SEA BUCKTHORN BERRY (*HIPPOPHAE RHAMNOIDES* L.) A COLD DESERT FRUIT: A REVIEW

Abstract

This review paper explores the medicinal and therapeutic uses of sea buckthorn (*Hippophae rhamnoides* L.) in curtailing different types of acute as well as chronic maladies. The plant is being used in different parts of the world for its nutritional and medicinal properties. Sea buckthorn based preparations have been extensively exploited in folklore treatment of slow digestion, stomach malfunctioning, cardiovascular problems, liver injury, tendon and ligament injuries, skin diseases and ulcers. In the recent years, medicinal and pharmacological activities of Sea buckthorn have been well investigated using various *in-vitro* and *in-vivo* models as well as limited clinical trials. Sea buckthorn has been scientifically analyzed and many of its traditional uses have been established using several biochemical and pharmacological studies. Various pharmacological activities such as cytoprotective, anti-stress, immuno-modulatory, hepatoprotective, radioprotective, anti-atherogenic, anti-tumor, anti-microbial and tissue regeneration have been reported.

Keywords: Leh berry, sea buckthorn, cold dessert, medicinal uses, oil

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I. INTRODUCTION

The sea buckthorn (SBT) plant is well known for its medicinal and aromatic uses as well as its numerous health benefits. Hippophae is a genus of sea buckthorns, deciduous shrubs in the family Elaeagnaceae. The name sea buckthorn may be hyphenated (Anon., 2021) to avoid confusion with the buckthorns (Rhamnus,family Rhamnaceae). It is also referred to as sandthorn, sallowthorn (Anon., 2022), or sea berry (Anon., 2012). Singh (2005) reported that in ancient times, leaves and young branches from sea buckthorn were supposedly fed as a remedy to horses to support weight gain and appearance of the coat, thus leading to the name of the genus, Hippophae derived from hippo (horse) and phaos (shining).

Hippophae rhamnoides, the common sea buckthorn, is by far the most widespread of the species in the genus, with the ranges of its eight subspecies extending from the Atlantic coasts of Europe across to northwestern Mongolia and northwestern China **(Li, 2002)**. In Western Europe, it is largely confined to sea coasts where salt spray off the sea prevents other larger plants from outcompeting it, but in central Asia, it is more widespread in dry semi-desert sites where other plants cannot survive in the dry conditions **(Bartish *et al.,* 2002)**. In central Europe and Asia, it also occurs as a sub-alpine shrub above the tree line in mountains and other sunny areas such as river banks where it has been used to stabilize erosion **(Li, 2002)**. They are tolerant of salt in the air and soil, but demand full sunlight for good growth and do not tolerate shady conditions near larger trees. They typically grow in dry sandy areas.

More than 90 per cent or about 1,500,000 ha of the world's natural sea buckthorn habitat is found in China, Mongolia, Russia, northern Europe and Canada. Where, the plant is used for soil, water and wildlife conservation, anti-desertification purposes and products (Li, 2002) as medicinal and other products.

II. PLANT (SHRUB) OF SEA BUCKTHORN

The shrubs reach 0.5–6.0 m tall, rarely up to 10.0 m in central Asia. The leaf arrangement can be alternate or opposite **(Swenson and Bartish, 2002)**.

- *Hippophaegoniocarpa* grows in mountainous regions in Nepal and China on mountain slopes, river banks, flood lands and valley terraces. The growth altitude is typically between 2650 and 3700 m. The species is divided into two distinct subspecies, *H. goniocarpa* subsp. *litangensis* and *H.goniocarpa* subsp. *goniocarpa*. *H. goniocarpa* subsp. *Litangensis* differs from the typical subspecies by the young branchlets and the lower surface of leaves **(Yongshan *et al.*, 2003*)***. The Latin specific epithet *goniocarpa* refers to goniocarpus with angular fruits **(Gledhill, 2015)**.

- *Hippophae rhamnoides*: Common sea buckthorn has dense and stiff branches and is very thorny. The leaves are a distinct pale silvery-green, lanceolate, 3–8 cm long and less than 7 mm broad. It is dioecious, with separate male and female plants. The male produces brownish flowers which produce wind-distributed pollen. The female plants produce orange berries 6–9 mm in diameter, soft, juicy and rich in oils. The roots

distribute rapidly and extensively, providing a nonleguminous nitrogen fixation role in surrounding soils.

- *Hippophae salicifolia* (willow-leaved sea buckthorn) is restricted to the Himalayas, to the south of the common sea buckthorn, growing at high altitudes in dry valleys (Nubravally of Leh); it differs from *H. rhamnoides* in having broader (to 10 mm) and greener (less silvery) leaves and yellow berries. A wild variant occurs in the same area, but at even higher altitudes in the alpine zone. It is a low shrub not growing taller than 1 m with small leaves 1–3 cm long.

1. **Varieties:** During the Cold War, Russian and East German horticulturists developed new varieties with greater nutritional value, larger berries, different ripening months and branches that are easier to harvest. Over the past 20 years, experimental crops have been grown in the United States, one in Nevada and one in Arizona and in several provinces of Canada (Anon., 2008).

2. **Fruits:** The fruits of sea buckthorn are rich in vitamin-C (120mg/100g) and vitamin-A, they contain too acid when raw for most people tastes, though most children seem to relish them. Used for making fruit juice, it is high in vitamins and have an attractive aroma. It is being increasingly used in making fruit juices, especially when mixed with other fruits, because of its reputed health benefits. The fruits of some species and cultivars contain up to 9.2% oil. The fruit is very freely borne along the stems and is about 6 - 8 mm in diameter. The fruit becomes less acid after a frost or if cooked. The fruit is ripe from late September and usually hangs on the plants all winter if not eaten by the birds. It is best used before any frosts since the taste and quality of frosted berries quickly deteriorates.

3. **History:** Tracing the history of sea buckthorn, can take us 2400 years ago. Ancient Greek scholar, Theophrastus (372-287 BC) and often considered as father of botany, mentions about medicinal use of Sea buckthorn in his text – "HistoriaPlanarum". References of medicinal and nutritional uses of sea buckthorn are also found in 8th century Tibetan medical text – the Rgyudbzi (The Four Books of Pharmacopoeia) and SibuYidian (The Four Medical Tantras). Hippophaë means "glittering horse" in Greek; ancient Greeks used that sea buckthorn leaves for feeding war horses. Hence the botanical name of the common sea-buckthorn – *Hippophae rhamnoides*. Anon. (2012) suggested that, Greeks believed that it were the sea-buckthorn leaves which made Pegasus, a mythical horse fly. If not fly, they would have definitely helped war horse regain energy and recover from wounds. It was in 12th century; Mongol conqueror Genghis Khan who not only fed his horses sea-buckthorn leaves, but also encouraged his army feed on sea buckthorn berry for stamina at high altitudes.

The area under cultivation of sea buckthorn is about 1.1 million ha. in China, followed by Russia, Mongolia and India. The plant is well adopted to grow in dry, cold climate, at altitudes well over 10000 feet. This plant is also introduced and cultivate in other temperate zones like Central Asia, Canada, Greece and parts of Europe. Today research on sea buckthorn is very active. Efforts of Chinese research on Sea Buckthorn have paved way for International Center for Research and Training on Sea buckthorn

(ICRTS), a global platform for researchers on sea buckthorn. Research wings of Indian Army have been studying sea buckthorn for its uses in combat situations at high altitudes. Sea buckthorn is also known by various names across globe. Some of them are sandthorn, sallowthorn, seaberry, Sea buckhorn, Seedorn, Siberian Olive, Siberian Pineapple, argouse, Argousier, False Buckthorn, Espino Falso, Oblepikha (Greek), Purging Thorn, Rokitnik (Polish), Tindved (Norwegian), Tsermang or Tasru (in Ladakhi), Chharma.

4. **Parts of Sea Buckthorn Used:** The berries are eaten raw in parts where they grow. However processed berries are distributed across globe. Most commonly used parts of sea buckthorn are berries, which includes the pulpy flesh and the seed. Leaves of sea buckthorns are also used for medicinal purpose. When the berries are presses, the pulp separates out from the cover and the seed. The pulp is essentially the juicy part of the berry. Fatty acids or cream are further separated out of the pulp which is sold as sea buckthorn pulp oil. While remaining juice is often sold directly or sediments in the juice are extracted, dried and sold in powdered form. Essential oil can be extracted from sea buckthorn seeds through solvent extraction petroleum-ether,supercritical carbon dioxide extraction process, screw processing and aqueous extraction.Seed residue remaining after extraction of sea buckthorn seed oil along with outer cover, forms part of sea buckthorn meal which is used as animal fodder. Sea buckthorn plant has been long used in cold deserts for fuel and fencing. While Sea buckthorn is used as herbs and its leaves, flowers and fruits form medicinal use, it widely used in culinary forms. Pulp is used in making jellies, juices, purees and sauce. Sea buckthorn pulp oil and sea buckthorn seed oil finds its use in cosmetics and anti-aging products because of its benefits for skin and hair. Supplements in form of sea buckthorn oil gel or pill are also popular. Other forms include liquid, juice, plaster, paste, ointment, liniments, tinctures, hand cream, face wash, deodorant, massage oil, syrup etc.

   Sea buckthorn leaves are considered healthy for horses. Sea buckthorn leaves, pulp and seed residues are used for animal feed. It is believed to improve mucous membranes of animals including skin, eyesight and milking organs in cattle.

   Sea buckthorn tea is made from its leaves. It is part of multi vitamin beverages. The pulp can be fermented and non alcoholic fermented drinks can be made from sea buckthorn. Apart from all this, it is still believed to be underutilized species of plants.

5. **Berries Juice and Other Products:** Sea buckthorn berries are edible and nutritious, though astringent, sour and oily, unpleasant to eat raw (Tiitenen *et al.*, 2005a), unless 'bletted' (frosted to reduce the astringency) and/or mixed as a drink with sweeter substances such as apple or grape juice. Additionally, malolactic fermentation of sea buckthorn juice reduces sourness, thus in general enhancing sensory properties. The mechanism behind this change is transformation of malic acid into lactic acid in microbial metabolism (Tiitenen *et al.*, 2005b). When the berries are pressed, the resulting sea buckthorn juice separates into three layers: on top is a thick, orange cream; in the middle, a layer containing sea buckthorn's characteristic high content of saturated and polyunsaturated fats; and the bottom layer is sediment and juice (Seglina, 2006) and (Zeb, 2004). Containing fat sources applicable for cosmetic purposes, the upper two layers can be processed for skin creams and liniments, whereas the bottom layer can be used for edible products such as syrup (Seglina, 2006). Sea buckthorn berries contain

sugar, which is crucial because it greatly influences how sweet the juice will be. All three primary subspecies of sea buckthorn (*H. rhamnoides ssp. sinensis, ssp. rhamnoides, and ssp. mongolica*) are typically claimed to contain just glucose and fructose as sugars (Yang et al.,2009).

Besides juice, sea buckthorn fruit can be used to make pies, jams, lotions, teas, fruit wines and liquors. The juice or pulp has other potential applications in foods, beverages and cosmetics products. Fruit drinks were among the earliest sea buckthorn products developed in China. Sea buckthorn-based juice is popular in Germany and Scandinavian countries. It provides a nutritious beverage, rich in vitamin-C and carotenoids. For its troops confronting extremely low temperatures (Siachen), India's Defence Research Development Organization (DRDO) established a factory in Leh to manufacture a multivitamin herbal beverage based on sea buckthorn juice (Anon., 2021). The seed and pulp oils have nutritional properties that vary under different processing methods (Cenkowski, 2006). Sea buckthorn oils are used as a source for ingredients in several commercially available cosmetic products and nutritional supplements.

6. **Sea Buckthorn leaves:** The berries and leaves of sea buckthorn are thought to be a rich source of bioactive compounds such isoflavones and flavonoids, which have a variety of positive health effects, including anti-atherogenic, antioxidant, anticancer, and antibacterial activities (Suomela.,2006). In particular, sea buckthorn leaves have been found to have higher levels of phenolic compounds and antioxidant activity than the berries, as well as higher concentrations of nutrients and bioactive compounds like minerals, vitamins, fatty acids, carotenoids, and phenolic compounds. In addition to their antioxidant properties, phenolic compounds from SB leaves have been shown to have antibacterial effects on a number of pathogenic pathogens. Additionally, it has been found that sea buckthorn leaf extracts have strong antibacterial, anticancer, anti-inflammatory, and antioxidant properties (Jain et al., 2008). Despite these possible health advantages and the resulting economic interest, most SB leaves are not used because they are regarded as agricultural waste after berry harvesting. Therefore, it would be important to encourage the widespread use of this plant and to develop fresh products based on the currently underused elements of it. It is widely known that the concentration and composition of phenolic compounds are greatly influenced by a variety of factors, including cultivar, harvesting period, leaf location on the plant, and processing techniques. Various plant components (leaves, shoots, and berries) of sea buckthorn (*Hippophae rhamnoides* L.) were examined using a reversed-phase high-performance liquid chromatography analysis (RP-HPLC) in conjunction with diode array detection (DAD) during the yearly growth cycle (Bittová et al.,2014). In all of the leaf samples, catechin, gallic acid, p-coumaric acid, caffeic acid, ferulic acid, rutin (quercetin 3-rutinoside), and quercitrin (quercetin 3-rhamnoside) were found. The leaf extracts were shown to have the highest overall amount of total polyphenolics, just as in this investigation. Significantly, it was discovered that leaves and berries with longer maturation times had more quercitrin (Bittová et al.,2014). Although the phytochemical profiles of the leaves and fruits are comparable, the leaves contain much more phenolic compounds, particularly hydrolysable and condensed tannins, triterpene compounds, and flavonoids. Due to its ability to block the entry of the SARS-CoV-2 spike pseudotyped virus into cells in vitro, flavonol isorhamnetin attracted scientific attention during the COVID-19 pandemic crisis (Zhan et al., 2021).

7. **Sea Buckthorn Seed Oil:** The seeds of sea buckthorn (*Hippophae rhamnoides* L.), which have exceptional nutritional, cosmetic, and medicinal benefits.In Tibetan, Chinese, and Mongolian cultures, the sea buckthorn has even been referred to as "God sent medicine" or "Liquid Gold." Although sea buckthorn berries, seeds are discarded during processing, they contain a special combination of fatty acids, including fat-soluble vitamins and minerals for industrial purposes (Yang, & Kallio, 2002). By using gas chromatography-mass spectrometry (GC-MS), fatty acid composition in total lipid extracts of whole berries, pulp, and seeds examined. Linoleic acid to linolenic acid ratio of 1:1 only exists in Sea buckthorn seed oil. Regarding oil content, sea buckthorn seed ranges from 0.26 to 15 g $hg^{-1,}$ depending on subspecies, origin, packaging of berries, berry harvesting period, and extraction techniques (Bal et al.,2011). Omega-3 fatty acid linolenic (C18:3n-3) and omega-6 fatty acid linoleic (C18:2n-6), which make up 20–35 g $hg^{-1}$and 30–40 g hg^{-1}respectively, are two essential fatty acids found in sea buckthorn seed oil. Omega-3 fatty acid linolenic (C18:3n-3) is well known to have chronic and heart disease prevention qualities, and omega-6 fatty acid linoleic (C18:2n-6) is an essential component of the human diet (Fan et al.,2007). Sea buckthorn seed oil is an essential component in skin photoprotection cosmetics because studies have revealed that it has special abilities to counteract UV-induced impairments as well as lipid metabolism issues (Gęgotek et al.,2018). Furthermore, Sea buckthorn seed oil promotes the healing of burns, wounds, and skin conditions including eczema. Consequently, it is used as a potentially effective therapeutic agent in treatment of dermatitis (Vinita et al.,2017). The oil's carotenoids promote the production of collagen, and phytosterols control inflammatory reactions and have anticancer properties (Punia & Kumari,2017).

8. **Sea Buckthorn Pulp Oil:** Sea buckthorn berries are abundant in vitamins, carotenoids, flavonoids, proteins, antioxidants, amino acids, vital fatty acids, and phytosterols. In recent years, attention has been drawn to the nutritional oil product known as sea buckthorn pulp oil which is made from the pulp of the SB berry (Gao et al.,2017). SBPO is characterized by an abundant composition of fatty acids, chemically includes palmitoleic acid (C16:1, 19.4%~38.5%), palmitic acid (C16:0, 28.9%~37.8%), oleic acid (C18:1, 10.8%~33.6%), linoleic acid (C18:2, 4.1%~14.2%) and α-linolenic acid (C18:3, 1.6%~7.4%)(Zheng et al.,2017). Additionally, Sea buckthorn pulp oil is one of the most unique edible oils due to the enrichment lipids phytochemicals, such as tocopherols, phytosterols, and carotenoids, that it contains. Sea buckthorn (*Hippophae rhamnoides* L) seed and pulp oils have traditionally been used for treating skin diseases in China and Russia,but are not widely used in other countries.Recently, (Yakimishen,et al.,2005) reported for sea buckthorn berries Indian-summer,seed oil recoveries of 7.2% and 4.5%using supercritical CO_2 extraction and screw pressing, respectively ,and a pulp-flake oil recovery of 17% for supercritical CO_2 extraction. Moreover, low recovery of pulp oil(1.2%) was obtained by aqueous extraction. Oil from the flesh/peel of the berries (pulp oil) is rich in palmitoleic acid(16:1n-7,24-39%) (Xin et al.,1993).Pulp oil supplementation increased the proportion of palmitoleic acid in plasma phospholipids of AD (atopic dermatitis) patients. In addition to being used medicinally, the pulp is processed to create a variety of products, including juice and jam (Yang et al.,2011).Despite the benefits of Sea buckthorn pulp oil, its application in the food industry is restricted by its poor water solubility and phytochemical instability. The planting of sea buckthorn is a step towards better ecological management as well as economic development because of the valuable components in the pulp and their biological activity.

III. MEDICINAL USES

Sea buckthorn is being used as folk medicine for more than 2,000 years in traditional Chinese, Tibetan, and Indian medicine. It is also used in Russian and Western European folk medicine. Asthma, hepatitis, gastrointestinal disorders, skin conditions, and rheumatism were all treated with it in Russia, along with hepatitis, skin conditions, and asthma. The fruit is most often used. Research has centered on the fruit, though some studies on anticancer effects have used leaf extracts. Both animal studies and clinical studies have shown numerous pharmacological effects, including antimicrobial, antiulcerogenic, antioxidant, anticancer, radioprotective and antiplatelet activities. Existing studies are of varied quality. Clinical evidence is needed of benefit in some claimed uses, such as renal support and prevention of urinary tract infections (UTI). Data on topical use of the fruit oils for wounds and atopic dermatitis is mixed, with evidence supporting its usefulness in the treatment of eye discomfort and burns. There is strong evidence of anti-inflammatory and antioxidant properties of the fruits, with liver and cardiovascular protectant effects including reductions in C-reactive protein **(Alam, 2004)** and **(Anon., 2018)**. More high-quality clinical studies are needed to show whether and how the evidence for reduced cardiovascular risk factors translates to improved cardiovascular outcomes **(Marietta *et al.,* 2014)**. There is no evidence of toxicity; in one case, an individual consuming five times the traditionally recommended dose of the fruit daily for six months presented with a harmless orange discoloration of the skin due to the fruit's high levels of beta carotene **(Anon., 2018)**.

The twigs and leaves of Sea buckthorn contain 4 - 5% tannin. They are astringent and vermifuge **(Olas, 2013)**. The tender branches and leaves contain bioactive substances which are used to produce oil that is quite distinct from the oil produced from the fruit. Yields around 3% of oil are obtained. This oil is used as an ointment for treating burns. A high quality medicinal oil is made from the fruit and used in the treatment of cardiac disorders, it is also said to be particularly effective when applied to the skin to heal burns, eczema, radiation injury and is taken internally in the treatment of stomach and intestinal diseases. The fruit is astringent and used as a tonic **(Li *et al.*, 1996)**. The freshly-pressed juice is used in the treatment of colds, febrile conditions, exhaustion etc.; the fruit is a very rich source of vitamins and minerals, especially in vitamins-A, C and E, flavanoids and other bioactive compounds. It is also a fairly good source of essential fatty acids, which is fairly unusual for a fruit. It is being investigated as a food that is capable for reducing the incidence of cancer and also as a means of halting or reversing the growth of cancers. The juice is also a component of many vitamin rich medicaments and cosmetic preparations such as face creams and toothpastes. A decoction of the fruit is used as a wash to treat skin irritation and eruptions **(Suryakumar and Gupta, 2011)**.

1. **Cardiovascular Therapy:** Sea buckthorn polyphenols are abundant in diversity and content, contain a wide range of bioactive properties, and have received a lot of attention. In male ICR mice with femoral artery thrombosis, sea buckthorn total flavones at a dose of 3.0lg/mL effectively reduced in vitro platelet aggregation brought on by collagen (2.0lg/mL) in a concentration-dependent manner (Cheng et al. 2003*).* Additionally, chronic sucrose-fed rats were treated with sea buckthorn seed total flavone, particularly at a dose of 150 mg/kg/day, which significantly reduced the elevated hypertension, hyperinsulinemia, and dyslipidemia and raised the circulatory blood angiotensin level as

effectively as an angiotensin receptor blocker(Pang et al.,2008).*Hippophae* is utilised as a cardioprotective drug (Chai et al.,1989).

2. **Gastrointestinal Ulcers:** In humans, gastric ulcers are spreading quickly. Laboratory tests have shown that the seed oil from hippophae is effective in treating gastrointestinal ulcers, which is a traditional usage for the plant (Zhou,1998). By regulating pro-inflammatory mediators, it may be able to normalise gastric acid output and reduce inflammation. On ulcer models generated by indomethacin and stress, a hexane extract from *Hippophae rhamnoides* was evaluated for its antiulcerogenic properties. Hexane extract from *Hippophae* was discovered to be effective in reducing stomach damage as a result (Suleyman et al.,1997).

3. **Liver Diseases:** In a clinical investigation, it was found that sea buckthorn extracts normalised immune system indicators linked to liver inflammation and degeneration, serum bile acids, and liver enzymes (Ze-Li Gao et al.,2003). Additionally, research in the lab has shown that sea buckthorn oil shields the liver from the negative effects of harmful substances. (Zhao et al.,1987) reported that From harm caused by CCl4, the liver may be protected by sea buckthorn.

4. **Skin Diseases:** Palmitoleic acid, one of the oil's ingredients, is found in skin. It is regarded as an effective topical medication for the treatment of burns and the healing of wounds. If enough sea buckthorn or its oil is consumed, this fatty acid can also nourish the skin when taken orally; this is a helpful way for treating systemic skin conditions like atopic dermatitis. For burns, scalds, ulcerations, and infections, topically applied sea buckthorn oil is already widely used, either alone or in a variety of formulations. It is a component of sunblock. Hippophae oil is useful for stimulating tissue regeneration since it has emollient and UV-blocking qualities (Goel et al.,2002).

5. **Cancer Therapy:** *Hippophae* has a limited role in the prevention and treatment of cancer, however now exists now available evidence based on recognised experimental research about its anticancer properties (Xu Mingyu, 1994). Researchers in China conducted a study on mice fed sea buckthorn oil to show that the mice's hemopoietic systems recovered more quickly from high-dose chemotherapy (Chen,2003). However, to confirm its effects and the precise mechanism on cancer patients in humans, well-designed clinical studies using sea buckthorn are required.

IV. HEALTH BENEFITS

Sea buckthorn berry has been long considered as cure for various ailments. Fruits, leaves, twigs, root and thorn have been used in various medicinal forms. Chinese, Tibetan and Mongolian medicine form glorifies health benefits of Sea buckthorn by describing it as “God Sent Medicine”, “Holy fruit of Himalayas”, “Liquid gold”, “Life oil”, etc. Chinese pharmacopeia classifies sea buckthorn oils as both food and medicine and considered as medicinal use for strengthening stomach, blood circulation and respiration **(Suryakumar and Gupta, 2011)**. This can be attributed to presence of Vitamin-E, Vitamin-A and Omega 7 fatty acids in sea buckthorn. Earliest efforts compiling health benefits of sea buckthorn was done by Thomas and Li in their book – Sea Buckthorn: Production and Utilization. Some of the health benefits of sea buckthorn are listed as **Olas (2013)**. Treating respiratory disorder,

treating high altitude sickness, anti-cancer properties, powerful anti-oxidant, improves cardiovascular health, treating cerebrovascular diseases, prevents ulcer, prevent damage of liver, useful for healthy prostate, good for eyes, skin and hair, whiten the teeth, full of vitamin-C, calms nerve, having anti-inflammatory properties, anti-bacterial property, relive pain, benefits in weight loss, keeps healthy gastro intestinal tract, increasing immunity, improves thyroid function, stamina building, prevents blood clotting, relieve menopause symptoms, healthy nails and collagen production, etc. People in Laddakh mix its juice in flour to get "rich" flour for their chapattis. Drink glass of sea buckthorn juice if you are suffering from cold or sore throat.

If you are visiting Laddakh in northern part of India or parts of Tibet you come across small yellowish orange (or oranges yellow) berry, you must have encountered with sea buckthorn berry. This extremely sour berry is native to cold desserts of China and Mongolia. It is also found in high altitude Karakoram region in Pakistan. There appears to be no evidence of the origin of the sea buckthorn. While buckthorn is common name in related genus of plants, however there appears to be no specific reference to meaning of name Sea buckthorn. Sea buckthorn has been cherished by native Tibetans and Mongolians for its nutritional value and varied medicinal uses. Today it is part of Chinese Pharmacopeia and Mongolian traditional medicine forms for its healing power. Ayurveda compares this "holy fruit of Himalayas" with Amla or Indian Gooseberry in terms rasas (tastes) and its health benefits.

1. **Nutritional Value of Sea Buckthorn Berry:** Like all sour fruits, sea buckthorn contains vitamin-C. To put some facts into place, an average adult daily requires about 65 mg of vitamin-C. Raw oranges juice provides about 50 mg, raw kiwi provides 95 mg and raw guava contains 228 mg of vitamin-C per 100 g. Some of the foods highest in vitamin-C are listed on self nutrition data portal. Vitamin-C content in sea buckthorn berry is around 400-1500 mg per 100 g. Similarly, it is rich in vitamin-E or Tocopherols. It contains 120-180 mg of vitamin-E per 100 g of berries. In the list of foods highest on self nutrition data portal, probably sea buckthorn would come first. Sea buckthorn is rich in vitamin-K. It contains vitamin A in form of carotene, lycopene and zeaxanthine. These fat soluble vitamins i.e. A, E and K get concentrated in sea buckthorn oil. A study found that per 100 g of various oil (seed oil, pulp oil, fruit residue oil) contains vitamin-E in the range of 170-600 mg, vitamin-K in the range of 50-230 mg and Caratenoids in the range of 30-1800 mg, making Sea Buckthorn oil as amazing source of fat soluble vitamins (except Vitamin-D). Vitamin content of sea buckthorn also includes vitamin-B1, B2 and B6.

   Mineral content of sea buckthorn include minerals like zinc, selenium, manganese and iron (Table-1). Sea buckthorn contains various fatty acids mainly Omega-9 fatty acids (oleic acid), Omega-6 fatty acids (palmitic acid and linoleic acid) and Omega-3 fatty acids (linolenic acid). Most importantly it is one of the highest natural sources of Omega-7 fatty acids (palmitoleic acid), nearly one third of total fatty acids in sea buckthorn. Amount of fatty acid may vary depending on species and geography, however fruit pulp contains about 3-5% of fatty acids while seed has concentrated form of lipids to around 8-20%. Health benefits of sea buckthorn oil can be very much attributed to these Omega-7 fatty acids. Sea buckthorn also contains flavonoids about 0.1-1% by weight, including–Quercetin, Oligomeric Proanthocyanidins, Isorhamnetin Kaempfermol, Catechins and Proanthocyanidins, which have amazing antioxidant properties. It also

contains high amount of natural plant sterols like beta-sitosterol, and erithrodiol, which exhibit antioxidant and anti-inflammatory properties. Amino acids and proteins in sea buckthorn account to 2-3% by weight, while concentrated in seeds (18-33%) which also makes sea buckthorn meal good animal fodder.

2. **Processing and Products:** The sea buckthorn fruit has the potential to be used to make a variety of products, including food, fresh fruit, nutraceuticals, pet feeds, cosmetics, and skin treatments to enhance the health and appearance of the skin.

3. **Juice Extraction:** Freshly squeezed juice will split into three stages if left to stand for one or two days: a top floating particulate phase, a centre liquid component, and a sinking particulate sediment. This division is undesirable from the perspective of the consumer (Kleinschnidt et al.,1996). If pulp oil is present in the juice, it will cause the formation of an oil layer on the juice surface and an oil ring that remains on the package surface once the juice has been removed. This oil ring that is still on the container is unattractive and undesirable. The floating oil issue can be resolved by centrifugally reducing the juice's oil concentration to under 0.1%. The coarse sediment will settle to the bottom of the bowl when the disc stack centrifuge removes the oil, and the dislodging mechanisms included into the centrifuge can automatically remove it (Beveridge et al., 1999). As an alternative, the juice from the crushed berries or the crushed berries may be treated with a pectinmethylesterase (PME) preparation or perhaps with one of the numerous commercially available hydrolytic enzyme preparations (Lui & Lui 1989). The juice must be sterilised or pasteurised for preservation purposes. The preferred procedure is high-temperature-short-time (HTST) at 80 to 90 °C for a few seconds (Liu and Lui 1989). This is due to the juice's relative fragility; if cooked over the recommended levels, it will lose flavour and develop an off-flavor. Additionally, heat destroys vitamin C, thus processing HTST encourages maximal retention.

   After around six months at 15° to 20°C, the juice starts to turn brown; under non-oxidative conditions, this browning is minimised. Enzymes and sunshine are significant drivers of browning initiation, which can be reduced to 4°C to extend storage life (Zhou & Chen 1989).

   The amount of suspended particulates that remain after centrifugation often causes sea buckthorn juice to range from being opalescent to extremely turbid. Ultra filtration, however, can be utilised to remove all particulates to produce a clear juice (Bock et al.,1990). The ultra filtration membrane can have a molecular weight cutoff of 100,000 or more, and the procedure creates an oil-free permeate and an oil-rich retentate that can be used to create pulp oil rich in vitamin E and a solid rich in carotenoids that can be used as a source of isolation for the pigment or as a dietary supplement.

4. **Oil Extraction:** Oil extraction from sea buckthorn can be done in two ways. Using centrifugal technology, pulp oil, which is present in the juice pulp, is separated as a cream layer. Oil-bearing material, such as seeds or pulp, must typically be extracted counter current using an organic solvent, most often hexane, to produce oil commercially (Weiss,1963). Consumers are increasingly demanding products with less residues. Oil residues can be reduced by using more recent extraction methods, including supercritical fluid extraction (SCE), which relies on carbon dioxide under high pressure. Since sea

buckthorn oil is a specialised oil used in medicine, as a nutraceutical supplement, and in cosmetics, it might be considered a secondary product (Beveridge et al.,1999).

5. **Pigment:** A colourant known as "sea buckthorn yellow" can be obtained from sea buckthorn waste. The waste material could be the press cake remaining after juice extraction or the sediments remaining after centrifugation. In one process the pigment is extracted with low concentrations of alcoholafter concentrating the suspension to 11°–13° Brix (Chen et al.,1995). Spray drying the waste material produces a yellow powder. Along with carotene and vitamin E, it also includes flavones. A yellow colouring component has also been extracted from sea buckthorn waste using supercritical CO_2. The biggest factor affecting extraction was pressure, which led to higher yields. Under processing conditions of 60 MPA, 85°C, a yield of 64% total carotenoids was obtained (Messerschmidt,1993).

6. **Teas:** Nutrients and bioactive compounds are present in sea buckthorn leaves. These include triterpenols, isoprenols (Goncharova & Glushenkova 1996) free and esterified sterols, carotenoids, and flavonoids. The air dried leaves can be used to make a variety of products, such as teas and tea powders.

7. **Animal Feed:** Nutraceutical products for animals are one potentially large market for sea buckthorn. The substantial amount of "waste" material from sea buckthorn, such as the leaves, fruit, pulp, and seed residues from juice and oil extraction, could be converted into a value-added product. The protein content of sea buckthorn leaves is about 15%, and the berry and seed residues still have small amounts of important chemicals in them.

8. **Initiatives for Development of Sea Buckthorn:** In 2005, the "EAN-Sea buck" network between European Union states, China, Russia and New Independent States was funded by the European Commission to promote sustainable crop and consumer product development. In Mongolia, there is an active National Association of Sea buckthorn Cultivators and Producers. The International Sea buckthorn Association, formerly the International Center for Research and Training on Sea buckthorn (ICRTS) was formed jointly in 1988 by the China Research and Training Center on Sea buckthorn, the Sea buckthorn Office of the Yellow River Water Commission and the Shaanxi Sea buckthorn Development Office. From 1995 to 2000, ICRTS published the research journal, *Hippophae.*

V. ECONOMIC IMPORTANCE

According to the historic classic Indian system of medicine, sea buckthorn has numerous medical benefits that have been known since 5000 BC. According to the Tibetan medical classic "rGyud bzhi," Tibetan physicians recognised the healing potential of this wonder plant as early as the eighth century. The twentieth century was the first time that they were discovered in modern times. Since 1940, Russia has had sea buckthorn industrial growth, and in the 1960s and 1970s, the country developed health goods for cosmonauts (Li 2002). In 1986, when a nuclear plant disaster in Chernobyl, Ukraine, caused radiation leaks, sea buckthorn received even more attention from the general public (Singh,2008). From sea buckthorn berries, oil, leaves, and bark extracts, hundreds of products have been developed. A few examples of processed products are oil, juice, alcoholic drinks, candy, ice cream, tea,

jam, biscuits, vitamin tablets, food colouring, medications, cosmetics, and shampoos (WuF 1991). Sea buckthorn is used in a variety of cosmetic products, such as lotions and creams for sun protection, anti-aging skin care, dandruff control, and hair loss prevention (Parimelazhagan et al.,2004).

VI. CONCLUSION

Sea buckthorn is a unique plant. Its beneficial properties against cardiovascular disorders have been attributed to its high UFA content and range of phytosterols, especially beta-sitosterol. It has high nutritional and medicinal values for humans as well as animals. The majority of sea buckthorn research has been conducted in Asia and Europe. It has attracted considerable attention by researchers, producers, and industry. However, information mentioned in this manuscript would give forward motion to new academic and research & development activities especially for the development of sea buckthorn based herbal medicine, nutraceuticals, new herbal & functional food products, etc.

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Table 1: Chemical composition of sea buckthorn (Nazir *et al.,* 2017)

S. No.	Constituents	Quantity
1.	Moisture	85.76%
2.	Oil	2.12%
3.	Ash	1.79%
4.	Total Solid	14.24%
5.	Protein	1.37%
6.	Antioxidant activity	26.0%
7.	Fe	26.15 ppm
8.	Mg	19.04 ppm
9.	Ca	169.02 ppm
10.	K	247.14 ppm
11.	Zn	1.27 ppm
12.	Vitamin-C	251 (Mg/100g)

Table 2: Chemical Composition of Sea Buckthrown Seed – and Pulp Oils (Zeb,2006: Erkkola & Yang,2003)

S.No.	Constituent	Seed oil	Pulp oil
1	Fatty acids		
	Palmitic 16:0	06-10	15 - 40
	Palmitoleic 16:1 n-7	<0.5	15 - 50
	Oleic 18:1 n-9	15 - 20	10-20-
	Linoleic 18:2 n-6	35 - 40	05-15-
	α-Linolenic 18:3 n-3	20 - 35	5 - 10-
2	Vitamins (mg / 100 g)		
	K	110 - 230	54 - 59
	E	207	171
3	Tocopherols & tocotrienols	100 - 200	100 - 400
4	Carotenoids	10-50-	100 - 400
5	Plant sterols (%)	1-2	2-3

Table 3: The description of yoghurt samples (Brodziak et al.,2021)

Characteristic	**Description**
Milk type	Organic
Season of milk production	Spring/summer (pasture) season
Milk thermal treatment	Very high temperature (VHT) pasteurization (85 C for20–25 s)
Addition	Sea buckthorn mousse (5%)
Starter strains of yoghurt bacteria	Thermophilic, probiotic starter yoghurt cultures, i.e., ABT-1 (0.15 g/L)
Yoghurt type	Plain, natural yoghurt
	Yoghurt with sea buckthorn fruit mousse
Day of storage	0,7,14,21

Table 4: The multifunctionality of sea buckthorn toward cardiovascular diseases (in vitro experiments).

Different parts of sea buckhtorn	**Action measured by markers of cardiovascular diseases**	**References**
Phenolic extract from fruits	Inhibition of blood platelet activation:	
	blood platelet adhesion to collagen and fibrinogen	(Olas et al., (sub.))
	thromboxane A2 biosynthesis and reactive oxygen species production	(Olas et al., 2016)
Flavone extract from fruits	Blood platelet aggregation (stimulated by arachidonic acid;) - no change	(Olas et al., (sub.))
	Inhibition of blood platelet aggregation (stimulated by collagen)	(Cheng et al., 2011)
	Blood platelet aggregation (stimulated by arachidonic acid or ADP)-no change	(Cheng et al., 2011)

Table 5: The multifunctionality of sea buckthorn toward cardiovascular diseases (in vivo experiments).

Different parts of sea buckhtorn	**Action measured by markers of cardiovascular diseases**	**References**
Powder made of dry fruits	The decrease of arterial blood pressure, heart rate, total plasma cholesterol, triglycerides	(Koyama et al., 2009)
Polyphenols from fruits	The decrease of serum lipids and eNOS expression	(Yang et al., 2016)
Fruit juice	The increase of HDL	(Eccleston et al., 2002)
	Blood platelet aggregation, LDL and total cholesterol e no change	(Eccleston et al., 2002)
Fresh fruits	The decrease of serum lipids	(Song et al., 2015)
Seed Oil	Inhibition of blood platelet aggregation	(Basu et al., 2007)
	Total lipids-no change	(Basu et al., 2007)
Tea	Anti-obesity property	(Park et al., 2009)
Tea	Anti-obesity property	(Lee et al., 2011)
Ethanolic extract of leaves	Anti-obesity property	(Pichiah et al., 2012)
Total flavones extracted from seed residues	Antihypertensive effect	(Pang et al., 2008)

Table 6: Summary of studied fermented beverages containing sea buckthorn juice.

Material	**Bacteria**	**Observed Benefits**	**Reference**
mixture of sea buckthorn juice and water in ratio 1:1	*Oenococcus oeni*	malolactic fermentation,	Tiitinen et al.,2005
		improved sensory attributes	
sea buckthorn juice	*Lactobacillus plantarum*	malolactic fermentation	Markkinen et al.,2019
	Oenococcus oeni		
sea buckthorn juice, mixture of sea	*Lactobacillus plantarum*	malolactic fermentation	Tkacz et al.,2020
buckthorn juice and	*Lactobacillus plantarum* subsp.	enhanced antioxidant activity	

apple juice in ratio 1:1			
	argentoratensis, Oenococcus oeni		

Table 7: Summary of studied probiotic dairy products containing sea buckthorn fruit or its component.

Food Product	**Sea Buckthorn Material**	**Bacteria**	**Observed Benefits**	**Reference**
soy milk	fruit syrup	*Lactobacillus casei subsp.*	enhanced probiotics viability	Maftei et al.,2013
		paracasei	improved sensory attributes	
supplemented sea buckthorn juice		*Lactobacillus rhamnosus*	enhanced probiotics viability	Sireswar et al.,2017
		Lactobacillus plantarum	antipathogenic activity	Sireswar et al.,2017
		Lactobacillus rhamnosus		
		Lactobacillus acidophilus		
		Lactobacillus casei		
yoghurt	fruit syrup	*Streptococcus thermophilus*	sufficient microbial stability	Selvamuthukumaran et al., 2014
		Lactobacillus delbrueckii	sensory attributes	
		subsp.*bulgaricus*		
	fruit	*Streptococcus thermophilus*	enhanced probiotics viability	Gunenc et al., 2016
	purified fruit mucilage	*Lactobacillus delbrueckii* subsp.		
		bulgaricus,Lactobacillus acidophilus		
		Bifidobacterium lactis		
	fruit mousse	*Lactobacillus acidophilus*	sufficient microbial stability	Brodziak et al.,2021
		Bifidobacterium lactis	sensory attributes	
		Streptococcus thermophilus	possibly increased digestibility	
	fruit lipid fraction	free or encapsulated	enhanced probiotics viability	Pop et al.,2017
		Lactobacillus casei		
frozen yoghurt	fruit	*Lactobacillus casei*	enhanced probiotics viability	Terpou et al.,2019
			improved sensory attributes	

feta-type cheese	fruit	*Lactobacillus casei*	enhanced probiotics viability	Terpou et al.,2017
			enriched aroma	
			sufficient sensory attributes	

Figure 1: The chemical composition of sea buckthorn