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SEA BUCKTHORN- SUPER FRUIT WITH NUTRACEUTICAL POTENTIAL

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Abstract
Sea Buckthorn (Hippophae L.) is a precious, various factory extensively grown in Asia, Europe, and Canada. This SB berry is nutritionally veritably rich because it contains all Vitamins fat soluble and water soluble vitamin 18 free amino acids. A unique unsaturated adipose acid profile makes berries the only factory source of omega-7 adipose acid, minerals, flavonoids, and several other bioactive substances. Its bioactive phytochemical compounds retain several biological activities similar to antioxidants, immunomodulatory, anti-carcinogenic, hepatoprotective, cardioprotective, anti-atherogenic and radio protective etc.

Its exceptional value is due to the presence of both lipophilic and hydrophilic antioxidants in appropriate excess amounts (lipophilic: carotenoids and tocopherols; hydrophilic: flavonoids, tannins, phenols, and Vitamin C). Many important nutrients, particularly lipids of the beneficial adipic acid, contribute to the nutritional value of sea buckthorn products for consumers. This review article, in addition to the above compounds and vitamins, also focuses on other important components, such as sugars, sugar derivatives, fiber, organic acids, proteins, amino acids, and minerals, and the therapeutic health benefits associated with these bioactive compounds. This article deals with the potential of SB for medical nutrition, cosmetics, food, and animal feed.

Keywords: Sea buckthorn, Biological activity, Food, Feed, Cosmeceuticals.

1.0 Introduction

Nutraceutical products, derived from various food sources, encompass a broad spectrum of items that provide both therapeutic and dietary effects. Examples of nutraceuticals include dietary supplements, herbal products, genetically modified foods, and vitamins, all of which contain substantial amounts of bioactive compounds sourced from natural origins. These products confer physiological benefits, contribute to prevention and treatment, and offer a range of health advantages. (Surya kumar and Gupta, 2011). Nutraceuticals play a pivotal role in supporting body composition and function, promoting overall health, retarding the aging process, preventing chronic diseases, and extending life expectancy. One particularly well-received nutraceutical, due to its potential to be a superfood, is SB. Its beneficial and unique properties have been recognized since at least the seventh century BC, attesting to its enduring significance in the realm of nutraceuticals. (Li and Hu, 2015). The shrubs typically reach heights of 0.5–6 m, occasionally reaching up to 10 m, and are commonly found in arid, sandy environments such as hills, hillsides, valleys, and riverbeds. Salt-tolerant and characterized by dense thorny foliage, SB shrubs thrive in areas with full sunlight. The leaves are lanceolate, 3–8 cm long, and less than 7 mm wide, exhibiting a distinct pale silver-green coloration. The fruit/berry size varies, with orange-colored fruits reaching a maximum length of 9.0 mm, yellow-colored fruits at 7.6 mm, and red-colored fruits at a minimum of 6.2 mm. Despite the differences in length, the width of all red, yellow, and orange-colored fruits remains consistently 1.0 cm (Kaushal and Sharma, 2012).

SB is dioecious, featuring separate male and female plants. The male plants produce brown flowers that disperse pollen through the wind (Singh, 1998). The plant's extensive root system plays a crucial role in atmospheric nitrogen fixation, as well as in preventing soil erosion and desertification (Cireasa, 1986; Yao and Tigerstedt, 1994).

2.0 Need to the study

Sea buckthorn, hailed as a superfruit, has earned huge consideration because of its momentous nutraceutical potential. A far reaching survey of the examinations on this outstanding natural product is fundamental to uncover the bunch medical advantages it offers. Loaded with a rich exhibit of bioactive mixtures, ocean buckthorn is prestigious for its high satisfied of nutrients, cell reinforcements, and omega unsaturated fats. These parts add to its true capacity in advancing cardiovascular wellbeing, supporting the resistant framework, and helping with skin recovery. Moreover, the organic product's mitigating and hostile to disease properties have started interest in its likely job in preventive medical care. Understanding the current assemblage of exploration is vital for tackling the full range of ocean buckthorn's nutraceutical benefits, making ready for creative dietary enhancements and helpful applications. As we dive into this survey, we plan to disentangle the science behind ocean buckthorn's superfruit status and investigate its promising ramifications for human prosperity.

3.0 Nutritional Value of Sea Buckthorn

Seabuckthorn berries boast an impressive composition of approximately 190 bioactive nutrients, encompassing omega 3, 6, and 9 fatty acids, 18 amino acids, 17 vitamins, 14 minerals, and various antioxidants. The soluble solids content in SB berries ranges from 12.0 to 20.75ºB. The acidity in these berries is primarily attributed to tartaric and succinic acids, complemented by the presence of malic acid and citric acid. Notably, the vitamin C content in SB berries is exceptional, ranging from 360 to 2,500 mg/100 g, surpassing other vegetables or fruits by 4 to 100 times (Bernath and Foldesi, 1992).

Moreover, variations in ascorbic acid levels have been observed in SB berries grown in different regions. For instance, levels of 650.0 mg/100 g were reported in the Nepal region, 3.50-85.7 mg/100 g in Ukraine, 425.0 mg/100 g in Himachal Pradesh, and 422.0 to 516.0 mg/100 g in berries from diverse agro-climatic regions of India (Kaushal and Sharma, 2012). Stobdan et al. (2010) found 275 mg/100 g of vitamin C in SB berries from the Leh valley in the trans-Himalaya region. Additionally, Stobdan et al. (2010) reported 3.54 mg/100g of Vitamin E in Seabuckthorn berries, while Kaushal and Sharma (2012) documented a range of 110 to 160 mg/100g of Vitamin E. Bernath and Foldesi (1992) even reported an exceptionally high vitamin E content of 600 mg/100 g in Seabuckthorn berries. Kaushal and Sharma (2012) reported that Seabuckthorn (SB) berries stand out as a rich source of numerous carotenoids, with beta-carotene being particularly notable, ranging from 10 to 30 mg/100 g. Among the 39 identified carotenoids, the content in SB berries from various regions worldwide varies, such as 6.8 mg/100g in India, 7.7-28.0 mg/100g in China, 3.28 mg/100g in Nepal, and 0.14-3.10 mg/100g in Ukraine. Stobdan et al. (2010) found higher vitamin A levels (432.4 IU/100g) in SB berries grown in the Leh valley of the trans-Himalayas. In addition to carotenoids, Stobdan et al. (2010) reported B complex vitamins in SB berries from the Leh valley, including Riboflavin (1.45 mg/100g), Niacin (68.4 mg/100g), Pantothenic acid (0.85 mcg/100g), and vitamin B6 (1.12 mg/100g). Similarly, Kaushal and Sharma (2012) noted the presence of folic acid up to 0.79 mg/100g, vitamin B1 (0.035 mg/100g), and Riboflavin (0.056 mg/100g) in SB berries. Mineral content in Seabuckthorn berries, as reported by Stobdan et al. (2010), includes potassium (647.2 mg/l), calcium (176.6 mg/l), iron (30.9 mg/l), magnesium (22.5 mg/l), phosphorous (84.2 mg/l), sodium (414.2 mg/l), zinc (1.4 mg/l), copper (0.7 mg/l), manganese (1.06 mg/l), and selenium (0.53 mg/l).

Furthermore, Kaushal and Sharma (2012) highlighted the diverse array of compounds present in SB berries, including flavonoids with a vitamin P effect, catechins, procyanidins, cyclitols, phospholipids, tannins, and sugars (galactose, fructose, xylose). The berries also contain approximately 3.9% organic acids such as malic acid, oxalic acid, and tartaric acid. Flavonoids found in SB berries are credited with potential benefits in treating conditions like high blood pressure, coronary heart problems, and angina, with observed concentrations of 109.7 to 778.5 mg/100g, consisting of leucoanthocyanidin, catechins, and flavonols compounds in H. Rhamnoides

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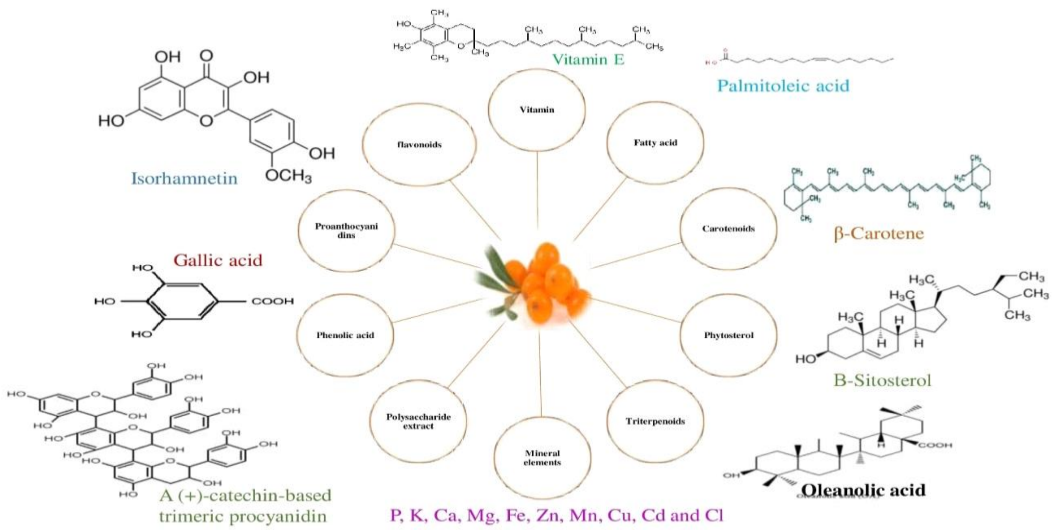
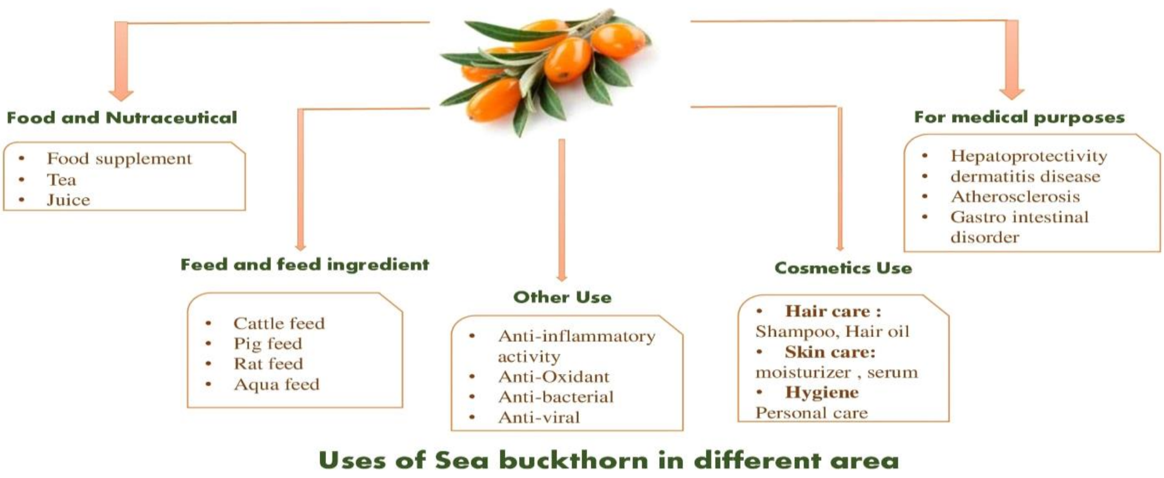


Figure 1 - Phytochemical constituent present in SB (Ren R.)

Table 1 : Chemical Composition

	Chemical composition of individual parts of the sea buckthorn	
S.No	**Part of plant**	**Chemical composition**
1	Fruits (berries)	Vitamins (C, E, B, K1, D, A, folic acid), Macro and trace elements (potassium, magnesium, calcium, iron, sodium, manganese, zinc, copper, nickel), Carotenoids, Phenolic compounds, Lipids, Amino acids, Organic acids, Proteins, Sugars, Pectins.
2	Leaves	Vitamins (E, folic acid), Calcium, magnesium, potassium, Carotenoids, Phenolic compounds, Amino acids, Chlorophyll, Proteins Pectins.
3	Seeds	Carotenoids, Phenolic compounds, Lipids, Proteins.
4	Roots	Carotenoids, Phenolic compounds, Lipids, Proteins.
5	Bark	Phenolic compounds.

Figure 2: SB role in different area



4.0 SB Potential as food & Feed

The most important and high-nutrient part of the plant is, by far, the Seabuckthorn (SB) berry, which consists of the pulp (68%), the seed (23%), and the strip (7.75%). The SB berry has a lovely aroma and an acidic flavor that make it a great addition to cuisine. It consists of a diverse range of substances, such as carotenoids, tocopherols, sugars (glucose and fructose), unsaturated fats (BFAs), amino acids, natural acids, flavonoids (isormantine, kaempferol, and quercetin), and mineral elements (Bal et al., 2011).

The SB berry stands out due to its exceptionally elevated vitamin C concentration. Based on berry weight (100 g), vitamin C contents vary between 360 and 1676 mg (Beveridge et al., 1999; Tiitinen et al., 2006b). Berries have been shown to have levels between 128 and 1300 mg/100 ml, which is higher than the concentrations seen in naturally vitamin C-rich fruits like oranges and lemons (Christaki, 2012) or even kiwis (Dumbravă et al., 2016). Only exotic fruits like acerola are similar to the greatest amounts (Cefali et al., 2018). SB stands out as a major source of vitamin C when you take into account that one of the lowest values reported in the literature is 80.58 mg of vitamin C/100 g of fresh berries (Teleszko et al., 2015). The variety name "Hippophae," derived from the words "hippo" and "phaos" meaning pony and sparkling, respectively, reflects its impressive nutritional profile (L. Li et al., 2002).

Research has demonstrated that SB benefits poultry. In addition to showing greater intramuscular fat in the thigh and breast tissue, broilers fed SB fruit had a considerably lower belly fat ratio than controls (Ma et al., 2015). Because SB contains vitamin C, it not only helps produce eggs of superior quality but also improves the quality of chicken meat (Kang et al., 2015). Furthermore, Ben-Mahmood et al. (2014) reported that adding 5% SB residue to broiler feed improves skin pigmentation. Furthermore, with a protein content that can reach as high as 21% of dry matter in mid-July and early August, SB leaves can be used as an unconventional source of protein in the human diet (Stobdan et al., 2013).

5.0 Potential as cosmeceuticals

Due to the significance of the fatty acids found in Seabuckthorn (SB), several cosmetic companies incorporate it into their products. Specifically, linoleic acid, a key component, plays a crucial role in regulating skin metabolism. It enhances the lipid membrane of the epidermis, particularly beneficial for dry skin, and acts as a protective barrier against trans-epidermal water loss (Levi L, 2016).

Linoleic acid has been identified in sebum, the skin's natural oil, contributing to its moisturizing and healing properties. Research indicates that individuals with acne tend to exhibit a decrease in the amount of linoleic acid in their sebum, leading to the formation of blackheads and blemishes (Lay FT et al, 2005). As a result, the incorporation of Seabuckthorn in cosmetic formulations is attributed to its potential in addressing skin conditions and promoting skin health.

S. no	Fatty acid	Qty
1	**Saturated**	
i	Palmitic acid	30-33
ii	Stearic acid	<1
2	**Unsaturated fatty acids**	
i	Palmitoleic acid	30-35
ii	Oleic acid	10-10
iii	Linoleic acid	5-7
iv	α- linolenic acid	30
v	Ɣ- Linolenic acid	35
vi	Gondoic acid	2

6.0 SB Potential as medicine

SB a rich history of medicinal applications in both Asia and Europe, as documented by Gurevich in 1956. Its therapeutic effects are attributed to a range of key phytochemicals, encompassing flavonoids, carotenoids, unsaturated fats, and various others. Despite being a thorny shrub, SB (Hippophae rhamnoides L.) produces thin, soft, and juicy berries that exhibit a spectrum of colors from yellow to dark orange. These berries, rich in hydrophilic and lipophilic components, have been traditionally utilized as both food and medicine. The plant holds a diverse array of herbal remedies addressing various medical conditions, including but not limited to cancer, heart disease, skin disorders, inflammation, central nervous system diseases, among others. Ongoing research is actively exploring the potential of SB-based products, currently available in the market for pharmaceutical, nutraceutical, and cosmeceutical applications, as highlighted in studies such as Kaur et al. (2017).

Bioactive compound in sea buckthorn					
S. No.	**Bioactive compound**	**Classification**	**Example**	**Health benefits**	**Reference**
1	**Phenolic**	Flavonol glycoside	Isorhamnetin-3 glucoside	Decrease fat deposition in adipose tissue. Cardiovascular mortality. Anti-inflammatory in macrophage. Anti-proliferative. Anti-Viral Anti-oxidative	Kaur *et al.*, 2017
		Tannins	Proanthocyanidins, Casuarinin	Against light induced retinal denegation, antioxidant, anti-inflammatory and anti-apoptotic , anti-proliferative effects, increase muscle health, Prebiotic effects	Grey et al 2010. Andreux et al 2019
		Phenolic acids	Gallic acid	Anti-proliferative, anti-inflammatory activity. Decrease DNA damage	Guo et al 2000. Paterson and
2	**Non Phenolic**	Organic acids	Ascorbic acid	Anti-oxidant, Cure scurvy, repair the mucosa injuries and effect on mRNA transcription	Gao et al 2000.
		Sugars derivatives and alcohols	Ethyl β-EG, L-quebrachsitol inositol's and methyl inositol's	Increase blood pressure, increase fasting insulin level, decrease hyperglycaemic and hyperlipidaemia	Matsubara 1999. Xue et al 2015.
		Lipophilics	Unsaturated fatty acid, carotenoids tocopherols and phytosterols, α-Linoleic acid	Beneficial effect on epithelial tissue. Lipid soluble antioxidants, anti atherogenic, cardio-protective, anti-platelet aggregation, antiulcer and anti-depressive in cell, animal models and humans	Ranard et al 2019.

6.1 In cancer therapy: Sea buckthorn demonstrates a broad range of biological and pharmacological activities, including potential anticancer effects. These active substances are known to be present in various organs and their derivatives, with a particular emphasis on juice and oil, although the precise molecular mechanisms remain unclear, as indicated by Xu et al. in 2011. Notably, these compounds play a protective role against oxidative damage, which can contribute to the development of cancer and genetic mutations (Christaki, 2012).

Moreover, sea buckthorn has been associated with enhancing digestive processes, stimulating appetite, restoring liver and kidney functions, and contributing to overall patient health, as highlighted in the work of Raj Kumar et al. in 2011. The multifaceted health benefits of sea buckthorn underscore its potential as a valuable natural resource in promoting well-being and addressing various health concerns.

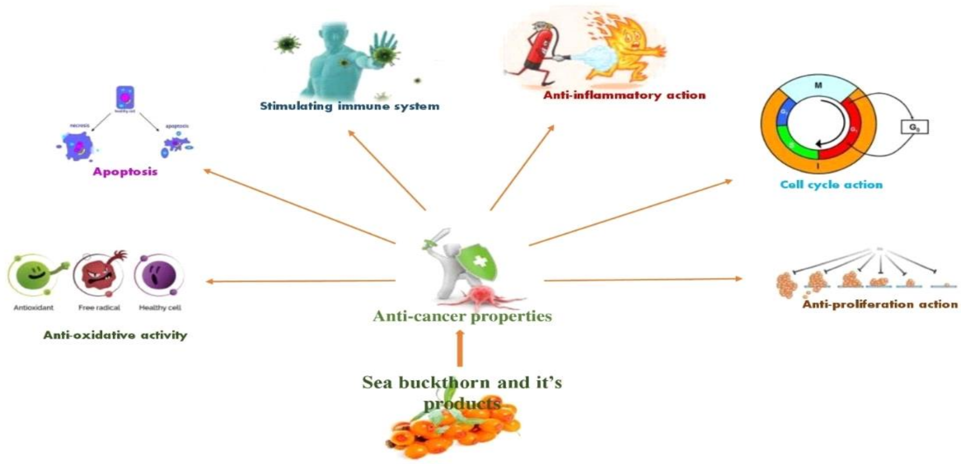


Figure 3: Hypothetical mechanisms of action by which SB may evoke chemo-preventive and therapeutic responses against cancer.

In a study focusing on MDA-MB-231 human breast cancer cells, Wang et al. (2014) observed that sea buckthorn procyanidins extracted from the seeds exerted a notable impact on fatty acid synthase (FAS), a key enzyme in the de novo biosynthesis of long-chain fatty acids—whose elevated levels are characteristic of cancer cells. The inhibition demonstrated a dose-dependent relationship, spanning concentrations from 0 to 0.14 µg/ml. Notably, at a concentration of 0.087 µg/ml, 50% of FAS activity was effectively inhibited. The richness of biologically active compounds and antioxidants in sea buckthorn has positioned it as a candidate in cancer therapy, particularly for its radioprotective activity. This attribute has been substantiated by various studies conducted by Goel et al. (2002, 2003a,b, 2004, 2005). Agrawala and Goel (2002) found that the whole extract of fresh sea buckthorn berries, specifically H. rhamnoides—RH-3 at 25–35 mg/kg body weight, exhibited protective properties, particularly against radiation-induced micronuclei in mouse bone marrow. Additionally, Goel et al. (2002) reported that RH-3 inhibited the Fenton reaction and the radiation-induced production of hydroxyl radicals in vitro.

6.2 Cardio-protection therapy

Several specific risk markers, including hypertension (high blood pressure), lipid metabolism disturbances (elevated plasma cholesterol, particularly low-density lipoprotein (LDL)-cholesterol, low plasma high-density lipoprotein (HDL)-cholesterol, and elevated plasma triglycerides), and blood platelet dysfunction (platelet aggregation), are recognized indicators of cardiovascular disorders. Consequently, mitigating the risk of cardiovascular diseases has become a primary focus for researchers. Well-established evidence indicates that diets rich in fruits, particularly berries and vegetables, are associated with a reduced risk of cardiovascular disease.

Sea buckthorn (SB) has demonstrated therapeutic and protective properties against myocardial ischemia, oxidative damage, and the aging process, as highlighted by Eccleston et al. in 2002. SB berries, leaves, and oils are rich in phenolic compounds, contributing to their potential benefits in various diseases, including cardiovascular disorders, as emphasized by Malinowska and Olas in 2016.

In specific studies, a dose of 20 mL kg_1 of SB pulp oil exhibited protective effects against myocardial ischemia-reperfusion injury, linked to the activation of the Akt/eNOS signaling pathway (Kapil Suchal1 et al., 2016). Furthermore, pretreatment with SB oil (20 mL kg_1 day_1) demonstrated a protective impact against isoproterenol-induced myocardial damage in rodents (Malik S et al., 2011). In both investigations, the cardioprotective effects of SB were fundamentally associated with antioxidant and anti-inflammatory activities (Linderborg K. M et al., 2012).

6.3 Hepatoprotective activity

Crude extracts, polysaccharides, and bioactive compounds derived from Sea Buckthorn (SB) have demonstrated protective effects against liver damage induced by drugs or chemicals. Specifically, SB seed oil and the phenolic-rich fraction from SB leaves were identified as protective agents against CCl_4-induced liver damage in animals, while SB extract exhibited a reduction in nicotine-induced oxidative stress in rat liver (D. T. Maheshwari et al., 2011).

Moreover, the polysaccharide extract isolated from SB fruits exhibited protective effects in mice against acetaminophen-induced hepatotoxicity and LPS/DGalN-induced acute liver failure. The former was primarily attributed to the activation of the Nrf-2/HO-1-SOD-2 signaling pathway, while the latter involved the suppression of TLR4-NF-kB signaling (X. Wang, 2018). In an in vitro study, compounds such as narcissin, isorhamnetin 3, 5, 7, 4-tetrahydroxy-3-methoxyflavon, and protocatechuic acid obtained from SB fruits demonstrated potent inhibitory effects on the activation of Hematopoietic stem cells (HSCs), with IC50 values of 46.03, 57.18, and 58.28 mM, respectively (Ren R.et al., 2015). The compounds present in SB showcase potential in preventing liver fibrosis by inhibiting HSC activation (Ren R et al., 2015).

6.4 Gastrointestinal ulcers

The prevalence of gastric ulcers is on the rise, particularly in developing nations, attributable to poor dietary habits, indifference, and lack of awareness. Testing facilities suggest that Sea Buckthorn (SB) oil is a suitable remedy for gastric ulcers, given its frequent utilization in treating stomach ulcers (Ren R. et al., 2015). Its potential benefits may include regulating the transition favoring inflammation to control stomach acid production, thereby reducing discomfort (Huff et al., 2012; Xing et al., 2002; Yuanpeng, 1994). The Lorenz distribution curves elucidated the genetic organization and supplementation suitability of the microbial community.

Hexane extract from SB has demonstrated inhibition against factors like indomethacin, tension, and ethanol, all implicated in the development of gastric ulcers. Furthermore, this extract has exhibited efficacy in the treatment of duodenal ulcers (S. Attri, et al., 2018). While SB was not successful in the treatment or prevention of normal equine non-glandular ulcers, it showed a slight reduction in the glandular ulcer score after feed deprivation. In scenarios involving sporadic feeding, SB could be utilized to prevent glandular ulcers in animals.

6.5 Anti-oxidant activity

The berries of sea buckthorn have been utilized as a medication in traditional medicine since ancient times. Their pharmacological impacts are because of nutrients, minor components, amino acids and other bioactive substances, for example, β-carotene, zeaxanthin, lycopene, flavonoids, folic corrosive, triterpene, unsaturated fats, tannic acid, etc. Gao et al,. (2000), Yao & Tigerstedt, 1992, Yeb, 2004. Antioxidants can interfere with the oxidation process by reacting with free radicals, chelating catalytic metals, and acting as a scavenger of reactive species. Antioxidant supplementation can be used to reduce oxidative damage. According to the study by Papuc et al., 2008, it was observed that sea buckthorn removes superoxide anions and DPPH free radicals better than BHA and BHT. Sea buckthorn extract exhibits antioxidant activity. The alcoholic extract was the most efficient antioxidant compared to BHT and BHA that showed less antioxidant activity. The antioxidant activity of sea buckthorn fruit extract can be attributed to its property to capture free radicals. Kallio et al., (2002), Yang et al.,(2001), Yang & Kallio (2001), Papuc et al.,(2008). These properties force sea buckthorn extract to be used as a natural antioxidant in the medicine, pharmaceutical, and food industries. A natural Sb extract has an astonishing ORAC (oxygen radical absorption capacity) worth of 895,281 µmolTE/100g (Anon-Yamus, 2021). Compared with benchmarks in the market, SB is 8 times stronger than Grape Seed Extract (Annie-Mouse 2021) and 1.7 times more potent than Pine Bark Extract (Legault, J. et al., 2013) Is. The research findings are also supported by the inhibition activity of various free radical assays, such as DPPH, O_2^-, HO, and lipid counter-oxidation assay.

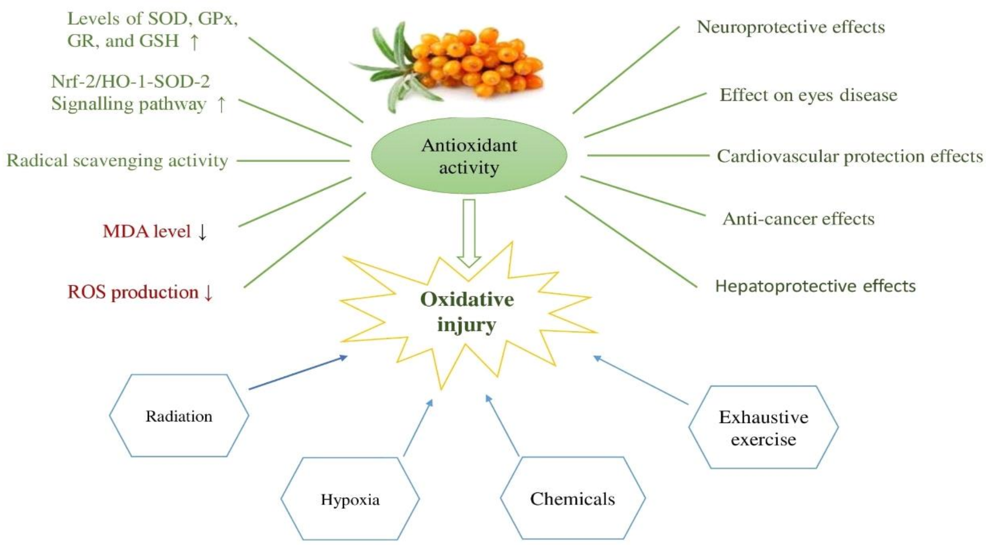


Figure 4: Anti-oxidant activity

6.6 Anti-Inflammatory activity:

In a recent review, the lipopolysaccharide/cystathionine γ-lyase (LPS/CSE)-induced overproduction of IL-1β, IL-6, CXCL1, PGE2, and MUC5AC in HBE16 cells was found to be notably mitigated by BAY 11-7082, a robust IκB inhibitor. These findings underscore the significant role of the NF-κB pathway in the progression of LPS/CSE-induced airway inflammation, aligning with prior research (Liou & Huang, 2017; Ma et al., 2015). In the current study, exposure to LPS/CSE resulted in a significant activation of the NF-κB signaling pathway, primarily evident in the degradation of IκBα, a suppressor of NF-κB activation. In contrast, both Total Flavonoids from Sea Buckthorn (TFSB) and BAY 11-7082 treatment effectively suppressed LPS/CSE-induced I-Bα degradation in HBE16 cells. Additionally, ERK and Akt, known activators of the NF-κB pathway, were also implicated in the process (Slomiany & Slomiany, 2013; Zha et al., 2014). Thus, TFSB demonstrated the ability to block LPS/CSE-induced activation of the NF-B pathway by inhibiting ERK and Akt in HBE16 cells, showcasing its anti-inflammatory potential.

The total flavonoids from Sea Buckthorn exhibited a robust protective effect against LPS/CS-induced airway inflammation both in vitro and in vivo. This protective activity is attributed to its capability to inhibit the activation of ERK, Akt, and PKC signaling pathways. These results are promising, suggesting the potential consideration of total flavonoids from Sea Buckthorn as a functional food or a candidate for the prevention and treatment of chronic bronchitis (Qing-cuo Ren et al., 2019).

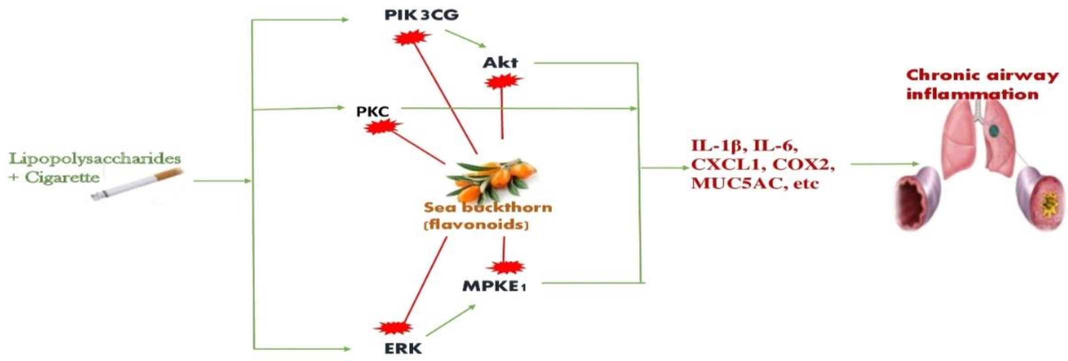


Figure 5: Anti-Inflammatory activity

6.7 Anti-stress and anti-ageing activity

Stress is characterized as "a pattern of physiological responses that readies an organism for activity" (Levi, 2016), and its manifestation varies among individuals. The prevalence of various stressors, such as environmental pollutants, food contamination, competitive lifestyles, synthetic medications, etc., has grown in tandem with the rapid advancements in society, industrialization, and overpopulation. Prolonged exposure to any form of unrelieved stress can diminish the tolerance to other stressors (S. K. Singh & Patra, 2019). Adaptogenic herbs offer potential assistance in restoring the natural balance and function of neurotransmitters affected by traumatic experiences. Unlike conventional drugs, adaptogenic herbs aid the body in maintaining proper homeostasis by harmonizing endocrine hormones and the immune system (Panossian & Wikman, 2010; Thakur et al., 2015). Plant adaptogens often function as mild pro-stressors, mitigating the reactivity of host defense mechanisms and alleviating the adverse effects of various stressors, notably by elevating basal levels of mediators associated with the stress response (S. K. Singh & Patra, 2019; Tulsawani, 2010).

In a study, it was discovered that an aqueous extract of Hippophae rhamnoides exhibited antiadaptogenic efficacy in rats following 30 days of administration. The extract demonstrated non-toxicity at a maximum effective dose of 75 mg/kg body weight.

6.8 Anti-bacterial and anti-viral effects

Plants have been employed for millennia to enhance flavor, preserve food, and address various medical conditions. In the realm of secondary plant metabolism, active compounds are synthesized, playing a pivotal role in diverse biological activities globally, including the treatment and prevention of infectious diseases (Silva & Fernandes Júnior, 2010). Secondary plant metabolites such as tannins, alkaloids, phenolics, and others have demonstrated antimicrobial properties (Guil-Guerrero et al., 2004).

The evaluation of antimicrobial activity often involves the agar well diffusion assay, relying on two key parameters: MIC (minimum inhibitory concentration), defined as "the lowest concentration at which inoculum viability is significantly decreased (>90 percent)," and MBC (minimum bactericidal concentration), defined as "the concentration at which 99.9% or more of the initial inoculum is destroyed" (Tajkarimi et al., 2010). Chauhan et al. (2007) explored the antibacterial effectiveness of Sea Buckthorn (SB) aqueous seed extract against L. monocytogenes and Y. enterocolitica, revealing MIC values of 750 ppm and 1000 ppm, respectively. Gupta et al. (2014) uncovered antibacterial and antifungal efficacy in Hippophae salicifolia seed extract against various bacteria and fungi strains. Aqueous and hydroalcoholic leaf extracts from SB inhibited B. cereus, S. aureus, E. faecalis, and P. aeruginosa (Jain et al., 2008).

7.0 SUMMARY: Although many studies have confirmed the biological activities of the magical berry sea buckthorn, its medicinal and prophylactic doses remain unknown, and not much clinical trials have yet been performed: only *in vitro* or *in vivo* studies involving experimental animals. It is known that sea buckthorn may participate in the prevention and treatment of multiple diseases, it also accelerates the return to health of patients receiving medical treatments like chemotherapy by significantly improving the performance of the immune system and relieves hematological damage. The hypothetical mechanism by which sea buckthorn may exert its chemopreventive and therapeutic responses against cancer and other diseases have been discussed. The bioactive substances in various parts of sea buckthorn have a range of properties, including antioxidant, anti-inflammatory, and anti-proliferative activities; they also induce apoptosis and strengthen the immune system; however, the molecular mechanisms remain unclear. Therefore, before sea buckthorn can be considered the “golden mean” for treatment of multiple diseases, it requires further study in a range of high-quality studies.

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