Seabuckthorn: A potential medicinal shrub

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Abstract

Sea buckthorn (*Hippophae rhamnoides* L.) or Leh Berry is a unique shrub 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) [83]. 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) [85]. Its berries consist of 68% pulp, 23% seed and 7.75% peel (Oomah, 2003) [82]. 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) [31]. 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 alpha hydroxysurosolic acid, dulcicic 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 (Saggi 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% (Löugas et al., 2006) [47] but the moisture content of pulp from Indian sea buckthorn berries is 84.9-97.6% (Dhyan 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, 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 (Plekhanova, 1988) [150]. 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]. Dharmamanda (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 Glushenkovka, 2001; Fatima et al., 2012) [6, 17].

The vitamin E content in sea buckthorn berries is 160 mg/100 g (Walhberg 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 zeaxanthin (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].

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Content in berries/juice</th>
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<tr>
<td>Moisture (%)</td>
<td>20.0 - 86.74</td>
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<tr>
<td>Ash (%)</td>
<td>1.76 - 1.8</td>
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<tr>
<td>TSS (˚Brix)</td>
<td>9.3 – 22.74</td>
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<tr>
<td>Vitamin C (mg/100g)</td>
<td>28 - 2500</td>
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<tr>
<td>Vitamin E (mg/100g)</td>
<td>160 - 255</td>
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<tr>
<td>Vitamin K (mg/100g)</td>
<td>100 - 230</td>
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<tr>
<td>Flavonoids (mg/100g)</td>
<td>354 - 1000</td>
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<tr>
<td>Total Carotenoids/Vitamin A (mg/100g)</td>
<td>2.0 - 836.5</td>
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<tr>
<td>Minerals (PPM)</td>
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<tr>
<td>Fe</td>
<td>1.6 - 15</td>
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<tr>
<td>Mg</td>
<td>39.8 - 240</td>
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<tr>
<td>Na</td>
<td>6.9 - 89.8</td>
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<tr>
<td>K</td>
<td>62.2 - 806</td>
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<tr>
<td>P</td>
<td>7.4 - 206</td>
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<td>Ca</td>
<td>64 - 256</td>
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Table 1: Nutritional composition of sea buckthorn berries/juice (Bal et al., 2011) [30]
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) [39]. 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.

4.2 Anti-inflamatory 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 ursoic 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) [31].

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 hepaticocyte damage, degeneration and subsequent death of hepatic cells (Rameshababu 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 β-carotene protect hepatic cells against damage by hepatotoxins (Rameshababu et al., 2011) [59]. Flavonoids are mainly responsible for protection against liver fattening (Li and Beveridge, 2003) [42]. Sea buckthorn extracts have also been shown 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) [80].

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, casuarin, 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 (Varshey 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) [5]. The reducing power of the extract 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 Hippophaena 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, seaberrys 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 isorhametin, 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 natrium 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 triterpenoid, 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
Effects of an antioxidant-rich BE2 Radical, known as Hippophae rhamnoides L., in mouse 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 pulp 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 (Hippophae rhamnoides 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 phenylpropanoids. 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.

6. References


50. Mishra KP, Mishra R, Yadav J, Chanda G et al. A comparative analysis of immunomodulatory potential of


56. Plekhanova, MN. A report on Seabuckthorn in Russia, 1988, 77.


71. Tulsawani R. Ninety day repeated gavage administration of Hippophae rhamnoides extract in rats. Food and Chemical Toxicology 2010; 48: 2483–2489.


