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Phytochemical and Pharmacological Profile of Seabuckthorn Oil: A Review

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ABSTRACT

Hippophae rhamnoides L. (Elaeagnaceae) also known as seabuckthorn, is a thorny, deciduous, temperate bush plant native to European and Asian countries. In India, it is widely distributed at high altitude, cold arid condition of Ladakh (Leh and Kargil), Himachal Pradesh, Sikkim and Arunachal Pradesh. *H. rhamnoides* has been used for the treatment of several diseases in traditional medicine in various countries throughout world. In Ladakh, the Sowa Rigpa system (Amchi System of medicine) has been using the plant parts in different herbal formulations. However, more scientific data is needed to support the various health claims. The various *in vivo* study of seabuckthorn oil reported to have anti-inflammatory, antioxidant, antimicrobial, anti-ulcer properties and hepatoprotective. Seabuckthorn oil is a unique source of high valued oils emphasizing its potential as a dietary and medicinal supplement and has become noted for its generally high levels of nutritionally and medicinally important components. The major unsaturated fatty acids were linolenic acid (omega-3) (20-23%), linoleic acid (omega-6) (40-43%), oleic acid (omega-9) (19-22%) and palmitoleic acid (1-3%) while the major saturated fatty acid contents were palmitic acid (7-9%), stearic acid (3-4%) in seed oil. Seabuckthorn pulp oil contains approximately 65% combined of the monounsaturated fatty acid and the saturated fatty acid. Both the seed and pulp oils are rich in Vitamin-E and β-Sitosterol. In addition, the pulp oil contains especially high levels of carotenoids. This ancient plant with its powerful and healing synergies has much to contribute to the livelihoods of high mountain people by utilizing this kind of hidden treasure of the Himalayas. In this review discusses on traditional use, phytochemistry and pharmacological data of the seabuckthorn oil.

Key words: *Hippophae rhamnoides,* seabuckthorn, phytochemistry, fatty acid profile, pharmacological activities

INTRODUCTION

Hippophae rhamnoides L. (Seabuckthorn) is the important indigenous bush of Ladakh and locally known as Tsestalullu. This plant is native to European and Asian countries like India, Pakistan, China, Russia, Nepal, etc. In India, seabuckthorn is mainly found at cold arid zone of Ladakh and Lahaul-Spiti, parts of Chamba and upper Kinnaur districts of Himachal Pradesh, Sikkim and Arunachal Pradesh. Seabuckthorn is a medium sized, hardy, deciduous thorny shrub

grows 2 to 6 min height. It is distributed in all around (3, 300 m to 4, 500 m above MSL) Ladakh. Mainly it appears in the river belts of Indus, Nubra, Shyok, Zanskar etc. of Ladakh (Chaurasia *et al*., 2007). It is a unisexual plant, male and female plants are different. Leaves are elongate-oblanceolate or elongate-spatulate, green at the top and silver-ash green on the underside. Bark is thick and rough. It flowers in April and the fruiting season is from August to October. Fruits are pearl-shaped, yellowish-orange and sour to taste. Several fungal entophytes were reported. There are nine described subspecies viz., *rhamnoides, salicifolia, tibetana, yuanensis, goniocarpa, mongolica, turkestanica and neurocarpa.*

SEABUCKTHORN AS TRADITIONAL MEDICINE

The generic name '*Hippophae*' means shining horse. The generic name it self came from the traditional use of the plant for fodder of horses since long. Local ethics of European countries also showed that the seabuckthorn is being used as a remedy for horses to induce rapid weight and shiny coat. It has a rich history of use in treating numerous medical conditions. It has been called a wonder plant in many Asian countries, including China, India and Pakistan. The barriers have been used for more than 1,000 years in Tibetan and Indian systems of medicine (Chaurasia and Ahmed, 2005). In middle Asia, the leaves are being used to treat skin disorders and rheumatoid arthritis. In Mongolia, extracts from the leaves and branches of the plant are used medicinally to treat colitis and enterocolitis in humans and animals. Ancient Tibetan and Chinese medicinal literature documented that the use of seabuckthorn berries for fever, hepatic disease, circulatory disorders, inflammation, toxicity, abscesses, cough, cold, ischemic heart diseases, clearing sputum, digestion, laxative effect, metabolic disorders, blood purification, tumours (particularly in the stomach and oesophagus) and gynaecological diseases (Ballabh and Chaurasia, 2007). The flowers are used as a skin softener in Tajikistan. In Russia, the oil from the seeds and fruits was used topically to treat chronic dermatoses, eczema, psoriasis, thrombosis, lupus erythematosus, burns, frostbite and cervical erosion. Oil extracts have been used in ophthalmology to treat keratitis, trachoma, conjunctivitis and injuries or burns of the eyelid. In Ladakh, the Sowa Rigpa system (Amchi System of medicine) has been using the plant parts i.e., leaves, berries, pulp oil, seed oil, etc., in different herbal formulations. This plant has been used for centuries in European and Asian countries as a main ingredient in food, pharmaceutical and cosmetic industries. The oil of seabuckthorn has general nourishing, revitalizing and restorative action. It can be used for acne, dermatitis, irritated, dry, itching skin, sore skin, skin ulcers, burns, scalds, cuts and tissue regeneration. Seabuckthorn oil effectively combats wrinkles, dryness and other symptoms of malnourished or prematurely aging skin and is utilized in anti aging skin creams and lotions (Xing *et al*., 2002). Seabuckthorn fruits are rich in carbohydrates, proteins, organic acids, amino acids and vitamins (Zeb, 2004a). All these beneficial compounds are derived from the berry of the seabuckthorn bush, which originally grew in the harsh climate of the Himalayan Mountains but has now spread all over the world.

EFFECTIVE CONSTITUENTS OF SEABUCKTHORN

Studies have shown that the fruit of seabuckthorn is a store house of vitamins, minerals and important bioactive substances viz. steroids, terpenoids, phenolics and fatty acids etc. Flavonoids are major component of seabuckthorn leaves and fruit whose main components are the leucocyanidin, catechin, flavonol and trace flavanone. From the flavonol, the isorhamnetin, quassin and camellin can be isolated. The physiological effects of flavonoids on the blood vessel wall require

the participation of Vit-C; their activity can stabilize Vit-C in the body and they can reduce Vit-C oxidation. These substances also have the following functions: controlling arteriosclerosis, lowering the cholesterol level, turning hyperthyroidism into euthyroidism and eliminating inflammation. The mineral contents of seabuckthorn make the shrub most important. Iron content of seabuckthorn in the range of 22 to 282 mg kg^{-1} (Yang and Kallio, 2001). Phenolic acids found in the leaves, juice or fruit of sea buckthorn include Gallic, protecatechuic, p-coumaric, ferulic, p-hydroxybenzoic and ellagic acid (Zadernowski *et al*., 2005). Seabuckthorn growing in Leh valley of Trans-Himalaya showed the presence of high content of multivitamins including Vitamin C (275 mg 100 g^{-1}), Vitamin A (432.4 IU 100 g^{-1}), Vitamin E (3.54 mg 100 g^{-1}), Riboflavin (1.45 mg 100 g^{-1}), Niacin (68.4 mg 100 g^{-1}), Pantothenic acid (0.85 mcg 100 g^{-1}), Vitamin B-6 (1.12 mg 100 g^{-1}) and Vitamin B-2 (5.4 mcg 100 g^{-1}). Similarly high amount of minerals were observed, including potassium (647.2 mg L^{-1}), calcium (176.6 mg L^{-1}), iron (30.9 mg L^{-1}), magnesium (22.5 mg L^{-1}), phosphorous (84.2 mg L^{-1}), sodium (414.2 mg L^{-1}), zinc (1.4 mg L^{-1}), copper (0.7 mg L^{-1}), manganese (1.06 mg L^{-1}) and selenium (0.53 mg L^{-1}) (Stobdan *et al*., 2010). More than 40 volatile compounds are in the fruit and leaves of seabuckthorn. Steam distillation of the fruit yielded 8 aliphatic esters, 9 aliphatic alcohols and 10 aliphatic hydrocarbons. The primary constituents of the volatile fruit aromas are ethyl dodecenoate, ethyl octanoate, decanol, ethyl decanoate, and ethyl dodecanoate.The tannins hippophaenins A and B have been isolated from the leaves of seabuckthorn.

The peel of stem and fruit contains 5-HT (5- hydroxytryptamine), a rare occurrence in the plant kingdom. The 5-HT existing in a free or grouped state can act as a neurotransmitter and regulate human emotion, blood pressure (BP), body temperature and hormone level. It can also have important antiradiation, anti-infection and anti-cancer functions and can promote coagulation by transforming fibrinogen into fibrin.

The pulp also contains high quality oil which is regarded to be very important for its medicinal value. The highest content of seed oil is 17.85% in *Hyppophae rhamnoides* sub spp., *tibetana* and lowest one is 7.80% in *Hyppophae neurocarpa* (Lebeda, 2004). It was concluded that oil content of seeds in other genotypes were in the range of 9.50 to 23.36%. Oil content of seabuckthorn from pulp of fresh berries form different origins was not higher than that of seeds (Rongsen, 2004). The highest content of oil in pulp was 18.75% in *Hyppophae neurocarpa* and the lowest one is 2.46% in spp. *Yunaanesis*. Carotenoids found in the fruit of sea buckthorn may decrease the risk for age-related macular degeneration and include α-, β- and γ-carotene; lycopene; zeaxanthin; zeaxanthin dipalmitat and β-cryptoxanthin palmitate. The antioxidant activity is more potent with extracted seabuckthorn oil because of higher carotenoid levels (Cenkowski *et al*., 2006; Lian *et al*., 2000). Organic acids in the juice of seabuckthorn have been identified as oxalic, citric, tartaric, malic, quinic and ascorbic acid.

SEABUCKTHORN OIL

Various parts of seabuckthorn viz., seed, pulp, fruit and pomace contain valueable medicinal oil. Oil content varies from species to species and variety to variety, plant part used, method of extraction and stage of harvesting. The mature seeds of seabuckthorn contain 8-20% oil whereas dried fruit pulp yields about 20-25% oil pomace, the residue left after juice extraction also contains 15-20% oil. The pulp and seed oils were also differ in their physico-chemical and bio-chemical properties. Physico-chemical properties of seabuckthorn oil are shown in Table 1 (Parimelazhagan *et al*., 2005). Both the seed and pulp oils are rich in tocopherols, tocotrienols

Table 1: Physico-chemical properties of seabuckthorn oil

Parameters	Pulp oil	Seed oil
Refractive index	1.46±0.002	1.41±0.017
Optical rotation	2.10±0.05	2.14±0.065
Acid value	8.80±0.14	10.0±0.235
Peroxidase value (meq O_2 kg^{-1})	1.36±0.02	1.42±0.038

All the values are Mean±SE

and phytosterols (Kallio *et al*., 2002). In addition, the pulp oil contains especially high levels of carotenoids (Beveridge *et al*., 1999). Seabuckthorn Oils from seeds and pulp differ considerably in fatty acid composition. Seabuckthorn pulp oil contains monounsaturated fatty acids and the saturated fatty acids, whereas polyunsaturated fatty acids are the major fatty acids of seed oil (Yang and Kallio, 2001). Seabuckthorn oil may be a secondary product since it is specialty oil used in medicine, as a nutraceutical supplement, and in cosmetics (Beveridge *et al*., 1999).

SEABUCKTHORN OIL EXTRACTION TECHNIQUES

Since ages, aboriginals of Asia and Europe have been extracted seabuckthorn oil from seeds as well as pulp. Whereas, the extraction process was crude and having several disadvantages. Generally, they are of four extraction techniques have been developed for the isolation of seed and pulp oil. These are solvent extraction using petroleum-ether, screw pressing, aqueous extraction and supercritical fluid extraction using carbon dioxide (SCFE CO_2). The usual method for extraction of the oil is solvent extraction, commonly hexane. In general, aqueous extraction was unsuccessful in extracting oil from seabuckthorn seeds and screw pressing was unsuccessful in extracting oil from pulp-flakes because the pulp oil exists in the juice pulp and is isolated as a cream layer by centrifugal technology. Supercritical fluid extraction using carbon dioxide (SCFE CO_2) is advanced technique for seed oil extraction. It is also an outstanding method for the extraction of natural agents and valuable components from plant materials because heat-sensitive compounds can be extracted without any degradation and, in addition, it is an environmentally acceptable technology. Supercritical carbon dioxide (SC-CO_2) is the most useful supercritical fluid in the food industry because it is non-toxic, non explosive, available in high (food-grade) purity and can be removed from the extracted products without leaving any residue (Cossuta *et al*., 2007). The concentration of fatty acids in oil extracted from seeds and pulp-flakes were varied from technique to technique. Petroleum-ether extraction recovered oils having the highest concentrations of tocopherols (420.6 and 170.7 mg/100 g), tocotrienols (9.7 and 7.6 mg/100 g), carotenoids (22.2 and 527.8 mg/100 g) and sterols (772.4 and 600.4 mg/100 g) in seed and pulp oils, respectively (Cenkowski *et al*., 2006). Screw pressed and aqueous extracted oils contained the lowest amounts of nutritionally important components. Concentrations of α,β,γ-tocopherols and total carotenoids extracted with oil from seeds and pulp-flakes and β-sitosterol and campesterol extracted with oil from seeds increased with the SCFE CO_2 duration (3 versus 6 h extraction time) but the duration of SCFE CO_2 extraction had no effect on concentrations of sterols extracted from pulp-flake oil. Composition of the unsaponificable matter of seabuckthorn pulp oil as shown in Table 2.

BIO-CHEMICAL PROFILE OF SEABUCKTHORN OIL

Seabuckthorn seed and pulp oil are rich source of fatty acids, carotenoids, phytosterols, Vitamins E, K and 28 trace elements viz: iron, zinc, calcium, magnesium, selenium, iodine etc., (Table 3).

Table 2: Composition of the unsaponificable matter of seabuckthorn pulp oil

Ingredient	Medium (mg/100 g)	SD (mg/100 g)	RSD (%)
Sterols	15.6	5.5	35.2
Tocopherols	3.7	3.2	87.1
Carotenoids	19.7	20.7	104.7
Fatty alcohols	14.8	3.9	26.4
Hydrocarbons	21.5	12.8	59.2
Polymer substances	26.9	19.7	73.2

Table 3: Major Phyto-constituents in seabuckthorn seed and pulp oil

Compounds	Seed oil	Pulp oil	Reference
Sterols (mg/100 g)			
Cholesterol	3.7	4.6	Beveridge (1999), Cenkowski *et al.* (2006)
Campesterol	22.5	12.4	
Stigmasterol	2.7	10.8	
β-sistosterol	748.1	576.9	
Fatty acid (Wt %)			
16:0 (Palmitic)	7.2	35.5	Beveridge (1999), Cenkowski *et al.* (2006)
16:1 (Palmitoleic)	ND	38.5	
18:0 (Stearic)	2.6	1.2	
18:1 n-9 (Oleic)	13.6	3.5	
18:1 n-7 (11-Octadecanoic)	2.3	7.3	
18:2 n-6 (Linoleic)	36.3	13.5	
18:3 n-3 (Linolenic)	38.5	2.0	
24:1 (Nervonic)	ND	1.3	
Tocopherol (mg/100 g)			
α-tocopherol	223.4	143.7	Beveridge (1999), Cenkowski *et al.*(2006), Mironov (1989)
α-tocopherol	12.1	21.1	
γ-tocopherol	177.4	11.1	
δ-tocopherol	8.8	6.5	
Tocotrienols (mg/100 g)			
β-tocotrienol	9.7	ND	
γ-tocotrienol	ND	2.5	
Plastochromanol-8	2.9	13.2	
Total carotenoids (mg/100 g)			
α-, β- and γ-carotene, lycopene, zeaxanthin and β-cryptoxanthin palmitate	22.2	527.8	Beveridge (1999), Cenkowski *et al.* (2006), Lian *et al.* (2000)

ND: not determined

Fatty acid: Fatty acid composition differs between the seed oil and soft parts of the fruit. The seed oil contains linoleic, α-linoleic, oleic, palmitic, stearic and vaccenic acids. Pulp oil contains high amount of palmitoleic, palmitic and oleic acids (Beveridge *et al.*, 1999; Cenkowski *et al.*, 2006; Riitta *et al.*, 2002). Seabuckthorn seed oil is the only seed oil that naturally provides a 1:1 ratio of Omega-3 (linolenic acid) to Omega-6 (linoleic acid). Omega-3 and 6 are the essential fatty acids of human body and they carry all fat soluble vitamins i.e., Vitamin A, D, E and K and also having another important function is to promote cognitive function and bone health.

Recent studies have shown that increasing the level of Omega-3 in the diet has had positive effect on many neurological disorders in people of all ages. These disorders include depression,

Alzheimer's, memory loss, schizophrenia. Seabuckthorn seed oil which has a level of 32% Omega-3 (linolenic acid) as per recent studies that it could be an important part of balanced diet which we have lost through our 'modern diet'. Seabuckthorn seed oil contains other beneficial fatty acids, one of which is oleic acid that has been shown to reduce blood cholesterol levels.

Tocopherol and Tocotrienol: Tocopherols and tocotrienols are collectively known as Vitamin E (Rafalowski *et al*., 2008). α-Tocopherol has the highest antioxidant activity and is the most abundant tocopherol, comprising approximately 76 to 89% of the berry (Beveridge *et al*., 1999; Mironov, 1989; Riitta *et al*., 2002). All groups of tocopherols are rich in seabuckthorn seed oil as compared to pulp oil except in β-tocopherols. Whereas, tocotrienols were observed more concentrated in pulp oil. The antioxidant Vitamin E content of seabuckthorn seed oil makes it a valuable contributor in helping the body fight and eliminates free radicals (Cenkowski *et al*., 2006).

Carotenoids: The most common carotenoids are lycopene and the Vitamin A precursor β-carotene. Carotenoids have many physiological functions. They are efficient free-radical scavengers and they enhance the vertebrate immune system. There are several dozen carotenoids in foods people consume and mostly carotenoids have antioxidant activity. Epidemiological studies have shown that people with high β-carotene intake and high plasma levels of beta-carotene have a significantly reduced risk of lung cancer. However, studies of supplementation with large doses of β-carotene in smokers have shown an increase in cancer risk (possibly because excessive beta-carotene results in breakdown products that reduce plasma Vitamin A and worsen the lung cell proliferation induced by smoke). Similar results have been found in other animals. Seabuckthorn pulp oil has maximum quantity of Carotenoids (527.4 mg/100 g). SCFE CO_2 extracted pulp oil has less quantity as compare to solvent extracted (148.4 mg/100 g oil, 6 h extraction) (Cenkowski *et al*., 2006).

Sterols: Sterols are found in 1 to 2% of the seed oil and 1 to 3% in the soft parts of the fruit as sitosterol, isofucosterol, campsterol, stigmastanol, citrostadienol, avenasterol, cycloartenol, 24-methylenecycloartanol and obtusifoliol. The concentration of β-sitosterol in seed oil changed with extraction method, namely solvent extraction (746.3 mg/100 g oil), SCFE CO_2 (667.8 to 748.1 mg/100 g oil) and screw pressing (635.0 mg/100 g oil) (Beveridge *et al*., 1999; Cenkowski *et al*., 2006; Riitta *et al*., 2002).

PHARMACOLOGY

In cancer therapy: Seabuckthorn seed oil plays a major role in cancer therapy. It can improve life quality of the patients by reducing the adverse effects of the chemotherapy or radiation in cancer treatment. It provides the patient with a rich and comprehensive supply of nutrients that help improve conditions of the patients and remove stasis and eliminates waste, promotes tissue growth and avoids infections at the site of the operation. For those under going chemotherapy, taking seabuckthorn seed oil may help counteract many side effects, improving gastrointestinal functions, increasing appetite, restoring liver and kidney functions, keeping the patient in good health.

In cerebral-cardiovascular health: Seabuckthorn seed oil has tonic effects to cerebral cardiovascular systems. The principal culprit of this disease is arteriosclerosis that is closely related to high blood fat. Seabuckthorn oil actively reduces blood fat level on the one hand and nurture the blood vessels and improves the quality of the vessels.

Oleic acid reduces cholesterol; linoleic acid regulates blood pressure and reduces serum cholesterol and prevent arrhythmia linolenic acid reduces blood pressure, dissolves accumulated fat and promote metabolism (Abdel-Salam, 2010). These unsaturated fatty acids together inhibit platelet agglutination and prevent thrombosis. Vitamin E and other antioxidants remove wastes including peroxides, ailing and dead cells from the blood and avoid damages the wastes may do to the artery walls. Total flavonoids increase blood flow of the coronary artery and nutrients in the blood supply to heart muscles, lower oxygen consumption, strengthen muscle contraction, thus improving the heart function and to increase the anti-hypoxia under normal or below normal blood pressure. Sitosterols soften the blood vessels and increase their tenacity, improve its elasticity, thus preventing hardening (arteriosclerosis). Vitamins E and other antioxidants remove wastes including peroxides and ailing and dead cells from the blood and void damages the wastes may do to the artery walls. 5-serotonin and betaine protect the cerebral cardiovascular functions by comprehensive regulation and coordination of the nervous, endocrine and the immune systems (Mingyu *et al*., 1994).

In Immune system: Immunity is the ability and process of resistance of the human body against pathogens harmful to our body (Olorunfemi, 2010). Seabuckthorn seed oil provides more than 100 nutrients and bioactive substances and many of them are considered immune building factors. It includes flavonoids (Yuzhen and Fuheng, 1997), glucosides, phenols, terpenes, vitamins and trace elements like Iron, zinc, selenium, manganese etc.

In Skin problems: Traditional use of seabuckthorn oil to promote the recuperation of skin injuries and support the healing of skin diseases, well agrees with the data of modern clinical studies (Ianev *et al*., 1995). Seabuckthorn oil is widely used to promote the recovery of various skin conditions, including eczema, burns, bad healing wounds and skin damaging effects of sun, therapeutic radiation treatment and cosmetic laser surgery (Zeb, 2004b). Russians and Tibatens prepare drugs from Seabuckthorn oil for various diseases including inflammation, bacterial infections, pain, promising regeneration of tissues and for skin grafting, cosmetology and operational treatment of corneal wounds, oedema, fever, chill, furuncle and abscess obstruction by sputum and stomach tumour (Anonymous, 2001). An ingredient of the oil, palmitoleic acid is a component of skin. It is considered a valuable topical agent in treating burns and healing wounds. This fatty acid can also nourish the skin when taken orally if adequate quantities of seabuckthorn oil are consumed; this is a useful method for treating.

Anti-oxidant activity: Seabuckthorn oil is rich in carotenoids (β-carotene), fatty acids (1:1 ratio of Omega-3 (linolenic acid) to Omega-6 (linoleic acid), oleic acid and lower saturated fatty acid) tocopherol (α- tocopherol,γ-tocopherol) and tocotrinol, phytosterols and 28 trace elements: iron, zinc, calcium, magnesium, selenium, iodine all are antioxidants with very low molecular weight to neutralize free radicals. With collective power they are even more effective. At the same time, seabuckthorn seed oil can also activate superoxide dismutase whose role in the body is to eliminate free radicals. As a natural immune enhancer, it maintains the stability of the immune system and keeps the supervisory role of the system normal, thus eliminating the mutant and dead cells caused by free radicals and enhancing phagocytosis of macrophage and killing cancerous cells.

SEABUCKTHORN OIL AS MULTI DIMENSIONAL MEDICINE

The concerted and mutual promoting actions of the more than elements have positive effects on the endocrine, circulation, immune and nervous systems and this in turn creates a most

favourable condition for the digestive system. First, the oil provides a protective coating inside the stomach, intestines and duodenum, thus preventing pathogens from harming them and keeping pathogenic changes from spreading. Its also reduces liver damage by alcohol, parasetamol and carbon tetrachloride and prevents fatty liver. This is because it increases metabolism of cholesterol and fat (Mohammad Salahat *et al*., 2002). The anti-inflammatory and anti-ulcer properties of b-sitosterol-b-D-glucosides, usorlic acid and betaine promote ulcer healing, prevent spread and inhibit erosion. β-carotene, Vitamin-E, unsaturated fatty acids stimulate cell metabolism at site and repair injuries (Tabassum *et al*., 1998). Meanwhile, Seabuckthorn seed oil has remarkable inhibiting effects on gastric acid and abnormal increase of gastric proteinase, thus keeping the ulcer from spread and metastasis.

CONCLUSION

Seabuckthorn grown wild in Ladakh under the waste and degraded land conditions. It is well known that plants under stress respond with biosynthesis of phytochemicals to enable them to adapt to the environment. As regards to Seabuckthorn, very limited phytochemical work has been reported from India. The DIHAR of DRDO in Leh has initiated a research work to develop products from Seabuckthorn oil for the people surviving in diverse climatic conditions. Since seabuckthorn has been used since ancient times in common medicines for curing many diseases affecting humans and other animals, the commercialization of seabuckthorn based nutritious products would be a great achievement in alternative nutritional diet sources.

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