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Vinita
Ph.D. Scholar, Department of Foods and Nutrition, CCS Haryana Agriculture University, Hisar, Haryana, India

Darshan Punia
Principal Scientist, Department of Foods and Nutrition, CCS Haryana Agriculture University, Hisar, Haryana, India

Correspondence
Vinita
Ph.D. Scholar, Department of Foods and Nutrition, CCS Haryana Agriculture University, Hisar, Haryana, India

Seabuckthorn: A potential medicinal shrub

Vinita and Darshan Punia

Abstract
Sea buckthorn (*Hippophae rhamnoides* L.) or Leh Berry is a unique shurb of cold desert region having enormous potential health benefits. It is a rich source of natural antioxidants such as ascorbic acid, tocopherols, carotenoids and flavonoids. It also contains proteins, vitamins (especially vitamin C and E), minerals, lipids (mainly unsaturated fatty acids), sugars, organic acids, phytosterols and elemental components which have been proved to be very effective for the treatment of various disorders and skin related problems. Various pharmacological activities such as cytoprotective, anti-inflammatory, cardioprotective, hepatoprotective, anti-atherogenic, anti-tumor, anti-microbial and tissue regeneration have been reported. Sea buckthorn fruits are used for making pies, jams, skin lotions, wines and liquors. The juice or pulp has potential applications as food or beverages. This review explores the medicinal and therapeutic applications of sea buckthorn in curtailing different types of acute as well as chronic maladies.

Keywords: Sea buckthorn, antioxidant, phytosterol, cardioprotective, medicinal

1. Introduction
Sea buckthorn (*Hippophae rhamnoides* L.) is a thorny nitrogen-fixing deciduous shrub widely distributed throughout the temperate zone of Asia, including India, Europe and all over the subtropical zones, especially high altitudes. It is currently domesticate in several parts of the world due to its nutritional and medicinal properties (Li, 2003) [43]. The vigorous vegetative reproduction and the strong complex root system with nitrogen-fixing nodules make it an optimal pioneer plant in soil and water conservation and reforestation for eroded areas (Yang and Kallio, 2002) [83]. Its berries consist of 68% pulp, 23% seed and 7.75% peel (Oomah, 2003) [52]. Its fruits are considered to possess a large number of bioactive compounds like flavonoids (isorhamnetin, quercetin, myricetin, kaempferol and their glycoside compounds), carotenoids (β- and δ-carotene and lycopene), tannins, triterpenes, glycerides of palmitic, stearic, oleic acid and some essential amino acids (Andersson *et al*., 2009; Suryakumar and Gupta, 2011; Pradhan *et al.*, 2012) [2, 69, 58], exceptionally high contents of vitamins (A, C, E and K) and organic acids (Geetha *et al*., 2002) [21]. The sea buckthorn juice is yellow in colour due to high levels of carotene and primarily valued for its golden-orange fruits. Many bioactive compounds such as cerebroside, oleanolic acid, ursolic acid, 19 alphahydroxyursolic acid, dulcioic acid, 5-hydroxymethyl-2-furancarbox-aldehyde, cirsiumaldehyde, octacosanoic acid, palmitic acid and 1-Ohexadecanolenin have been extracted from its berries (Zheng *et al*., 2009) [92]. Zeaxanthin and beta-cryptoxanthin esters in seabuckthorn berries can be used as food additives, cosmetic ingredients or nutraceuticals (Pintea *et al*., 2005; Andersson *et al*., 2009) [57, 2]. There are many mineral elements present in berries and juice of sea buckthorn. Fruits also contain flavoxanthin, progestin, violaxanthin and neoxanthin. Berries are edible and nutritious, although they are astringent, oily and unpleasant to eat raw unless *bletted* (frosted to reduce astringency) and/or mixed as a drink with sweeter substances such as apple or grape juice. It is often used in juices, jams, sauces, liqueurs and dairy products because of their unique taste. The high vitamin concentrations make the sea buckthorn fruit highly suitable for the production of nutritious soft drinks.

For centuries, it has been utilized not only for the purpose of feeding but also as traditional medicine to prevent or treat various ailments (Suryakumar and Gupta, 2011) [69], such as inflammation, gastric ulcers and dermatological disorders (Gao *et al*., 2000; Zeb, 2004) [19, 88]. Natural bioactive compounds from sea buckthorn have been found to possess significant anti-microbial, immunomodulatory, anti-inflammatory, anti-oxidative, radio-protective, adaptogenic and tissue regenerative properties (Chauhan *et al*., 2007; Ganju *et al*., 2005;

Geetha *et al*., 2005) [9, 18, 23]. Several studies have indicated that sea buckthorn products are safe food supplements with no major side effects except for an increase in blood glucose in rats reported to occur with a high dose (>100 mg/kg/day) of sea buckthorn (Saggu *et al*., 2007; Tulsawani, 2010; Upadhyay *et al*., 2009) [62, 71, 72]. Its leaves, stems, tubers, roots as well as blossoms contain a high content of ascorbic acid and also carotenoids, polyphenols, flavonoids, tocopherols, alkaloids, chlorophyll derivatives, amino acids and amines (Bal *et al*., 2011; Christaki, 2012) [3, 12]. Sea buckthorn has gained popularity all over the world due to its nutritional and functional properties. The objective of this paper is to popularize the plant species as this is in the list of neglected plant in Sikkim Himalaya and only very few people know its importance. The present review paper is an endeavor to acknowledge the medicinal importance and richness of this plant.

2. Nutritional properties

The moisture content (g/100 g fresh weight) of berries is highest, *i.e*., 80-87% (Lõugas *et al*., 2006) [47] but the moisture content of pulp from Indian sea buckthorn berries is 84.9-97.6% (Dhyani *et al*., 2007) [14] and lowest in Pakistani varieties berries, *i.e*., 20-32% (Sabir *et al*., 2005) [61]. The variation in berries moisture is due to the variation in origin and climate. Sugar components mainly glucose, fructose and xylose are important ingredients of sea buckthorn berries. Total soluble sugars reported for Chinese origins ranged from 5.6 to 22.7% in raw juice (Kallio *et al*., 1999) [35]. All parts of the plant contain many different proteins, mainly albumins and globulins (Li and Beveridge, 2003) [42]. Seabuckthorn is a source of organic acids, mainly malic acid, quinic acid, oxalic acid, citric acid and tartaric acid. Sea buckthorn is also a good source of flavonoids, mainly quercetin, kaempferol, myricetin, and isorhamnetin, and an important source of tocopherols (Fatima *et al*., 2012) [17]. The mineral contents of sea buckthorn make the shrub most important. Sea buckthorn berries provide a rich source of many minerals, including, calcium, phosphorus, iron, and potassium. However, potassium is the most abundant among all the elements investigated in berries or juice (Kallio *et al*., 1999) [35]. Iron content in sea buckthorn of different origins is found in the range of 22 to 282 mg (Yang and Kallio, 2001) [82] and in Russian cultivars 40-300 mg/100g (Plekhanove, 1988) [56]. Shah *et al* (2007) [64] reported minerals, iron and phosphates in the range of 2.6-7 and 34.3-466.6 mg/100g, respectively, which again reflects variations among the ecotypes.

Sea buckthorn has a large amount of vitamin C, which is several folds as compared to other fruits (Christaki, 2012) [12]. The vitamin C content in sea buckthorn ranges between 360 and 2500 mg/100 g (Bal *et al*., 2011) [3]. Dharmananda (2004) [13] reported that the Portland sea buckthorn fruit has high vitamin C content in a range of 114 to 1550 mg/100 g, with an average content of 695 mg/100 g, which is about 12 times greater than oranges, placing sea buckthorn fruit among the most enriched plant sources of vitamin C. The concentration of vitamin C in sea buckthorn fruit has been found to be higher than strawberry, kiwi, orange, tomato, carrot and hawthorn (Bernath and Foldesi, 1992) [7]. The Turkestanica sea buckthorn fruit has vitamin C content in the range of 200 to 1500 mg/100 g, which is 5 to 100 times higher than any other fruit or vegetable (Ahmad and Kamal, 2002) [1]. Its plant is a valuable source of B group vitamins, mainly thiamine and riboflavin (Christaki, 2012) [12]. Other vitamins rich in sea buckthorn include vitamin E (Michel *et al.,* 2012) [49], vitamin A and K (Bekker and Glushenkova, 2001; Fatima *et al*., 2012) [6, 17].

Table 1: Nutritional composition of sea buckthorn berries/juice (Bal *et al*., 2011) [3]

Nutrient	Content in berries/juice
Moisture (%w/w)	20.0 - 86.74
Ash (%)	1.76 – 1.8
TSS (˚Brix)	9.3 – 22.74
Vitamin C (mg/100g)	28 - 2500
Vitamin E (mg/100g)	160 - 255
Vitamin K (mg/100g)	100 - 230
Flavonoids (mg/100g)	354 - 1000
Total Carotenoids/Vitamin A (mg/100g)	2.0 – 836.5
Minerals (PPM)	
Fe	1.6 - 15
Mg	39.8 - 240
Na	6.9 - 89.8
K	62.2 - 806
P	7.4 - 206
Ca	64 - 256

The vitamin E content in sea buckthorn berries is 160 mg/100 g (Wahlberg and Jeppsson, 1992) [19]. The juice of Chinese varieties berries contains vitamin E in the range of 162-255 mg/100 g (Zhang *et al*., 1989) [91] and pulp of Pakistani varieties berries contains vitamin E 481 mg/100 g (Zeb, 2004a) [89], which is higher than that found in wheat embryo, safflower, maize and soybean (Bernath and Foldesi, 1992) [7]. The berries provide a good source of carotenoids, mainly β-carotene, lycopene, lutein and zeaxantin (Michel *et al*., 2012) [49]. Bioactive substances like flavonoids, organic acids (malic acid and oxalic acid), sterols (ergosterol, stigmasterol, lanosterol, and amyrins) and some essential amino acids, which vary with maturity, fruit size, species, geographic locations, climate and methods of extraction (Zeb, 2004; Leskinen *et al*., 2010) [88, 41], have been found in all parts of the plant (Hakkinen *et al*., 1999; Upendra *et al*., 2008) [29, 74]. Its berries contain organic acids mainly malic and quinic acids together constituting around 90% of all the fruit acids in different origins.

3. Uses as food

Sea buckthorn fruit has been used to make pies, jams, skin lotions, wines and liquors. The juice or pulp has other potential applications in food or beverages. It provides a nutritious beverage, rich in vitamin C and carotenes. In Mongolia, it is made into a juice drink. In Finland, it is used as a nutritional ingredient in baby food. Fruit drinks were among the earliest sea buckthorn products developed in China. Sea buckthorn based juice is popular in Germany and Scandinavian countries. For its troops confronting extremely low temperatures, India's Defence Research Development Organization established a factory in Leh to manufacture a multi-vitamins herbal beverage based on sea buckthorn juice (Cenkowski *et al*., 2006) [8]. To date, more than 10 different drugs have been isolated from sea buckthorn in Asia and Europe and are available in different forms such as liquids, powders, plasters, films, pastes, pills, liniments, suppositories and aerosols (Lu, 1992) [48]. In Europe, sea buckthorn juice, jellies, liquors, candy, vitamin C tablets and ice cream are readily available (Bernath and Foldesi, 1992) [7]. Saturated and polyunsaturated fatty acids of fruit are used in preparation of cosmetic (skin creams) and syrup products (Seglina *et al*., 2006) [63].

4. Medicinal benefits

4.1 Digestive problems: Preparations from fruits and seeds of sea buckthorn have demonstrated great promise in the treatment of mucous membranes including ulcers and gastrointestinal disorders. Sea buckthorn can increase the production of plasma leptin and neuropeptide Y in children with functional dyspepsia. The overall effect of sea buckthorn is improvement of gastric emptying, gastric mobility, gastrointestinal digestive function and promotion of children's growth (Xiao *et al*., 2013) [79]. In traditional medicine, sea buckthorn has been used for the treatment of stomach ulcers due to its anti-inflammatory effect (Xing, 2002) [80]. Hexane extract from sea buckthorn acts positively against indomethacin, stress and ethanol, which contribute to the development of gastric ulcers (Khan *et al*., 2010) [36]. The extract also shows positive effects in the treatment of duodenal ulcers (Li and Beveridge, 2003) [42]. Huff *et al*. (2012) [33] studied the efficacy of a commercial product containing the berries and pulp of sea buckthorn in the therapy and prevention of gastric ulcers.

Table 2: Medicinal properties and active compound of sea buckthorn fruit

Used for treatment of	Active compound	Reference
Gastric ulcer	Vitamin K, Phytosterol	Xing *et al.* (2002) [80], Li and Beveridge (2003) [42], Khan *et al*. (2010) [36], Huff *et al*. (2012) [33]
Skin disorders	Vitamin E	Yang *et al.* (2000) [81], Khan *et al.* (2013) [37]
Cardiovascular diseases	Flavonoids and fatty acids	Yang and Kallio (2002) [83], Eccleston *et al.* (2002) [15], Larmo *et al.* (2008) [40]
Radiation-induced oxidative damage	Vitamin E, Triterpenoids	Goel *et al.* (2005) [24]
Wound healing	Flavones, Vitamin C and Carotenoids	Gupta *et al*. (2006) [27]
Thrombosis and platelet aggregation	Flavone and Flavonoid	Cheng *et al.* (2003), Bao and Lou (2006) [4]
Hepatic disorders	α-tocopherol, ß-carotene and Flavonoids	Gao *et al*. (2003) [20], Li and Beveridge (2003) [42], Gupta and Flora (2005) [26], Barkat *et al*. (2010) [5], Ramesbabu *et al.* (2011) [59], Yeh *et al*. (2012) [86].
Anti-cancer	Flavanoid and Triterpenoids	Hibasami *et al.* (2005) [31], Teng *et al.* (2006) [70], Yasukawa *et al.* (2009) [85], Christaki (2012) [12]

4.2 Anti-inflammatory properties: Sea buckthorn berries caused a reductive effect on C-reactive protein (marker of inflammation and a risk factor for cardiovascular diseases) (Larmo *et al.*, 2008) [40]. The branches of sea buckthorn contain epigallocatechin and ursolic acid that exhibit anti-inflammatory effects (Yasukawa *et al*., 2009) [85]. Alcoholic leaf extract of sea buckthorn (70% ethanol) inhibits hypoxia-induced cytotoxicity, mitochondrial integrity, reactive oxygen species (ROS) production and DNA damage better than vitamin C (Narayanan *et al*., 2005) [51].

Dermatological effects

Substances contained in sea buckthorn prevent dermatological diseases such as atopic eczema (Khan *et al*., 2010) [36]. Creams containing seabuckthorn extracts support treatment of skin disorders such as melanosis, chloasma, xeroderma, and recurrent dermatitis (Li and Beveridge, 2003; Barkat *et al*., 2010) [42, 5]. Topical application of sea buckthorn extract demonstrated significant improvement in facial skin mechanical parameters, indicating that the extract possesses anti-ageing characteristics (Khan *et al*., 2013) [37]. The sea buckthorn flavone promoted the wound healing activity as indicated by improved rate of wound contraction, decreased time taken for epithelialization (16.3 days versus 24.8 days in control) and significant increase in hydroxyproline and hexosamine content, indicating collagen production and stabilization in wound tissue (Gupta *et al*., 2006) [27]. Vitamin C was among the antioxidants which is essential for collagen synthesis, the levels of which was greater in sea buckthorn (Gupta *et al*., 2006) [27].

4.3 Hepatoprotective

Hepatotoxins such as ethanol, carbon tetrachloride and acetaminophen cause various degrees of hepatocyte damage, degeneration and subsequent death of hepatic cells (Ramesbabu *et al*., 2011; Michel *et al*., 2012; Solcan *et al*., 2013) [59, 49, 66]. Sea buckthorn has shown numerous positive effects on liver protection and treatment of liver diseases (Barkat *et al*., 2010) [5]. Substances contained in seabuckthorn such as unsaturated fatty acids, α-tocopherol or ß-carotene protect hepatic cells against damage by hepatotoxins (Ramesbabu *et al.*, 2011) [59]. Flavonoids are mainly responsible for protection against liver fattening (Li and Beveridge, 2003) [42]. Sea buckthorn extracts have also seen to help normalize liver enzymes, serum bile acids, liver inflammation and degeneration (Gao *et al*., 2003) [20]. Gupta and Flora (2005) [26] investigated the detoxifying efficacy of an herbal formula prepared from fruit extract of sea buckthorn. Twenty-five mice were exposed to arsenic toxicity through drinking water (25 ppm) for a period 3 months and then treated with a different fruit extract of sea buckthorn at a dose of (500 mg/kg/day) for 10 days; the blood and tissues samples were assayed for various biochemical indices of oxidative stress. This treatment showed significant protection against arsenic poisoning and restoration of reduced glutathione levels in blood. Furthermore, sea buckthorn extract significantly protect the reduced and oxidized glutathione ratio in liver, kidney and brain. A trial focused on the effect of sea buckthorn on the toxicity of oxidized cholesterol proved that sea buckthorn administered in the diet reduced plasma concentrations of alanine transaminase (ALT), aspartate transaminase (AST) and alkaline phosphatase (ALP), which indicates that the plant may have a protective effect against hepatotoxicity induced by oxidized cholesterol (Yeh *et al*., 2012) [86].

4.4 Antimicrobial (antiviral, antibacterial, antifungal) activity

Phytochemical compound "Hiporamin" is a purified fraction of polyphenols fraction, containing monomeric hydrolysable galloellagi- tannins (preferably strictinin, isostrictinin, casuarinin, casuarictinpedunculagin, stachyurin according to the NMR spectra (Suryakumar and Gupta, 2011) [69]. Shipulina *et al*. (2005) [65] recorded potent inhibitory antiviral

activity against Influenza and Herpes viruses from sea buckthorn fruit extracts. It also showed inhibitory effect in a HIV infection in the cell culture and antimicrobial activity (Suryakumar and Gupta, 2011) [69]. The aqueous extract of sea buckthorn seeds was found to possess antibacterial activity (Chauhan *et al*., 2007) [9]. The leaf and seed extracts was effective against gram positive bacteria and seed oil extract against fungus (Mucor and Tilletia) (Gupta *et al*., 2011) [28]. Similar studies found that, aqueous and hydro-alcoholic leaf extracts of sea buckthorn showed growth inhibiting result against *Bacillus cereus*, *Pseudomonas aeruginosa*, *Staphylococcus aureusand Enterococcus faecalis* (Upadhyay *et al.,* 2010) [73].

4.5 Antioxidant properties

The interest in natural antioxidants has increased considerably. Sea buckthorn (SBT) provides protection against chromium induced oxidative injury (Suryakumar, and Gupta, 2011) [69]. Sea buckthorn has been shown to have potent antioxidant activity, mainly attributed to its flavonoids (Li and Schroeder, 1996), vitamins E and C (Varshney and Tyagi, 2004) [75]. Triterpenoids bioactive compounds from sea buckthorn extract showed significant inhibitory effect on nitric oxide production and enhanced radical-scavenging activities (Yang *et al.,* 2007) [84]. Similarly alcoholic fruit extract found significant cytoprotection against sodium nitroprusside induced oxidative stress in the lymphocytes (Geetha *et al.,* 2002) [21]. Animal studies documented that sea buckthorn extracts also attenuated the nicotine induced oxidative stress in rat liver and heart (Gumustekin *et al.,* 2010) [25]. Isorhamnetin isolated from seabuckthorn, showed significant antioxidant activity in several antioxidant assays (Pengfei *et al.,* 2009) [55]. In addition, the antioxidant property of isorhamnetin extracted from sea buckthorn by scavenging the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical, iron(III) to iron(II)-reducing, and iron-chelating assays has also been reported (Liu *et al*., 2009) [46]. The results obtained from the antioxidant assays showed that isorhamnetin from seabuckthorn exerted significant antioxidant effects compared to that of ascorbic acid and butylated hydroxytoluene. Other natural antioxidants present in seabuckthorn include sterols, tannins, vitamins, and minerals (Kumar *et al.,* 2013) [39].

Natural antioxidants inhibit or delay the oxidation of other molecules by inhibiting the initiation or propagation of oxidizing chain reactions (Bal *et al.,* 2011) [3]. The reducing power of the extracts increased in a dose-dependent manner and was highest in 70% methanol extract (Varshneya *et al*., 2011) [76]. Alcoholic fruit extract of SBT showed significant cytoprotection against sodium nitroprusside induced oxidative stress in the lymphocytes (Geetha *et al*., 2002b) [22]. Chemopreventive potential of SBT was evaluated in mice by Padmavathi *et al*. (2005) [53] and the results showed that Hippophaen fruit extract stimulated activities of both phase II and antioxidant enzymes in the mouse liver. The berry extract also had a positive effect on all antioxidant enzymes, and decreased the lipid peroxidation, indicating reduced levels of cellular oxidation processes.

4.6 Cardiovascular effects

In China, seaberries have been used in traditional medicine for centuries (Li and Beveridge, 2003) [42]. Since sea buckthorn is an excellent source of natural flavonoids such as isorhamnetin, quercetin and aglycones. Various investigators have examined the effect of different edible components of sea buckthorn such as fruit berry, flavonoid extracts, and supplements in the prevention and treatment of CVD. Researchers found that sea buckthorn flavonoids help in reducing cholesterol level and improved cardiac function. Several epidemiological studies have reported an inverse correlation between flavonoid consumption and CVD risk (Hertog *et al*., 1993; Hollman *et al*., 2010; Joseph, 2005; Yochum *et al*., 1999) [30, 32, 34, 87].

Sea buckthorn food supplementation has been proved to be able to reduce total cholesterol, triglycerides and LDL-cholesterol, and increase HDL-cholesterol levels in comparison to sea buckthorn-free diet (Yang and Kallio, 2002; Suryakumar and Gupta, 2011) [83, 69]. Another study was carried out for investigating effects of seabuckthorn flavonoids in acute heart failure induced by phenobarbital natricum in a dog model. The result showed supplementation with sea buckthorn flavonoids could significantly increase cardiac contractility and improve the cardiac pump function in dogs with heart failure. At the same time, sea buckthorn decreased myocardial oxygen consumption index and peripheral vessel resistance, indicating that sea buckthorn flavonoids have beneficial effects in heart failure (Wu *et al*., 1997) [78]. Taken together it is evident that flavonoids from seabuckthorn may not only decrease the risk of CVD but may also be useful for the treating CVD. A comparison of the effects of sea buckthorn flavone and aspirin on thrombogenesis and platelet aggregation has been conducted (Cheng *et al*., 2003a, 2003b) [10-11]. These investigators reported that sea buckthorn flavone (300g/kg) had a similar effect on thrombogenesis compared to that of aspirin. In addition, sea buckthorn flavones at a concentration of 3.0lg/ml significantly inhibited *in vitro* platelet aggregation induced by collagen but did not affect aggregation induced by arachidonic acid and adenosine diphosphate. Similar effects were seen with quercetin and isorhamnetin confirming that the two flavonoids constituents of sea buckthorn conferred protective effects of sea buckthorn on endothelial cells. These observations can be interpreted to explain the anti-atherosclerotic effects of sea buckthorn (Bao and Lou, 2006) [4]. Positive effects on platelets are mainly shown by flavonoids and fatty acids. Their main function is suppression of platelet aggregation induced by collagen, probably by inhibition of the thyrosine kinase activity (Patel *et al*., 2012) [54].

4.7 Anticarcinogenic

Favourable effects of sea buckthorn also include the anticarcinogenic activity. Anticarcinogenic effects have mainly been reported for substances extracted from sea buckthorn berries (Christaki, 2012) [12]. One of the main components contributing to this effect is quercetin that induces apoptosis in cancer cells. The best effect has been reported in relation to the treatment of patients with colon cancer, leukaemia, and prostatic carcinoma (Patel *et al*., 2012) [54]. Therapeutic effects are due to substances such as catechin, gallocatechin and epigallocatechin (Khan *et al.,* 2010) [36]. Sea buckthorn has also been reported to favourably affect the inhibition of certain factors causing stomach cancer in humans (Li and Beveridge, 2003) [42]. Yasukawa *et al.* (2009) [85] isolated and identified three phenolic compounds, (+)-catechin, (+)-gallocatechin, and (-)-epigallocatechin and a tritepenoid, ursolic acid from the active fraction of the 70% ethanol extract of sea buckthorn, which exhibited a remarkable antitumour activity. Induction of the apoptotic activity and apoptotic morphological changes of the nucleus including chromatin condensation were also observed in the

HL-60 cells treated with some of the flavonols isolated from sea buckthorn such as quercetin, kaempherol, and myricetin (Hibasami *et al.*, 2005) [31]. Flavonoids of sea buckthorn protect cells against oxidative damage, subsequent genetic mutations, and cancer (Gao *et al*., 2000; Zeb, 2006) [19, 90]. A potential chemopreventive effect of sea buckthorn berries in mice was observed by Suryakumar and Gupta (2011) [69]. The cytotoxic effects of sea buckthorn flavonoids have also been reported in human hepatocellular carcinoma cells (BE2-7402) (Teng *et al*., 2006) [70]. This cytotoxic action was found to be due to accumulation of isorhamnetin in the cells. In fact, a 48 h treatment of BE2-7402 tumor cells with isorhamnetin induced chromatin condensation as well as fragmentation indicating that sea buckthorn extract exerts antitumour and growth inhibitory effect on these tumor cells.

4.8 Other medicinal properties

Li and Beveridge (2003) [42] reported that Russian cosmonauts used sea buckthorn berries in their diet and oils in creams for protection against solar radiation. The freshly pressed juice used in the treatment of colds, febrile conditions, and exhaustion (Yang *et al*., 2000) [81]. The fruit pulps also used to treat fever, diarrhoea, scabies, constipation and other intestinal disorder. It has properties of anti-aging, anti-inflammatory, immunomodulatory activity and specifically activates the cell-mediated immune response (Geetha *et al.*, 2005; Mishra *et al.*, 2011) [23]. Palmitoleic acid contained in sea buckthorn is a component of skin fat and thus represents a valuable component of topical treatment of cellular tissue and wounds (Bal *et al*., 2011; Kumar *et al*., 2011) [3, 38].

5. Conclusion

The sea buckthorn (*Hippophaerhamnoides L.*), known as Siberian pineapple, sea berry, sand thorn and swallow thorn, is reported to be the natural reservoir of vitamins, minerals, antioxidants, flavonoids, lipids (mainly unsaturated fatty acids), sugars, organic acids and phytosterols. From the scientific knowledge of their importance, it is clear that sea buckthorn should be used as alternative nutritional sources in the commercial market. Sea buckthorn berries contain a large variety of substances, which possess a strong biological activity. Animal and human studies suggest that sea buckthorn may have various beneficial effects: cardioprotective, anti-atherogenic, antioxidant, anti-cancer, immunomodulatory, anti-bacterial, antiviral, wound healing and anti-inflammatory. Sea buckthorn seems to be a promising plant having potential beneficiary role in improving human health. All this indicates vast potential of sea buckthorn berries as a food resource. Due to the changes in consumer preference towards natural products with functional properties, in recent years, the use of sea buckthorn berries as a natural food ingredient has been increasing.

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