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Unveiling the Multifaceted Benefits of Hippophae Rhamnoides (Sea Buckthorn): From Traditional Medicine to Modern Therapeutics

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ABSTRACT

Sea buckthorn (Hippophae rhamnoides), a deciduous shrub native to Europe and Asia, has attracted growing scientific attention due to its remarkable nutritional and therapeutic potential. Its berries, seeds, and leaves are rich in bioactive compounds, including vitamins C, A, E, and K, flavonoids (quercetin, kaempferol), essential fatty acids (omega-3, -6, -7, -9), phenolic acids, carotenoids, phytosterols, and amino acids. This diverse phytochemical profile underlies its broad pharmacological actions—antioxidant, anti-inflammatory, anticancer, hepatoprotective, cardioprotective, neuroprotective, and dermatological. Traditionally valued in Tibetan, Chinese, and Greek medicine, sea buckthorn has found modern uses in nutraceuticals, cosmeceuticals, and functional foods. Its potent antioxidant activity, primarily due to high vitamin C and polyphenol content, helps neutralize free radicals and mitigate oxidative stress. Oil extracted from its seeds and pulp promotes skin regeneration, hydration, and anti-inflammatory effects. Additionally, it shows promise in managing metabolic disorders like diabetes and hyperlipidemia and supports cardiovascular health by improving lipid profiles and regulating blood pressure. Preclinical studies indicate anti-cancer potential through apoptosis induction and tumor growth suppression. While its health-promoting effects are well-documented, clinical validation is needed to determine standardized dosing, safety, and interactions. This review highlights sea buckthorn's phytochemistry and therapeutic promise, positioning it as a valuable agent in integrative medicine.

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Introduction

Sea buckthorn (Hippophae rhamnoides) is increasingly being recognised as a source of therapeutically important substances as a dietary supplement. The nutrient-rich berries of the plant are filled with essential vitamins including C, A, E, and K, minerals and important fatty acids – this is the foundation of its many health benefits. Its remarkable antioxidant capabilities are mainly due to its high vitamin C and flavonoids, which neutralise oxidative stress and protect cells from harmful free radicals [1]. This multipurpose plant has broad implications that benefit dozens of health concerns. It is known as a very effective immune booster. Sea buckthorn contains a large number of vitamins that help improve the immune system and overall health. Additionally, the omega fatty acids found in it, including omega-7 and omega-3, play a significant role in cardiovascular health [2]. These omega-3 fatty acids can lower inflammation and cholesterol, which leads to better heart health. Sea buckthorn oil is a popular constant in the skincare field for its hydrating and inflammation-reducing properties and its wound-healing capabilities [3]. These qualities have made it a popular ingredient in many skincare products. Furthermore, beyond skin health, sea buckthorn is being researched for its potential therapeutic role in the gut. Its anti-inflammatory effects may help calm and heal the digestive system, which is beneficial for digestive conditions like ulcers and gastritis. Early studies are also investigating the possible cancer-preventing qualities of sea buckthorn. Studies show that its high antioxidant and bioactive content could reduce the growth and spread of specific cancer cell types, making it a natural tool to consider when treating cancer [4]. Additionally, it is used as a remedy for diabetes, and studies are currently exploring sea buckthorn's role in helping to manage the condition, with initial findings suggesting it could help stabilise blood sugar and improve insulin sensitivity. Regarding inflammation-based illness, sea buckthorn's anti-inflammatory traits may be helpful in diseases such as arthritis. The plant's multiple bioactive constituents, such as quercetin, catechins and beta-carotene, may account for its vast therapeutic possibilities. While sea buckthorn is very promising, we should be cautious about it. More studies are also needed to understand its effects and potential side effects thoroughly. People should check with a doctor before trying sea buckthorn, particularly if they use other medications [5].

History of Sea Buckthorn (Hippophae Rhamnoides)

Sea buckthorn (Hippophae rhamnoides) has a rich heritage that spans thousands of years and is well-established in traditional medicine, nutrition, and horticulture. A native of Europe and Asia, with some of its species growing in the Himalayas, China, Russia, and other parts of Europe, its medicinal use has been known for approximately 1,000 years in the interior of China [6]. Tibetan medicine has long recognised its healing power, especially for lung, cardiovascular, and digestive ailments. Mongolian literature from the 8th century refers to the sea buckthorn as a

way to treat these same issues. The plant's name, derived from the Greek Hippophae, which translates to "shiny horse," has its roots in ancient Greek mythology. The Greeks are reported to have given sea buckthorn leaves to horses to fatten them and provide a lustrous shine to their coats [7]. This reflects the plant's ancient connection to vitality and well-being. Traditional Chinese Medicine (TCM) has utilised sea buckthorn since the Tang dynasty (7th century) to treat various illnesses, including allergies, cardiovascular diseases, gastrointestinal issues, and skin conditions. In the 20th century, with the rise of Soviet science, sea buckthorn was being scientifically studied, particularly for its adaptogenic and radioprotective properties. The Soviets researched the efficacy of radiation protection, and cosmonauts even used sea buckthorn oil as a protective measure in space. Following the dissolution of the Soviet Union, research on sea buckthorn has continued primarily in Russia, China, and Europe, focusing on its nutrient content, including vitamins C, E, A, and K, omega fatty acids (particularly omega-7), flavonoids, and carotenoids [8]. Now, sea buckthorn's anti-inflammatory, antioxidant, and regenerative effects have made it a global favourite in natural health, skincare, and nutraceuticals. It is a diversified applied product in cosmetics, health food products and functional foods, which can improve skin care, enhance immunity and regulate metabolism. The historically relevant and current use of sea buckthorn demonstrates the plant's ongoing role as a potent health-inducing agent in both traditional and modern times.

Table 1: Taxonomic Classification of Sea Buckthorn (Hippophae Rhamnoides)

Rank	Classification
Kingdom	Plantae
Clade	Angiosperms
Clade	Eudicots
Clade	Rosids
Order	Rosales
Family	Elaeagnaceae
Genus	Hippophae
Species	Hippophae rhamnoides
Common Name	Sea buckthorn

Sea Buckthorn has been Well Researched with A Variety of Health Benefits:

Antioxidant Protection: Sea buckthorn contains a rich natural content of powerful antioxidants that protect the cells from the harmful oxidative stress caused by free radicals. These antioxidants can quench damaging molecules, turn free radicals, that attack tissues and bring on ageing and chronic disease [9].

Anti-inflammatory Benefits: Sea buckthorn is a key player in helping to regulate the immune system and reduce inflammation. It aids in the regulation of the inflammatory response and may be beneficial in relieving symptoms of arthritis and other inflammatory conditions [10].

Anti-cancer Quality: New research also indicates that sea buckthorn may have anti-cancer benefits. Its bioactive compounds, such as antioxidants and flavonoids, have the potential to suppress the proliferation and metastatic spreading of cancer cells, thus making it an adjuvant in cancer prevention and therapy [11].

Liver Protection (Hepatoprotective): Sea buckthorn has been shown to have a hepatoprotective effect, in the sense that it helps to protect your liver from damage while promoting good liver health. Its compounds are thought to promote the generation of liver cells and fibrogenesis, as well as to lower liver fat content and stimulate detoxification pathways; all beneficial for liver patients [12].

Heart Health: Sea buckthorn is said to protect our Hearts. For example, it's good for Heart Health. It can lower blood pressure, cholesterol levels, and triglycerides, all of which are key causes of heart disease. It may also help keep atherosclerosis (hardening of the arteries) at bay, thereby helping maintain better heart health and reducing the chances of cardiovascular diseases [13].

Neuroprotective Properties: This is one of the best sea buckthorn benefits; it helps to keep memory and cognitive function intact, due to its powerful neuroprotective effect. Some research indicates it may help shield the brain from neurodegeneration, possibly providing support for Alzheimer's and other cognitive-decline-inducing disorders [14].

Skin Health (Dermatological Benefits): Sea buckthorn is also well known for promoting skin health. Its high vitamin, fatty acid, and antioxidant content helps regenerate skin, treat conditions such as eczema, and fade scars and blemishes. Its moisturizing qualities are great for dry and stressed skin, too [15].

Opthalmic Health: Sea buckthorn offers many eye health benefits, which can prevent and treat dryness, infection, and irritation. Its rich supply of vitamin A, omega fatty acids and antioxidants can support the health of our vision and may help fight age-related eye conditions [16].

Gastrointestinal: Sea buckthorn has been used to remedy gastrointestinal disturbances, including ulcers and gastritis. It has an anti-inflammatory effect and aids in healing the tissues of the gastrointestinal tract. It can also bring relief or potentially support regularity in the bowels, which is beneficial for your digestive system [17].

Sea buckthorn, which is becoming more common as a dietary supplement, may contain oil, juice, powder or capsules. It is also implemented in edible goods such as preserves, pies, beverages, and cosmetics. Nevertheless, additional clinical studies are required to better clarify both the safety and efficacy of sea buckthorn in human health. Though it has several medicinal values, adverse effects of CP have been reported, such as allergy, hemorrhagic diathesis, hypoglycemia and drug-herb interactions. Thus, it is important to be advised by a doctor before taking sea buckthorn supplement.

Sea buckthorn is variety of spiny shrubs with bright orange-yellow berries. It has multiple species and sub species, possessing unique features and living in distinct localities. The main races and their outstanding characteristics are as follows:

Table 2: Classification and Distribution of Hippophae Species

Species/Subspecies	Description	Geographical Distribution	Key Characteristics
Hippophae rhamnoides	The most common and widely distributed species, often referred to as common sea buckthorn.	Dry and cold regions of Asia and Europe	Silvery-green leaves, nine subspecies, including H. rhamnoides ssp. sinensis (China)
Hippophae salicifolia	Found only in the Himalayas, this species thrives at high altitudes in dry valleys.	Himalayas	Broader, greener leaves, yellow berries
Hippophae goniocarpa	Grows in mountainous regions of Nepal and China, typically between 2650 and 3700 meters in elevation.	Nepal and China	Two subspecies, differing in leaf shape and color
Hippophae neurocarpa	Endemic to Xizang, this species grows on rocky slopes and river banks.	Xizang (Tibet)	Small, narrow leaves, orange-red berries

Some varieties of sea buckthorn have been cultivated for their superior fruit quality and higher yields. These varieties differ in thorniness, fruit taste, and overall plant vigor:

Table 3: Cultivated Varieties for Fruit Quality and Yield

Variety	Description	Key Features
Russian Orange	Cultivated for large, high-quality fruits with a sweet and juicy taste.	Fewer thorns, large and top-quality fruits
Sirola	A strong and vigorous variety, known for producing sweet berries.	Fewer thorns, vigorous growth, sweet berries
Pollmix	Male variety used for pollination of female plants.	Different flowering times, thorniness varies

Figure 1: Nutritional and Phytochemical Composition of Sea Buckthorn Berries and Their Health Benefits

Vitamins
Vitamin C Sea buckthorn is the richest plant source of Vitamin C, which is required for collagen formation, wound healing, and immune function. It is also an antioxidant, defending your cells from oxidative stress.

Vitamin A is found in the form of carotenoids, specifically beta-carotene, which is transformed into Vitamin A. Vitamin A is involved with vision, immunity and skin integrity.

Vitamin E is a powerful antioxidant that plays a key role in protecting cells from oxidative damage and maintaining healthy skin. It's also got anti-inflammatory tendencies.

Vitamin K is essential for blood clotting and bone health. Vitamin K is necessary for maintaining proper bone density and preventing uncontrolled bleeding.

B Vitamins: Sea buckthorn is high in several types of B vitamins, including thiamine (B1), riboflavin (B2), pyridoxine (B6), and folic acid, which are necessary for energy production, metabolism and nerve function.

Fatty Acids
Omega-7 (Palmitoleic Acid): Seabuckthorn is rarely known as a source of omega-7 fatty acid. Omega-7 has anti-inflammatory benefits for skin and can help with cholesterol and blood sugar control.

Omega-3, Omega-6, Omega-9: These essential fats are essential for heart health, lessen inflammation, and help the brain function. Omega-3 fats, especially alpha-linolenic acid (ALA), contribute to decreasing heart disease risk.

Flavonoids
Quercetin is a powerful antioxidant that helps decrease inflammation and protect cells from oxidative stress. It is also good for the health of the heart and vessels and possibly has anti-cancer benefits.

Kaempferol: Its antioxidant, anti-inflammatory, and possibly anti-cancer effects help protect against chronic diseases and boost immunity.

Catechins: A type of flavonoid in sea buckthorn with antioxidant effects may support heart health and wellness in general.

Rutin: This flavonoid is recognised for its anti-inflammatory and antioxidant properties. It also fortifies blood vessels and promotes circulation.

Carotenoids
Beta-carotene: This carotenoid provides a precursor to Vitamin A and is key for maintaining good vision, healthy skin, and a strong immune system. Beta-carotene also serves as an antioxidant, protecting organs from free radical harm.

Lutein and zeaxanthin: These carotenoids may be especially good for promoting eye health. They protect the retina, support the chain of processes that enable your eyes to see, and help protect your eyes from age-related macular degeneration.

Phenolic Acids

Ferulic acid

A powerful antioxidant and antioxidantmatory, ferulic acid helps protect your cells from the oxidative effects of free radicals, and promote heart and skin health.

Caffeic Acid

This has an anti-inflammatory and antioxidant quality that supports the immune system, reduces inflammation, and can improve the overall condition.

Triterpenes

Sea Buckthorn Oil Oleanolic Acid

This triterpene is extracted from sea buckthorn and contains anti-inflammatory, anti-viral and hepatoprotective agents. It has been found to guard the liver against damage and might have anti-cancer properties.

Phytosterols

Beta-sitosterol is a plant sterol that helps lower cholesterol and promote healthy immune function. It also supports overall cardiovascular health and might possess anti-inflammatory and anti-cancer capabilities.

Amino Acids

Seabuckthorn necessarily contains amino acids like glutamic acid, aspartic acid, glycine, etc , that provide essential building blocks for protein synthesis, muscle building & repair and nutrition for overall body metabolism.

Saponins

These glycoside substances have shown the effects of anti-inflammation, immune stimulation, and cholesterol reduction. Sea buckthorn contains a variety of saponins, which could contribute to general health by preventing chronic conditions.

Essential Oils

The compounds present in Seabuckthorn oil MEM contain numerous bioactive components, such as fatty acids, tocopherols, and flavonoids, which may be linked to its antioxidant, anantioxidant, and skin-healing properties.

Bioactive Compounds in Sea Buckthorn

Polyphenols

Although polyphenols represent the largest and most ubiquitous class of plant specialised metabolites, they are usually classified according to the number of phenolic rings and their structural components. Almost all sea buckthorn tissues, such as berries, roots, leaves, stems, and branches, are rich in polyphenols, with high levels observed in fruit and leaves, which, depending on variety, location, and maturity, can vary considerably in the amount of phenols they contain . Phenolic acids and flavonoids are the primary polyphenols present in sea buckthorn. The amount of total phenols in sea buckthorn (calculated as gallic acid equivalents (GAE)) varies from 32.93 to 1417 mg·100 g tissue-1 and depends to a great extent on the variety of sea buckthorn. The free form of gallic acid, the most common phenolic acid, is found in sea buckthorn, with the highest quantity in the leaves (79 mg/kg) and the lowest in the berries (16.9 mg/kg). Other phenolic acids like caffeic, p-coumaric, and ferulic acids exist at much lower levels [18].

Table 4: Concentration of Phenolic Acids in Sea Buckthorn Berries and Leaves (mg/kg Dry Matter) and Their Noted Characteristics

Phenolic Acids	Berries (mg/kg DM)	Leaves (mg/kg DM)	Reference	Notes
2,5-Dihydroxybenzoic acid	0.1–6.1		[20]	Present in both leaves and berries but in small concentrations
Gallic acid	1.0–16.9	19.1–79.1	[19,20]	Dominant phenolic acid; higher in leaves compared to berries
Pyrocatechinic acid	0.8–6.3		[19]	Found mainly in berries with moderate concentrations
Protocatechuic acid	0.7–4.3		[20]	Concentrations in berries are low compared to other acids
Salicylic acid	21–47.5		[20]	Relatively high in berries, linked to anti-inflammatory effects
Vanillic acid	0.5–1.8		[20]	Low concentration in both tissues but with potential benefits
Caffeic acid	0–6.7	5.9–9.8	[19,20]	Present in both, with berries having slightly lower levels
m-Coumaric acid	0.3–6.1		[20]	Found in both, more concentrated in berries
o-Coumaric acid	2.2–13.3		[20]	Present in berries, contributing to its overall antioxidant effect
p-Coumaric acid	1.4–22.3	8.4–13.4	[19,20]	Found in both berries and leaves, contributing to antioxidative properties
p-Hydroxyphenyl-lactic	5.3–24.1		[19]	Found more abundantly in berries, supports anti-inflammatory effects
Ferulic acid	0–10.5	7.2–15.1	[19,20]	Present in higher concentrations in leaves than berries

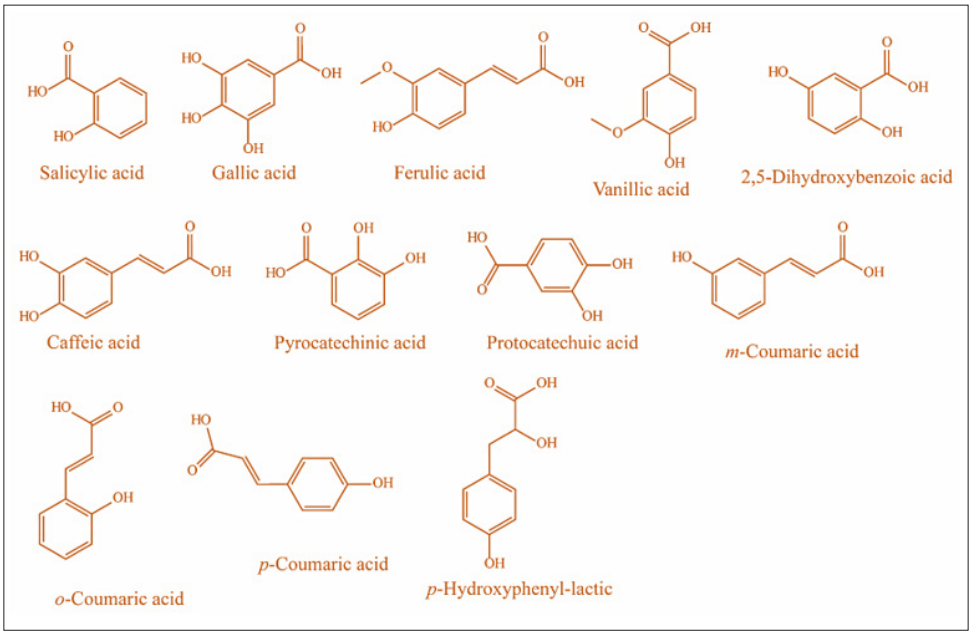

Figure 2: Chemical Structures of Phenolic Acids in Sea Buckthorn

Flavonoids

Flavonoids are one of the most important bioactive compounds identified in sea buckthorn, and exceptionally high concentrations have been recorded among sea buckthorn berries compared to other plants rich in flavonoids (such as hawthorn, dogwood, cherry, and blueberry) [21,22]. These compounds are responsible for the beneficial health properties of plants, mainly antioxidant, antiinflammatory, and cardiovascular protective. Sea buckthorn has four major flavonoid glycosides: isorhamnetin, quercetin, myricetin and kaempferol, potent free radical scavengers and protectors against oxidative damage [23]. These flavonoids play a role in the plant's well-known medicinal properties to treat diseases such as heart problems, diabetes, and even different types of cancer. While the flavonoid content is lower than that found in the berries, the seeds are also a rich source of many flavonoids. In addition to flavonoid glycosides, seeds contain relatively small amounts of other important phytochemicals of spin-off interest, such as proanthocyanidins, catechins, triterpene saponins, and polar and hydrophobic compounds [24]. Increases the nutritional and medicinal value of the plant further with these plank-like compounds. Additionally, the flavonoid composition in the end-product can be highly affected by the processing of sea buckthorn, particularly by the drying method. These compounds are sensitive and likely lose some potency and efficacy during the drying process, compromising the quality of the sea buckthorn. Hence, drying approaches should be exploited well to preserve as much of the health-promoting effects of these bioactive substances as possible.

Table 5: Flavonoid Composition in Sea Buckthorn Berries, Leaves, and Seeds with Associated Health Benefits

Flavonoids	Berries	Leaves	Seeds	Reference	Additional Notes
Kaempferol	102	2.8–4.1	60	[25]	Known for its antioxidant properties
Quercetin	40–375	332–1381	110	[25]	Found in high amounts in onions and apples
Isorhamnetin	103–964		270	[25]	Often associated with anti-inflammatory effects
K-3-O-glucoside		56–101		[25]	A glycoside form of Kaempferol
K-3-O-rutinoside		291–894		[25]	Present in apples, grapes, and onions
Q-3-O-rutinoside/Rutin	233–288	471–1310	590	[25]	Known for its cardiovascular health benefits
Q-3-O-glucoside	402			[25]	Common in citrus fruits
Q-3-O-galactoside		205–458		[25]	Found in many plants, especially leafy greens
Q-3-O-sorphroside-7-O-rhamnoside	227–272	301–359	240	[25]	Related to quercetin, may support immunity
I-3-O-rutinoside	210–840	107–496	490	[25]	Often seen in citrus and berries
I-3-O-glucoside	260	254–339	280	[25]	Found in a variety of fruits and vegetables
K-3-O-sophroside-7-rhamnoside	341			[25]	A rarer form of Kaempferol

I-3-O-sophroside-7-O-rhamnoside	308–753	250–446	370	[25]	May play a role in supporting skin health
I-3-O-glucoside-7-O-rhamnoside	1340	691–1110		[25]	A potent antioxidant
I-3-O-neohesperidoside	546–1847	585–1639		[25]	Found in citrus fruits and known for anti-inflammatory properties
I-3-O-[(6-O-E-sinapoyl)-β-D-glucopyranosyl-(1→2)]-β-D-glucopyranosyl-7-O-α-L-rhamnopyranoside	122–300	91–345		[26]	Rarely found in nature, mostly in plant-based extracts
Q-3-O-[(6-O-E-sinapoyl)-β-D-glucopyranosyl-(1→2)]-β-D-glucopyranosyl-7-O-α-L-rhamnopyranoside	15–253	751–1821		[26]	Unique compound with potential neuroprotective effects
K-3-O-[(6-O-E-sinapoyl)-β-D-glucopyranosyl-(1→2)]-β-D-glucopyranosyl-7-O-α-L-rhamnopyranoside	75–597	292–1134		[26]	May have benefits for heart health
Proanthocyanidins (PA)					Known for their strong antioxidant effects
PA Dimers	10–89			[27]	Linked to improving cardiovascular health
PA Timers	13–95			[27]	Can be found in the skin of many fruits
PA Tetramers	8–71			[27]	Often found in foods like dark chocolate and wine
PA oligomers	37–255			[27]	May support healthy blood vessels

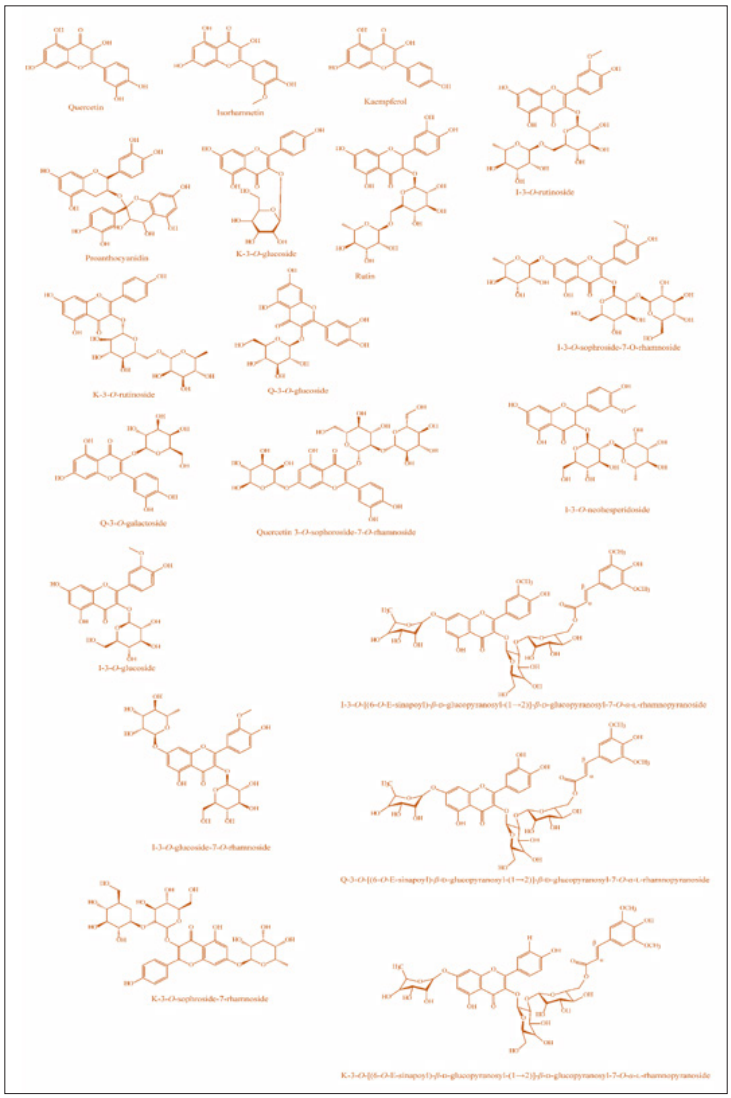

Figure 3: Chemical Structures of Flavonoids in Sea Buckthorn

Vitamins

The health benefits of sea buckthorn are largely attributable to the wealth of vitamins contained in the plant itself [28]. The sea buckthorn berries stand out in terms of especially high vitamin C content. Sea buckthorn berries have an average vitamin C content of 7950 mg/kg fresh berries, fifteen times higher than the vitamin C content in oranges. Sea buckthorn is a great natural source of this crucial vitamin with an immune-boosting and antioxidant capacity [29]. Sea buckthorn also contains many B vitamins besides vitamin C, such as B1 and B2. The plant is high in several B vitamins, including B1(thiamine), B2(riboflavin), and B11(folate). Specifically, B1, B2, and B11 vary between 0.16–0.35 mg/kg of fresh weight, 0.30–5.0 mg/kg, and 0–7.9 mg/kg, respectively [30]. The B vitamins are essential, aiding in energy metabolism, nervous system function, and red blood cell formation; all important for overall health and wellness. Also notable for the vitamin content of sea buckthorn are the fat-soluble vitamins, most especially vitamin K and E; vitamin E, specifically, is comprised of a family of eight fat-soluble compounds, together with tocopherols and tocotrienols, each possessing antioxidant activity [31]. The most biologically active part of vitamin E among its eight isomers is α-tocopherol. Sea buckthorn contains 43 to 223 mg/kg of fresh weight. Potent antioxidant effects of α-tocopherol aid in protecting from oxidative stress at the cellular level, help skin health, and have anti-aging effects and cardiovascular health. Additionally, the vitamin K found in sea buckthorn supports blood clotting, bone health, and the integrity of the cardiovascular system. It also means that it can make the plant more nutritious overall. Thus, instead of being found in a particular vitamin in its composition, the numerous vitamins provide all the ingredients that contribute to the plant's healthy quality, general support, and maintainable abilities. The high content of vitamin C and E, plus B vitamins and fat-soluble vitamins, can benefit any natural health program or diet for immune health, dermal support, heart support, and a greater number of other clinical functions [32].

Table 6: Nutrient Profile of Sea Buckthorn: Vitamins and Antioxidants Across Different Plant Parts

Compound	Berries	Seeds	Pulp	Seed Oil	Pulp Oil	Reference	Health Role / Notes
Vitamin B11 (Folate)	0–7.9	—	—	—	—	[31]	DNA synthesis, pregnancy support
δ-Tocopherol	0.294	—	—	37–113	320–490	[33]	Potential anticancer activity
β-Tocotrienol	0.7–2.3	3–11	—	30–120	—	[33]	Cholesterol-lowering properties
Vitamin K (VK) (μg/kg)	1100–2300	—	—	—	—	[34]	Blood clotting
γ-Tocopherol	0.5–15	56–95	0.6–13	461–1349	1–3	[33]	Anti-inflammatory properties
α-Tocotrienol	0.2–4.5	—	—	—	—	[33]	Neuroprotective, antioxidant
Carotenoids	20–600	—	300	—	1200	[35]	Precursor of vitamin A
Vitamin C (VC)	400–15,500	—	—	—	—	[35]	Immune support, antioxidant
α-Tocopherol	43–223	42–160	21–168	444–1550	630–1940	[33]	Main form of vitamin E; antioxidant
β-Carotene	2–170	—	—	—	—	[36]	Pro-vitamin A, vision health
γ-Tocotrienol	0.3–3.5	—	0.6–8.4	—	—	[37]	Potential anti-cancer agent
Vitamin B1 (VB1)	0.16–0.35	—	—	—	—	[38]	Energy metabolism
δ-Tocotrienol	0.133	—	—	—	—	[37]	Rare, under research
β-Tocopherol	1.3–17	10–16	1.2–19	67–164	—	[33]	Antioxidant, less active than α-form
Vitamin B2 (VB2)	0.3–5.0	—	—	—	—	[38]	Cell growth and function

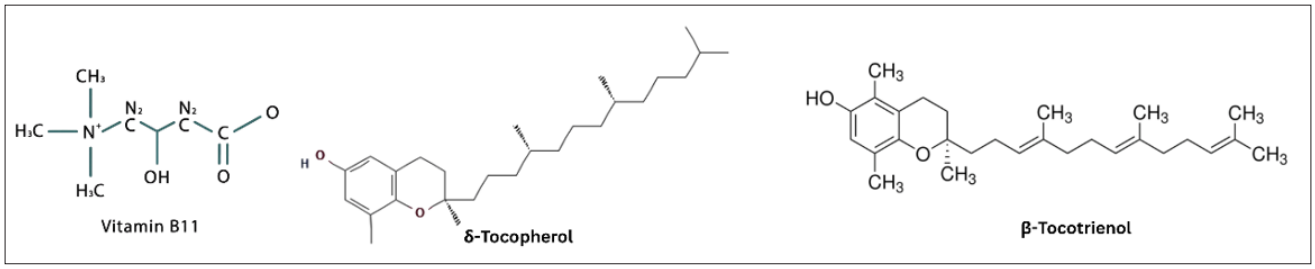

Figure 4: Chemical Structures of Vitamins in Sea Buckthorn

Phytosterols

Sea buckthorn is one of the most abundant plant sources of phytosterols, with 20 different phytosterols being detected so far in different plant parts [39]. Sea buckthorn is one of the richest natural sources of phytosterols (bioactive compounds) with a total fresh weight of 20–30 g/kg phytosterol content. This is 4 to 20 times higher than concentrations for the common oils, such as soybean oil, suggesting that sea buckthorn has an excellent nutritional profile.β-Sitosterol is the most common phytosterol, accounting for about 5.2 to 5.7 g/kg of fresh fruit weight [40]. The compound is also well-known for lowering cholesterol and possibly acting as an anti-inflammatory agent. Besides β-sitosterol, other significant phytosterols available in sea buckthorn are campesterol, stigmasterol, and Δ5-avenasterol, which all add their components for the so-called health-promoting benefits of the plant [41]. Research shows these compounds are good for heart health and immune function; some offer protection from some cancers. The significant phytosterol profile, particularly in the oil fractions of sea buckthorn, indicates its potential benefit as a dietary supplement for health and future functional food ingredient development [42].

Table 7: Phytosterol Content in Sea Buckthorn Oils and Seeds

Phytosterol	Pulp Oil	Seed Oil	Seeds	Reference	Health Role / Notes
β-sitosterol	3.0–5.7	5.9–13.8	5.6–10.3	[43-45]	Most abundant; supports heart health, cholesterol lowering
Δ5-Avenasterol	—	3.3	3.5	[44]	Contributes to antioxidant activity
Cycloartenol	—	1.9	1.8	[44]	Precursor in sterol biosynthesis
Stigmasterol	1.0–1.2	0.6–1.2	—	[45]	May aid in reducing blood cholesterol levels
Gramisterol	—	0.6	0.5	[44]	Lesser-known sterol with potential antioxidant role
Citrostadienol	—	0.5	—	[45]	Involved in sterol biosynthesis
Campesterol	—	0.3–1.9	0.3	[44,45]	Supports lipid metabolism; structurally similar to cholesterol
Total Sterols	20–30	10–20	—	[46]	Indicates very high phytosterol richness overall

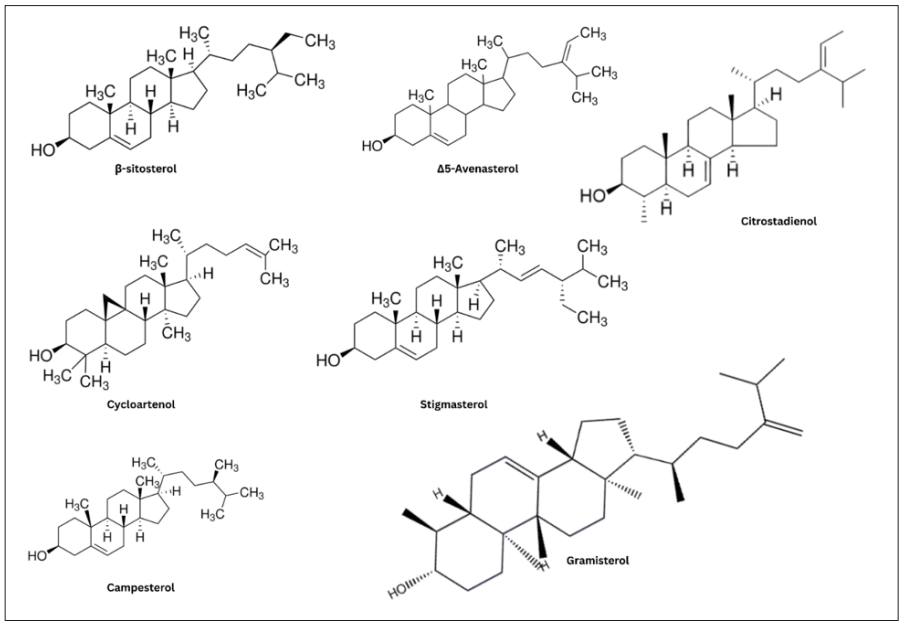

Figure 5: Chemical Structures of Phytosterols in Sea Buckthorn

Fatty Acid

Showcasing a diverse and high-value fatty acid profile, sea buckthorn is a source plant of nutritional interest. Nineteen different fatty acids, including eight saturated and eleven unsaturated fatty acids, have been identified in its various components [47]. The most notable are the essential fatty acids — α-linolenic acid (omega-3) and linoleic acid (omega-6),- required to preserve cardiovascular function, promote brain function, and modulate inflammation. Sea buckthorn is also different and stands out among other plant sources because it is an excellent source of unique omega-7 fatty acids. These comprise traces of palmitoleic acid, hexadecatrienoic acid, heptadecenoic acid and vaccenic acid [48]. In particular, sea buckthorn possesses exceptionally high levels of palmitoleic acid, comprising ~16%−54% of the total sea buckthorn FA profile. Naturally found in animal fat (and a few fish oils), this omega-7 fatty acid is not very common in the typical plant foods available. Sea buckthorn is a unique dietary source of palmitoleic acid, with a particularly high fat content in this bioactive compound [49]. Some studies show palmitoleic acid may provide skin hydrating properties, insulin-sensitizing, and potential anti-inflammatory effects. Except for relatively few foods, this fatty acid's rarity allows sea buckthorn to be a functional food of considerable value. It provides unique opportunities for nutraceuticals and skin care formulations with health benefits not easily attainable from common nutrition [50].

Table 8: Fatty Acid Content and Nutritional Role in Sea Buckthorn Fractions

Fatty Acid	Fatty Acid Type	Berries	Seeds	Pulp/Peel	Reference	Health Role / Notes
Saturated Fatty Acids	Saturated	13.70–42.68	10.62–63.92	18.99–71.02	[51]	Energy source; high amounts may affect lipid profile
Monounsaturated FAs	Monounsaturated	40.73–60.37	12.52–22.95	19.66–68.86	[51]	Support heart health and reduce inflammation
Polyunsaturated FAs	Polyunsaturated	3.70–24.62	22.75–76.70	3.55–25.92	[51]	Include essential fatty acids; crucial for brain and cell health
Palmitoleic Acid (16:1 ω-7)	Omega-7 (MUFA)	16–54	0.8–5	15–50	[51,52]	Rare plant source; supports skin and metabolic health
Vaccenic Acid (18:1 ω-7)	Omega-7 (MUFA)	4.55–8.12	2.2	8.1	[51,52]	Converts to rumenic acid; anti-inflammatory potential
Palmitic Acid (16:0)	Saturated	17–47	6–11.3	15–40	[51,52]	Common in many plants; excessive intake may raise LDL
Oleic Acid (18:1 ω-9)	Omega-9 (MUFA)	2–45.90	15–26	10–26.2	[51,52]	Improves cardiovascular function; found in olive oil
Linoleic Acid (18:2 ω-6)	Omega-6 (PUFA)	3.05–20.13	35–40	4.4–15	[51,52]	Essential FA; involved in skin health and cell membrane function
Stearic Acid (18:0)	Saturated	—	2.6	0.55–1.37	[51,52]	Neutral effect on cholesterol; commonly found in cocoa butter

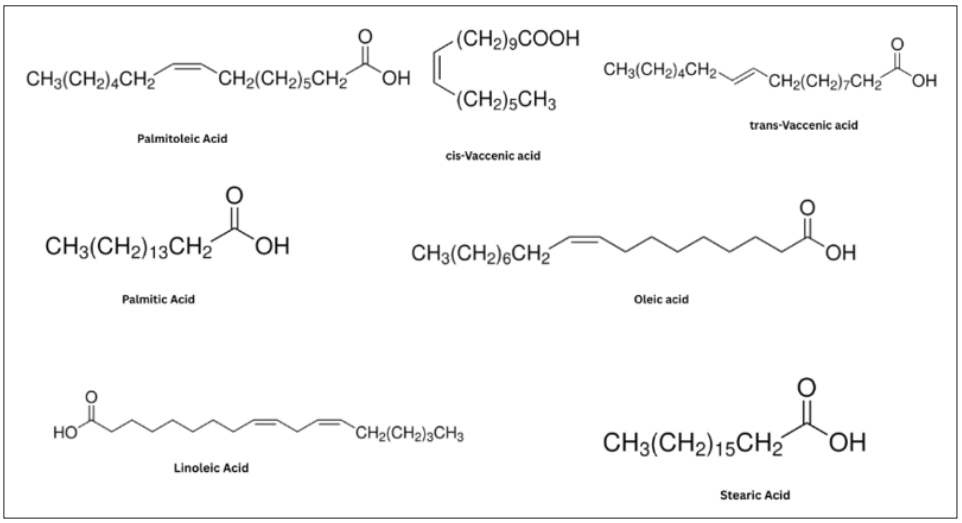

Figure 6: Chemical structures of Fatty Acids in Sea Buckthorn

Table 9: Ethnomedicinal and Modern Utilization of Sea Buckthorn Across Health and Industry Sectors"

Use Type	Traditional Uses	Modern-Day Uses
Medicinal	Used in Tibetan and Mongolian medicine for treating respiratory, cardiovascular, and digestive disorders.	Used in modern herbal medicine for anti-inflammatory, antioxidant, and immune-boosting purposes.
Skin Health	Traditionally applied for wound healing and to treat skin disorders like eczema and burns.	Incorporated in skincare products like creams, oils, and lotions for hydrating, soothing, and regenerating skin.
Gastrointestinal	Used to heal ulcers and gastritis by promoting digestive health.	Used in functional foods and supplements for gastrointestinal support and gut health.
Cardiovascular	Used for heart-related health in ancient medicines, especially to improve circulation and reduce heart disease risks.	Known to support heart health by lowering blood pressure, cholesterol, and triglycerides.
Immune Boosting	Boosts immunity, commonly used in folk medicine to prevent colds and flu.	Commonly used in supplements for boosting immune function, especially during cold and flu season.
Eye Health	Used in traditional medicine for eye health, especially to treat dryness and irritation.	Found in supplements for preventing dry eyes and improving vision-related issues, as well as in eye drops.
Anti-Cancer	In traditional uses, it was believed to support the body in fighting cancerous growths.	Research into its anti-cancer properties is ongoing, with studies exploring its potential to inhibit cancer cell growth.
Hepatoprotective	Used for liver health, especially to prevent liver damage and improve liver function.	Used for liver health, especially to prevent liver damage and improve liver function. Used in supplements for liver detoxification and protection against liver disease.
Cosmetic	Used in traditional beauty treatments for improving skin texture and tone.	Popular in modern cosmetics and skincare for anti-aging, rejuvenating, and healing benefits.
Culinary	Berries were traditionally used to make jams, juices, and herbal teas.	Now used in food products such as smoothies, juices, jams, pies, and functional foods.

Sea buckthorn is known for its diverse species and varieties, each offering different benefits depending on the region in which it grows. Its wide range of applications, from supplements to skincare, demonstrates its versatility. However, anyone considering adding sea buckthorn to their health regimen should consult a healthcare professional due to potential side effects and interactions with other medications.

Figure 7: Illustrating the Multifaceted Role of Sea Buckthorn in Disease Prevention and Treatment

Antioxidant Protection

Sea buckthorn (Hippophae rhamnoides) is an extraordinary plant known for its extensive health-promoting effects, including strong antioxidant properties. Antioxidants protect the body's cells from oxidative stress, a harmful condition caused by free radicals (unstable molecules capable of inducing cancer, stroke, cardiovascular diseases, and more). Sea buckthorn is a source of many potent antioxidant ingredients such as phenolic compounds, flavonoids, carotenoids, tocopherols, tocotrienols, and vitamin C, which all provide antioxidant, antiinflammatory, and genomic stability effects to counteract oxidative stress and DNA damage within cells [53].

Sea Buckthorn Antioxidant Activity

Studies indicate that sea buckthorn oil obtained from seeds or pulp of berries is a potent antioxidant[3]. Sea buckthorn oil, for instance, has been shown to partially inhibit the formation of reactive oxygen species (ROS) induced by ultraviolet (UV) radiation, a significant

source of oxidative damage. It also increases concentrations of non-enzymatic antioxidants (including glutathione, thioredoxin, vitamins E and A) in human skin cells, which are important for cellular maintenance and protection against oxidative stress [54]. Finally, sea buckthorn oil promotes Nrf2 activity. Nrf2 is one of the most important transcription factors that regulate the expression of antioxidant enzymes, such as catalase, superoxide dismutase, and glutathione peroxidase. These enzymes are essential for neutralising free radicals and protecting the cell from oxidative damage. It has demonstrated anticancer activities by inhibiting the growth of several cancer cells. This is done through several mechanisms: apoptosis (programmed cell death), cell cycle arrest, and autophagy, which are important mechanisms to remove dysfunctional, damaged, or abnormal cells from the body [55].

Sea Buckthorn Berries Health Benefits

Apart from oil, the berries of sea buckthorn are edible in the form of fresh fruit, juice, jam, and dietary supplements. These provide the sugar, organic acid, pectin and vitamin C that give the fruit its characteristic tart and sweet flavour. Many publications report the antioxidant activity of sea buckthorn berries using assays such as ABTS, FRAP, ORAC, and iron chelation assays, which mainly measure the free radical scavenging potential of food antioxidants [56]. Despite the high variability of sea buckthorn antioxidant capacity depending on the cultivar, extraction method and solvent used, it presents much higher antioxidant potential than many other fruits and vegetables.

Sea Buckthorn for Skin Care

Sea buckthorn oil is widely recognized for its therapeutic potential in dermatological applications. Depending on individual requirements, it may be administered both topically and orally. When used as a facial oil, sea buckthorn oil is particularly beneficial for individuals with dry or mature skin, as it enhances hydration, improves skin elasticity, and promotes firmness [57]. A few drops applied to the face and neck following cleansing and toning routines can provide noticeable benefits. Additionally, the oil can be blended with moisturizers or serums to further enrich the skin with nutrients. For individuals with oily or acne-prone skin, sea buckthorn oil may serve as a targeted treatment. When incorporated into purifying cleansers or facial masks (at a concentration of 2–3 drops), it can assist in regulating sebum production and reducing inflammatory responses associated with acne lesions. Its anti-inflammatory properties are effective in calming skin irritation and reducing redness, making it suitable for managing conditions such as sunburns or minor wounds [58,59]. In such cases, topical application can alleviate pain, promote faster cell regeneration, and support wound healing. Moreover, sea buckthorn oil is available in oral capsule form, which may contribute to enhanced immune function and increased systemic antioxidant activity [60].

Anti-inflammation Properties

As a multipurpose plant, sea buckthorn (Hippophaë rhamnoides) has a broad spectrum of medicinal attributes, particularly well-known for its potent anti-inflammatory properties [61]. Sea buckthorn (Hippophaë rhamnoides) has long been utilisedutilised in folk medicine in assorted fashions throughout Europe and Asia, however,has attracted increasing interest in recent decades for its potential efficacypotential efficacy toward inflammatory disorders, including arthritis. It contains bioactive compounds such as flavonoids, phenolic acids, omega fatty acids, and vitamins responsible for major antioxidant, anti-inflammatory, and immunomodulatory activities [62]. A field where Sea buckthorn is quite promising is inflammatory diseases. The effectiveness of modulating immune activity and decreasing inflammation has been researched with applications in treating arthritis, which involves chronic inflammation of the joints. Recent investigations regarding sea buckthorn leaf (SBL) extract have shown a significant effect on inflammation regulation at cellular and molecular stages, which has therapeutic significance [63]. Using the adjuvant-induced arthritis (AIA) rat model to induce inflammation by injecting Complete Freund's Adjuvant (CFA) in the right hind paw of rats, a new study tested the immunomodulatory activity of Sea buckthorn leaf extract [64]. Different methods were used to evaluate the anti-inflammatory effects of sea buckthorn, including scintigraphic visualisation, clinical tests, and studies on lymphocyte proliferation [65]. These methods aided in assessing both inflammation and the response to treatment, enabling a complete overview of Sea buckthorn as an anti-inflammatory agent. These findings provide the first convincing evidence that Sea buckthorn leaf extract may reduce inflammation in a dose-dependent manner and may thus be a suitable candidate for treating inflammatory diseases like arthritis in substitutive doses [66].

Anticancer Properties

Sea buckthorn has long offered medical miracles for its abundance of health perks, such as blocking and curing cancer. New reports propose that sea buckthorns may have anti-tumour impacts by adjusting key processes like cell proliferation, programmed cell death, and immune system alteration [67]. Specifically, Sea buckthorn pulp oil, rich in palmitoleic acid—a scarce fatty substance in plants—has been demonstrated to deter the development of human leukemia cells and trigger apoptosis by enacting the caspase-3 and caspase-9 pathways. Sea buckthorn seed oil, containing a blend of omega-3, omega-6, omega-7, and omega-9 unsaturated fats, has likewise appeared capable to suppress human breast disease cell development and improve the cytotoxicity of doxorubicin (a chemotherapy medication) by controlling the articulation of basic qualities, for example, Bcl-2, Bax, and p53, which are engaged with controlling cell passing [68]. Moreover, Sea buckthorn organic product, rich in phenolic compounds like flavonoids, has been shown to prevent the development of colon cancer in animal models [69]. Sea buckthorn demonstrates notable potential in cancer prevention and treatment, largely attributed to its rich phytochemical profile. Its efficacy may, in part, be explained by the reduction of fecal bile acid levels and the enhancement of detoxifying enzyme activity. The leaves of sea buckthorn, which contain a complex blend of flavonoids, terpenes, and ursolic acid, have exhibited anti-angiogenic and anti-metastatic properties in murine models of melanoma and lung cancer. These effects are associated with the downregulation of vascular endothelial growth factor (VEGF) and matrix metalloproteinases (MMPs), both of which play critical roles in tumor invasion and metastasis [69]. The chemopreventive potential of sea buckthorn is further supported by the presence of several bioactive compounds, including proanthocyanidins, curcumin, and resveratrol [70]. These constituents have been shown to mitigate the adverse effects of radiotherapy and inhibit cancer progression. Substantial experimental evidence supports the protective role of diets rich in phenolic compounds—particularly procyanidins and flavonoids—against the onset of various malignancies. Sea buckthorn berries are particularly abundant in flavonoids such as kaempferol, quercetin, and isorhamnetin. These compounds are known to protect cellular structures from oxidative stress, a key factor in DNA damage and carcinogenesis. Multiple in vitro studies have confirmed the anticancer activities of sea buckthorn, underscoring its potential role as a functional

component in cancer-preventive dietary strategies [71]. In one such study, Zhang and colleagues explored how flavonoids from Sea buckthorn seed affect the expression of apoptosis-related genes in the human breast carcinoma cell line Bcap-37 [72]. Bioinformatic analysis revealed that flavonoid treatment modulated 32 genes, including CTNNB1, IGFBP4, GADD34 and caspase 3, known to be involved in Bcap-37 cellular apoptosis. In another experiment, Teng et al. found that isorhamnetin, a flavonoid isolated from Sea buckthorn, exhibited cytotoxic effects on human hepatocellular carcinoma cells (BEL-7402) with an IC50 of around 75 μg/ml following 72 hours of exposure [73]. Similarly, Li et al. showed that isorhamnetin inhibited the proliferation of lung cancer cells both in vitro and in vivo, triggering apoptosis through downregulating oncogenes and upregulating apoptotic genes. Also, isorhamnetin curbed the growth of human colorectal cancer cell lines (HT-29, HCT 116, and SW480) by inducing cell cycle arrest at the G2/M stage and hampering the PI3K-Akt-mTOR signalling pathway crucial to cell growth and survival [74]. Sea buckthorn-derived procyanidins, particularly those extracted from the seeds, have demonstrated significant anticancer potential against human breast cancer cells, notably the MDA-MB-231 cell line. One of the primary mechanisms underlying this effect is the inhibition of fatty acid synthase (FAS)—an enzyme critical for lipid biosynthesis and frequently overexpressed in cancerous tissues. By suppressing FAS activity, these procyanidins disrupt a vital metabolic pathway in tumor cells, thereby impairing their proliferation. Experimental findings indicate that sea buckthorn procyanidins inhibit FAS in a dose-dependent manner, with concentrations ranging from 0 to 0.14 μg/ml. Notably, even at a relatively low concentration of 0.087 μg/ml, a 50% reduction in FAS activity was observed. In addition to enzymatic inhibition, these compounds also promote apoptosis (programmed cell death), further supporting their potential application in cancer prevention or therapeutic intervention [74].

Hepatoprotective Properties

Sea buckthorn (Hippophae rhamnoides) is an excellent plant with well-known hepatoprotective activity, meaning that it can protect the liver against damage or disease [75]. This plant is rich in bioactive principles like fatty acids, flavonoids, vitamins, and phytosterols that enhance liver function by several mechanisms. Sea buckthorn can decrease the action of liver enzymes, for example, alanine aminotransferase (ALT) and aspartate aminotransferase (AST), which serve as biomarkers for the extent of liver damage [76]. It could stop or perhaps heal liver fibrosis, the scarring of liver tissue due to chronic inflammation or injury. This is because sea buckthorn also helps to mitigate oxidative stress and inflammation, which are two factors that can cause damage to liver cells and other liver tissues. Its action leads to modulation of the individual immune system and, in this way, acts on the liver to eliminate infections and neutralise toxins [77]. Sea buckthorn, whose taste is moderately sweet and sour but with a pleasant aroma wafting through the air, can be eaten either fresh or made into drinks, jams, oils, or supplements. Despite its impressive working mechanism, it is usually considered safe and well tolerated; consult your health care provider beforehand, especially if you have one of the medical conditions, are allergic to one of the ingredients or are on medication. Sea buckthorn has the potential to interact with certain medications, including blood thinners or blood pressure medications [78]. One such study presented the hepatoprotective activity of Sea buckthorn berry oil against aflatoxin B1 (AFB1) toxicity in broiler chickens. Aflatoxin B1 is a highly toxic and mutagenic agent to the liver. Our results revealed that AFB1 exposure decreased total serum proteins and was preferential for albumin, as well as increased serum aspartate aminotransferase (AST) [79]. study aimed to assess the hepatoprotective and renoprotective effects of a byproduct mixture derived from grapeseed and sea buckthorn oil processing in mitigating the toxic impact of ochratoxin A (OTA) and aflatoxin B1 (AFB1) in weaned piglets. Forty TOPIGS-40 hybrid piglets were allocated into three experimental groups and one control group, receiving specific dietary treatments for 30 days. Mycotoxin exposure resulted in significant histopathological alterations in hepatic and renal tissues, accompanied by downregulation of key detoxification-related genes, particularly CYP1A2, CYP2A19, CYP2E1, and CYP3A29. Notably, dietary supplementation with the grapeseed and sea buckthorn byproduct mixture partially attenuated these adverse effects, highlighting its potential as a functional feed additive to counteract mycotoxin-induced toxicity in swine production [80].

Cardioprotective Activity

Besides having hepatoprotective activity, sea buckthorns also possess strong cardioprotective abilities. The oil richness in monounsaturated and polyunsaturated fatty acids, flavonoids, vitamins, and other bioactive compounds contributes to its cardiovascular protective properties in various ways. By lowering cholesterol and triglyceride values, sea buckthorn reduces the risk of atherosclerosis and heart attack [81]. It can help prevent platelets from sticking together, preventing blood flow to the heart and brain from being blocked, and can lower blood pressure and heart rate, reducing the burden on the heart. Additionally, study explored the combined therapeutic potential of Hippophae rhamnoides L. (sea buckthorn, SBU) extract and metformin in a mouse model of type 2 diabetes-induced cardiomyopathy (DCM). The combination treatment significantly improved glucose metabolism, reduced inflammation, and protected cardiac tissue from oxidative stress. Bioinformatic analysis revealed modulation of key genes and pathways related to ferroptosis, including downregulation of lncRNAs NEAT1 and MALAT1 and inflammatory markers like oncostatin. Histopathological assessments confirmed reduced cardiac necrosis and fibrosis. These findings suggest that SBU combined with metformin may offer a promising strategy for managing DCM through synergistic metabolic and anti-inflammatory effects [82]. Cardiovascular diseases (CVDs) remain a global health burden, influenced by complex risk factors such as obesity, hypertension, dyslipidemia, type 2 diabetes, and physical inactivity. While conventional pharmacological treatments—including ACE inhibitors, beta-blockers, statins, and antiplatelet agents—are essential, there is increasing scientific and clinical interest in phytotherapeutic alternatives that offer comparable benefits with fewer side effects. Among these, Elaeagnus rhamnoides (sea buckthorn) has gained attention due to its rich composition of bioactive compounds, including flavonoids, phytosterols, unsaturated fatty acids, and tocopherols. Sea buckthorn exhibits significant cardioprotective effects, largely attributed to its antioxidant, anti-inflammatory, and lipid-modulating properties. Studies have shown that its extracts can reduce total cholesterol, LDL levels, and oxidative stress markers while improving endothelial function. Moreover, sea buckthorn has been associated with the modulation of nitric oxide production and inhibition of platelet aggregation, mechanisms that support vascular health and reduce atherosclerotic risk. In addition to sea buckthorn, other botanicals such as Morus alba (white mulberry), Allium sativum (garlic), Crataegus spp. (hawthorn), Leonurus cardiaca (motherwort), and Convallaria majalis (lily of the valley) also demonstrate cardiovascular benefits through various mechanisms. The leaves, berries, seeds, and oil of sea buckthorn, in particular, represent a potent and versatile therapeutic source that may serve as a complementary approach in

CVD management. As research advances, sea buckthorn continues to emerge as a promising natural agent in both the prevention and adjunctive treatment of cardiovascular disorders [83].

Conclusion

Sea buckthorn (Hippophae rhamnoides) emerges as a botanically and pharmacologically significant plant, enriched with a diverse array of bioactive compounds including vitamins, flavonoids, fatty acids, phytosterols, and polyphenols. Its impressive therapeutic portfolio-ranging from antioxidant and anti-inflammatory effects to hepatoprotective, cardioprotective, neuroprotective, dermatological, and anticancer activities—underscores its value in both traditional healing practices and contemporary scientific applications. This review highlights the plant's wide-ranging health benefits substantiated by in vitro, in vivo, and emerging clinical evidence. Despite these promising findings, the transition of sea buckthorn from a traditional remedy to an evidence-based therapeutic agent demands further rigorous clinical investigations. Standardization of dosage, safety profiling, and elucidation of mechanisms of action are essential for the integration of this approach into mainstream healthcare. Moreover, attention must be given to potential herb-drug interactions and contraindications, particularly in vulnerable populations.

In conclusion, sea buckthorn represents a versatile natural resource with substantial potential in nutraceutical, pharmaceutical, and cosmeceutical industries. With continued research and validation, it may contribute significantly to preventive and integrative health strategies worldwide.

References

1. Zulfiqar R, Fatima K, Haq IU, Mugabi R, Sharma A, et al. (2025) The miracle berry: Unveiling the therapeutic attributes of sea buckthorn – A review. Hum Nutr Metab 41: 200321.
2. Dubey RK, Shukla S, Shukla V, Singh S (2024) Sea buckthorn: A potential dietary supplement with multifaceted therapeutic activities. Intell Pharm 2: 681-687.
3. Song A, Li Y, Wang W, Hu Y, Xu J, et al. (2024) Revealing the effect of sea buckthorn oil, fish oil and structured lipid on intestinal microbiota, colonic short chain fatty acid composition and serum lipid profiles in vivo. Nat Prod Bioprospect 14: 41.
4. Duojie X, Ling Y, Fandi M, Doudou L, Mengying C, et al. (2024) Research progress on antitumor effects of sea buckthorn, a traditional Chinese medicine homologous to food and medicine. Front Nutr 11: 1430768.
5. Evendran N, Abirami K, Priyanga J (2025) Unveiling the secrets of sea buckthorn: A comprehensive review of its bioactive compounds and potential therapeutic applications. Preprints.org https://www.preprints.org/manuscript/202505.0232/v1.
6. Mei Duozhuoga, Xiaojie Ma, Fangfang Fu, Fuliang Cao (2023) Research Status and Development Prospects of Sea buckthorn (Hippophae rhamnoides L.) Resources in China. Forests 14: 2461.
7. Chen A, Feng X, Dorjsuren B, Chimedtseren C, Damda TA, et al. (2023) Traditional food, modern food and nutritional value of Sea buckthorn (Hippophae Rhamnoides L): a review. J Future Foods 3: 191-205.
8. Panossian AG, Efferth T, Shikov AN, Pozharitskaya ON, Kuchta K, et al. (2021) Evolution of the adaptogenic concept from traditional use to medical systems: Pharmacology of stress- and aging-related diseases. Med Res Rev 41: 630-703.
9. Cristina Romeo T, Erieg A Mohamed, Camelia Tulcan, Eugenia Dumitrescu, Florin Muselin, et al. (2024) The Oxidative Stress Markers' Protective Influence of Sea Buckthorn and Grape Extracts in Atorvastatin-Treated Hyperlipidemic Rats. Nutrients 16: 1954.
10. Zugravu GS, Pintilescu C, Cumpat CM, Miron SD, Cojocaru DC (2024) Sea buckthorn fruit oil supplementation in active rheumatoid arthritis: A focus on composite disease activity indices and Euler response. Med-Surg J 128.
11. Olas B, Skalski B, Ulanowska K (2018) The Anticancer Activity of Sea Buckthorn [Elaeagnus rhamnoides (L) A.Nelson]. Front Pharmacol 9: 232.
12. Michal M, Roychoudhury S, Sirotkin AV, Kolesarova A (2023) Sea buckthorn, its bioactive constituents and mechanism of action: potential application in female reproduction. Front Endocrinol (Lausanne) 14: 1244300.
13. Vashishtha V, Barhwal K, Kumar A, Hota SK, Chaurasia Op, et al. (2017) Effect of seabuckthorn seed oil in reducing cardiovascular risk factors: A longitudinal controlled trial on hypertensive subjects. Clin Nutr 36: 1231-1238.
14. Zhao H, Liu J, Wang Y, Shao M, Wang L, et al. (2023) Polysaccharides from Sea Buckthorn (Hippophae Rhamnoides l.) Berries Ameliorate Cognitive Dysfunction in ad Mice Induced by a Combination of d-gal and alcl3 by Suppressing Oxidative Stress and Inflammation Reaction. J Sci Food Agric 103: 6005-6016.
15. Rodriguez E, Flores J, Click K, Li V, Loperfito A, et al. (2024) Use of Sea Buckthorn Oil in the Treatment of Skin Disease: Anti-Inflammatory Benefits, Clinical Applications, and Formulary Challenges. Journal of Biosciences and Medicines 12: 271-284.
16. Jaśniewska A, Diowksz A (2021) Wide Spectrum of Active Compounds in Sea Buckthorn (Hippophae Rhamnoides) for Disease Prevention and Food Production. Antioxidants (Basel) 10: 1279.
17. Yuan H, Huang H, Du Y, Zhao J, Yu S, et al. (2025) Sea buckthorn polyphenols on gastrointestinal health and the interactions with gut microbiota. Food Chem 469: 142591.
18. Chen Y, Cai Y, Wang K, Wang Y (2023) Bioactive Compounds in Sea Buckthorn and their Efficacy in Preventing and Treating Metabolic Syndrome. Foods 12: 1985.
19. Bittova, M, Krejzova, E, Roblova, V, Kuban P, Kuban V (2014) Monitoring of HPLC profiles of selected polyphenolic compounds in sea buckthorn (Hippophae Rhamnoides L.) Plant Parts During Annual Growth Cycle and Estimation of their Antioxidant Potential. Cent Eur J Chem 12: 1152-1161.
20. Zadernowski R, Naczk M, Czaplicki S, Rubinskiene M, Szlakiewicz M (2005) Composition of Phenolic Acids in Sea Buckthorn (Hippophae Rhamnoides L). Berries J Am Oil Chem Soc 82: 175-179.
21. Ji M, Gong X, Li X, Wang C, Li M (2020) Advanced Research on the Antioxidant Activity and Mechanism of Polyphenols from Hippophae Species-a Review. Molecules 25: 917.
22. Cosmulescu S, Trandafir, Nour V (2017) Phenolic Acids and Flavonoids Profiles of Extracts from Edible Wild Fruits and their Antioxidant Properties. Int J Food Prop 20: 3124-3134.
23. Slawinska N, Zuchowski J, Stochmal A, Olas B (2023) Extract from Sea Buckthorn Seeds-a Phrytochemical, Antioxidant and Hemostasis Study; Effect of Thermal Processing on its Chemical Content and Biological Activity in Vitro. Nutrients 15: 686.
24. Geng, Z, Wang J, Zhu L, Yu X, Zhang Q, et al. (2023) Metabolomics Provide a Novel Interpretation of the Changes in Flavonoids During Sea Buckthorn (Hippophae Rhamnoides L.) Drying. Food Chem 413: 135598.
25. Ruixue G, Xiaoxiao C, Xinbo G, Brennan CS, Tong L, et al. (2017) Phenolic Compounds, Antioxidant Activity, Antiproliferative Activity and Bioaccessibility of Sea

Buckthorn (Hippophae Rhamnoides L.) Berries as Affected by in Vitro Digestion. Food Funct 8: 4229-4240.

26. Chen C, Xu XM , Chen Y, Yu MY, Wen FY, et al. (2013) Identification, Quantification and Antioxidant Activity of Acylated Flavonol Glycosides from Sea Buckthorn (Hippophae Rhamnoides ssp. Sinensis). Food Chem 141: 1573-1579.
27. Xueying M, Wei Y, Marsol-Vall A, Laaksonen O, Baoru Y (2020) Analysis of Flavour Compounds and Prediction of Sensory Properties in Sea Buckthorn (Hippophae Rhamnoides L.) berries. Int J Food Sci Technol 55: 1705-1715.
28. Żuchowski J (2023) Phytochemistry and Pharmacology of Sea Buckthorn (Elaeagnus Rhamnoides; syn. Hippophae Rhamnoides): Progress from 2010 to 2021. Phytochem Rev 22: 3-33.
29. Wang Z, Zhao F, Wei P, Chai X, Hou G, et al. (2022) Phytochemistry, Health Benefits, and Food Applications of Sea Buckthorn (Hippophae Rhamnoides L.): A Comprehensive Review. Front Nutr 9:1036295
30. Nakos Michail, Beutel Sascha, Scheper Thomas (2015) Determination of Vitamin B12 in Sea Buckthorn (Hippophaes rhamnoides). J Diagnos Tech Biomed Anal https://www.scitechnol.com/proceedings/determination-of-vitamin-b12-in-sea-buckthorn-hippophaes-rhamnoides-2032.html.
31. Martinez-Villaluenga C, Penas E, Hernandez-Ledesma B (2020) Pseudocereal grains: Nutritional value, health benefits and current applications for the development of gluten-free foods. Food Chem Toxicol 137.
32. Stobdan Tsering (2024) Seabuckthorn The Superfruit. Beeja House, New Delhi
33. https://www.researchgate.net/publication/387069086_Seabuckthorn_The_Superfruit.
34. Tkacz K, Gil-Izquierdo Á, Medina S, Turkiewicz IP, Domínguez-Perles R, et al. (2022) Phytoprostanes, phytofurans, tocopherols, tocotrienols, carotenoids and free amino acids and biological potential of sea buckthorn juices. J Sci Food Agric 102: 185-197.
35. Dobre MZ, Virgolici B, Costina Andrada Stefan D, Timnea-Florescu AC, Timnea O (2025) Synergistic Role of Vitamins and Bioactive Compounds in Sea Buckthorn. IntechOpen https://www.intechopen.com/online-first/1213734.
36. Dong K, Binosha Fernando, Durham R, Stockmann R, Jayasena V (2021) Nutritional Value, Health-promoting Benefits and Food Application of Sea Buckthorn. Food Reviews International 39: 2122-2137.
37. Vasile S, Ioan C, Mircea V, Daniela G, Ioana P, et al. (2024) The efficient extraction of β-carotene from sea buckthorn berries using a novel solvent, fatty acid ethyl esters, and a combination of ultrasound and microwave. Agronomy 14.
38. Ruru R, Nan L, Chao S, Yingli W, Xiaojun Z, et al. (2020) The bioactive components as well as the nutritional and health effects of sea buckthorn. RSC advances 10: 44654-44671.
39. Seunghee K, Jeongho L, Hyerim S, Kang HL,Youngsang C, et al. (2024) Improvement in natural antioxidant recovery from sea buckthorn berries using predictive model-based optimization. Agriculture 14: 1095.
40. Wang Z, Zhao F, Wei P, Chai X, Hou G, et al. (2022) Phytochemistry, health benefits, and food applications of sea buckthorn (Hippophae rhamnoides L.): A comprehensive review. Front Nutr 9: 1036295.
41. Chen Y, Cai Y, Wang K, Wang Y (1985) Bioactive Compounds in Sea Buckthorn and their Efficacy in Preventing and Treating Metabolic Syndrome. Foods 12.
42. Yao B, Liao F, Yang J, Liu A, Wang J, et al. (2023) Effect of sea buckthorn extract on production performance, serum biochemical indexes, egg quality, and cholesterol deposition of laying ducks. Front Vet Sci 10: 1127117.
43. Maria D, Elena C, Isabela T, Simona M, Daniela P, et al. (2021) A fatty acid fraction purified from Sea Buckthorn seed oil has regenerative properties on normal skin cells. Frontiers in Pharmacology 12: 737571.
44. Sun Y, Wang Y, Guo J, Zhao Y (2025) Bioactive Compounds from Sea Buckthorn. Sea Buckthorn. Springer, Singapore 13-25.
45. Zheng, Shi, L.-K.; Zhao, C.-W.; Jin, Q.-Z.; Wang, X.-G. Fatty acid, phytochernical, oxidative stability and in vitro antioxidant property of sea buckthorn (Hippophae rhamnoides L.) oils extracted by supercritical and subcritical technologies. LWT-Food Sci. Technol. 2017, 86, 507-513.
46. Zheng Li, Shi Long-Kai, Zhao Chen-Wei, Jin Qing-Zhe, Wang Xingguo, et al. (2017) Fatty acid, phytochemical, oxidative stability and in vitro antioxidant property of sea buckthorn (Hippophaë rhamnoides L) oils extracted by supercritical and subcritical technologies. LWT - Food Science and Technology 86.
47. Changting S, Yang G, Jing M, Eun-Kyung H, Benyin Z, et al. (2022) Metabolomic profiling reveals protective effects and mechanisms of sea buckthorn sterol against carbon tetrachloride-induced acute liver injury in rats. Molecules 27.
48. Dudau M, Codrici E, Tarcomnicu I, Mihai S, Popescu ID, et al. (2021) A fatty acid fraction purified from sea buckthorn seed oil has regenerative properties on normal skin cells. Front Pharmacol 12: 737571.
49. Wei C, Tan W, Tian J, Liu W (2025) Chemical Composition and Antioxidant Active Components of Sea Buckthorn Oil. Sea Buckthorn. Springer, Singapore 205-220.
50. Solà Marsiñach M, Cuenca AP (2019) The impact of sea buckthorn oil fatty acids on human health. Lipids Health Dis 18.
51. Solà Marsiñach M, Cuenca AP (2019) The impact of sea buckthorn oil fatty acids on human health. Lipids Health Dis 18: 145.
52. Craciun Isabela (2018) Comparative Study of Liposoluble Vitamins and Fatty Acids from Sea Buckthorn Oil, Wheat Germ Oil and Fish Oil. Acta Universitatis Cibiniensis. Series E: Food Technology 22: 85-90.
53. Dudau M, Codrici E, Tarcomnicu I, Mihai S, Popescu ID, et al. (2021) A fatty acid fraction purified from sea buckthorn seed oil has regenerative properties on normal skin cells. Front Pharmacol 12: 737571.
54. Kim S, Lee J, Son H, Lee KH, Chun Y, et al. (2024) Improvement in Natural Antioxidant Recovery from Sea Buckthorn Berries Using Predictive Model-Based Optimization. Agriculture 14: 1095.
55. Akhter P, Bhatti TY, Shafiq I, Farrukh J, Rabia Nazar, et al. (2023) Antioxidant activity of sea buckthorn (Hippophae rhamnoides) seed oil extracted using various organic solvents. Korean J Chem Eng 40: 2914-2920.
56. Podder B, Kim Y, Song H (2013) Cytoprotective effect of bioactive sea buckthorn extract on paraquat-exposed A549 cells via induction of Nrf2 and its downstream genes. Molecular Medicine Reports 8: 1852-1860.
57. Wang N, Wen X, Gao Y, Lu S, Li Y, et al. (2022) Identification and characterization of the bioactive polyphenols and volatile compounds in sea buckthorn leaves tea together with antioxidant and α-glucosidase inhibitory activities. Front Nutr 9: 890486.
58. She A, Li Y, Jiang L, Liang R, Hao S, et al. (2025) Study on the anti-free radical, antibacterial, and whitening effects of sea buckthorn extract and its product development. J Dermatol Sci Cosmet Technol 2: 100061.

59. Hussain A, Abidi SH, Syed Q, Saeed A, Alim-Un-Nisa, et al. (2022) A supernatural multipurpose plant Sea buckthorn (Hippophae rhamnoides L): An updated overview of its folk traditional uses, phytochemical profile and biological activities. Journal of Berry Research 13: 21-66.
60. Rodriguez E, Flores J, Click K, Li V, Loperfito A, et al. (2024) Use of Sea Buckthorn Oil in the Treatment of Skin Disease: Anti-Inflammatory Benefits, Clinical Applications, and Formulary Challenges. Journal of Biosciences and Medicines 12.
61. Liu W, Wei C, Sun Q, Tian J (2025) Preparation Technology of Sea Buckthorn Essential Oil Microcapsules. Sea Buckthorn. Springer, Singapore 221-235.
62. Popescu ID, Codrici E, Pop S, Fertig TE, Dudău M, et al. (2025) Potential of Newly Synthesized Sea Buckthorn Phytocarriers as Anti-Inflammatory Active Agents. Pharmaceuticals 18: 212.
63. Mei D, Ma X, Fu F, Cao F (2023) Research Status and Development Prospects of Sea buckthorn (Hippophae rhamnoides L.) Resources in China. Forests 14: 2461.
64. Liu Y, Ran L, Wang Y, Wan P, Zhou H (2023) Basic characterization, antioxidant and immunomodulatory activities of polysaccharides from sea buckthorn leaves. Fitoterapia 169: 105592.
65. Swati G, Mishra KP, Bhuvnesh Kumar, S B Singh, Lilly Ganju, et al. (2020) Andrographolide attenuates complete freund's adjuvant induced arthritis via suppression of inflammatory mediators and pro-inflammatory cytokines. Journal of ethnopharmacology 261: 113022.
66. Jin Z, Hong-Chang Z, Shuai-Bing H, Xiu-Fang Z, Yu-Hang L, et al. (2021) The immunoenhancement effects of sea buckthorn pulp oil in cyclophosphamide-induced immunosuppressed mice. Food & Function 12: 7954-7963.
67. Devi Yengkhom Linthoingambi, Biseshwori Thongam, Rajkumari Jashmi Devi (2025) Amaranthus and Sea Buckthorn: Future Smart Crops for Cancer Therapy. Neglected and Underutilized Crops. CRC Press 77-93.
68. Michal M, Roychoudhury S, Sirotkin AV, Kolesarova A (2023) Sea buckthorn, its bioactive constituents, and mechanism of action: potential application in female reproduction. Front Endocrinol (Lausanne) 14: 1244300.
69. Fu Y, Liu Z, Wang K, Li X, Fu J, et al. (2024) Fermented sea buckthorn compound juice inhibits colorectal cancer growth by regulating immunity and the gut microbiome. J Funct Foods 121: 106408.
70. Viney Kumar, Souvik Ghosh, Saakshi Saini, Himanshu Agrawal, Deo Paranav Milind, et al. (2022) Pro-Angiogenic and Anti-Angiogenic Effects of Phytochemicals as Nutraceuticals. Handbook of Nutraceuticals and Natural Products: Biological, Medicinal, and Nutritional Properties and Applications 2: 91-141.
71. Visan S, Soritau O, Tatomir C, Baldasici O, Balacescu L, et al. (2023) The Bioactive Properties of Carotenoids from Lipophilic Sea buckthorn Extract (Hippophae rhamnoides L.) in Breast Cancer Cell Lines. Molecules 28: 4486.
72. Wang Mengyuan, Zhang Xingfang, Zhang Zonghao, Tong Li, Yu Song, et al. (2024) Flavonoid Compounds in Hippophae rhamnoides L. Protect Endothelial Cells from Oxidative Damage Through the PI3K/AKT-eNOS Pathway. Chemistry & Biodiversity 21. e202400300.
73. Martiniakova M, Penzes N, Biro R, Sarocka A, Kovacova V, et al. (2024) Sea buckthorn and its flavonoids isorhamnetin, quercetin, and kaempferol favorably influence bone and breast tissue health. Front Pharmacol 15: 1462823.
74. Teng BS, Lu YH, Wang ZT, Tao XY, Wei DZ (2006) In vitro anti-tumor activity of isorhamnetin isolated from Hippophae rhamnoides L. against BEL-7402 cells. Pharmacol Res 54: 186-194.
75. Li Q, Ren FQ, Yang CL, Zhou LM, Liu YY, et al. (2015) Anti-proliferation effects of isorhamnetin on lung cancer cells in vitro and in vivo. Asian Pac J Cancer Prev 16: 3035-3042.
76. Dubey RK, Shukla S, Shukla V, Singh S (2024) Sea buckthorn: A potential dietary supplement with multifaceted therapeutic activities. Intelligent Pharmacy 2: 681-687.
77. Sławińska Natalia, Prochoń Katarzyna, Olas Beata (2023) A Review on Berry Seeds-A Special Emphasis on Their Chemical Content and Health-Promoting Properties. Nutrients 15: 1422.
78. Allameh A, Niayesh-Mehr R, Aliarab A, Sebastiani G, Pantopoulos K (2023) Oxidative Stress in Liver Pathophysiology and Disease. Antioxidants (Basel) 12: 1653.
79. Sun R, Zhang M, Zhao J, Lu M, Hao J, et al. (2024) Anti-atherosclerotic effect of sea buckthorn (Hippophae rhamnoides Linn) and its molecular mechanism. J Funct Foods 117: 106248.
80. Popescu RG, Bulgaru C, Untea A, Vlassa M, Filip M, et al. (2021) The Effectiveness of Dietary Byproduct Antioxidants on Induced CYP Genes Expression and Histological Alteration in Piglets Liver and Kidney Fed with Aflatoxin B1 and Ochratoxin A. Toxins 13: 148.
81. Popescu RG, Bulgaru C, Untea A, Vlassa M, Filip M, et al. (2021) The Effectiveness of Dietary Byproduct Antioxidants on Induced CYP Genes Expression and Histological Alteration in Piglets Liver and Kidney Fed with Aflatoxin B1 and Ochratoxin A. Toxins 13: 148.
82. Wenting Yu, Yongqiang Du, Shanshan Li, Lun Wu, Xingyu Guo, et al. (2024) Sea buckthorn–nutritional composition, bioactivity, safety, and applications: A review. J Food Compos Anal 133: 106371.
83. Safavi K, Abedpoor N, Hajibabaie F, Kaviani E (2025) Mitigating Diabetic Cardiomyopathy: The Synergistic Potential of Sea Buckthorn and Metformin Explored via Bioinformatics and Chemoinformatics. Biology 14: 361.
84. Witkowska A, Gryn-Rynko A, Syrkiewicz P, Kitala-Tańska K, Majewski MS (2024) Characterizations of White Mulberry, Sea-Buckthorn, Garlic, Lily of the Valley, Motherwort, and Hawthorn as Potential Candidates for Managing Cardiovascular Disease-In Vitro and Ex Vivo Animal Studies. Nutrients 16: 1313.