Asian Journal of Science and Applied Technology
ISSN: 2249-0698 (P) Vol.8 No.1, 2019, pp.10-15

DOI: https://doi.org/10.51983/ajsat-2019.8.1.1041

Promising Health Benefits of *Hippophae rhamnoides L.* (Sea Buckthorn): A Miracle Plant

Madhuri Mehta[1], Vijayta Gupta[2], Vinay Kant[3] and Chandresh Varshneya[4]
[1]Department of Zoology, Punjab Agricultural University, Ludhiana, India
[2]Department of Chemistry, University of Jammu, Jammu, India
[3]Division of Pharmacology & Toxicology, IVRI, Bareilly, UP, India &
Department of Veterinary Pharmacology and Toxicology,
Lala Lajpat Rai University of Veterinary & Animal Sciences, Hisar, Haryana, India
[4]Department of Pharmacology and Toxicology, COVAS, CSKHPKV, Palampur, Himachal Pradesh, India
E-Mail: drvinaykant2001@yahoo.co.in; drvinaykantluvas@gmail.com
(Received 15 March 2019; Revised 9 April 2019; Accepted 18 May 2019; Available online 26 May 2019)

Abstract **- Seabuckthorn (*Hippophae rhamnoides L.*), a spiny bush plant native to Europe and Asia, have many nutritional and medicinal properties. All parts of this plant are rich source of bioactive components such as, tocopherols, carotenoids, flavonoids, vitamins, sugar, organic acids and minerals. Various *in vivo* and *in vitro* studies on animals and human suggest that seabuckthorn has many beneficial effects as cardioprotective, antiatherogenic, antioxidant, anticancer, immunomodulatory, anti-bacterial, antiviral and anti-inflammatory, which reveals its medicinal and pharmacological properties. Seabuckthorn can be supplemented as nutraceuticals in animal feed to enhance its antioxidative potential, strengthen the immune system, which may help the organism to resist stress. To promote the large scale utilization of seabuckthorn, it would be worthwhile to perform more research on this plant.**
Keywords: **Seabuckthorn, Anti-Cancer, Antioxidant, Anti-Inflammatory**

I. INTRODUCTION

The herbal formulations have been used as therapeutic, prophylactic and health promotive agents for many years not only globally for human well-being [1, 2]. The use of natural medicines based on their beneficial effect and to initiate step to cultivate and conserve the medicinal plants has been actively recommended by world health organization. A number of studies have revealed that plants possess potent anti-oxidants to combat the oxidative damage by various physical and chemical stresses [3]. People are becoming increasingly interested in medicinal plants because of their good therapeutic performance and low toxicity. *Hippophae rhamnoides* (Sea Buckthorn), belongs to family *Elaeagnaceae*, is a deciduous shrub native to Eurasia [4]. It has been used mainly in food, fuel, medicine, veterinary, agricultural tools and bio-fencing purposes [5]. The "Sibu Yidian", a classical Tibetan medicinal book, has mentioned the use of different parts of Seabuckthorn for the treatment of various disorders like skin wounds, cardiopulmonary and gastrointestinal disorders [6]. It has silvery deciduous leaves and colourful orange berries that persist most of the winter. The name *Hippophae rhamnoides* has been derived from Latin words-'*Hippo*' which means "horse" and '*phaos*' which means "to shine". People of ancient Greek have used leaves and young branches of this plant in the fodder for horses to attain rapid weight gain and shiny coat. Its name was kept as Seabuckthorn because of its habit of growing near the sea, and possession of many spines or thorns.

II. DISTRIBUTION

Seabuckthorn's natural distribution area includes China, Mongolia, India, Great Britain, France, Denmark, Netherlands, Nepal, Pakistan, Finland, Russia, Germany, Poland, Sweden and Norway. More than 90% of the world's Seabuckthorn resources are present in China, where it is mainly planted for soil and water conservation purposes.

In India, Seabuckthorn is the plant of cold deserts regions comprising Lahaul- Spiti, Kullu, Kinnaur, Shimla, Chamba and Ladakh, of Himachal Pradesh, Jammu & Kashmir and Uttrakhand. It is one of the most valuable plants of these areas because of rich source of vitamin, organic acids, fiber, pectic compounds, carotenes, polyunsaturated fatty acids and other components. Based on morphological variations, there are total seven species for genus *Hippophae*viz. *H. rhamnoides* L., *H. salicifolia* D. Don, *H. neurocarpa* Liu & He, *H. tibetana* Schlecht, *H. gyantsensis* (Rousi) Lian, *H. litangensis* Lian & Chen ex Swenson & Bartishand *H. goniocarpa*. *Hippophae rhamnoides* is further subdivided in to 9 subspecies viz *carpartica, caucasica, mongolica, gyantsensis, rhamnoides, turkestanica, yunnanensis, sinensis, fluviatilis* Rousi. The main species of Seabuckthorn distributed in India are *H. rhamnoides*, *H. salicifolia* and *H. tibetana*, of which *Hippophae rhamnoides* L. ssp. Turkestanica is the major one. Two species, i.e., *H. salicifolia* D. Don and *H. tibetana* S. has been reported in Uttarakhand [7].

III. PLANT DESCRIPTION

Seabuckthorn (SBT) plant is a medium sized or small deciduous tree or large shrub with 2.5 – 6 m in height. Its main trunk has a thick and rough bark, whereas the young branches are smooth, grey and light ash colored with needle

shaped thorn. Leaves are alternate, narrow and lanceolate with a silver-gray color. The root system of the plant has nitrogen-fixing nodules, which makes SBT an optimal pioneer plant for water and soil conservation in eroded areas [8]. SBT is a dioecious shrub; the male bud consists of four to six apetalous flowers, which produce wind-distributed pollen. However, the female bud usually has one single apetalous flower with one ovary and one ovule. The berries, fruit of SBT produce by female plants are soft, juicy and are rich source of oils. Traditionally, every part of the plant such as fruit, leaf, twig, root and bark has been used for medicine and as nutritional supplement but berries attain much greater importance. Although, SBT berries are highly nutritious, but possess very acidic and astringent taste and are unpleasant to eat raw unless bletted (frosted to reduce the astringency) and/or mixed as a juice with sweeter substances such as apple or grape juice. In Europe and Asia, SBT berries are used as a source of herbal medicines, food and natural skin care products. These were also used in the treatment of sputum, cough, to improve the blood circulation and in the functioning of the digestive system in Tibetan and Mongolian traditional medicines. SBT was used for treatment of many disorders like skin diseases, asthma, jaundice, rheumatism, and gastro-intestinal problems in Russia and Indian Himalayan region [9]. The berries and seeds of SBT are rich source of oil which has great medicinal potential. The oil extracted from berries is used for treatment of gastritis, stomach ulcers, inflammatory condition of genital organs and erosion of uterus. In animal models the oil extracted from sea buckthorn seeds helps in reducing the oxidation process and thus stabilizing the membrane structure [10, 11]. It has also been reported to combat atopic dermatitis [12] and gastric ulcers in rats [13].

IV. CONSTITUENTS

The tremendous therapeutic potential of this plant is due to its bioactive substances notably lipids, fatty acids, vitamins, flavanoids, tannins, phenols, steroids and 5HT. More than 100 different kinds of nutrients and bio-active substances are present in the berries. The presence of these bioactive substances in the plant contributes to its various pharmacological/ therapeutic properties like immunomodulator [14], antioxidant [15], anti-carcinogenic [16], hepato-protective [17] and wound healing [18]. The exact composition of bioactive substances in fruit varies with the origin, size, climate and method of extractions [19, 20].

The leaves of seabuckthorn are also rich in carotenoids, organic acids, flavonoids, micronutrients and polyphenolic compounds which mainly includes flavonols, leucoanthocyanidins, (−) epicatechin, (+) gallocatechin, (−) epigallocatechin and gallic acid. Seabuckthorn yields two different oils: seed oil (about 0.5% of the whole berry) and the pulp oil (2-3% of the whole berry) [21]. SBT oil is also a rich source of fatty acids containing high levels of oleic, linoleic and linolenic acid in seed oil. The fruit pulp oil contains 16-54% palmitoleic acid (9-*cis*- hexadecenoic acid).

TABLE I CONSTITUENTS OF SEABUCKTHORN

Constituents of Seabuckthorn fruit	Reference
Vitamins C (200-500mg/100g fruit) and Vitamin E (up to180mg)	[22]
Carotenoids (30-40 mg; beta carotene, lycopene, lutein, zeaxanthin)	[23]
Flavonoids (0.1%-1.0% ; isorhamnetin,quercetin,kaempferol, isorhamntin-3-beta-d-glucosaminide)	[24]
Fatty acids (saturated 13.7%, unsaturated 86.3% including palmitic acid, oleic acid, palmitoleic acid, linoleic acid and linolenic acid)	[24]
Organic acids, micro and macronutrients	[24, 25]
Total soluble solids (TSS) (10.19-22.74)	[16]
Ash (1.76-1.8%)	[26]

V. SEA BUCKTHORN: HEALTH BENEFITS

A. Immune System

The immune system, composed of many interdependent cell types, is a complex system that protects us from infections and foreign substances. The cells of the immune system in association with different proteins seek out and destroy anything foreign or dangerous that enters our body. Seabuckthorn may be able to strengthen the resistance to disease by increasing Interlukein 2, superoxide dismutase, suppresses lipid peroxidation, and removes free radicals. Different *in vitro* studies using rat spleenocytes, macrophages, C-6 glioma cell line and *in vivo* studies on male albino rats revealed the antioxidant and immunomodulatory potential of Seabuckthorn. Geetha *et al.*, reported that the alcoholic leaf extract of SBT (500 µg/ml) helps in inhibiting chromium induced free radical production, apoptosis, and helps in restoring the antioxidant status, mitochondrial transmembrane potential to that of control cells [27]. The extract alone inhibited chromium induced decline in IL-2 and γ-IFN production, but did not alter IL-4 production suggesting that SBT has significant immunomodulatory activity and specifically activates the cell-mediated immune response [28]. SBT alcoholic leaf extract has also shown an immune boosting and anti-aging effect which is exhibited by an up regulated antigen presentation ability of macrophages in aged mice [29].

Ramasamy *et al., has* also showed the an immunoprotective effect of SBT berries against T-2 toxin-induced immuno-depressionin in 15-day-old chicks [30].

B. Anti Oxidative Effect

Alcoholic leaf extract of SBT at concentration of 100 mg/kg b.wt. has the potential to protect the animals from chromium induced oxidative damage [15]. Besides providing protection against chromium induced oxidative injury, the SBT leaf extract also has the capability to protect the glial cells against hypoxia induced oxidative damage [31]. Varshneya *et al.,* in a study reported that both 100% methanolic and 70% methanolic (aqua-methanolic) extract of SBT pomace without seeds has good potential to scavenge free radicals and are good source of antioxidants [32]. The reducing power of the extracts increased in a dose-dependent manner and was highest in 70% methanol extract. Similarly, Kant *et al.,* reported that the methanolic extract of SBT pomace (end product of SBT berries) possess good antioxidative property and are good scavengers of free radicals [33]. Mehta *et al.,* observed that 100% methanolic extract of SBT seedcake showed higher recovery (14%) and total phenolic contents (236.50 ± 2.60 mg of GAE/gm of extract), as compared to the other extracts (70% aqua-methanolic and 100% aqueous) [34].

C. Cardiovascular Disease

The higher production of free radicals inside the body leads to the production of reactive oxygen species (ROS) and ultimately to the oxidative stress. There is increasing evidence that shows free radical mediated oxidative damage contributes to altherogenesis (the process of forming plaques on the inner lining of arteries). The presence of polyunsaturated fatty acids, flavanoids and different antioxidants in seabuckthorn provides cardiovascular benefits. SBT fruits and leaves are rich sources of flavanoids, which are well known to improve the functioning of cardiovascular system. The total flavones extracted from seed residues of SBT showed antihypertensive effect in chronic sucrose fed rats by regulating its insulin and angiotensin II levels [35]. Cheng *et al*., observed that the production of pathogenic thromboses in mouse has been reduced by SBT flavonoids [36]. Also, flavonoids from SBT protect the endothelial cells from oxidized low-density lipoprotein induced injuries via regulation of LOX-1 and eNOS expression [37]. A significant vasorelaxation has been observed after the application of SBT seed oil [38]. The administration of SBT seed oil along with high cholesterol diet in rabbits restricted the further rise of total cholesterol and caused a significant decline of triglyceride and LDL-cholesterol as compared to animals fed on high cholesterol diet only.

D. Liver Disease

Liver, one of the most important vital organ, plays an important role in biotransformation of a chemical. A multitude of environmental pollutants and drugs may damage or weaken the liver which leads to the development of Hepatitis or cirrhosis. Seabuckthorn leaves and fruit are rich in phenols and flavonoids, (gallic acid, myricetin, quercetin, kaempferol and isorhamnetin) which provides protection against hepatic injury. SBT has the potential in normalizing the liver enzymes like aspartate aminotransferase, alanine aminotransferase, γ-glutamyl transpeptidase and bilirubin in people with liver inflammation [39]. The histological and biochemical findings suggest that both SBT leaf alcoholic extract and seed oil has ameliorative effect on CCl_4 induce liver injury in animals [40, 41].

E. Anti Cancer Effect

It has been estimated that 30 to 40 percent of all cancers can be prevented by lifestyle and dietary measures. Protective elements in a cancer prevention diet include many of the Vitamins, Minerals and Antioxidants as found in significant quantities in Sea Buckthorn fruit. Yasukawa *et al.,* 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 SBT which exhibited remarkable anti-tumor activity [42]. Comparative activities of SBT berry extract against cell proliferation in the Caco-2 (colon) and Hep G2 (liver) cancer cell lines showed that the ethyl acetate soluble extract has the strongest anti-proliferative effects due to the presence of high amounts of ursolic acid in this extract [43]. A decrease in carcinogen-induced stomach and skin tumorigenesis, has been reported by SBT fruit, which might involves in the up-regulation of phase II and antioxidant enzymes as well as DNA-binding activity of IRF-1, anti-oncogenic transcription factor, which causes growth suppression and apoptosis induction for its anticancer effect [44]. Sea buckthorn juice inhibits the growth of the human gastric carcinoma (SGC7901) and lymphatic leukemia (L1200) [45].

F. Skin Injuries

The data of modern preclinical and clinical studies agrees with the use of SBT oil to promote recuperation of skin injuries and support for healing of skin diseases. SBT oil, extracted from fruits and seeds, is rich in unsaturated fatty acids (omega 3,6,7), natural antioxidants, vitamins (E, K), carotenoids and phytosterols [46, 47], which make it ideal for medicinal and cosmetic industries for giving synergistic power to protect cell membrane and enhance cell regeneration. Seabuckthorn oil contains a high concentration of essential fatty acids i.e. linoleic, alpha-linolenic and palmitoleic acid, which are essential component of skin fat cells. Seed oil treatment showed an increase in endogenous enzymatic and non enzymatic antioxidant and decrease in the free radical production in burn wounds [48-51]. Palmitoleic acid, a component of skin, present in seed oil is considered a valuable topical agent in treating burns and healing wounds. It has been

reported that SBT seed oil helps in preventing and curing of different types of gastric ulcers, chronic cervicitis and atopic dermatitis [13, 52, 53]. The mitogenic potential of SBT seed oil has been involved in fibroblasts and keratinocytes proliferation at the wound site which has the potential to increase new blood capillaries formation thus contributing in structural repair through the formation of granulation tissue. Gupta *et al.*, observed positive healing effects of SBT flavone (isolated from fruit pulp 1.0% w/v) on dermal wounds in experimental rats on its topical application [49].The SBT treated animals showed faster reduction in wound area in comparison with control and silver sulfadiazine (standard care) treated animals. The topical application of SBT increased neovascularization, collagen synthesis and stabilization at wound site, as evidenced by up-regulated expression of VEGF, collagen type-III, matrix metalloproteinases (MMP-2, 9) and increased contents of hydroxyproline and hexosamine [54].

G. Anti Viral and Anti Bacterial Activity

A new phytochemical drug named Hiporamin has been isolated from the active fractions of SBT leaves, which possess a wide spectrum of anti-viral and antimicrobial activities. It is a purified fraction of polyphenol fraction, containing monomeric hydrolysable gallo-ellagi-tannins [55]. Seabuckthorn possess very strong anti-virus activity and wide range of action against influenza and herpes viruses [56]. Hiporamin has inhibitory effect on the viral neuraminidase which contributes to its anti-viral activity in respect of Influenza virus. It also has inhibitory effect in a HIV infection in the cell culture and antimicrobial activity. The leaf extract of SBT also has a significant anti-dengue activity when evaluated in dengue virus type-2 infected blood-derived human macrophages with a decrease and increase in TNF-α and IFN-γ, respectively [57]. The aqueous extract of SBT was also found to possess antibacterial activity against *Listeria monocytogenes* and *Yersinia enterocolitica* [58]. Aqueous and hydroalcoholic leaf extracts of SBT inhibits the growth of *Bacillus cereus, Pseudomonas aeruginosa, Staphylococcus aureus and Enterococcus faecalis* [59].

H. Anti-Inflammatory

Recent studies in rats have shown that Sea Buckthorn has significant anti-inflammatory activity and has the potential for the treatment of arthritis. It has been shown that application of SBT oil on postoperative tonsillitis, chronic cervicitis, UV induced erythema and exudative peritonitis effectively arrest the inflammatory reaction and help in progression of recovery [60, 61]. Feeding of seabuckthorn extract (15g three times a week) for six months also resulted in the decrease of serum collagen III, IV and bile acids [62].

VI. CONCLUSION

Seabuckthorn is a promising plant, which contains many dietary and beneficial components necessary for animal and human health. Different parts of SBT (leaves, fruits, pomace and seeds) possess multiple pharmacological and therapeutic potential such as antioxidant, immunomodulatory, anti-inflammatory, antiatherogenic, anti-stress, cardioprotective and wound healing. Different formulations based on SBT can be developed as functional food and nutraceutical to increase the antioxidant status and strengthen the immune system which in turn may be useful in improving the health status of animals and human.

REFERENCES

[1] I. I. Brekhman, *Man and Biologically Active Substances*. 1st ed., Oxford, England: Pergamon Press, 1980.

[2] S. Fulder, "The drug that builds Russians", *New Scientist*, Vol. 88, pp. 576-579, 1980.

[3] P. Scartezzini, and E. Speroni, "Review on some plants of Indian traditional medicine with antioxidant activity", *Journal of Ethanopharmacology*, Vol. 71, pp. 23-43, 2000.

[4] A. Rousi, "The genus Hippophae L., a taxonomic study", *Annals Botanica Fennici*, Vol. 8, pp. 177-227, 1971.

[5] D. Dhyani, R. K. Maikhuri, S. Misra, and K. S. Rao, "Endorsing the declining indigenous ethnobotanical knowledge system of Seabuckthorn in Central Himalaya, India", *Journal of Ethanopharmacology*, Vol. 127, pp. 329-34, 2010.

[6] T. Xiaoping, S. Qaiohong, C. Xiaolon, and C. Jun, *Study of biochemical pharmacology of Seabuckthorn fruit oil and its compound health products*, In: Proceedings of International workshop on Seabuckthorn. Beijing, 1995, pp. 162-164.

[7] V. K. Yadav, V. K. Sah, A. K. Singh, and S. K. Sharma, "Variations in morphological and biochemical characters of Seabuckthorn (Hippophae salicifolia D. Don.) populations growing in Harsil area of Garhwal Himalaya in India", *Tropical Agricultural Research and Extension*, Vol. 9, pp. 1-7, 2006.

[8] R. Lu, *Sea buckthorn: A multipurpose plant species for fragile mountains*, International Centre for Integrated Mountain Development, Karmandu, Nepal, 1992.

[9] V. Singh, *Seabuckthorn (Hippophae L.) in traditional medicines*, In: Seabuckthorn (*Hippophae* L.): A Multipurpose Wonder Plant. New Delhi, India: Daya Publishing House, 2005. Vol. 2, pp. 505-521.

[10] L. H. Shi, H. J. Cai, X. Y. Chen, and C. M. Yang, "Study on the Antioxidation effect of *Hippophae rhamnoides* L. seed oil", *Acta Nutrimenta Sinica*, Vol. 3, pp. 292-295, 1994.

[11] Y. B. Ji, and Y. Gao, "Effect of feeding sea buckthorn seed oil and sea buckthorn seed oil supplemented with sodium selenite in vivo on structural stability of erythrocyte ghosts in rats", *Journal of Biological Chemistry*, Vol. 7, pp. 441-446, 1991.

[12] B. Yang, K. O. Kalimo, L. M. Mattila, S. E. Kallio, J. K. Katajisto, O. J. Peltola, and H. P. Kallio, "Effects of dietary supplementation with sea buckthorn (*Hippophae rhamnoides* L.) seed and pulp oils on atopic dermatitis", *Journal of Nutritional Biochemistry*, Vol.10, pp. 622-630, 1999.

[13] J. Xing, B. Yang, Y. Dong, B. Wang, J. Wang, and P. H. Kallio, "Effects of sea buckthorn (*Hippophae rhamnoides* L.) seed and pulp oils on experimental models of gastric ulcer in rats", *Fitoterapia*, Vol. 73, pp. 644-650, 2002.

[14] M. Spansu, R. Morar, E. Morar, P. Brudasca, M. Oprea, and S. Tordai, "Effect of different treatment schedules with "Polivitarom" (*Hippophae rhamnoides* extracts) and humoral and cellular immune response in rabbits", M*edivinoVeterinaria*, Vol. 48, pp. 281-288, 1994.

[15] S. Geetha, M. S. Ram, V. Singh, G. Ilavazhagan, and R. C. Sawhney, "Evaluation of antioxidant activity of leaf extract of Sea buckthorn (*Hippophae rhamnoides* L.) on chromium (VI) induced oxidative stress in male albino rats", *Journal of Ethnopharmacology*, Vol. 87, pp. 247-251, 2003.

[16] W. Zhang, J. Yan, J. Duo, B. Ren, and J. Guo, *Preliminary study of biochemical constitutions of berry of sea buckthorn growing in Shanxi province and their changing trend*, In: Proceedings of international symposium on sea buckthorn (H. rhamnoides L.), Xian, China: 1989, pp. 96−105.

[17] T. Cheng, T. Li, Z. Duan, Z. Cao, Z. Ma, and P. Zhang, "Acute toxicity of flesh oil of Hippophaerhamnoides L. and its protection against experimental hepatic injury" *Zhongguo Zhong Yao Za Zhi*, Vol. 15, pp. 45-47, 1990.

[18] X. Yaonian, L. Yonghai, W. Sulin, S. Xiuzhi, and K. Aiztmuller, *A study of the compositions of seabuckthorn oils in China*, In: Proceedings of International Workshop on Seabuckthorn. Beijing: 1995.

[19] A. Zeb, "Important therapeutic uses of Sea buckthorn (Hippophae): a review", *Journal of Biological Sciences*, Vol. 4, pp. 687-693, 2004.

[20] H. M. Leskinen, J. P. Suomela, B. Yang, and H. P. Kallio, "Regioisomer compositions of vaccenic and oleic acid containing triacylglycerols in sea buckthorn (*Hippophae rhamnoides*) pulp oils: influence of origin and weather conditions", *Journal of Agricultural and Food Chemistry*, Vol. 58, pp. 537-545, 2010.

[21] B. R. Yang, "Lipophilic components of sea buckthorn (Hippophaërhamnoides) seeds and berries and physiological effects of sea buckthorn oils", PhD thesis, Turku University, Finland, 2001.

[22] H. Kallio, B. Yang, and P. Peippo, "Effects of different origins and harvesting time on vitamin C, tocopherols and tocotrienols in Sea buckthorn (*Hippophae rhamnoides* L.) berries", *Journal of Agricultural and Food Chemistry*, Vol. 50, pp. 6136-6142, 2002.

[23] S. C. Andersson, M. E. Olsson, E. Johansson, and K. Rumpunen, "Carotenoids in sea buckthorn (*Hippophae rhamnoides* L.) berries during ripening and use of pheophytin a as a maturity marker", *Journal of Agricultural and Food Chemistry*, Vol. 57, pp. 250-258, 2009.

[24] B, Yang, and H. P. Kallio, "Fatty acid composition of lipids in Sea buckthorn (Hippophae rhamnoides L.) berries of different origins", *Journal of Agricultural and Food Chemistry*, Vol. 49, pp. 1939-1947, 2001.

[25] R. K. Gupta, and V. Singh, *Mineral composition of Seabuckthorn (Hippophae L.)*, In: Seabuckthorn (Hippophae L.): A Multipurpose Wonder Plant. New Delhi, India: Daya Publishing House, 2005. Vol. 2, pp. 272-284.

[26] A. S. Chauhan, M. N. Rekha, R. S. Ramteke, and W. E. Eipeson, "Preparation and quality evaluation of processed products from sea buckthorn (*Hippophaė rhamnoides* Lin.) berries", *Beverage and Food World*, Vol. 1, pp. 31−34, 2001.

[27] S. Geetha, M. S. Ram, V. Singh, G. Ilavazhagan, and R. C. Sawhney, "Antioxidant and immunomodulatory properties of Sea buckthorn (*Hippophae rhamnoides*) - an *in vitro* study", *Journal of Ethnopharmacology*, Vol. 79, pp. 373-378, 2002a.

[28] S. Geetha, M. S. Ram, V. Singh, G. Ilavazhagan, and R. C. Sawhney, "Immunomodulatory effects of seabuckthorn (*Hippophae rhamnoides* L.) against chromium (VI) induced immunosuppression", *Molecular and Cellular Biochemistry*, Vol. 278, pp. 101-109, 2005.

[29] K. P. Mishra, R. Mishra, A. P. Yadav, B. Jayashankar, S. Chanda, and L. Ganju, "A comparative analysis of immunomodulatory potential of Seabuckthorn leaf extract in young and old mice", *Biomedicine and Aging Pathology*, Vol. 1, pp. 61-64, 2011.

[30] T. Ramasamy, C. Varshneya, and V. C. Katoch, "Immunoprotective effect of Seabuckthorn (*Hippophae rhamnoides*) and Glucomannan on T-2 toxin-induced immunodepression in poultry", *Veterinary Medicine International*, 6 pages, 2010, DOI: 10.4061/2010/149373.

[31] S. Narayanan, D. Ruma, B. Gitika, S. K. Sharma, T. Pauline, M. S. Ram, G. Ilavazhagan, R.C. Sawhney, D. Kumar, and P.K. Banerjee, "Antioxidant activities of seabuckthorn (*Hippophae rhamnoides*) during hypoxia induced oxidative stress in glial cells", *Molecular and Cellular Biochemistry*, Vol. 278, pp. 9-14, 2005.

[32] C. Varshneya, V. Kant, and M. Mehta, "Total phenolic contents and free radical scavenging activities of different extracts of seabuckthorn (*Hippophae rhamnoides*) pomace without seeds", *International Journal of Food Sciences and Nutrition*, Vol, 63, pp. 153-159, 2012.

[33] V. Kant, M. Mehta, and C. Varshneya, "Antioxidant potential and total phenolic contents of Seabuckthorn*(Hippophae rhamnoides*) pomace", *Free Radical and Antioxidants*, Vol. 2, pp. 79-86, 2012.

[34] M. Mehta, V. Kant, and C. Varshneya, "Screening of *in vitro* antioxidant potential of seabuckthorn seedcake extracts", *Journal of Intercultural Ethnopharmacology*, Vol. 2, pp. 99-104, 2013.

[35] X. Pang, J. Zhao, W. Zhang, X. Zhuang, J. Wang, R. Xu, Z. Xu, and W. Qu, "Antihypertensive effect of total flavones extracted from seed residues of *Hippophae rhamnoides* L. in sucrose-fed rats", *Journal of Ethnopharmacology*, Vol. 117, pp. 325-331, 2008.

[36] J. Cheng, K. Kondoa, Y. Suzuki, Y. Ikeda, X. Meng, and K. Umemura, "Inhibitory effects of total flavones of Hippophae rhamnoides on thrombosis in mouse femoral artery and *in vitro* platelet aggregation", *Life Science*, Vol. 72, pp. 2263-2271, 2003.

[37] M, Bao, and Y. Lou, "Flavonoids from seabuckthorn protect endothelial cells (EA.hy926) from oxidized low-density lipoprotein induced injuries via regulation of LOX-1 and eNOS expression", *Journal of Cardiovascular Pharmacology*, Vol. 48, pp. 834-841, 2006.

[38] M. Basu, R. Prasad, P. Jayamurthy, K. Pal, C. Arumughan, and R. C. Sawhney, "Anti-atherogenic effects of Sea buckthorn (*Hippophae rhamnoides*) seed oil", *Phytomedicine*, Vol. 14, pp. 770-777, 2007.

[39] D. T. Maheshwari, M. S. Y. Kumar, S. K. Verma, V. K. Singh, and S. N. Singh, "Antioxidant and hepatoprotective activities of phenolic rich fraction of Seabuckthorn (*Hippophae rhamnoides* L.) leaves", *Food and Chemical Toxicology*, Vol. 49, pp. 2422-2428, 2011.

[40] S. Geetha, P. Jayamurthy, K. Pal, S. Pandey, and R. C. Sawhney, "Hepatoprotective activity of Sea buckthorn (*Hippophae rhamnoides* L.) against carbon tetrachloride induced hepatic damage in rats", *Journal of the Science of Food and Agriculture*, Vol. 88, pp. 1592-1597, 2008.

[41] Y. Hsu, C. Tsai, W. Chen, and L. Fung-Jou, "Protective effects of Seabuckthorn (*Hippophae rhamnoides* L.) seed oil against carbon tetrachloride-induced hepatotoxicity in mice", *Food and Chemical Toxicology*, Vol. 47, pp. 2281-2288, 2009.

[42] K. Yasukawa, S. Kitanaka, K. Kawata, and K. Goto, "Anti-tumor promoters phenolics and triterpenoid from *Hippophae rhamnoides"*, *Fitoterepia*, Vol. 80, pp. 164-167, 2009.

[43] C. Grey, C. Widen, P. Adlercreutz, K. Rumpunen, and R. D. Duan, "Antiproliferative effects of sea buckthorn (*Hippophae rhamnoides* L.) extracts on human colon and liver cancer cell lines", *Food Chemistry*, Vol, 120, pp.1004-1010, 2010.

[44] B. Padmavathi, M. Upreti, V. Singh, A. R. Rao, R. P. Singh, and P. C. Rath, "Chemoprevention by *Hippophae rhamnoides*: effects on tumorigenesis, phase II and antioxidant enzymes, and IRF-1 transcription factor", *Nutrition and Cancer*, Vol. 51, pp. 59-67, 2005.

[45] B. S. Teng, Y. H. Lu, Z. T. Wang, X. Y. Tao, and D. Z. Wei, "*In vitro* anti-tumor activity of isorhamnetin isolated from *Hippophae rhamnoides* L. against BEL-7402 cells", *Pharmacological Research*, Vol. 54, pp. 186-194, 2006.

[46] T. S. C. Li, and W. R. Schroeder, "Sea buckthorn (*Hippophae rhamnoides* L.): a multipurpose plant", *Horticulture Technology*, Vol. 6, pp. 370-380, 1996.

[47] T. Beveridge, T. S. C. Li, B. D. Oomah, and A. Smith, "Sea buckthorn products: manufacture and composition", Journal of Agricultural and Food Chemistry, Vol. 47, pp. 3480-3488, 1999.

[48] A. Gupta, R. Kumar, K. Pal, P. K. Banerjee, and R. C. Sawhney, "A preclinical study of the effects of Sea buckthorn (*Hippophae rhamnoides* L.) leaf extract on cutaneous wound healing in albino rats", *International Journal of Lower Extremity Wounds*, Vol, 4, pp. 88-92, 2005.

[49] A. Gupta, R. Kumar, K. Pal, P. K. Banerjee, and R. C. Sawhney, "Influence of Sea buckthorn (*Hippophae rhamnoides* L.) flavone on dermal wound healing in rats", *Molecular and Cellular Biochemistry*, Vol. 290, pp. 193-198, 2006.

[50] A. Gupta, N. K. Upadhyay, R. C. Sawhney, and R. Kumar, "A poly-herbal formulation accelerates normal and impaired diabetic wound healing", *Wound Repair and Regeneration*, Vol. 16, pp. 784-790, 2008.

[51] N. K. Upadhyay, R. Kumar, S. K. Mandotra, R. N. Meena, M. S. Siddiqui, R. C. Sawhney, and A. Gupta, "Safety and wound healing efficacy of sea buckthorn (*Hippophae rhamnoides* L.) seed oil in experimental rats", *Food and Chemical Toxicology*, Vol. 47, pp. 1146-1153, 2009.

[52] W. L. Zhang, Z. F. Zhang, J. J. Fan, S. Y. Yang, Z. M. Li, and Z. C. Deng, "Experimental observation and clinical investigation effect of sea buckthorn oil on acute radio dermatitis", *Hippophae*, Vol. 1, pp. 27-30, 1988.

[53] B. Yang, K. O. Kalimo, R. L. Tahvonen, L. M. Mattila, J. K. Katajisto, and H. P. Kallio, "Effect of dietary supplementation with sea buckthorn (*Hippophae rhamnoides*) seed and pulp oils on the fatty acid composition of skin glycerophospholipids of patients with atopic dermatitis", *Journal of Nutritional Biochemistry*, Vol. 11, pp. 338-340, 2000.

[54] N. K. Upadhyay, R. Kumar, M. S. Siddiqui, and A. Gupta, "Mechanism of wound healing activity of *Hippophae rhamnoides* L. leaf extract in experimental burns", *Evidence Based Complementary and Alternative Medicine*, 2011, DOI: 10.1093/ecam/nep189.

[55] S. Geetha, and A. Gupta, "Medicinal and therapeutic potential of Sea buckthorn (*Hippophae rhamnoides* L.)", *Journal of Ethnopharmacology*, Vol. 138, pp. 268-278, 2011.

[56] L. D. Shipulina, O. N. Tolkachev, L. V. Krepkova, V. V. Bortnikova, and A. A. Shkarenkov, *Anti-viral anti-microbial and toxicological studies on Seabuckthorn (Hippophae rhamnoides)*, In: Seabuckthorn (*Hippophae* L.): A Multipurpose Wonder Plant. New Delhi, India: Daya Publishing House, 2005. Vol. 2, pp. 471-483.

[57] M. Jain, L. Ganju, A. Katiyal, Y. Padwad, K. P. Mishra, S. Chanda, D. Karan, K. M. Yogendra, and R. C. Sawhney, "Effect of *Hippophae rhamnoides* leaf extract against Dengue virus infection in human blood-derived macrophages", *Phytomedicine*, Vol. 15, pp. 793-799, 2008.

[58] A. S. Chauhan, P. S. Negi, and R. S. Ramteke, "Antioxidant and antibacterial activities of aqueous extract of Sea buckthorn (*Hippophae rhamnoides*) seeds", *Fitoterapia*, Vol. 78, pp. 590-592, 2007.

[59] N. K. Upadhyay, M. S. Y. Kumar, and A. Gupta, "Antioxidant, cytoprotective and antibacterial effects of Sea buckthorn (*Hippophae rhamnoides* L.) leaves", *Food and Chemical Toxicology*, Vol. 48, pp. 3443-3448, 2010.

[60] B. A. Fayman, "Treatment of operative wounds in ear, nose, throat with Seabuckthorn oil", *Seabuckthorn*, Vol. 4, pp. 7, 1991.

[61] L.V. Sabynich, L.A. Sibileva, L.S. Belova, and V.S. Chuchalin, "Anti inflammatory of thick extract from fruit of pulp of *Hippophae rhamnoids* L.", *Rastitelnye Resursy*, Vol. 30, pp. 70-74, 1994.

[62] Z. L. Gao, X. H. Zu, F. T. Cheng, and F. H. Jiang, "Effect of Seabuckthorn on liver fibrosis: a clinical study", *World Journal of Gastroenterology*, Vol. 9, pp. 1615-1617, 2003.