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# SEABUCK THORN "THE ORANGE JEWEL OF HEALTH"

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**ABSTRACT**

Sea buckthorn (Hippophae rhamnoides) is a deciduous shrub native to Europe and Asia, known for its bright orange berries and exceptional nutritional value. This review explores the diverse health benefits of sea buckthorn, which range from its rich antioxidant content to its unique profile of essential fatty acids, vitamins, and minerals. Additionally, the potential therapeutic applications of sea buckthorn, such as its use in skincare, wound healing, and cardiovascular health, are discussed. The review also examines the traditional uses of sea buckthorn in various cultures and its modern applications in food, pharmaceuticals, and cosmetics. Overall, sea buckthorn emerges as a versatile and valuable natural resource with promising implications for human health and wellbeing. Sea-buckthorn, with high economic value, is one of the important tree species for windbreak, sand fixation and conservation of water and soil. Sea buckthorn (Hippophae L., Elaeagnaceae) is an economically and ecologically important medicinal plant comprising of species which are winter hardy, dioecious, wind-pollinated multipurpose shrubs bearing yellow or orange berries with nitrogen-fixing ability. It grows widely in cold regions of Indian Himalayas, China, Russia, Europe and many other countries. It is commonly known as 'cold desert gold' due to its high potential as a bio-resource for land reclamation, reducing soil erosion and its multifarious uses. The wild populations are being used for harvesting economic benefits with negligible plantation efforts. Although this plant has many excellent traits, it is still in an early phase of domestication. This woody plant is prone to many pests and diseases which destroy the plants and halt its commercial production. Sea buckthorn holds significant economic importance, serving as a key species for windbreaks, sand fixation, and soil and water conservation. This economically and ecologically vital medicinal plant belongs to the family Elaeagnaceae and consists of six species and twelve subspecies. Hippophae rhamnoides, also known as sea buckthorn, sandthorn, or seaberry, is particularly notable and is currently being domesticated in many parts of the world. The plant's ability to fix nitrogen and thrive in cold regions, such as the Indian Himalayas, China, Russia, and Europe, further underscores its ecological benefits. Known as "cold desert gold," sea buckthorn is valued for its potential in land reclamation and reducing soil erosion, as well as for its multiple uses. Despite its many advantageous traits, sea buckthorn is still in the early stages of domestication and faces challenges from pests and diseases that impede commercial production. Sustainable harvesting and cultivation practices are essential to ensure its long-term availability. Future research is needed to enhance cultivation techniques, improve pest and disease management, and fully unlock the potential of sea buckthorn. As a multifunctional plant, sea buckthorn promises significant contributions to ecological sustainability and human health, marking it as a valuable resource for the future.

**KEYWORDS:** Hippophae rhamnoides, Elaeagnaceae, dioecious.

## INTRODUCTION

Sea buckthorn (genus Hippophae) is a robust, berry-bearing shrub within the family Elaeagnaceae. Native to Asia and Europe, it has also been introduced to North and South America. The genus includes six species and twelve subspecies, with Hippophae rhamnoides—commonly referred to as sea buckthorn, sandthorn, or seaberry—being particularly notable. This plant is currently being domesticated in various regions globally (Li, 2003; Li and Schroeder, 1996; Rousi, 1971). It is known for its resilience to drought and cold, making it valuable for land reclamation and farmstead protection due to its vigorous vegetative reproduction and robust, complex root system with nitrogen-fixing nodules (Rongsen, 1992). Sea buckthorn berries have a long history of medicinal and nutritional use in Russia, Europe, and Asia. Recognized as a future food source, these berries have gained attention for their nutritional benefits, containing over 190 compounds in the seeds, pulp, fruit, and juice. These compounds include fat-soluble vitamins (A, K, and E), fatty acids, lipids, organic acids, amino acids, carbohydrates, vitamins C, B1, B2, folic acid, tocopherols, flavonoids, phenols, terpenes, and tannins. Many of these substances are known to have beneficial health effects (Li & Wang, 1998). The berries and seeds are rich in natural antioxidants, including ascorbic acid, tocopherols, carotenoids, and flavonoids, as well as health-beneficial fatty acids (Gao et al., 2000; Kallio et al., 2002; Rosch et al., 2003). The berries, from which juice is extracted, are particularly important and have contributed to the plant's global popularity (Beveridge, Li, Oomah, & Smith, 1999). This indicates the significant potential of sea buckthorn berries as a food resource. This review discusses the chemical and medicinal constituents of sea buckthorn berries/juice, various processing methods, and their effects on the nutritive value of processed berries from different origins and varieties, to provide a clear understanding for future nutritional research. Future R&D areas related to enhancing quality control have been identified. Sea buckthorn is widely distributed throughout north and east Anatolia, where it is known locally as "Yalancı igde" and "Karga dikeni."

### Parts of Sea Buckthorn

#### 1) Berries and Seeds

The ripe fruits of sea buckthorn are dark yellow, orange, or red, oval-shaped, and measure 6–9 mm in length. Each fruit contains a seed encased in soft, juicy, and fleshy pulp. The seeds are dark brown, ellipsoid, glossy, and range from 2.8 to 4.2 mm in length. The chemical composition of sea buckthorn berries can vary depending on factors such as the variety, climate conditions, fruit size, ripeness, and processing method. Sea buckthorn berries are an excellent source of minerals, including calcium, phosphorus, iron, and potassium.

They are particularly noted for their high vitamin C content, which can range from 360 to 2500 mg per 100 g of fruit. In addition to vitamin C, the plant provides significant amounts of vitamins B1 (thiamine) and B2 (riboflavin), as well as vitamins E, A, and K. The berries are rich in carotenoids such as ß-carotene, lycopene, lutein, and zeaxanthin. Common carbohydrates found in the berries include glucose, fructose, and xylose. The plant parts are also a source of proteins, primarily albumins and globulins. Organic acids present in the berries include malic acid, quinic acid, oxalic acid, citric acid, and tartaric acid. Additionally, the berries contain various flavonoids, such as quercetin, kaempferol, myricetin, and isorhamnetin, along with tocopherols. Overall, sea buckthorn berries are a nutrient-dense fruit with a complex and varied chemical composition, making them a valuable resource for both nutritional and medicinal purposes.

**2) Pulp**

The pulp of sea buckthorn primarily contains α-, ß-, and γ-carotene, lycopene, and zeaxanthin. The vitamin B group in the pulp includes B1 (thiamine), B2 (riboflavin), B6 (pyridoxine), niacin (vitamin B3), and folic acid, which are essential for nucleic acid synthesis. The vitamin C content varies with the variety and natural conditions, with Central Asian plants containing 150–200 mg per 100 g, and Alpine plants containing around 800 mg per 100 g. The berries do not contain ascorbinase, ensuring that vitamin C is well-preserved in dried fruit and products. Additionally, the peel of the stem and fruits contains 5-hydroxytryptamine, which is used in treating post-shock depression. Overall, sea buckthorn pulp is rich in various carotenoids and vitamins, contributing to its significant nutritional and therapeutic value.

**3) Leaves**

The leaves of sea buckthorn are rich in nutrients and bioactive substances, primarily phenolics. They contain an average of 3.8% saccharides, 0.2% protopectin, 1% organic acids, 170 mg per 100 g of catechin, polyphenols, carotenoid lycopene, bioflavonoids, and coumarins. The leaves also have a significant concentration of vitamin C, up to 370 mg per 100 g, and tannins, comprising about 8%. Overall, sea buckthorn, with its extensive nutritional and medicinal properties, offers vast potential as a food resource, contributing significantly to ecological sustainability and human health.

**Composition**

The volatile oil extracted from Hippophaë rhamnoides L. fruits was analyzed using GC and GC-MS, revealing thirty constituents that make up 94.6% of the oil. The major components identified were ethyl dodecenoate (39.4%), ethyl octanoate (9.9%), decanol (5.6%), ethyl decanoate (5.5%), and ethyl dodecanoate (3.7%). Analysis of fatty acids in lipid extracts from both the mesocarps and seeds of H. rhamnoides showed fifteen different fatty acids. The mesocarp contained predominantly palmitoleic acid (47.8%) and palmitic acid (29.3%), while the seeds had oleic acid (32.8%), palmitic acid (26.3%), and linoleic acid (21.7%) as the major components. Similarly, in Myrtus communis L., oleic acid was the dominant fatty acid in both mesocarps (up to 72.1%) and seeds (up to 64.1%). Free fatty acid analysis of M. communis seeds indicated oleic acid (69.5%), palmitic acid (17.8%), and stearic acid (6.4%) as the main components. The fruits of H. rhamnoides are known for their richness in carotenoids, lipids, ascorbic acid, tocopherols, sterols, flavonoids, and triterpenes. These fruits are a valuable source of both aqueous and lipophilic antioxidants, including vitamins D and E, carotenoids, and various superoxide dismutase isoenzymes. The leaves of H. rhamnoides contain tannins, flavonoids such as quercetin, catechin, and myricetin derivatives, and volatile oils. Meanwhile, the fruits are mainly composed of volatile oils, tannins, sugars, flavonoids, and organic acids like citric and malic acids. In Turkish

folk medicine, both leaves and fruits have been traditionally used as antiseptics, for wound healing, and in the treatment of urinary diseases.

**Vitamin C**

Sea buckthorn fruits, specifically subspecies sinensis, have been found to contain significantly higher concentrations of vitamins A, B2, and C compared to other fruits and vegetables such as carrots, tomatoes, and oranges. They also show appreciable levels of vitamins B1, P, and K (Lu, 1992). These high concentrations of vitamins make sea buckthorn fruit highly suitable for the production of nutritious soft drinks. In Hippophae rhamnoides, extensive variations in vitamin C content have been observed among individuals, populations, and subspecies. For instance, in the European subspecies rhamnoides, vitamin C concentrations range from 28 to 310 mg per 100 g of berries (Rousi and Aulin, 1977; Jeppsson and Gao, 2000; Yao et al., 1992). Russian cultivars belonging to subspecies mongolica show vitamin C levels ranging from 40 to 300 mg per 100 g of berries, while subspecies fluviatilis exhibits concentrations ranging from 460 to 1330 mg per 100 g of berries (Xurong, 2002). Chinese subspecies sinesis has the highest variation, with vitamin C levels ranging from 200 to 2500 mg per 100 g of berries (Ma et al., 1989; Yao et al., 1992; Zheng and Song, 1992). Factors such as temperature (Yao, 1993), harvesting time, geographical origin (Kallio et al., 2002), and processing methods (Beveridge et al., 2002) can influence the vitamin C content of sea buckthorn juice.

**Mineral Elements**

Sea buckthorn berries or juice are rich in various mineral elements, with potassium being the most abundant among those investigated (Chen, 1988; Tong et al., 1989; Zhang et al., 1989a; Kallio et al., 1999).

Significant variations in elemental concentrations have been observed, with more than tenfold differences noted for elements such as molybdenum (Mo) and iron (Fe) in juice, as well as for iron in dry mass within Chinese sea buckthorn. Comparative studies by Kallio et al. (1999) between Chinese and Finnish sea buckthorn revealed that Finnish berries had lower levels of iron, calcium, and lead, but higher cadmium content compared to Chinese berries. Fruit maturity has also been shown to affect the levels of nitrogen (N), calcium (Ca), potassium (K), sodium (Na), magnesium (Mg), copper (Cu), iron (Fe), zinc (Zn), and manganese (Mn) (Bounous and Zanini, 1988). In liqueurs made from sea buckthorn, trace amounts of various elements including aluminum (Al), arsenic (As), calcium (Ca), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), potassium (K), magnesium (Mg), manganese (Mn), sodium (Na), lithium (Li), lead (Pb), rubidium (Rb), and zinc (Zn) have been detected (Harju and Ronkainen, 1984). Finnish berries were found to have lower amounts of iron (Fe), calcium (Ca), and lead (Pb), but higher levels of cadmium compared to Chinese berries.

**Organic acids**

There are significant variations in the concentrations of acids among different origins of sea buckthorn. Russian berries have been reported to exhibit relatively lower total acidity, ranging from 2.1 to 3.2 g/100 ml. Finnish genotypes show intermediate levels, ranging from 4.2 to 6.5 g/100 ml, while Chinese genotypes demonstrate the highest concentrations of organic acids, ranging from 3.5 to 9.1 g/100 ml (Ma et al., 1989; Zhang et al., 1989a; Kallio et al., 1999). Among the organic acids found in sea buckthorn juice, malic and quinic acids are the major components, together constituting approximately 90% of all fruit acids across different origins. However, the extent to which these variations in acidity are genetically determined remains unclear (Kallio et al., 1999).

**Amino Acids**

Sea buckthorn juice is abundant in various free amino acids. According to Chen (1988), 18 different types of free amino acids were detected in Chinese sea buckthorn juice. The total amino acid content in Chinese sea buckthorn, as reported by Zhang et al. (1989a), shows higher levels of aspartic acid (426.6 mg/100g) compared to the findings by Chen (1988).Among these amino acids, eight are essential for the human body: threonine, valine, methionine, leucine, lysine, tryptophan, isoleucine, and phenylalanine.

**Vitamin E & Carotenoids**

Sea buckthorn juice is rich in carotenoids and vitamin E. Researchers in Germany have successfully extracted yellow carotenoid pigments from sea buckthorn waste using supercritical CO2 extraction. It was found that pressure significantly influences the extraction process, with higher pressures resulting in increased yields. For instance, at 60 MPa and 85°C, the yield of carotenoids reached 67% (Messerschmidt et al., 1993).

**Volatile Compounds**

The volatile compound profile of sea buckthorn juice is distinct and characteristic compared to other common berries. These compounds primarily consist of esters of short-chain, branched or straight-chain fatty acids and alcohols. The composition of these volatiles varies significantly depending on the time of harvesting the berries (Yang, 2001). Chinese sea buckthorn berries have been observed to contain higher levels of ethyl 3methylbutanoate, butyl pentanoate, 2-methylpropyl 3-methylbutanoate, and pentyl 3-methylbutanoate compared to Finnish berries, which are richer in compounds like ethyl 2-methylbutanoate, ethyl 3methylbutanoate, and ethyl hexanoate (Kallio et al., 1999; Ma and Cui, 1987). Further investigations using quantitative sensory profiling and correlation analysis are necessary to fully understand the impact of these volatile compounds on the overall aroma of sea buckthorn berries.

**Seabuck Thorn Oil**

The variation in vitamin E content in sea buckthorn oil depends on the source, whether it is derived from seed oil (64.4-92.7 mg/100g of seeds), juice oil (216 mg/100g of berries), or pulp oil after the juice and pulp removal (481 mg/100g of berries). Typically, pulp oil contains the highest concentration of vitamin E. Variations in vitamin E content among different species or subspecies of sea buckthorn have also been documented (Lu, 1993). Hippophae rhamnoides (sea buckthorn) tends to exhibit higher levels of vitamin E in seed oil compared to other species. Alpha-tocopherol, the most biologically active form of vitamin E in humans, acts as a potent antioxidant (Farrell and Roberts, 1994; Traber, 1999). Exceptionally high levels of alpha-tocopherol (1046 mg/100g in pulp oil) have been reported for specific cultivars of subspecies mongolica from Altai (Jablczynska et al., 1994). The tocopherol fraction in sea buckthorn oil typically comprises nearly 50% alpha-tocopherol and varies depending on the source of the oil (Lian et al., 2000). Carotenoids, including beta-carotene, alphacarotene, and lycopene, constitute 15-55% of total carotenoids in sea buckthorn, with significant variations observed based on origin and processing methods (Mironov, 1989; Kallio, 2001). The concentration of betacarotene in sea buckthorn carotenoids is notably affected by factors such as berry maturity, environmental conditions, and agricultural practices (Zhang et al., 1989a; Yang, 2001). Pulp oil generally contains higher levels of beta-carotene compared to seed oil, with Hippophae salicifolia showing the highest levels of betacarotene among sea buckthorn species in both pulp and seed oils.

**The Potential Therapeutic Applications of Sea buckthorn**

❖ **Skin Benefits**

**Protection from UV Radiation and Air Pollution**

Protection from UV radiation and air pollution is crucial for maintaining skin health due to the harmful effects of reactive nitrogen species and oxidative stress. Peroxynitrite, formed during UV irradiation and inflammation, along with nitrogen dioxide and nitrous acid from air pollution, are potent oxidants and mutagenic agents that damage DNA.Gamma-tocopherol (γ-tocopherol) plays a significant role in deactivating these reactive nitrogen molecules by forming stable 5-nitro-γ-tocopherol. Compared to alpha-tocopherol (αtocopherol), γ-tocopherol is more effective in quenching reactive nitrogen species. Research indicates that γtocopherol has anti-inflammatory properties and is beneficial not only in topical applications but also through oral supplementation, providing effective protection against air pollution and UV radiation. Tocotrienols, another form of vitamin E, exhibit superior radical scavenging abilities and can regenerate themselves and other antioxidants more efficiently compared to tocopherols. Specifically, gamma-tocotrienol (γ-tocotrienol) has been shown to be up to 60 times more effective than α-tocopherol in inhibiting lipid peroxidation under certain conditions.

**Clinical studies on Omega-7 sea buckthorn oil**

It have demonstrated its benefits in skin health. Oral supplementation with supercritical CO2 extracted sea buckthorn seed oil and pulp oil improved conditions in individuals with atopic skin. It also increased the proportion of essential fatty acids in their plasma. In a recent study focusing on skin hydration, elasticity, and roughness, oral supplementation with standardized SBA24® Sea Buckthorn Oil capsules (2 g oil per day) for three months significantly improved skin hydration and elasticity among female subjects averaging 61 years of age. The treatment also reduced skin roughness, indicating its potential anti-wrinkle efficacy. These findings underscore the role of sea buckthorn oil as an effective oral supplement for enhancing skin health and combating the effects of aging and environmental stressors.

❖ **Health Benefits**

Sea buckthorn contains a variety of bioactive components, including vitamins, carotenoids, polyphenols, fatty acids, and phytosterols. These components exert a wide range of health benefits by exerting antioxidant, anticancer, anti-inflammatory, antimicrobial and antiviral effects, as well as exerting protective cardiovascular, dermatological, neuroprotective, and hepatoprotective effects.

**1) Antioxidant Activity**

Sea buckthorn has been extensively studied for its potent antioxidant properties both in vitro and in vivo. The phenolic fraction derived from sea buckthorn fruits has demonstrated significant antioxidant activity by inhibiting hydrogen peroxide (H2O2) or H2O2/Fe-stimulated plasma lipid peroxidation and protein carbonylation. Protein carbonylation, a stable biomarker of oxidative stress, was reduced in plasma proteins treated with sea buckthorn phenolic fractions, with a notable 60% inhibition rate of plasma lipid peroxidation observed at a concentration of 50 μg/mL for 60 minutes (51). In the context of managing hyperlipidemia, in vitro trials have shown that sea buckthorn extract, alone or in combination with atorvastatin, helps mitigate oxidative damage induced by lipid peroxidation (52). Additionally, sea buckthorn leaf extract has been found to dose-dependently attenuate intracellular oxidative stress, thereby enhancing neuronal PC-12 cell viability and preserving membrane integrity (53). Systematic reviews by Serban et al. (54) across multiple databases, including PubMed, Scopus, and Web of Science, highlighted that sea buckthorn fruit exhibits

cardiovascular benefits by lowering blood cholesterol levels and reducing inflammation and oxidative stress parameters in numerous studies. Furthermore, sea buckthorn seed oil has been shown to inhibit UV-induced disturbances in redox balance in skin cells (55). Research by Gęgotek et al. (55) indicates that incubation of fibroblasts with sea buckthorn oil reduces reactive oxygen species (ROS) generation by approximately 25%, underscoring its potential as a natural antioxidant source for preventing and treating diseases associated with oxidative stress. Overall, these findings underscore the therapeutic potential of sea buckthorn in combating oxidative stress-related conditions and supporting overall health through its antioxidant-rich components.

**2) Anti-cancer Activity**

Sea buckthorn (Hippophae rhamnoides) has garnered attention for its potential anticancer properties, primarily attributed to its bioactive compounds such as polyphenols and carotenoids. Several studies have provided compelling evidence of sea buckthorn's anticancer effects across different types of cancers:

**Colon Cancer:** Sea buckthorn polyphenols, including kaempferol and its derivatives, have demonstrated significant anti-colon cancer activity both in vitro and in vivo. These polyphenols upregulate microRNAs (miR-195-5p and miR-497-5p) that suppress cyclin expression, thereby arresting the cell cycle in the G1 phase and inhibiting further proliferation of colon cancer cells. In animal studies, sea buckthorn polyphenols reduced tumor volume and controlled tumor growth in xenografted mice.

**Prostate Cancer:** Sea buckthorn leaf aqueous extract has shown promise in targeting the androgen receptor (AR) and downregulating androgen response genes such as prostate specific antigen (PSA), ELL2, EAF2, and calreticulin (CALR). This extract effectively inhibited the proliferation and migration of prostate cancer cells in vitro, suggesting its potential as a preventive agent for prostate cancer in high-risk populations.

**Glioma Cancer:** Sea buckthorn leaf extract has been reported to reduce intracellular reactive oxygen species (ROS) levels and inhibit the proliferation of C6 glioma cells. This extract upregulates the expression of the pro-apoptotic protein Bax, further supporting its potential as a pharmacological intervention for glioma treatment.

**Gastric Cancer:** Isorhamnetin, an active component found in sea buckthorn, has demonstrated anticancer effects in gastric cancer cells. It increases the expression of pro-apoptotic proteins in the mitochondrial pathway (cytochrome c-caspase 9-caspase 3), inhibits autophagy in cancer cells, and promotes apoptosis by activating the PI3K-AKT-mTOR signaling pathway under hypoxic conditions.

These studies collectively highlight sea buckthorn's diverse mechanisms in combating cancer, including regulation of cell cycle progression, induction of apoptosis, inhibition of cancer cell migration, and modulation of signaling pathways crucial for cancer cell survival. However, despite the promising preclinical findings, there remains a need for more extensive in vivo experiments and clinical trials to fully evaluate the anticancer potential of sea buckthorn in human subjects. Moreover, while carotenoids such as lycopene have been extensively studied for their anticancer properties in various cancers, including prostate, breast, lung, and cervical cancers, there is a dearth of research specifically investigating the anticancer activity of sea buckthorn carotenoid extracts. This area presents a promising avenue for future research to explore and validate sea buckthorn's role in cancer prevention and treatment.

**3) Antihyperlipidemia Activity**

Sea buckthorn (Hippophae rhamnoides) has been extensively studied for its potential benefits in managing hypercholesterolemia and improving lipid profiles, which are crucial in reducing the risk of cardiovascular disease. Here's a summary of the evidence supporting its effects:

**1. Phytosterols:** Sea buckthorn pulp is rich in phytosterols, bioactive compounds known for their cholesterollowering effects. Phytosterols inhibit the absorption of dietary cholesterol and promote its excretion in the form of neutral steroids. This mechanism helps to reduce serum cholesterol levels, particularly low- density lipoprotein cholesterol (LDL-C), which is a major risk factor for cardiovascular diseases.

**2. Clinical Trials:** Numerous clinical trials have evaluated the effects of sea buckthorn berries or extracts on lipid profiles, particularly in individuals with hyperlipidemia. Meta-analyses of randomized controlled trials have shown that supplementation with sea buckthorn significantly improves total cholesterol, triglycerides (TG), LDL-C, and high-density lipoprotein cholesterol (HDL-C) levels in subjects with hyperlipidemia. These improvements are attributed to the bioactive compounds present in sea buckthorn.

**3. Animal Studies:** In vivo studies using animal models have further demonstrated the anti-hyperlipidemic effects of sea buckthorn. For example, flavonoid-enriched extract from sea buckthorn seed reduced serum and liver triglyceride concentrations in obese mice fed a high-fat diet. This extract improved lipid metabolism by modulating the expression of peroxisome proliferator-activated receptors (PPARγ and PPARα) and suppressing adipose tissue inflammation (64). Additionally, sea buckthorn fruit oil extract dose-dependently improved blood lipid composition and relieved oxidative stress and liver impairment in hyperlipemic hamsters through pathways involving AMP-activated protein kinase (AMPK) and Akt.

**4. Bioactive Compounds:** Sea buckthorn is a rich source of phenolic compounds, especially flavonoids, and phytosterols. These compounds contribute to its cardiovascular benefits by reducing lipid levels, improving lipid metabolism, and alleviating oxidative stress, all of which are critical in preventing cardiovascular diseases. In conclusion, sea buckthorn fruit, seed, and oil are promising natural sources of bioactive compounds with potential therapeutic benefits for managing hyperlipidemia and preventing cardiovascular diseases. Further research, including clinical trials in human subjects, is warranted to fully establish the efficacy and safety of sea buckthorn in cardiovascular health management.

**4) Antiobesity Activity**

Sea buckthorn (Hippophae rhamnoides) appears to offer promising benefits for managing obesity and related conditions through various mechanisms involving its bioactive components. Here's a summary of the evidence supporting its effects:

**1. Promotion of Thermogenesis and Weight Management:** Sea buckthorn polysaccharides have been found to promote the expression of PPARγ-coactivator 1α (PGC1α), uncoupling protein-1 (UCP-1), and PR domain containing 16 (PRDM 16) in adipocytes. These proteins are involved in activating brown adipocytes and enhancing thermogenesis. By doing so, sea buckthorn polysaccharides help to inhibit lipid accumulation and weight gain.

**2. Reduction in Body Weight and Obesity:** Studies using sea buckthorn fruit oil extracts rich in palmitic acid have demonstrated significant reductions in body weight and blood sugar levels in hypercholesterolemic hamsters. These effects are particularly beneficial in alleviating obesity caused by dyslipidemia.

**3. Flavonoid-Enriched Extracts:** Flavonoid-enriched extracts from sea buckthorn seeds (FSH) have shown promising results in reducing body weight gain in obese mice fed a high-fat diet. Administration of FSH at doses of 100 and 300 mg/kg significantly decreased body weight gain by 33.06% and 43.51%, respectively, indicating its potential in managing obesity.

**4. Impact on Gut Microbiome:** Sea buckthorn freeze-dried powder, produced using low-temperature freezedrying technology to preserve nutrients, has been studied for its effects on obesity induced by high-fat diets. The powder was found to alter the composition and structure of the gut microbiome, which plays a crucial role in regulating metabolism and obesity.

**5. Functional Food and Dietary Supplements:** Given its diverse bioactive compounds and demonstrated effects on weight management, sea buckthorn is increasingly recognized as a potential ingredient in functional foods and dietary supplements targeted at obesity management.

These products could leverage sea buckthorn's natural properties to support weight loss and overall metabolic health. In conclusion, sea buckthorn offers multiple avenues for combating obesity, including modulation of adipocyte function, promotion of thermogenesis, reduction of lipid accumulation, and alteration of gut microbiota composition. Further research, particularly clinical trials in human subjects, will be valuable to fully establish the efficacy, safety, and optimal dosages of sea buckthorn products for obesity management.

**5) Antiplatelet Agent**

Sea buckthorn (Hippophae rhamnoides) demonstrates significant potential as an anticoagulant and antiplatelet agent, contributing to the prevention and treatment of cardiovascular thrombotic events. Here's a summary of its effects based on recent studies:

**1. Potent Antiplatelet Activity:** The polyphenol-rich fraction derived from sea buckthorn fruit, particularly at a concentration of 50 μg/mL, exhibits potent antiplatelet activity. This fraction has been shown to inhibit the expression of PAC-1 in various platelet activation models, including non-activated platelets, platelets activated by adenosine diphosphate (ADP), and platelets activated by collagen. PAC-1 inhibition suggests a mechanism involving reduced platelet aggregation, likely through decreased expression of GPIIb/IIIa receptors.

**2. Comparison of Fractions:** Studies have compared different fractions of sea buckthorn components. For instance, the non-polar fraction from sea buckthorn twigs was found to possess stronger antiplatelet activity compared to phenolic and other non-polar fractions from leaves. This enhanced activity may be attributed to its regulation of arachidonic acid metabolism, modulation of reactive oxygen species (ROS) concentration, and effects on platelet receptor expression.

**3. Inhibition of Platelet Adhesion:** The 50 μg/mL sea buckthorn fraction has demonstrated significant inhibition (65% and 55%, respectively) of both resting platelets and thrombin-activated platelets adhering to fibrinogen.

This inhibition is crucial in preventing platelet aggregation and subsequent thrombus formation, key events in cardiovascular thrombotic events. In conclusion, sea buckthorn shows promise as a natural source of bioactive compounds with potent anticoagulant and antiplatelet properties. Its ability to inhibit platelet activation, aggregation, and adhesion underscores its potential therapeutic application in preventing cardiovascular thrombotic events. Further research is warranted to explore the specific mechanisms of action and to validate these findings in clinical settings.

**6) Dermatological Effect**

Sea buckthorn (Hippophae rhamnoides) has demonstrated diverse therapeutic effects in dermatology, supported by clinical trials and experimental studies:

**1. Anti-Psoriasis Effects:** Clinical trials using topical sea buckthorn fruit extract showed improvements in Psoriasis Area Severity Index (PASI) scores and Dermatology Life Quality Index (DLQI) scores compared to placebo. This indicates efficacy in treating mild to moderate psoriasis. - In animal models, both oral and topical application of sea buckthorn oil significantly reduced ear edema and ear biopsy weights in a psoriasis-like lesion mouse model induced by TPA (12-O-tetradecanoylphorbol-13-acetate). This effect is attributed to the anti-inflammatory properties of sea buckthorn oil, which inhibits reactive nitrogen species and down-regulates NF-κB protein and pro-inflammatory cytokines. - Sea buckthorn oil also demonstrated anti-atopic dermatitis (AD) effects by reducing severity in mice models. It inhibited TARC and MDC expression in IFN-γ/TNF-α-stimulated HaCaT cells, thereby blocking the NF-κB/STAT1 signaling pathway and preventing AD-like skin lesions.

**2. Wound Healing Properties:** Clinical trials have shown that sea buckthorn cream accelerated the healing of second-degree burns compared to silver sulfadiazine dressings. The cream exhibited better clinical efficacy and reduced the healing time by approximately 5 days. - Sea buckthorn seed oil has been found to promote wound contraction and enhance wound healing by increasing hydroxyproline, hexosamine, DNA, and total protein content in the wound area. This effect is attributed to its rich content of omega-3 and omega-6 fatty acids, tocopherols, and carotenoids. - The palmitic acid-rich fraction from sea buckthorn seed oil promotes cell proliferation of keratinocytes and dermal fibroblasts, indicating its potential use in developing skin care products and wound healing preparations.

**3. Photoprotective Effects:** Sea buckthorn seed oil exhibits promising photoprotective properties against UV- induced damage in skin fibroblasts and keratin-forming cells. It helps maintain the redox balance and lipid metabolism in skin cells exposed to UV light, thereby protecting against UV-induced skin damage. In conclusion, sea buckthorn demonstrates significant therapeutic potential in dermatology, attributed to its diverse bioactive compounds such as fatty acids, tocopherols, carotenoids, and phenolic compounds. Further research is needed to elucidate the specific mechanisms of action of these compounds and to explore their full potential in clinical settings.

**7) Anti-inflammatory Activity**

Sea buckthorn (Hippophae rhamnoides) has garnered attention in traditional medicine for its potent antiinflammatory properties, supported by various studies:

**1. Edematous Inflammation:** A study using a 70% methanolic extract of sea buckthorn demonstrated significant inhibition of 48/80-induced edematous inflammation in rats. Treatment with the extract (500 mg/kg) reduced foot swelling, with the peel extract showing the greatest effect. Active compounds like ursolic acid and oleanolic acid in the peel extract were suggested to stabilize cell membranes by inhibiting mast cell degranulation.

**2. Inhibition of Nitric Oxide (NO) Production:** Extracts from sea buckthorn branches, leaves, and fruits have been shown to inhibit NO production, a key marker of inflammation. These extracts effectively reduced NO levels by 73-98% without displaying cytotoxic effects in cell viability assays. This indicates strong anti-inflammatory potential in vitro.

**3. Anti-Inflammatory Effects on Macrophages:** Sea buckthorn leaf extract demonstrated potent antiinflammatory activity by inhibiting NO production, inducible nitric oxide synthase (iNOS), cyclooxygenase-2 (COX-2) expression, and reducing pro-inflammatory cytokine levels in response to lipopolysaccharide (LPS) stimulation. Similarly, sea buckthorn fruit extract, particularly its citric acid derivatives, inhibited LPS-induced inflammation in macrophages by targeting NF-κB signaling pathway components (IKKα/β, I-κBα, NF-κB p65), as well as iNOS and COX-2 enzymes, and pro-inflammatory cytokines such as IL-6 and TNF-α.

**4. Effects on Diet-Induced Inflammation:** Flavonoids from sea buckthorn were found to reverse inflammation induced by a high-fat and high-fructose diet in mice. They suppressed overexpression of iNOS and reduced mRNA levels of IL-1β and COX-2 in the hippocampus, thus mitigating diet-induced inflammatory reactions. In summary, the anti-inflammatory activity of sea buckthorn can be attributed to bioactive compounds such as ursolic acid, oleanolic acid, citric acid derivatives, and flavonoids.

These compounds exert their effects by modulating the expression of pro-inflammatory cytokines and reducing the production of inflammatory mediators like NF-κB, iNOS, and COX-2. While promising, further in vivo and clinical studies are necessary to fully elucidate the therapeutic potential of sea buckthorn in treating inflammatory diseases.

**8) Antimicrobial & Antiviral Activity**

Sea buckthorn (Hippophae rhamnoides) has demonstrated notable antimicrobial and antiviral activities, positioning it as a promising natural agent for combating infections:

**1. Antimicrobial Activity**

Against Gram-Positive Bacteria: Research by Verma et al indicated that sea buckthorn leaf extract effectively inhibited the growth of various gram-positive bacteria. At a concentration of 5%, the extract reduced the growth of pathogens such as S. aureus, S. epidermidis, S. intermedius, and S. pyogenes by approximately 50%.

**Against Methicillin-Resistant S. aureus (MRSA):** Studies have shown that sea buckthorn berry and leaf extracts, particularly at concentrations like 6 mg/mL, exert significant inhibitory effects on MRSA growth. This suggests potential applications against antibiotic-resistant strains of bacteria.

**Against Periodontal Pathogens:** Smida et al. developed a mouthwash containing sea buckthorn pulp oil, which exhibited bactericidal effects against periodontal pathogens. It effectively inhibited the formation of both single-strain and multi-strain biofilms, indicating potential oral health benefits.

**2. Antiviral Activity**

**Against Herpes Simplex Virus Type 2 (HSV-2):** Compounds isolated from sea buckthorn fruit extracts, such as 14-noreudesmanes and a phenylpropane heterodimer from a 70% methanol extract, demonstrated inhibitory effects against HSV-2 replication. This highlights sea buckthorn's potential as a source of antiviral agents, especially against strains

resistant to conventional treatments like acyclovir and penciclovir.

**Enhancement of Immune Response:** Sea buckthorn leaf extract has been shown to enhance immune responses when administered with inactivated rabies virus antigens. This combination increased levels of rabies virus neutralizing antibodies, cytotoxic T lymphocyte responses, memory T cells, and plasma cells compared to vaccination with the rabies virus alone. The immune-enhancing effects are attributed to components like isorhamnetin and other flavonoids found in sea buckthorn leaf extract. These studies underscore sea buckthorn's potential therapeutic applications in both traditional and modern medicine for combating microbial infections and enhancing immune responses. However, further clinical research is essential to validate these findings and explore the full spectrum of health benefits that sea buckthorn can offer.

**9) Neuroprotective Activity**

Sea buckthorn (Hippophae rhamnoides) has shown promising neuroprotective effects, making it a potential therapeutic agent for conditions like Alzheimer's disease and other neurodegenerative disorders:

**1. Removal of Aβ Deposits:** Studies have demonstrated that sea buckthorn, particularly in the form of sea buckthorn berry powder at a concentration of 1.5 g/mL, effectively removes intracellular amyloid-β (Aβ) deposits. This action is attributed to the high antioxidant content in sea buckthorn, which helps inhibit Aβinduced toxicity and prevents neuronal cell death, thereby exerting a neuroprotective effect.

**2. Improvement of Insulin Signaling and Neuroinflammation:** Sea buckthorn flavonoids have been shown to stimulate insulin receptor substrate (IRS)/AKT activation, reduce the expression of protein tyrosine phosphatase 1B (PTP1B), and normalize insulin signaling pathways. This normalization helps mitigate insulin resistance and neuroinflammation, which are associated with cognitive impairment and neurodegeneration.

**3. Effects on Neurological Conditions:** Research indicates that sea buckthorn can improve epileptiform activity in the cerebral cortex and hippocampus of rats with iron-induced epilepsy. It also reduces anxietylike behavior, improves memory impairment, and mitigates histological damage in experimental models. In summary, sea buckthorn exerts neuroprotective effects through multiple mechanisms, including the removal of Aβ deposits, inhibition of Aβ-induced toxicity, modulation of insulin signaling pathways, and attenuation of neuroinflammation. These beneficial effects are largely attributed to the presence of flavonoids and other antioxidant compounds in sea buckthorn. While preclinical studies have shown promise, further research, particularly clinical trials in humans, is essential to validate these findings and explore the full potential of sea buckthorn in neuroprotection and neurodegenerative disease management.

**10) Hepatoprotective Activity**

Sea buckthorn (Hippophae rhamnoides) extract and oil have demonstrated significant hepatoprotective properties, primarily attributed to their rich content of flavonoids and carotenoids:

**Carotenoids in Sea Buckthorn:** Sea buckthorn oil is particularly rich in carotenoids, which include bioavailable lutein among other compounds. Carotenoids like β-carotene, lycopene, lutein, and βcryptoxanthin are known for their hepatoprotective effects. They reduce oxidative stress and regulate lipid metabolism in hepatocytes, thereby supporting liver health.

**1. Flavonoid Extracts:** Studies have shown that flavonoid extracts from sea buckthorn significantly improve biomarkers associated with liver health. For instance, in non-alcoholic fatty liver disease (NAFLD) models, sea buckthorn flavonoids improved serum and liver biomarkers such as triglycerides (TG), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), as well as liver enzymes like aspartate aminotransferase (AST) and alanine aminotransferase (ALT). These effects were found to be superior to those of curcumin, highlighting sea buckthorn's potent therapeutic potential.

**2. Fermentation Solution and Hepatic Lipid Metabolism:** Fermented sea buckthorn fruit solutions have been shown to modulate hepatic lipid metabolism and oxidative stress by influencing the composition of intestinal microbiota. This modulation helps prevent conditions like alcoholic liver disease and contributes to its hepatoprotective.

**3. Anti-fibrotic Effects:** Active ingredients in sea buckthorn have been reported to inhibit the activation of hepatic stellate cells, which are involved in liver fibrosis. This inhibition reduces inflammatory cytokine levels and mitigates fibrosis development induced by bile duct ligation (BDL) in animal models. These findings suggest that sea buckthorn can help reduce liver injury, inflammation, and restore liver function

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**4. Reduction of Fatty Infiltration:** Flavonoid extracts from sea buckthorn seed residues have been shown to reduce the number of adipocytes in the liver of obese mice. This reduction significantly alleviates highfat diet-induced fatty infiltration in liver tissue. The mechanism involves downregulation of peroxisome proliferator-activated receptor gamma (PPARγ) expression in the liver and adipose tissue, which helps in reducing fat accumulation.

In conclusion, sea buckthorn's hepatoprotective effects are mediated through its rich content of flavonoids and carotenoids. These compounds regulate lipid metabolism, reduce oxidative stress, inhibit inflammation, and improve liver function. While promising, further in vivo studies and clinical trials are necessary to fully elucidate the mechanisms and validate the hepatoprotective benefits of sea buckthorn in humans.

### ❖ Food Applications

In addition to medical biological activities, sea buckthorn is also widely used in food, and has high economic value. Sea buckthorn is rich in nutritional value and contains a variety of biologically active compounds. Sea buckthorn is currently used as an antioxidant, antimicrobial and other natural additives in a variety of food products. The application of sea buckthorn in the food industry is more and more extensive, such as sea buckthorn oil, freeze-dried powder, fruit juice, fruit wine, milk tablets, fruit vinegar drinks, tea (94), preserved fruit, yogurt, and jam. The maximum utilization of sea buckthorn to improve the sensory properties and nutritional value of sea buckthorn products is currently being pursued by food industry manufacturers and researchers.

#### 1) Food Additives

The meat processing industry is currently seeking natural additives to replace chemical additives in their products. Kozhakhiyeva et al. (95) found that the new functional cooked and smoked horse meat Jaya product, produced by adding 5.0% sea buckthorn fruit powder extract, is rich in 1.0% bioactive substances. The samples showed a 38% reduction in lipolysis and a significant 24% reduction in lipid hydroperoxides after 21 days of storage. This improved the oxidative stability and quality of new functional horsemeat delicacies. The addition of 3% ethanolic extract of sea

buckthorn fruit to pork sausage effectively inhibited lipid oxidation and reduced the total bacterial count. Total sausage colonies were reduced by approximately 7 times, improving the microbiological content of the sausage.

The addition of sea buckthorn fruit powder to wheat bread extends the shelf life of the bread by 1–3 days. It also improves the antioxidant and organoleptic properties of the bread. The addition of 0.8 g/L of sea buckthorn leaf powder to white wine increased its free radical scavenging activity from 28.4 to 55.8%. The reducing ability of white wine, as measured by the amount of reduced ferric ion in an antioxidant power assay, increased from 35.3 to 62.1% with the addition of sea buckthorn. The total phenolic content of white wine increased from 11 to 23.7% and the color intensity increased from 39.9 to 50.7%, which contributed to the antioxidant capacity of the wines without sulfites. Sea buckthorn leaves have significant antioxidant capacity, and can be used as an alternative to increase the antioxidant capacity of wines.

Studies have found that sea buckthorn juice and its by-products could be used in chewing gum formulations and significantly improve the antioxidant activity.

It showed antimicrobial properties against MRSA, Klebsiella pneumoniae, Salmonella enterica, Pseudomonas aeruginosa, Bacillus cereus, etc. Sea buckthorn juice and its by-products have great potential as antimicrobial agents in the food industry.

Furthermore, sea buckthorn seeds used to purify chitinase, via its action on the antifreeze protein HrCHI4 preserved the integrity of frozen green pea membranes and helped preserve sample freshness by retaining volatile compounds. This study opens up the possibility of using edible products to preserve food and preserve its texture and freshness by natural means.

All in all, sea buckthorn has a promising future as a natural food additive. The bioactive compounds contained in sea buckthorn, such as polyphenols (especially flavonoids), ascorbic acid, vitamins, carotenoids, and antifreeze proteins exert antioxidant, antibacterial and antifreeze effects. In the future, it will be necessary to investigate these mechanisms of action in depth for better application in food production.

**2) Seabuck Thorn yogurt**

Sea buckthorn, as a new plant-based additive, is becoming increasingly popular in dairy production worldwide due to its healthful, nutritional benefits. This is exactly the kind of nutritional quality that consumers are happy to seek. Sea buckthorn is rich in nutritional active substances and its addition to yogurt enhances the nutritional value of yogurt. Developed from sea buckthorn berries, sea buckthorn yogurt is rich in fat, protein, carbohydrates and antioxidants (vitamin C, vitamin E, carotenoids, phenols, etc.) meeting people's nutritional needs. The yogurt can be stored safely at 4°C for 12 days and at 15°C for 3 days without losing its microbiological quality. In addition to adding sea buckthorn to yogurt, carrot, tomato water chestnut, yellow peach, and passion fruit have also been added to sea buckthorn yogurt to develop novel healthy yogurt. The different additions add to the unique natural flavor of fruits and vegetables, enriching the yogurt with a variety of functional ingredients and making up for the nutritional deficiencies of plain yogurt.

**3) Seabuck Thorn Jam & Jelly**

Sea buckthorn berries have a sour taste and a short shelf life. Therefore, processing berries into jam is an effective means to improve sensory characteristics and increase berry utilization. The jam, produced using sea buckthorn fruit at 102°C with stevia, contains high levels of total carotenoids and polyphenols and exhibits antioxidant activity. After 21 days of storage at room temperature, the value of yeast and mold was less than 100 CFU/g, and the value of Enterobacteriaceae was less than 5 CFU/g. Ordinary jam has a single flavor. In the Elaeagnus angustifolia and sea buckthorn compound jam, sea buckthorn was used both as a raw material and as an acidulant instead of citric acid. The jam has a shelf life of 177 days at 20°C without the addition of preservatives. In addition, sea buckthorn can be combined with sweet potatoes, pumpkins and carrots in a certain ratio to make novel, nutritious and healthy compound jam. A reasonable mixture of sea buckthorn juice with other fruit juices (papaya, watermelon, grape) can produce a delicious and nutritious jelly. Among them, sea buckthorn mixed jelly prepared in certain ratios with grapes has shown good organoleptic characteristics. The shelf life of sea buckthorn-grape jelly is 6 months at room temperature and its microbial load is also within the specified limits. Sea buckthorn has the potential to be a potentially rich source of bioactive compounds for the production of sugar-based products.

**4) Seabuck Thorn Beverages**

Sea buckthorn berry wastes are inevitably generated in the sea buckthorn processing industry, and improper disposal of these wastes will cause environmental pollution. Fermentation and reuse of these wastes can improve the utilization rate of sea buckthorn and increase the economic value of these wastes. Waste from the sea buckthorn processing industry can be used as a suitable substrate for fermentation. Fermentation under optimal fermentation conditions resulted in 3% ethanolic sea buckthorn beverage. This beverage contains high levels of phenolic compounds (including gallic acid, protocatechuic acid, vanillic acid, chlorogenic acid, etc.) and high antioxidant activity, and contains carbon dioxide and low levels of ethanol. So it is a refreshing and healthy functional drink. In addition to fermentation, a waste-free whole fruit pulp juice of sea buckthorn can be developed using the microwet milling (MWM) process. Compared to mixed milled and commercial sea buckthorn juice, MWM sea buckthorn juice has a better color (bright yellow tint, highest total carotenoid content of 145 ± 0.10 mg/mL), smaller particle size, higher ascorbic acid value (67.67 ± 1.15 mg/mL), total phenolic content and antioxidant activity. The process minimizes the loss of heat-sensitive bioactive compounds. It also provides a fiber-rich juice, showing great promise for processing sea buckthorn juice in the food industry. Sea buckthorn is rich in nutrients and bioactive compounds. The potential of sea buckthorn as a botanical ingredient for novel functional food applications is obvious. It is promising to make full use of sea buckthorn fruits, peels, and seeds and to explore new ways of processing sea buckthorn.

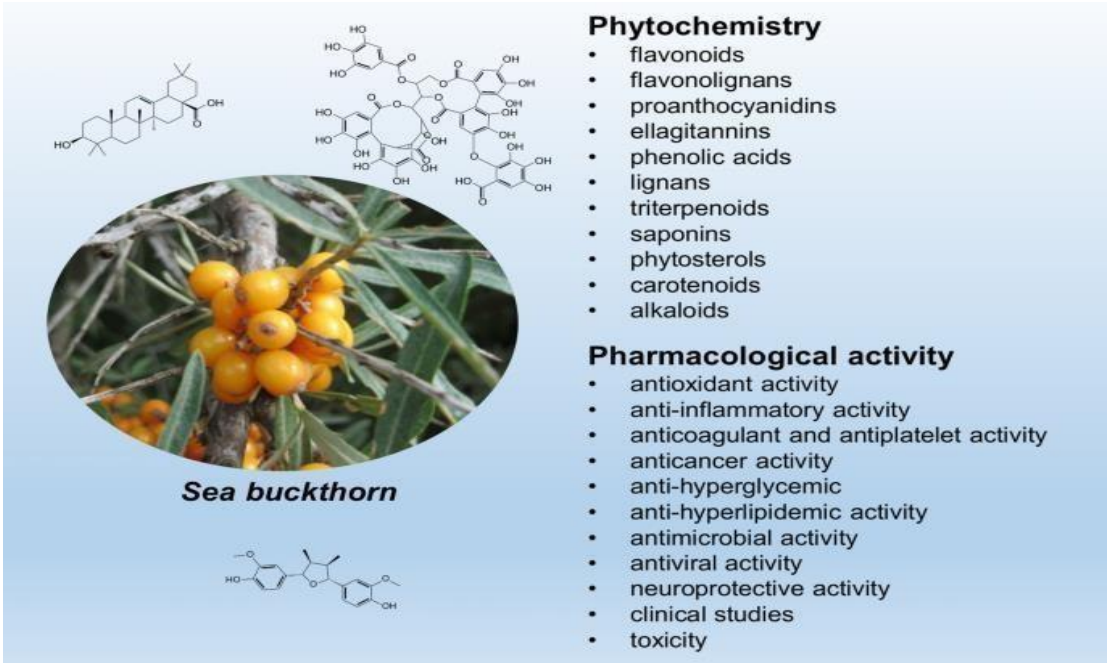
This ancient plant has powerful therapeutic synergies and has made many contributions to humankind. Sea buckthorn has an outstanding ability to help with economic development and improve the ecological environment. In order to rationally develop and utilize sea buckthorn resources, further research should focus on:

(1) Developing mechanical harvesting and reasonable preservation technology. Sea buckthorn is a berry plant and manual harvesting is inefficient. The berries have high moisture content and are easily squeezed leading to deformation and mold. It is necessary to improve the efficiency at the harvesting stage;
(2) Isolation and identification of more specific bioactive compounds and further study of their health promoting mechanisms;
(3) Conducting more clinical trials to verify the health benefits of sea buckthorn for humans;

(4) Applying sea buckthorn in the prevention and treatment of diseases;

(5) Developing functional foods and other products based on sea buckthorn;

(6) Adhering to the mode of combining economy and ecology, and developing the sea buckthorn industry in a scientific, reasonable and sustainable manner.




*(Potential Dietary supplement with multifaceted therapeutic activities Author links open overlay panel by Roshan Kumar Dubey)*

**Limitations**

While sea buckthorn (Hippophae rhamnoides) offers numerous health benefits and is versatile in various applications, there are also some potential disadvantages or considerations associated with its use:

1) **Taste and Astringency:** Sea buckthorn berries have a tart and astringent taste, which may not be palatable to everyone. This characteristic can limit their direct consumption and require processing into products like jams, jellies, or beverages where sugar or other flavors can be added to improve taste.
2) **Allergies:** Like many natural products, sea buckthorn could potentially cause allergic reactions in some individuals, especially those with allergies to other plants or berries. Symptoms may include itching, swelling, or respiratory issues. It's advisable to proceed with caution, especially with direct consumption or topical applications.
3) **Potential Drug Interactions:** Sea buckthorn contains bioactive compounds that could interact with medications. For example, its high vitamin E content might interfere with blood-thinning medications like warfarin. It's essential for individuals on medications to consult healthcare professionals before incorporating sea buckthorn into their diet or skincare regimen.
4) **Processing Challenges:** Harvesting and processing sea buckthorn berries can be labor-intensive due to their small size, thorny branches, and tendency to spoil quickly if not handled properly. This can affect the efficiency and cost-effectiveness of commercial production.
5) **Regulatory Issues:** Depending on the region and intended use, regulations and standards for sea buckthorn products may vary. Ensuring compliance with food safety regulations and quality standards is crucial for commercial applications.

Overall, while sea buckthorn offers significant advantages and potential as a natural ingredient in food, cosmetics, and pharmaceuticals, careful consideration of these factors is essential to maximize its benefits while mitigating potential disadvantages.

**Business Values**

Sea buckthorn (Hippophae rhamnoides) is utilized in a variety of products across different industries due to its rich nutritional profile and bioactive compounds. Here are some real-time products where sea buckthorn is commonly used:

**1. Cosmetics and Skin Care Products**

Sea buckthorn oil and extracts are popular ingredients in cosmetics and skincare due to their antioxidant properties and potential benefits for skin health. Products include:

- Facial creams and lotions
- Anti-aging serums
- Moisturizers
- Lip balms and lipsticks
- Shampoos and conditioners
- Soaps and body washes

**2. Nutraceuticals and Dietary Supplements**

Sea buckthorn is consumed in supplement form for its nutritional and health-promoting benefits. Common products include:

- Capsules and softgels containing sea buckthorn oil
- Powdered sea buckthorn extract supplements
- Liquid extracts for oral consumption
- Vitamin and mineral formulations enriched with sea buckthorn

**3. Medicinal and Herbal Products:**

Sea buckthorn n is used in traditional and herbal medicine practices for its therapeutic properties.

Products include:

- Herbal teas and infusions
- Tinctures and extracts for medicinal use
- Ointments and salves for topical applications
- Herbal remedies for digestive health, immunity, and skin conditions

**4. Functional Ingredients in Food Industry**

Sea buckthorn extracts are used as functional ingredients in various food processing applications:

- Natural food additives and preservatives
- Flavor enhancers in beverages and dairy products
- Colorants and natural dyes in food products
- Antioxidant additives in meat and seafood processing

**5. Environmental and Agricultural Applications**

Beyond human consumption, sea buckthorn has applications in environmental conservation and agriculture:

- Soil erosion control and reclamation projects
- Landscaping and ornamental plantings
- Animal feed supplements

These products highlight the versatility of sea buckthorn across different sectors, from personal care and cosmetics to dietary supplements and functional foods, demonstrating its broad utility and potential benefits for human health and well-being.

**CONCLUSION**

Sea buckthorn (Hippophae rhamnoides) emerges from a rich historical backdrop in Indo-Tibetan medicine and continues to garner scientific interest for its diverse therapeutic potential. Studies cited reveal its bioactive compounds, including antioxidants like tocopherols and tocotrienols, which vary significantly based on geographical origins and harvesting times. This variability underscores its nutritional importance and potential health benefits, positioning sea buckthorn as a valuable dietary supplement and functional food ingredient. The lipophilic components extracted from sea buckthorn seeds and berries exhibit robust antioxidant properties, which have implications for skincare formulations and dietary supplements. Research highlights its efficacy in promoting skin health, combating aging effects, and alleviating conditions like atopic dermatitis. These findings underscore its dual role in cosmetic and therapeutic applications, supported by both traditional knowledge and modern scientific validation. Moreover, preliminary investigations suggest that sea buckthorn, particularly in combination with grape extracts, may contribute to managing lipid levels, suggesting hypolipidemic effects that could mitigate cardiovascular risks. This potential opens avenues for its inclusion in cardiovascular health formulations and dietary interventions. The development of novel processing techniques, including fermentation and extraction methods, aims to maximize the bioavailability and effectiveness of sea buckthorn's bioactive compounds in various culinary and industrial applications. Looking forward, further research is needed to delve into the specific mechanisms of action of sea buckthorn's bioactive compounds and validate its therapeutic benefits through rigorous clinical trials. Sustainable harvesting practices and ecological considerations will also be crucial for the continued development and responsible utilization of sea buckthorn resources, ensuring its long-term viability as a beneficial botanical resource. Sea buckthorn (Hippophae rhamnoides) has a deep-rooted history in Indo-Tibetan medicine and continues to captivate scientific interest due to its diverse therapeutic potential. Research

highlights its rich array of bioactive compounds, such as antioxidants including tocopherols and tocotrienols, which vary significantly depending on geographical origin and harvest times. This variability underscores sea buckthorn's nutritional significance and potential health benefits, positioning it as a valuable dietary supplement and functional food ingredient. The lipophilic components extracted from sea buckthorn seeds and berries demonstrate potent antioxidant properties, making them valuable for both skincare formulations and dietary supplements. Studies underscore its effectiveness in promoting skin health, combating signs of aging, and relieving conditions like atopic dermatitis. This dual role in cosmetics and therapeutics is supported by a blend of traditional knowledge and modern scientific validation. This opens doors for incorporating sea buckthorn into cardiovascular health formulations and dietary interventions. In addition to its medicinal uses, sea buckthorn is extensively utilized in the food industry, enhancing products like jams, jellies, and yogurt with improved nutritional profiles and sensory attributes. Innovations in processing techniques, including fermentation and extraction methods, aim to maximize the bioavailability and efficacy of sea buckthorn's bioactive compounds across various culinary and industrial applications. Looking ahead, further research is crucial to deepen our understanding of the specific mechanisms through which sea buckthorn bioactives exert their benefits and to validate these findings through rigorous clinical trials. Sustainable harvesting practices and environmental considerations will also be essential to ensure the responsible utilization and long-term viability of sea buckthorn as a valuable botanical resource.

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