| Dry matter (%) | 24.6-33.8 | Igoshina <i>et al</i> (1987) |
| Oil (seed) (%) | 8.0-12.0 | Lu (1992) |

Seabuckthorn, *Hippophae* spp. The Golden Bush, SSPH, Delhi-110033

Table 3 – Proximate Composition of Seabuckthorn Oil (mg/100g)

| Ingredient | Seed | Pulp | Pomace |
|------------------|---------|---------|-----------|
| Vitamin E | 207 | 171 | 300-600 |
| Vitamin K | 110-230 | 54-59 | - |
| Carotenoids | 30-250 | 300-870 | 1280-1860 |
| Total Acids | 11 | 38 | - |
| Total Flavonoids | - | - | 550 |
| Total sterols | 1094 | 721 | - |

Seabuckthorn, *Hippophae* spp. The Golden Bush, SSPH, Delhi-110033

LEAF

Seabuckthorn leaves are good feed/fodder for 51 types of birds and 29 animals. In Ladakh, the endangered double humped camel, yak, sheep, goat, cattle, donkey, and poultry survive mainly on the dried leaves of seabuckthorn during the frozen winter months when no other fodder is adequately available in the region. Seabuckthorn leaves make nutritive fodder for animals. Its leaves are a good source of protein, ether extract, carbohydrates, crude fibre and total ash as is evident from Table 4.

The leaves are also a good source of vitamins, flavonoids and minerals, which make them important for use in development of food, beverages and cosmetics. Defense

Institute of Physiology and Allied Sciences, New Delhi reported that alcoholic leaf extract of seabuckthorn has significant antioxidant and immune-modulatory activity against chromium induced oxidative stress in rat lymphocytes. The leaf extract has potent cytoprotective activity against hypoxia induced oxidative stress in glial cells. It has been found to inhibit hypoxia induced cytotoxicity, mitochondrial integrity, reactive oxygen species (ROS) production and DNA damage better than vitamin C and maintains the cellular antioxidant levels similar to that of control cells. The main antioxidant

Table 4 – Proximate Chemical Composition of Leaves.

| Constituents | (%) |
|---------------------|-----------|
| Moisture | 52-69 |
| Total Ash | 1.76 |
| Crude Protein | 2.2-2.4 |
| Crude Fibre | 4.6-4.85 |
| Ether Extract | 6.6-6.94 |
| Total Carbohydrates | 32-37 |
| Calcium | 69mg/100g |

FRL (DRDO), The Seabuckthorn 2006

components of leaves are flavonoids, quercetin, isorhamnetin and flavonols like epicatechin and leucanthocynadins. Seabuckthorn leaf extract has been found to have significant anti-inflammatory activity affecting cell viability with potential for treating inflammatory diseases like arthritis in line with traditional uses. A preclinical study of the effect of aqueous leaf extract of seabuckthorn indicated promotion of wound healing in albino rats. Almost all parts of seabuckthorn plants are important as is evident from Table 5.

Table 5 – Seabuckthorn Plant Parts and their Uses

| S. No. | Plant Part | Uses |
|--------|------------|--|
| 1 | Roots | Fuel, Fixes atmospheric Nitrogen (Frankia) |
| 2 | Bark | Pharmaceuticals & Cosmetics |
| 3 | Leaves | Pharmaceuticals, Cosmetics, Tea, Food, Animal and Poultry Feed |
| 4 | Fruit | |
| | Juice | Sport Drink, Health Drink, Food, Beverages, Wines |
| | Oil | Pharmaceuticals & Cosmetics |
| | Pomace | Animal Feed, Food Colours |

| | | |
|---|-----------|-----------------------------|
| 5 | Seed | |
| | Seed Oil | Pharmaceuticals & Cosmetics |
| | Seed Cake | Food & Feed |
| 6 | Twigs | Fuel, Fencing, Fodder |

Seabuckthorn, *Hippophae spp* SSPH, Delhi-110033

Pharmacological potential of *Hippophae rhamnoides ssp turkestanica*

The earliest documented pharmacological properties of seabuckthorn are reported in the rGyud-bZhi, which is the classical medical text book of Sowa-Rigpa (Amchi/Tibetan Medicine). Amchis use Kyuru-25, Tsowo-25, Duetse-Chesoe, Seru-25 and many other preparations made out of seabuckthorn in the treatment of stomach, lung and skin diseases. Besides these, there are several pharmacological effects of seabuckthorn reported in different traditional systems of treatment, healthcare and wellness. In modern medical treatment, some of the important uses of seabuckthorn are:

Cardiovascular System : Experiments conducted in West China based on the total flavonoids extracted from the fruits and leaves of *Hippophae* showed that coronary heart diseases can be treated with this plant; those from the leaves improved the cardiac functions in white rats. Seabuckthorn oil has been reported to decrease cholesterol, triglycerides and β -lipoprotein (LP) and counteract high fat diet induced hyperlipemia. Seabuckthorn seed oil on one hand reduces blood fat level and on the other hand nurtures the blood vessels. Unsaturated fatty acids reduce cholesterol, regulate blood pressure and reduce serum cholesterol and prevent arrhythmia. They also inhibit platelet agglutination and prevent thrombosis. Seed oil is helpful in checking arteriosclerosis. Acetylsalicylic flavonoid tablets made out of seabuckthorn are available in China and Mongolia and used as approved drug for cardiac diseases.

Scientists in Japan studied the effect of fruits of seabuckthorn on microvessels in the left ventricular wall, hematological parameters, cardiovascular performance and plasma constituents in spontaneously hypertensive stroke-prone rats (SHRSP/EZO) treated for 60 days. The experimental rats were fed *ad libitum* with blocks of rat chow supplemented with *Hippophae* powder (containing the vitamins C, B₁, B₂ and E, provitamin A, rutin, serotonin, cytosterol, selenium and zinc, among other constituents) at a concentration of 0.7 g/kg . The mean arterial blood pressure, heart rate, total plasma cholesterol, triglycerides, and glycated hemoglobin were found to be significantly decreased by the *Hippophae* treatment. The arteriolar capillary portions of microvessels decreased but there was a trend for an increase in the total capillary density. It was concluded that *Hippophae* fruits improved the metabolic processes accompanied by reduction of hypertensive stress on the ventricular microvessels.

Cancer : The direct effects of seabuckthorn on tumorigenesis include inhibiting action on the cancer cells and blocking the carcinogenic factors. This is in addition to its

indirect effect caused by general immunity or other mechanisms. Seabuckthorn oil also exhibited anti-carcinogenic effects. Anticarcinogenic factors in seabuckthorn seed oil cut short the cancer process and stimulated the immune functions and activities of globulin C, increased antibodies, enhanced phagocytosis of macrophages, thus strengthening the body's resistance to cancerous mutations and improving life quality of the patients by reducing the adverse effects of operation, chemotherapy and radiation. It provides the patient with a rich and comprehensive supply of nutrients, improves blood circulation and removes stasis and eliminates waste, promotes tissue growth and avoids infection, improves gastrointestinal functions, restores liver and kidney functions, increases the self-repairing ability of the traumatized organs and cells, promotes the functions of the spleen and bone marrow and blood generation. It protects the heart, spleen, liver, kidney against the damaging effects of radiation. Most of the work done in this area has been with laboratory animals. The Institute of Nuclear Medicine and Allied Sciences (INMAS), DRDO, New Delhi has published several reports on the potential of a *Hippophae* extract (an alcohol extract, which mainly contains the flavonoids) to protect the bone marrow from damage due to radiation. This group also showed that the extract may help faster recovery of bone marrow cells. In China, a study was done in mice fed with seabuckthorn oil to demonstrate faster recovery of the hemopoietic system after high dose chemotherapy (with 5-FU). The seed oil has been found to enhance non-specific immunity and to provide anti-tumor effects in preliminary laboratory studies. Numerous animal tests and clinical applications have proved the curative effects of seabuckthorn oil on radiodermatitis, non-radiodermatitis (pressure sore), mucositis, erosion of cervix and ulcers. It was shown that the oil eliminates inflammation, facilitates anathrepsis and tissue regeneration and cures ulcers. The traditional use of *Hippophae* seed oil in the treatment of gastric ulcers, has been confirmed now through laboratory studies. Its function may be to normalize output of gastric acid and reduce inflammation by controlling pro-inflammatory mediators. Detailed studies are in progress to understand the mechanism and role of seed oil constituents.

Anti-Ageing: Blocking peroxidation and scavenging of free radicals produced by peroxidation in body slows down senescence. In a study in Mongolia, total flavonoids of seabuckthorn have been found significantly to inhibit chemiluminescence of the human polymorphonuclear leukocytes stimulated by phorbol myristate acetate, distinctly to clear away the super-oxide free radicals produced by the purine oxidase system and the active oxy-radicals including the free radicals of the superoxide negative ions and hydroxy free radicals. Active compounds of seabuckthorn have been found to promote the immune function and regulate the activity of immune cells thus playing important role in promoting human resistance against diseases and postponing senescence. In Seabuckthorn oil, free fatty acids of carbohydrates, phytosterol, phosphatide, vitamin E & A, and carotenoids are organically combined together providing protection and nutrition to the skin. An ingredient of the oil, palmitoleic acid (also a component of skin) is considered a valuable topical agent in treating burns and

healing wounds. This fatty acid can also nourish the skin when adequate quantities of seabuckthorn or its oil are consumed. This is a useful method for treating systemic skin diseases, such as atopic dermatitis. Seabuckthorn oil is widely used alone or in various preparations as topical application for burns, scalds, ulceration, and infection. *Hippophae* oil has UV-blocking activity as well as emollient properties. It aids in promoting regeneration of tissues. The fruit may also be used in improving hair growth and luster, as documented on horses.

Liver Cirrhosis : A clinical trial demonstrated that seabuckthorn extracts helped normalize liver enzymes, serum bile acids, and immune system markers involved in liver inflammation and degeneration. In addition, seabuckthorn oil protects the liver from damaging effects of toxic chemicals as revealed in laboratory studies.

SEABUCKTHORN WELLNESS FOODS

There are several products of seabuckthorn pulp, juice and seeds in China, Mongolia, Canada and Germany. The Defence Food Research Laboratory (DFRL, DRDO), Mysore, through extensive research has come up with wellness products using its fruit (Jelly, Jam and Squash) and leaves (Tea, Biscuits, Buns, Rusks and Cake). The Defence Institute of High Altitude Research, Leh of DRDO has developed, popularized and commercialized seabuckthorn juice under the name of Leh Berry, Kargil Berry, Power Berry, Hill Berry, Ladakh Berry, etc. Besides, this laboratory has developed seabuckthorn products like squash, nectar, sauce, pickle, vinegar, juice concentrate, juice powder, seabuckthorn tea, seabuckthorn wine and some cosmetic products like creams.

Feel Good Factor: Seabuckthorn products provide various nutrients and bio-active substances which are needed by the body such as unsaturated fatty acids, carotenoids, polysterols, amino acids, vitamins, trace elements, etc. They regulate and harmonize endocrine, circulatory, digestive, and autonomous nervous systems of the human body. Chronic fatigue complex, poor appetite or congestion, palpitation, and general lack of strength which occur after a serious or chronic illness are critical state of health through which pathogens may invade and cause diseases. Seabuckthorn beverages and other preparations made out of its fruits help in over -coming the above problems. Regular fruit juice users may not face above problems at all because of self immunity enhancing effects of seabuckthorn.

OTHER USES

Feed, Fodder, Fuel and Biofence: Seabuckthorn is a favourite fodder and feed for high altitude animals like double humped camel, pashmina goats and sheep, yak, and donkeys. Seabuckthorn seeds serve as feed to many bird species found in high altitude cold deserts and other places where seabuckthorn occurs. Its leaves are a rich

source of protein, vitamins and minerals. Seeds and pomace (fruit parts other than juice) are an excellent, potential feed for poultry and cattle. Nutritional constituents present in seabuckthorn foliage, fruit fiber and seed make them rich feed and fodder for animals and birds. Its dry twigs and roots make excellent fuel. Being a thorny plant, Seabuckthorn fits well as an ideal bio-fence (live as well as non-live) for crop fields and forests.

Ice Nucleating Agent: Fruits of seabuckthorn are a plant resource of 'ice nucleating agents' (most biological nucleating agents are found in microorganisms or insects). Aqueous extract of fruits of this shrub are added to other products for increasing their freezing points. Its fruit juice has high freezing point and has been found ideal for areas experiencing subzero temperature for considerable periods. Storage of the beverage up to 12 months at ambient temperature under Ladakh conditions was found to be stable. The observations recorded at various posts in Siachen glacier (12,000 to 21,000 ft above MSL) highlighted the fact that seabuckthorn squash remained in liquid form and did not freeze even at -22°C and, thus it could be consumed without thawing.

SUMMARY

Hippophae, a shrub of cold region, during its evolution has developed several substances in its fruit, seed and leaf which are quite rare but useful for the wellness of one and all. The author succeeded in identifying the *Hippophae* treasure in the cold desert of Jammu and Kashmir (Ladakh region) and popularizing its utilization for the wellness of humanity. Because of its wonderful biochemical constituents and being a life line in remote bone chilling climates, it can be called as wellness shrub.

Further Reading:

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