

CHEMICAL COMPOSITION AND REMEDIAL PERSPECTIVES OF *HIPPOPHAE RHAMNOIDES LINN*

Ayesha REHMAN¹, Shabbir HUSSAIN¹, Mohsin JAVED², Zulfiqar ALI³, Hajira REHMAN¹, Tanzeela Gulab SHAHZADY¹, Asmat ZAHRA⁴

¹Department of Chemistry, Lahore Garrison University, Lahore, Pakistan

²Department of Chemistry, University of Management and Technology, Lahore, Pakistan

³Department of Basic Sciences and Humanities, University of Engineering and Technology Lahore, KSK Campus, Pakistan

⁴Institute of Chemistry, University of the Punjab Lahore, Pakistan

Summary: *Hippophae Rhamnoides Linn* (Sea buckthorn) is a thorny nitrogen fixing deciduous shrub. It finds a lot of importance due to its very rich vitamins A, B₁, B₁₂, C, E, K, and P; carotenoids, lycopene, phytosterols and flavonoids. Its therapeutic value is owed to the presence of potent antioxidants. SBT reduces level of stress hormones and increases hypoxic tolerance in animals demonstrating its anti-stress and adaptogenic activity. Sea-buckthorn oil plays a greater role in the proper functioning of the human body and gives healthy and beautiful look to the skin due to the presence of valuable nutrients in it. SBT oil finds very important applications in cosmetic products and is frequently employed for the cure of rapidly aging, flaky or dry skin due to a balanced composition of fatty acids and vitamins. Sea-buckthorn oil also has skin regeneration and repair properties due to the presence of unique unsaturated fatty acids, such as gamma-linolenic acid (omega-6) and palmitoleic acid (omega-7). This ancient plant contains powerful and healing synergies. In this review we discuss traditional uses, photochemistry and pharmacological data of sea buckthorn.

Keywords: hippophae, pharmacological, cosmetics

List of abbreviations: **cm** – centimeter, **H** – hippopha, **m** – meter, **mm** – millimeter, **SBT** – Sea buckthorn, **T-2** – trichothecene

INTRODUCTION

Hippophae rhamnoides L. (Sea buckthorn, SBT) is the important indigenous bush and it is native to European and Asian countries [1]. It is unique plant that is currently domesticated in different countries particularly in Pakistan, China, Russia, Germany, Finland and India *etc* [2, 3]. The Sea buckthorns may rise in height from 0.5 to 6 m and even up to 18 m in central Asia [4]. The plant is a deciduous shrub and is both drought and salt tolerant and has the ability to survive even at a temperature as low as -40°C . The branches are dense and very thorny. The linear-shaped leaves have a dark grey-green upper surface while distinct pale and silvery-grey lower surface. These leaves are less than 7 mm in width and 3 to 8 cm in length [5]. The fruits of Sea buckthorn vary in shape as well as in color; however, they are mostly egg-shaped or globose berries ranging in color from bright orange to yellow [6]. The fantastic contrast between the color of the leaves and fruits together with an excellent set up of fruit size and shape, evidently describes the ornamental value of this beautiful plant. However, the plant is unable to tolerate the shady conditions near larger trees as it needs full sunlight for its healthy growth and survival [7]. In the present review, attempts have been made to elucidate the chemical composition and justify the ancient and modern pharmacological value of SBT.

HISTORICAL BACKGROUND

The history of sea buckthorn dates back many years crossing diverse countries and cultures and it is as colourful as its berries. The word “Hippophae” pertains to a Latin word “Hippo” meaning “Horse” and “Phaos” meaning “shine”. SBT twigs and leaves were used in Greece to nourish the animals which resulted in shining coat especially in horses and weight gain [8]. It was indicated by local ethos of European countries that utilization of SBT as a remedy for horses was a common practice to induce their shiny coat and rapid weight [1]. In many Asian countries like Pakistan, China and India, SBT has been commonly named as a wonder plant. The SBT leaves were the favourite food of the flying horse (Pegasus) as shown Greek mythology. Due to its greater nutritional and medicinal value, SBT has been applied in the traditional medicinal system of Europe and Asia from centuries [8].

SBT AS TRADITIONAL MEDICINE

SBT is a store house of vitamins, minerals and important bioactive substances. Berries, leaves, shrubs and seeds of SBT all are used as a traditional medicine. The berries have been utilized in medical system of India and Tibetan from more

than 1000 years [9]. SBT berries are rich in vitamins, organic acids, proteins, and carbohydrates [10]. The leaves have been applied to cure rheumatoid arthritis and skin disorders in middle Asia. The references to medicinal and nutritional applications of SBT were found in classic Tibetan medicinal texts, including "The RGYUD BZI" and the ancient Greek texts ascribed to Dioskorid and Theophrastus. SBT leaves extract was used in Mongolia to treat colitis [11].

Herbal medications of Sea buckthorn are commonly employed to treat the digestive system and diseases of skin [9]. The SBT oil finds excessive applications for the treatment of various skin conditions including cosmetic laser surgery, therapeutic radiation treatment, skin damaging effects of sun, burns, bad healing wounds and eczema [10]. SBT was also employed to cure asthma, jaundice, as laxative and for the treatment of rheumatism [12]. There are reports regarding the use of infusions of dried berries to cure the skin diseases [13, 14]. SBT was utilized long back in Germany for the ecological purposes [15]. In traditional Chinese medicine it was used in 618-907 A.D. against cough and to improve blood circulation, to overcome the digestive problems and relieve pain [16].

BOTANICAL DESCRIPTION

The Genus *Hippophae* is considered to have seven species; the exact number of species is still unknown and is not clear. Three common species include *Hippophae hamnoide*, *Hippophae tibetana* and *Hippophae salicifolia* of which *H. rhamnoides* L. *ssp. Turkestanica* is the most significant. SBT growing in north west Jambalaya at high altitude of 7000-15,000 feet is a dwarf thorny deciduous (3-15 feet) and nitrogen fixing shrub has been grown in various regions of the world due to its lot of medicinal and nutritional value [17]. Sea buckthorn is more known, widely eaten and cultivated in northern Europe and Asia [18]. From temperature point of view, it is able to withstand high daytime temperature even in summer and severe winter frost [16]. Its ripe berries are red/orange in colour. Each berry contains a single seed covered by an outer soft fleshy tissue. The seeds are 2.8-4.2 mm in size and elliptical in shape; they look glossy, dark brown and drupe like [2].

PHYTOCHEMISTRY

SBT leaves and berries contain numerous bioactive compounds which find a special importance. The plant material can especially be screened for compounds of interest. The presence of polyphenols in the leaves and the existence of tocotrienols, tocopherols, carotenoids, numerous bioactive components and essential polyunsaturated fatty acids in the berries have been reported by many investigators [19, 20].

SEA BUCKTHORN BERRIES

Although the berries of SBT are very acidic yet they are full of nutrients [21]. They combine a cocktail of components found separately in common and constitute a unique and distinct composition. The bioactive components vary in their methods of extraction, climate, geographic locations, species, fruit size and fruit maturity [10, 22]. They also composed of many important mineral elements like iron, calcium, phosphorus and most especially the potassium which has been suggested the most abundant element among all other elements [21]. The red, yellow or orange colour berries are highly valued as they are the rich sources of flavonoids, carotenoids (lutein, B-carotene, zeaxanthin and lycopene) and multiple vitamins (C and E), organic acids and micro-macro nutrients [19]. The SBT berries also constitute potassium and some other vitamins such as folic acid, B₁ and B₂ [23]. Owing to the presence of a lot of volatile compounds i.e., ethyl dodecenate, ethyl olecanote, ethyl octanoate and ethyl decanoate *etc*, the Hippophae berries have a distinct aroma which cannot be comparable to any other commonly found fruits [1, 22]. Moreover, very high amount of natural antioxidants in Hippophae berries owes to its the greatest antioxidant potential among the other medicinal plants [21]. Their major antioxidant is ascorbic acid [24]. Table 1 presents the antioxidant composition of SBT juice [25]. The constituents of SBT berries are described in table 2 [26].

TABLE 1. Antioxidant composition of SBT juice

| ANTIOXIDANT COMPOUNDS IN SBT JUICE | |
|--|--------|
| Item Name | mg/l |
| Vitamin E | 13.5 |
| α - β - γ tocopherols | 12.4 |
| α - β - γ Tocotrienols | 1.1 |
| Vitamins C | 1540.0 |
| Carotenoids | 73 |
| Flavonoids | 1182.0 |

SBT LEAVES

The leaves of SBT also have a remarkable amount of bioactive components and useful nutrients, especially phenolics. Such valuable ingredients include flavanols, leucoanthocyanidins, (-) epigallocatechin and gallic acid [8]. The fresh leaves of SBT

are rich in total chlorophyll (98.8mg/100g) and total carotenoids (26.3 mg/100g) [27]. There are also reports regarding the extraction of the tannins Hippophaenms A and B from the leaves of sea buck thorn [1].

TABLE 2. Constituents of SBT berries

| SR. NO | CONSTITUENTS | PER 100G FRESH BERRIES |
|--------|--|--|
| 1 | The main unsaturated fatty acids are oleic acid (Omega-9), palmitoleic acid (Omega-7), palmitic acid and linoleic acid (Omega-6) and linolenic acid (Omega-3); there are also saturated oils and sterols (mainly β - sitosterol) | 6-11% (3-5% in fruit pulp, 8-18% in seed) fatty acid composition and total oil content vary with subspecies. |
| 2 | Vitamin C | 28-310mg |
| 3 | Carotenoids, including β -carotene, lycopene and zeaxanthin | 32-45mg fatty acids (oils) |
| 4 | Vitamin E | Upto 180 mg |
| 5 | Folic acid | Upto 80 mg |
| 6 | Flavonoids | 50-500mg |

SBT OIL

SBT seed and pulp oil are rich source of fatty acids, carotenoids, phytosterols, vitamin E, K and 28 traces elements viz I₂, Mg, Ca, Zn and Fe etc. From the SBT, two different oils-the seed oil and pulp oil can be extracted [26]. Physiochemical properties of SBT are shown in table 3 [28].

TABLE 3. Physiochemical properties of SBT

| PARAMETERS | PULP OIL | SEED OIL |
|------------------|--------------|--------------|
| Refractive Index | 1.46 ± 0.002 | 1.4 ± 0.017 |
| Optical rotation | 2.10 ± 0.05 | 2.14 ± 0.065 |
| Acid Value | 8.80 ± 0.14 | 10.0 ± 0.235 |
| Peroxidase value | 1.36 ± 0.02 | 1.42 ± 0.030 |

SBT oil from pulp and seeds varies substantially in its fatty acid contents; it comprises of mono unsaturated fatty acid whereas seed oil contains majorly the poly unsaturated fatty acids [29].

BIO-CHEMICAL PROFILE OF SBT OILS

SB pulp and seed oil are rich source of carotenoids, fatty acids, phytosterols, vitamins K, E and twenty eight trace elements *viz*: Fe, Zn, Ca, Mg, Se, and I₂ *etc* [1]. Table 4 shows the major physio-constituents of SBT seeds and pulp oils.

TABLE 4. Major physio-constituents in SBT seed and pulp oil

| COMPOUNDS | SEED OIL | PULP OIL | REFERENCES |
|------------------------------------|----------------|----------------|------------|
| Sterols mg/100g | mg/100g | mg/100g | |
| Cholesterol | 3.7 | 4.6 | [1] |
| Campesterol | 22.5 | 12.4 | |
| Stigmasterol | 2.7 | 10.8 | [7] |
| B-Sistosterol | 748.1 | 576.9 | |
| Fatty acid (wt.) | (wt.) | (wt.) | |
| 16:0(Palmitic) | 7.2 | 35.5 | |
| 16:1(Palmitoleic) | ND | 38.5 | |
| 18:0(Stearic) | 2.6 | 1.2 | |
| 18:1 n-9(Oleic) | 13.6 | 3.5 | [30] |
| 18:1n-7 (11-Octadecanoic) | 2.3 | 7.3 | |
| 18:2 n-6(Linoleic) | 36.3 | 13.5 | |
| 18:3 n-3 (Linolenic) | 38.5 | 2.0 | |
| 24:1 (Nervonic) | ND | 1.3 | |
| Tocopherol (mg/100g) | mg/100g | mg/100g | |
| α-tocopherol | 223.4 | 143.7 | |
| Beta-tocopherol | 12.1 | 21.1 | |
| γ-tocopherol | 177.4 | 11.1 | |
| Delta-tocopherol | 8.0 | 6.5 | |
| Total Carotenoids (mg/100g) | mg/100g | mg/100g | |
| α,β and γ carotene | 22.2 | 527.8 | [31] |

ND – not determined

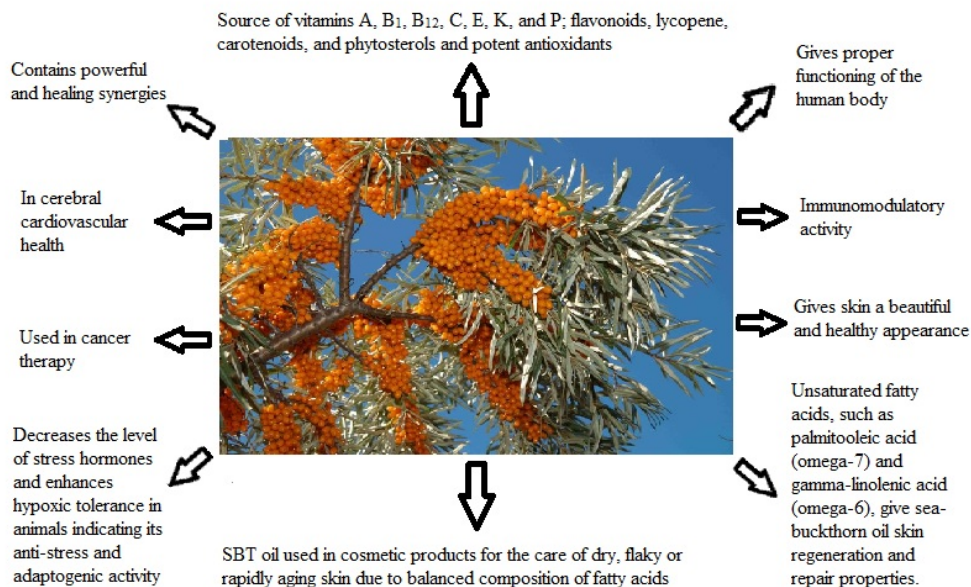


FIGURE 1. Important applications of SBT plant

POTENTIAL IMPORTANCE OF SBT FRUITS

Figure 1 displays some of the important applications of beautiful SBT plant. The major uses have been described below:

IN CEREBRAL-CARDIOVASCULAR HEALTH

The beneficial effects and medicinal usage of SBT in Tibetan traditional medicine have been reported since more than thousand years for the treatment of cardio-vascular diseases. SBT oil has tonic effect to cerebral cardio-vascular systems. The unsaturated fatty acids in the oil and the presence of flavonoids in numerous parts of SBT can improve the performance of cardiovascular system [32]. It can avert coronary heart disease [33] and can relieve symptoms of diabetes millets [34].

IN CANCER THERAPY

Sea buckthorn oil has ability to improve the life quality of the cancer patients during their treatment. Thus it plays a vital role in cancer therapy. The anti-cancer properties are majorly owed to the presence of flavonoids which are present in numerous parts of the this valuable plant [35].

IMMUNOMODULATORY ACTIVITY

Immunity is defined as the process and ability of our body to resist against the pathogens which are harmful for us [36]. The berries of SBT have been found effective against T-2 toxin induced immunodepression in broiler chickens, due to their immunoprotective effects [37].

ANTI-BACTERIAL EFFECTS

Hippocampal leaves possess antibacterial inhibiting effects against *Staphylococcus aureus*, *Enterococcus*, *Pseudomonas aeruginosa* and *Bacillus cereus* [38].

IN SKIN PROBLEMS

SBT oil has been employed traditionally to support the healing of skin diseases and enhance the recovery of skin injuries; these findings are completely concordant with the data obtained from modern clinical studies [39]. The oil of sea buckthorn has been found useful in the treatment of various diseases such as bacterial infections, pain, stomach tumour and abscess obstruction by inflammation and sputum [30].

ANTIOXIDANT ACTIVITY

SBT oil is rich in fatty acids (1:1 ratio of Omega-3), Omega-6, carotenoids (β -carotene), phytosterols, oleic acid and 28 trace elements [40].

OTHER USES

SBT products have been used to treat a variety of other diseases [10]. SBT oil acts as a strong antioxidant and has been applied for the balancing of an immune system. SBT flavonoids could significantly increase the antihyperglycemic condition [41].

DRAWBACKS OF SEABUCKTHORN

Very few side effects from sea buckthorn have been reported. These include high blood pressure, swelling, headache, dizziness and palpitations in some people. When used on the skin to treat burns, it sometimes caused a rash. It has been investigated that the overconsumption of SBT over six months may cause the yellowing of the skin [26].

CONCLUDING REMARKS

SBT has high-nutritional and medicinal values due to its very rich antioxidant property. SBT is a optimistic plant since it contains a lot of medicinal compounds as well as the dietary nutrients which play a crucial role in the improvement of the human health. SBT shows multiple therapeutic and pharmacological activities such as immune modulatory, antioxidant, anti-stress, anti-inflammatory, cardioprotective and anticancer. Its different parts (leaves, fruits and seeds) play an important role in wound healing. The SBT oil can be successfully applied for the treatment of skin diseases and skin injuries. There is no doubt that the future holds great promise for SBT bio-activities and remedial prospective.

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Shabbir Hussain

Department of Chemistry

Lahore Garrison University

Lahore, Pakistan

e-mail: shabchem786@gmail.com

phone: # +92-3214140130

