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Hippophae rhamnoides L. Botanical, Medicinal, Traditional, and Current Use of Plant and Fruits: A Review

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Abstract: Scientific research on medicinal plants is increasing day by day. Hippophae rhamnoides L. is a medicinal plant, which belongs to the family of L. Elaeagnaceae, and is consumed as a medicinal and food at the same time. It is a type of plant in the form of a bush with thorny, nitrogen-fixing roots and fruit that grows in cold and arid regions. It is native to and widely found in cold temperate regions of Europe and Asia. The species differ in their phytochemical compositions, depending on the climate and the soil they grow in. Due to its rich chemical composition, it has been used in traditional medicine for centuries as herbal medicine, health promoter, and food additive. Hippophae rhamnoides L. plant; It has attracted worldwide attention due to the presence of different types of nutrients and bioactive compounds such as vitamins, amino acids, fatty acids, carotenoids, phenolic compounds, and micro and macro elements, including its leaves, fruits, and seeds. Hippophae rhamnoides L. contains phytochemicals besides reducing platelet aggregation, blood pressure, and blood sugar; It has been reported to have a wide range of activities ranging from anticarcinogen, antifungal, antibacterial, antioxidant, antihistaminic, antiviral, anti-inflammatory, spasmolytic, gastroprotective, cardioprotective and radioprotective potential. In addition, it is promising to be used as an alternative support for the treatment of diseases such as skin burns and atopic dermatitis, since it protects and regulates cell metabolism and has a protective effect on skin cells. Hippophae rhamnoides L., which has economic value with the rich components it contains, is used in the medical, food, and cosmetic industries, while at the same time, it is used as a feed additive for animals and to prevent the destruction of the field by flood waters for ecological purposes. Studies on the plant Hippophae rhamnoides L. are important due to the use of a wide spectrum. The aim of this review is to give information about the botanical, medicinal, traditional and current uses of the fruit and plant of Hippophae rhamnoides L. ©2024 NTMS.

Keywords: Hippophae rhamnoides; Sea buckthorn; Omega 7.

1. Introduction

1.1. Botanical Information

Section: Plantae
Branch: Magnoliophyta

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Class: Magnoliopsida
Team: Rosales
Genus: Elaeagnaceae
Type: Hippophae L. 1

Genre and species characteristics

The Elaeagnaceae family is native to Australia, Asia, and Europe, as well as tropical North and South America, and has three genera, Hippophae, Shepherdia, and Elaeagnus, and about 70-80 subspecies [2, 3].

Hippophae rhamnoides L., on the other hand, is a flowering plant species with spiny shoot tips, orange fruits, deciduous at various heights, and shrub-shaped that can grow up to 10 m [4–6]. This shrub, which is generally described as a weed; is hard, woody, often multiparous, cylindrical, perennial, and waxy. Each branch of the stem develops into thorns and the spines are stiff and 1-5 cm 2 apart [7-9]. Hippophae rhamnoides L., which takes its name from the Latin word "Hippos" meaning "horse" and "Phaos" meaning "brightness", was used in Greece to feed horses with its leaves and branches, to gain weight and shine their feathers [10-12]. Hippophae rhamnoides L. is named differently in each geography. There are 23 different nomenclatures in Russian alone. in English Seabuckthorn in French Argousier in German Sanddorn is known as Havtorn in Danish, Tyrni in Finnish, Tindved in Norwegian, Havtorn in Swedish, Dzbidda in Uzbekistan, and Tea thistle in Azeri. It has been given different names such as sand willow, sea thistle, shore thistle, Rhine thistle, Haff thistle, grassland thistle, meadow thistle, painful thistle, fire thistle, coral bush, scarlet thistle, or pheasant fruit [12].

Fruit and seed properties

Depending on the height, flowering occurs in April-May, and fruit formation occurs in September-October. Ripe Hippophae rhamnoides L. fruit color is yellow-orange and its shape can be spherical or oval. The weight of the fruit is usually in the range of 4-60 g per 100 pieces and can be exceptionally heavier for some varieties grown in Russia [10]. The importance of the plant is due to the bioactive substances in its fruit and seed [13]. The plant contains many bioactive substances such as vitamins, carotenoids, flavonoids, sterols, organic acids, saturated and unsaturated fatty acids, and some essential [14–17].

Hippophae rhamnoides L., its fruit is the main component of herbal value 6. Its fruits have a unique composition that combines a cocktail of ingredients that are often found separately. Each fruit is surrounded by a cellular structure (pulp) filled with the juice of the fruit and consists of a single seed [18]. The fruit of Hippophae rhamnoides L. consists of 68% pulp, 23% seeds, and 7.75% peel 19. There are various bioactive substances in Hippophae rhamnoides L. fruits and seed oil [13]. Fruits contain carbohydrates, proteins, flavonoids, antioxidants, sugars, sugar alcohols, fat- or water-soluble vitamins, phytosterols, polyphenols, carotenoids, polyunsaturated fatty acids, amino acids, fruit acids, plant sterols, and minerals [6, 20, 21].

Natural growing geography and agricultural production

Hippophae rhamnoides L. It has a wide geographical distribution, peculiar to cold temperate regions ranging from latitudes and longitudes of 27°-69°, extending from Europe to China (Bulgaria, Caucasus, Northern Iran, Western Europe, Asia, Azerbaijan, Turkey) [22]. In our country, in the cities of Samsun, Ordu, Giresun, Trabzon, Çankırı, Nevşehir, Kayseri, Sivas, Kahramanmaraş, Erzincan, Ağrı, Van, Mersin, and Erzurum, mainly on the In our country, mainly on the North Anatolian line, in the cities of Samsun, Ordu, Giresun, Trabzon, Çankırı, Nevşehir, Kayseri, Sivas, Kahramanmaraş, Erzincan, Ağrı, Van, Mersin, and Erzurum, from -40°C to +40°C, from the sea coast to 5000 It has a natural distribution up to meters altitude [4, 6, 12, 22]. It grows naturally in mountainous areas, lake shores, wet areas to arid areas, cold tolerant, sandy, and stony areas, especially near rivers and streams. It can spread rapidly with its rhizome roots and because its requirements are low in growing conditions; When it is rooted in the soil by cutting a single branch in low humidity, alluvial gravel, wet landslides, and river banks, it acts invasively in the area where it is planted within two years [23].

Historical background and traditional uses and present

Used for centuries by the people of Northeast, Central, and Southeast Asia as an agent of traditional medicine, this plant appears to be widely used for the treatment of various ailments such as asthma, skin diseases, stomach ulcers, and lung ailments [24]. The medicinal pharmacological effects of Hippophae rhamnoides L. in Chinese sources can also be found in the 'RGyud Bzi' medical text, pharmacopeias, and various Chinese classical works written during the Tang Dynasty (618-907 AD) [12, 25, 26]. In the 8th century AD, in the work " Djud-shi " written by the famous doctor Yuthog Yontan Gonpo , more than 300 medicinal preparations of sea buckthorn are presented by processing, either alone or in combination with other herbs, minerals, and even foods [12]. The fruits of Hippophae rhamnoides L. have been used in Europe and Asia as a source of herbal medicine, nutritional supplement, and natural skin care. Every part of the plant, such as fruit, leaves, branches, roots, and bark, has been seen as a multidimensional and valuable bioresource for centuries. Some of the usage areas; food, fuel, feed, nutritional supplements, cosmetics, pharmaceuticals, veterinary, agricultural tools and timber, biofencing [12, 27–31]. Hippophae rhamnoides L. Various medicine in China, such as raw herbs (juice, fruit oil, seed oil, pigment, etc.), soft and alcoholic beverages, cosmetics, flavonoid tablets to treat ischemic cardiomyopathy disease, and capsules for ulcer and inflammation treatment and health products [32]. Used by local people in Central Asia (in the mountainous regions of Tajikistan and Afghanistan) for the treatment of hypertension, digestive system, and skin diseases, Tibetan and Mongolian people for liver diseases, gallstones, gynecological diseases, rheumatic pains and joint edema, expectorant, cough treatment, blood It has been used to support circulation and improve the function of the digestive system. Dsejchar

It is mentioned in the Tibetan book Migczan that it heals the way of the lungs and throat, and for this reason, it is called 'the blood of the king's heart'. The people of Russia and the Indian Himalayan regions used it in the treatment of skin diseases, jaundice, asthma, laxatives, and rheumatism [12, 33, 34]. Oils obtained from its fruits; It has been used for therapeutic purposes in gastritis, gastric ulcer, uterine necrosis, and inflammation of genital organs [12, 33]. In addition, the fruits of Hippophae rhamnoides L. have traditionally been used in Austrian medicine as tea, juice, or syrup for the treatment of infections [12, 21].

Today, Hippophae rhamnoides L. drugs have been developed due to the excess of bioactive substances it contains which used in the field of health with its increasing commercial importance in western countries and is used in different forms such as liquid, powder, cream, paste, ointment [6, 35, 36]. The highly acidic nature of the fruits and their exotic flavors are also valued in the food and cosmetics industry. Hippophae rhamnoides L. subsp sinensis and Hippophae rhamnoides L. subsp rhamnoides are the most used subspecies for commercial purposes [37]. Hippophae rhamnoides market products from L. range from oil, juice, and food additives to candies, instant beverages, pastes, purees, syrups, jams, pies, lotions, liqueurs, jellies, cosmetics, and shampoos [6, 21, 35, 38]. In Finland, the fruit of Hippophae rhamnoides L. is used as a nutrient in baby food, while India's Defense Research and Development Organization has set up a factory to produce a multi-vitamin herbal drink based on Hippophae rhamnoides L. juice for its military troops facing extremely low temperatures [39]. It is seen as a potential additive in the production of wheat bread [40].

In Ladakth, Hippophae rhamnoides L. thickets were cut during winter and placed on opposite banks of the river, and the thickets that turned into a long and thick ice cover over time were used as a bridge. Today, this bridge mastery has sunk into oblivion. It is preferred by blacksmiths as wood charcoal. Branches used as roofing material in building constructions are used for certain religious rites in Buddhism and are believed to drive away evil spirits [31].

Hippophae rhamnoides L., which usually harbors nitrogen-fixing actinomycetes in root nodules, is very useful for soil improvement [4, 5, 9, 34]. Its extensive root system is used for land reclamation and protection due to its tolerance to strongly eroded, nutrient-poor, and sometimes salty soils and drought, as well as being used as candara to prevent landslides and flooding. Hippophae rhamnoides L. is one of the most used species for afforestation of heavily degraded fields in Romania and is called 'the balm of degraded soils [23]. Hippophae rhamnoides for the control of industrial dumps, soil erosion, and degraded soils, especially from coal mining, in Germany the use of L. began a long time ago. Apart from these, it can be planted around these areas to prevent the damage of stray animals and pedestrian movement to agriculture and planting areas [31].

Table 1: Pharmacological effects of Hippophae rhamnoides L.

Effect	References
Anti-inflammatory	24, 49
Antioxidant	50
Antibacterial	50,51
Cytoprotective	50
Antitumor	52–54
Anti-ulcerogenic effect	55
Hepatoprotective effect	56, 57
Improves alcoholic fatty liver disease	58, 59
Liver fibrosis treatment	60
Anti-atherogenic	61
Anti-hypertensive	51, 62
Cardiovascular protection	51
Regulating coagulation	51
Keratitis and dry eye treatment	63
Treatment of skin diseases (eczema, acne, psoriasis, dermatitis)	64
UV radiation shielding	65
Tissue regeneration, Burn, wound healing	66
Vaginal atrophy	67, 68
Antihyperglycemic	69
Treatment of acrylamide-induced neurotoxicity	70
Alzheimer's	71
Antidepressant	72
It prevents oxidative stress	73–75
Metabolic syndrome	76, 77

Hippophae rhamnoides L. has a positive effect on the health and development of newborn calves in nutrition [41]. It increases egg quality when used in the feeding of layer hens [42, 43]. Increases egg quality when used in the feeding of laying hens [43]. It has been observed that when used as a feed additive by reversing the low growth performances of broilers grown in severe climatic conditions and high altitude regions, it has been observed to increase live weight, and it has been reported that it reduces the death rate due to acidosis and coccidiosis [44]. The use of its oil for the treatment of gastric ulceration and erosions in dogs has resulted in positive results [45]. It is promising against gastrointestinal nematodes in small ruminants 46.

Hippophae rhamnoides L. contributed positively to aquaculture and production. Many formulations containing many additives have been developed to improve growth performance in aquaculture, but natural plant extracts and oils must promote growth and create strong immunity. For example; in Bayir, rainbow trout (Oncorhynchus mykiss), it was stated that the addition of 0.5% and 1% Hippophae rhamnoides L. to the diet revealed positive growth results [47].

Pharmacological effects

Hippophae rhamnoides L. has been scientifically analyzed and many of its traditional uses have been distinguished by pharmacological studies Table 1. No adverse effects were observed in acute toxicity studies with oral administration [48].

1.2. Chemical Content

Hippophae rhamnoides L may vary according to the plant's origin, climate, geographical location, plant

parts, fruit maturity, fruit size, harvest time, and extraction method 11, 28, 38, 78. Hippophae rhamnoides L. The fruit and leaves of mainly contain organic acids, vitamins, carotenoids, tocopherols, flavonoids, sterols, volatile compounds, oils, saturated and unsaturated fatty acids, sugar alcohols, minerals, amino acids, macro, and microelements Table 2 [14-17].

1.7.1. Vitamins

Hippophae rhamnoides L. fruits their high vitamin C content. The rate of vitamin C in fruits grown in the USA can reach up to 1550 mg/100g. It has a much higher vitamin C ratio than fruits that are considered high in vitamin C [85] *Hippophae rhamnoides* L. contains [86] Another vitamin found high in [86]. The amount of vitamin E in fruits reaches a maximum level of over 800 mg/kg from the 30th day to the 150th day after flowering and decreases over time in the following period [79]. Apart from these, it also contains vitamins A, B, and K [6].

1.7.2. Sugar

Glucose and fructose are the two main sugar groups found in *Hippophae rhamnoides* L. fruit. Fructose content varies between 0.2-3.5 g/100 mL and glucose content varies between 1.5-4.2 g/100 mL [87]. Apart from these sugars, it also contains sucrose, xylose, mannitol, ethyl β-D glucopyranose, sorbitol, xylitol, and methyl inositol sugars. The total amount of sugar in the species is between 9-25g/L [38].

1.7.3. Organic acids

The organic acids contained in it are; malic acid, quinic acid, citric acid, tartaric acid, and succinic acids. The malic acid content in fruit juice varies between 11-60 mg/L and quinic acid content varies between 7-49mg/ L. Malic acid and quinic acid constitute approximately 98% of all fruit acids in fruit [87], [38].

1.7.4. Amino acids

It contains 18 of 22 known amino acids in *Hippophae rhamnoides* L. fruit. These; aspartic acid, serine, glutamine, glycine, alanine, cysteine, valine, tyrosine, isoleucine, methionine, proline, phenylalanine, histidine, lysine, threonine, and arginine [38].

1.7.5. Fatty acids

From a nutritional point of view, fatty acids have an important role in various metabolic and structural functions. The main component of cell membranes, they are responsible for the transport of vitamins and regulate the concentration of lipids in the plasma. It also produces compounds important for metabolisms such as fatty acids eicosanoids, eicosanoids, steroid hormones, and biliary acid [37].

From *Hippophae rhamnoides* L. 21-47% of saturated and 39-53% of unsaturated fatty acids are composed of fruits, especially in their seeds [21]. It is also rich in fatty acids including palmitic acid, oleic acid (omega-9), palmitoleic acid (omega-7), linoleic acid (omega-6), linolenic acid (omega-3), and phytosterols [4, 37]. *Hippophae rhamnoides* L.'s reputation is due to its seed oil enriched with essential fatty acids (omega-3 and 6) and high levels of omega-7 [37, 88]. Although the prevalence of fatty acids in different parts is well known, there may be differences depending on subspecies, harvest time, and isolation method [37]. *Hippophae rhamnoides* L. oil is the only oil that naturally provides a 1:1 ratio of omega-3:omega-6 (linolenic and linoleic acid, respectively). β-Sitosterol has been identified as the main component of phytosterols in the oil of *Hippophae rhamnoides L.* The β-carotene content in *Hippophae rhamnoides* L. oils acts as a quality indicator.

Seed oils contain high levels of unsaturated fatty acids. More than 73% of these unsaturated fatty acids are composed of linoleic and linolenic acids. Palmitic acid constitutes 38% and palmitoleic acid constitutes 14-59% of the pulp oil of the plant. *Hippophae rhamnoides* It is oleic acid, an important saturated fatty acid found in L. and it is found in approximately 13-19% of,, seed oil and 12-33% of pulp oil [21]. Oleic acid has an important place in the protection of cardiovascular diseases [37]. It is rich in *Hippophae rhamnoides* L oil and fatty acids and has various therapeutic benefits. There are prominent studies of *Hippophae rhamnoides* L. on vaginal atrophy, skin hyperpigmentation or sores, skin and mucus disorders, hypercholesterolemia, diabetes, and liver dysfunction [37]. It is a promising source of seed oil because of its high unsaturated fatty acid content, its seed, ultraviolet light absorption, and its emollient properties promoting healthy skin [21, 33, 68, 89]. Due to its high lipid content, the freezing point of unfiltered juice can be as low as -18.5 degrees. This juice is a very important advantage for storage, as it can maintain its liquid form even at sub-zero temperatures Table 3 [90].

1.7.6. Flavonoids

The flavonoids isolated from the orange-yellow to red fruit of *Hippophae rhamnoides* L. mainly contain various simple glycosides such as isorhamnetin, quercetin, kaempferol, myricetin, and syringin. Glucosides in its structure, rutinosides, sophorosides, α- rhamnosides, rutinosides, rhamnosides, quercetin other bioactive compounds such as cerebroside, oleanolic acid, ursolic acid, 19-alpha-hydroxyrimolic acid, succinic acid, 5-hydroxymethyl-2-furancarbox-aldehyde, cirsiumaldehyde, octacosanoic acid, isorhamnetin and 1-O hexadecanolenin are widely available [6, 16, 91-96].

Table 2: Major phytochemicals in *Hippophae rhamnoides* L. and their medicinal properties.

SBT phytoconstituents	Medicinal properties	References
Tocopherols	Acts as an antioxidant, minimizes lipid oxidation, helps relieve pain	[79]
Carotenoids	Acts as an antioxidant and aids collagen synthesis and epithelization	[80]
Vitamin K	Prevents bleeding, promotes wound healing, anti-ulcer effect	[81]
C vitamin	Acts as an antioxidant and maintains cell membrane integrity, accelerates collagen synthesis	[79]
Vitamin B complex	Stimulates cell repair and nerve regeneration	[81]
Phytosterols	Improves skin microcirculation, anti-ulcer, anti-atherogenic, and anti-cancer, regulates the inflammatory process	[82]
Polyphenolic compounds	Antioxidant, cytoprotective, cardioprotective, wound healing	[50]
Polyunsaturated fatty acids (PUFA)	Immunomodulatory, neuroprotective, anti-tumor	[19]
Organic acids	Reduce the risk of heart attack and stroke, anti-ulcer, wound healing, anti-arthritic	[19]
Coumarins and triterpenes	Control of appetite, sleep, memory, and learning	[83]
Zinc	It strengthens blood circulation, anti-tumor aids in cell proliferation, acts as a cofactor for enzymes, and increases the use of vitamin A.	[84]

Table 3: Fatty acid composition of *Hippophae rhamnoides L*. oil.

Common Name	Systematic Name	Amount (%)	Symbol	Omega family
Saturated fatty acids				
Palmitic acid	hexadecanoic acid	30–33	C16:0	-
Stearic acid	Octadecanoic acid	<1	C 18:0	
Unsaturated fatty acids				
Palmitoleic acid	(Z)-9-exadecenoic acid	30–35	16:1	7
oleic acid	(Z)-9-octadecenoic acid	14–18	18:1	9
Linoleic acid (LA)	(Z, Z)-9, 12-octadecadienoic acid	5–7	18:2	6
α-Linolenic acid (ALA)	(Z, Z, Z)-9, 12, 15- octadecatrienoic acid	30	18:3	3
γ-linolenic acid (GLA)	(Z, Z, Z)-6, 9, 12- octadecatrienoic acid	35	18:3	6
Gondoic acid	(Z)-11-eicosenoic acid	2	20:1	9

1.7.7. Micro and Macro Elements

Although the most abundant element in the fruit is potassium, nearly 30 macro and microelements such as iron, nitrogen, magnesium, copper, zinc, nitrogen, manganese, calcium, phosphorus, magnesium, and sodium have been detected [97]. The maturity of the plant also affects the number of elements [38].

The juice also contains an oil phase and is called pulp oil. In this phase, it contains in fruit carotenoids are beta-carotene, lutein, zeaxanthin, and lycopene. Alpha-tocopherol is the main vitamin E compound. The content of tocopherol and tocotrienol in the fruit varied between 100-300 mg/100g [28, 79]. The fruit is also rich in phytosterols (340-520 mg/kg), the main sterol as β-sitosterol makes up 57-83% of the total sterols compound.

The purpose of this review is to give information about the fruit and plant of *Hippophae rhamnoides* L.

especially to scientists who are interested in health and agriculture, about botany, chemical content, medicine, traditional and current use.

2. Discussion

Hippophae rhamnoides L. are rich in carbohydrates, protein, organic acids, amino acids, and vitamins, which have strong biological activity. It is also extremely important in that it contains a wide variety of substances such as intense carotenoids, vitamin E, dietary minerals, β- sitosterol, and polyphenolic acid. Although wild plant Hippophae rhamnoides Due to the nutritional, medical, and economic potential of L, it's scientific research and commercial importance are increasing day by day, and the excess of the substances it contains makes this plant not only used in the field of health but also agriculture, cosmetics, food, etc. sectors have also been evaluated. The use of Hippophae rhamnoides L. in various forms as a natural product has been increasing in recent years due to the shift of consumers' attention to natural products with functional properties. Hippophae rhamnoides L. prevents the issuance of a standard prescription about the nutritional value and chemical composition of bioactive substances, which vary according to the origin of the plant, climate, geographical location, plant parts, fruit maturity, fruit size, harvest time, and extraction method. For this reason, Hippophae rhamnoides L.'s nutritional value and chemical composition. The literature describing it is both scattered and limited. As a result, it is extremely important to standardize the products to be obtained with this plant. The mechanism of action of targeted studies with concentration, isolation of pure substances, further production by culture, lethal dose (although not reported), effective dose and bioavailability mechanisms need to be realized in the future.

3. Conclusions

Within the scope of our literature review, we think that the sustainable harvest and production potential of this species can increase the local economy and have a serious impact on the socio-economic and ecological balance. The fact that the sharp spines on the Hippophae rhamnoides L. bush are difficult to harvest increases the importance of breeding studies on the plant. The harvested fruit of Hippophae rhamnoides L. can be used to produce beverages and natural food ingredients, and can be used to produce seed oil, creams, shampoos, soaps, etc. can be used for cosmetic products such as Due to the high nutritional value and increasing demand of the fruits of Hippophae rhamnoides L. it can be recommended to investigate them for use in different food products with high added value. Hippophae rhamnoides L. leaf, fruit pulp, and seed residues from the juice and oil extraction of Hippophae rhamnoides L. can be turned into a large amount of "value-added waste" product. Its leaves have great potential to support the food industry and human health. However, due to the nutrients contained in the waste products, it can potentially be used as a feed additive for animals in livestock. It is recommended to increase medical and therapeutic R&D researches for reducing different types of acute and chronic diseases with components of Hippophae rhamnoides L. with strong biological activity.

Limitations of the Study

Bioaccessibility and potential applications in female reproduction.

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Conflict of Interests

The authors have no conflicts of interest to declare.

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Author Contributions

Conception and Design of the study, Collection and/or Processing and Literature review, Writing Original Manuscript, Analysis and/or interpretation and final version and is responsible for final approval of the submitted manuscript; HB, BİŞ, YB.

Ethical Approval

None.

Data sharing statement

None.

Consent to participate

None.

Informed Statement

None.

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