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# Pharmacological Action, Medicinal Potential of Sea Buckthorn (Hippophae Rhamnoides L.) : A Comprehensive Review

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**ABSTRACT :** The little sea buckthorn tree (Hippophae rhamnoides L.) has long been prized for its therapeutic qualities. Known to contain phytochemicals, sea buckthorn leaves and berries have been used in traditional medicine to treat wounds, ulcers, oedema, inflammation, and high blood pressure. The ancient miracle plant known as sea buckthorn (Hippophae rhamnoides L.) is of significant interest due to its biological activity, toughness, and plenty of nutritional active components. The sea buckthorn belongs to the family Elaeagnaceae and is a deciduous shrub or tree of the genus Hippophae. It is a pioneer tree species for conserving soil and water, improving soil, and controlling wind and sand. Numerous nutritionally active substances, including vitamins, carotenoids, polyphenols, fatty acids, and phytosterols, are found in sea buckthorn. Antioxidant, anticancer, anti-hyperlipidemic, anti-obesity, anti-inflammatory, antibacterial, antiviral, dermatological, neurological, and hepatoprotective properties are only a few of the numerous health advantages of sea buckthorn. Sea buckthorn is a plant with considerable therapeutic and medical potential as well as potential commercial value. The phytochemistry, nutrition, health advantages, and culinary uses of sea buckthorn are mostly outlined in this paper. All things considered, sea buckthorn is a dietary source of bioactive chemicals that may be turned into functional foods or dietary supplements for the treatment and prevention of specific chronic illnesses, which merits more investigation.

**KEYWORDS***:* Sea Buckthorn, Hippophae Rhamnoides, Medicine, Cultivation, Cosmeceuticals.

## 1. INTRODUCTION

Seabuckthorn (Hippophae rhamnoides L.), the widest berry-bearing shrub, is a member of the Elaeagnaceae family. Elaeangnus L., Hippophae L., and Shepherdia Nutt are the three genera into which its six species are grouped. It may be found all throughout Europe, Asia's Temperate Zone, and areas with subtropical climates, particularly at high altitudes on both continents. Hippophae rhamnoides is a plant with a thick, grayish-green crown, rough, earthy-colored or black bark, and a well developed and widespread root system. Its height can range from two to four meters. In eastern nations, sea buckthorn berries have long been used as food and medicine.[1] Sea buckthorn's nutritive and healing properties were validated by a number of rational investigations and clinical early reports during the 20th century. Numerous studies highlight a few key areas of research, including liver defense, gastrointestinal ulcer treatment, cardiovascular diseases, skin issues, and malignant growth therapy. To comprehend the processes that alleviate certain illnesses at the atomic and cell levels, much more investigation is required. Lipids are abundant in the sea buckthorn berry's seeds, herbal food, and strip. Like strawberries, the berry is oval or delicately roundish, with high quantities of vitamin E, vitamin C, flavonoids, carotenoids, and unsaturated fatty acids. It weighs between 270 and 480 mg and ranges in color

from bright yellow to dull orange. The extracted/pressed oils have a variety of unsaturated fat structures and are abundant in plant sterols and fatsoluble vitamins. Depending on where they are collected, the berries' structure and health advantages might change. It has acquired groundbreaking financial capability and has been utilized for hundreds of years in Europe and Asia for a variety of reasons.[2,3]

**Figure.1. Seabuckthorn Plant.**

Sea buckthorn snacks and radiation protection creams for Russian cosmonauts have been developed as a result of Russian scientists' research into the bioactive compounds found in sea buckthorn's berries, leaves, and bark since the 1940s. Sea buckthorn is said to as a "natural vitamin treasure house and a source of nutrition and health care" since it contains about 200 nutritional and bioactive components. As a result, the food sector uses sea buckthorn extensively to make breads, yogurts, jams, drinks, teas, and other goods.[4] As early as the first part of the ninth century, the Tibetan medical classic "Somaratsa" mentions the sea buckthorn's therapeutic benefits. Sea buckthorn has been widely used in traditional medicine to heal ulcers, sluggish digestion, stomach issues, liver damage, cardiovascular issues, and skin conditions. Numerous studies on sea buckthorn's pharmacological properties, such as its antiviral, anticancer, anti-inflammatory, and antibacterial properties, as well as its potential to protect the heart, have been published in recent years. The fact that sea buckthorn contains a variety of vitamins, carotenoids, polyphenols, and fatty acids may be the reason for its undeniable medicinal and therapeutic potential. An important plant for the environment and the economy is sea buckthorn. The International Sea Buckthorn Association (ISA) was founded in 1999 by China, India, Canada, and other countries to promote the benefits of sea buckthorn for human health, economic growth, and environmental preservation. More nations have recently learned about sea buckthorn's potential as a medicine, and many more are starting to acknowledge and grow their sea buckthorn industries.[4,5]

### 1.1. HISTORICAL BACKGROUND AND TRADITIONAL USES

The Latin words "Hippo" (meaning horse) and "Phaos" (meaning shine) are the roots of the English term "Hippophae." Animals in Greece were fed SBT leaves and twigs, which caused them to gain weight and have shiny coats, particularly horses. It has been used historically to treat a wide range of illnesses. Classics like Jing Zhu Ben Cao from the Qing Dynasty and Sibu Yidian from the Tang Dynasty have documented several of its medicinal effects. As early as 900 AD, it was utilized in Tibet as a medicinal herb. Ancient Tibetan medical writings, such as "the RGyud Bzi" (The Four Books of Pharmacopoeia), which dates to the Tang Dynasty (618–907 AD), have allusions to the therapeutic use of SBT. SBT has been used as a traditional medicine for generations by people in central and southeast Asia to avoid a variety of illnesses. With centuries of local use as fuel, fodder, small lumber, food, and medicine, it has been regarded as one of the most significant and valuable bioresources. In Europe, the SBT berries were utilized to make herbal remedies, nutritious foods, and natural skin care products. SBT berries have been used in traditional Tibetan and Mongolian medicine to alleviate cough and phlegm, as well as to enhance blood circulation and digestive system function. SBT was used in the Indian Himalayan area and Russia to cure rheumatism, skin conditions, jaundice, asthma, gastrointestinal disorders, and as a laxative.[4,6]

### 1.2. GEOGRAPHICAL DISTRIBUTION

In India, the three most common species of seabuckthorn are Hippophae rhamnoides, H. salicifolia, and H. tibetana. In India, H. rhamnoides is the most common of them. India, China, Pakistan, Russia, Nepal, and other European and Asian nations are home to a large population of Hippophae rhamnoides Linn. Leh, Nubra, Changthang, Suru, Lahaul, and Spiti are the six valleys where sea buckthorn (Hippophae rhamnoides) grows natively. Additionally, it may be found in some areas of Sikkim's Nathula. Using

remote sensing and GIS, seabuckthorn has been mapped in the Jammu and Kashmir areas of Himachal Pradesh, Lahaul Spiti, and Ladakh.[6]

## 2. BOTANICAL DESCRIPTION

### 2.1. MORPHOLOGY

The sea buckthorn belongs to the genus Hippophae L. and family Elaeaceae. Some plants can reach a height of 18 meters, although most are between 1 and 8 meters. Typically about 3 to 8 cm in length and less than 7 mm in width, the leaves are lanceolate or linear. The leaves have a pronounced silver-gray bottom surface and a dark gray top surface. The fruits have a diameter of 5–8 mm and are oblate or spherical.[7] Usually, a number of fruits are clumped together. The fruit has a ruffled surface and is either orange-yellow or brownish-red in hue. The pulp has a soft texture and is greasy. Sea buckthorn seeds are obliquely oval, measuring around 4 mm in length and 2 mm in width. The seeds are glossy and brown, with a longitudinal groove in the middle. The seed coat is hard, and the seed kernel is creamy white.[8]

### 2.2. TAXONOMIC CLASSIFICATION OF HIPPOPHAE RHAMNOIDES LINN

Arne Rousi divided Hippophae L. (2n = 24) into three species—H. rhamnoides L., H. salicifolia D. Don, and H. tibetana Schlecht—based on the examination of morphological variation. SSP. carpatica Rousi, ssp. caucasica Rousi, ssp. gyantsensis Rousi, ssp. mongolica Rousi, ssp. sinensis Rousi, ssp. turkestanica Rousi, ssp. yunnanensis Rousi, ssp. rhamnoides, and ssp. fluviatilis van Soest are among the nine subspecies of H. rhamnoides. A fourth species, H. neurocarpa, was described by Liu and He. Liu and He, located in China's Qinghai-Tibet Plateau. The exact taxonomy of the genus Hippophae is still up for debate among taxonomists, though. The classification method has been updated and refined by Chinese scientist Hu, who has reclassified Hippophae L. into six species and seventeen subspecies.[8]

| | |
|---|---|
| Kingdom | Plantae |
| Sub kingdom | Phanerogamia |
| Division | Angiospermae |
| Class | Dicotyledons |
| Subclass | Monochalamydae |
| Series | Daphnales |
| Family | Elaeagnaceae |
| Genus | *Hippophae* |
| Species | *rhamnoides* Linn. |

**Table.1. Taxonomical Classification of Hippophaerhamnoides.**

## 3. CULTIVATION PRACTICES

### 3.1. CLIMATE AND SOIL

At an elevation of 2000 meters above mean sea level, sea buckthorn is a low-demanding shrub that grows wild in mountain valleys, slopes, riverbanks, etc. For its development, 400–600 mm of precipitation each year is ideal. It can withstand temperatures between -40°C and +40°C and thrives on sandy loam soils with a pH of 6-7. But beyond 30°C, the seedlings exhibit a burning effect. Since the crop needs a low temperature to blossom and set its fruit, it cannot be introduced to the tropical plains. Conditions that are wet and high in humidity are not conducive to its growth. Its cultivation is said to be specialized in the Trans-Himalayan Ladakh area of the Indian continent, which is distinguished by harsh weather conditions such as strong wind speeds, a high rate of soil erosion, and extremely high temperatures (from -30°C in the winter to +35°C in the summer). With its broad root structure, sea buckthorn is a resilient shrub that helps fix nitrogen by binding soil particles. Arable and marginal soils are appropriate for plant development, which improves soil health and serves as a support structure for other plants to grow smoothly.[9]

### 3.2. PLANTING AND CARE:

Sea buckthorn thrives in deep, sunny soils with reliable irrigation and a well-functioning drainage system. Its roots are deep (3–5 m), and for it to develop well, the soil surface must be smooth (free of stones and hard rocks) and at an ideal depth of 2-3 m. The single or double hedge row method is often advised for planting since it allows for more distance (1 m) between rows and less

distance between plants, making it easier to access each plant for cultural activities like as training, trimming, and harvesting. However, planting techniques and spacing might differ according on the climate, soil fertility, varietal characteristics, and orchard management techniques. Digging pits for plantations is best done in the fall (October to early November) and spring (March to April), after dormancy has begun and before buds appear, or at least 45 days prior to planting. Spring planting has been shown to provide the best plant establishment and survival.[9]

**3.3. VARIETIES AND PROPAGATION METHODS**:

Pencil-thick hardwood cuttings are the primary means of propagating sea buckthorn. Additional means of proliferation include suckers and seeds. Depending on the circumstances, the seeds typically germinate in 5–10 days, although they can remain viable for up to 3 years. The most often utilized high-yielding selections in horticulture are FRL Selection-1, FRL Selection-2, and FRL Selection-3. The most popular, less prickly, large fruit, and short-term foreign imports are being assessed in Kukumseri, Himachal Pradesh's Lahaul region. There are several ways to spread these choices.[9]

**3.4. TRAINING AND PRUNING:**

Training is a necessary process to provide the plant a desired form that facilitates cultural activities and gives it a robust, scientific structure. Since sea buckthorn is a thorny shrub, it has been noted that, in order to facilitate harvesting, the plant should not grow higher than two meters. Four years after planting, sea buckthorn plants under proper management have a crown that is 2-3 meters in diameter.[10]

**3.5. PLANTING AND NUTRIENT MANAGEMENT**

Sea buckthorn is best planted in the field in the spring. It takes three years before it bears fruit. Three by one meter is the space between the rooted cuttings. Since the crop is dioecious, a male to female ratio of 1:8 is maintained during planting in order to increase productivity. The crop reacts favorably to vitamin addition and phosphorus treatment.[10]

**3.6. HARVESTING**:

Handpicking, stripping, or flailing on the ground are the traditional methods of harvesting. Another typical method was to beat the shrub or remove the branches, then thresh them when the green fruits were soft, juicy, and deep yellow-orange or red. Conventional methods of sun-drying and storing fruit were shown to be ineffective and to lower fruit quality, which in turn affected market pricing. Sea buckthorn plants that are vegetatively propagated begin to bear fruit three to four years after planting, as opposed to seedlings that take five to six years. It takes them eight years of plantation life before they begin commercial output in the orchard.[11,12]

**3.7. YIELD**

The sea buckthorn plant's productivity is influenced by its age, cultivation type, and management techniques. Fruit production from cultivated types ranges from 10 to 15 tons per hectare when orchard conditions are appropriately handled. However, because plants are cultivated in a wild and natural environment, the yield of ripe fruits in Ladakh ranges from 0.6 to 2.0 kg/plant. After eight years of planting, 200–300 q of fresh leaves may be gathered per hectare annually.[12]

**3.8. DISEASES AND INSECT-PEST**:

In Russia, sea buckthorn has been shown to be afflicted by around 47 pathogen species from 42 genera. There aren't many reports on illnesses in India. At Gangotri and Ranichuri in Uttarakhand, the main illnesses in nurseries root rot brought on by Rhizoctonia solani, Verticillium sp., and Fusarium sp. Infestations have been noted.[10]

**3.9. POST-HARVEST PRACTICES**:

Non-climacteric, sea buckthorn ripens exclusively on the plant and does not ripen after harvest. around Ladakh and Lahaul, the fruits usually start to mature around the middle to end of August. Surface color, texture, juice content, and total soluble solids may all be used to assess their physiological maturity. Following maturity, there was a noticeable rise in the fruits' TSS (12° Brix) and

juice content (>70%). Although ripe fruits may stay on plant branches all winter long until April, storing them for as extended period of time might degrade their texture and freshness. Fruits cannot be carried over long distances because they are soft, tiny, fragile, juicy, and very perishable. Fruits are gathered in 10-kg plastic baskets to prevent pressure damage. Additionally, rinsing the ripe fruits with cold water reduces their musky odor before processing. After harvesting, they must be processed right away (within 24 hours). However, fruits can help lower post-harvest losses.[13]

## 4. PHYTOCHEMISTRY

SBT leaves and berries contain a variety of bioactive chemicals that are particularly interesting, and the plant material is being tested for a few of these compounds. Numerous studies are looking at the amounts of carotenoids, tocopherols, tocotrienols, important polyunsaturated fatty acids, and other bioactive substances in berries and polyphenols in leaves.

- **Fruits :**

SBT berries combine a variety of ingredients that are often only obtained separately, giving them a distinctive makeup. Fruit size, age, species, location, climate, and extraction techniques all affect the bioactive components. Berries are orange-yellow to red fruits that are rich in numerous vitamins (C and E), and 1-Ohexadecanolenin are among the several bioactive components that were extracted from the SBT berries. Chromatographic study of SBT berries revealed the presence of zeaxanthin and betacryptoxanthin esters, which can be utilized as nutraceuticals, food additives, or cosmetic components.[14]

- **Leaves :**

Flavonoids, carotenoids, free and esterified sterols, triterpenols, and isoprenols are among the nutrients and bioactive compounds found in SBT leaves. Important antioxidants such as beta-carotene, vitamin E, catechins, elagic acid, ferulic acid, folic acid, and notable amounts of calcium, magnesium, and potassium are also abundant in the leaves. Flavonols, leucoanthocyanidins, epicatechin (−), gallocatechin (+), epigallocatechin (−), and gallic acid are the polyphenolic chemicals found in leaves. The main constituents of the hydrolyzable gallo- and ellagi-tannins of monomeric type strictinin, isostrictinin, casuarinin, and casuarictin were the tannin fraction that was extracted from the leaves for the research. Aqueous and hydroalcoholic leaf extracts of SBT have recently been investigated for their antibacterial, cytoprotective, and antioxidant properties employing a variety of in vitro systems and RP-HPLC analysis of marker chemicals. RP-HPLC was used to quantify a number of its bioactive phenolic compounds in aqueous and hydroalcoholic SBT leaf extracts, including isorhamnetin, kaempferol, quercetin-3-O-galactoside, and quercetin-3-O-glucoside.[14]

## 5. CHEMICAL COMPOSITION

Because of its inherent capacity to contain a variety of advantageous substances, including carotenoids and b-Lactoglobulin, sea buckthorn is highly valued in the nutraceutical and pharmaceutical industries. Sea buckthorn also contains important flavonoids as kaempferol, quercetin, and isorhamnetin. Tocopherols, carotenoids, and organic acids are among the many phytochemicals and polyphenols found in abundance in this fruit. Antioxidants, vitamins, proteins, carbs, amino acids, flavonoids, phytosterols, and vital minerals like calcium, phosphorus, and iron are all abundant in its berries. Sea buckthorn's outstanding relevance is demonstrated by the remarkably high amounts of both hydrophilic antioxidants (flavonoids, tannins, phenolic acids, and ascorbic acid) and lipophilic antioxidants (mostly carotenoids and tocopherols). Sea buckthorn juice is rich in several free amino acids. Chinese sea buckthorn juice contains eighteen distinct kinds of free amino acids.[15]

| Composition | Concentration In Pulp Oil (Mg/100G) |
|---|---|
| Vitamin E | 171 |
| Vitamin K | 54-59 |
| Carotenoids | 300-870 |
| Total acids | 38 |
| Total sterols | 721 |
| Vitamin C | 400 |

**Table 2. Major Phytochemical Compounds In Sea Buckthorn.**

## 6. NUTRITIONAL PROFILE

The plant has a distinct blend of bioactive substances, particularly in the fruits. Fruit juices, jams, and oils that contain phenolics, vitamins, minerals, amino acids, fatty acids, and phytosterols should have a variety of positive anti-inflammatory, anti-carcinogenic, antioxidant, and anti-atherosclerotic effects in both in vitro and in vivo studies using human and animal models. Nonpolar solvents like hexane can be used to extract plant oils, which are typically hydrophobic or lipophilic substances. There are a lot of therapeutic and nutritious components in the fruit oil. The pulp and seeds may both be used to extract oil. Eight to twenty percent of the mature seeds are oily, twenty to twenty-five percent are dried fruit pulp (flesh and peel), and around.[16]

### 6.1. NUTRIENTS AND BIOACTIVE COMPOUNDS

Nearly 200 minerals and bioactive substances may be found in sea buckthorn. The health advantages of several of the ingredients are widely recognized. One of the most crucial nutrients in sea buckthorn is vitamin C. Sea buckthorn's primary bioactive and antioxidant constituents include carotenoids and polyphenolic chemicals, particularly phenolic acids and flavonoids. Additionally significant are the sea buckthorn's organic acids, amino acids, fatty acids, phytosterols, and minerals. Sea buckthorn's health benefit is influenced by its minerals and bioactive makeup.[16]

## 7. PHARMACOLOGICAL ACTIVITY

### 7.1. ANTIOXIDANT ACTIVITY

Numerous investigations have verified sea buckthorn's antioxidant properties both in vitro and in vivo. Protein carbonylation and hydrogen peroxide (H2O2) or H2O2/Fe induced plasma lipid peroxidation are inhibited by the phenolic portion found in sea buckthorn fruits. Protein carbonylation is really a quite reliable indicator of oxidative stress. The quantity of carbonyl groups in plasma protein treatment with H2O2 or H2O2/Fe was decreased by the phenolic components of sea buckthorn fruit. The inhibition rate of plasma lipid peroxidation reached 60% when plasma was treated with sea buckthorn phenolic fractions at a concentration of 50 g/mL for 60 minutes. When administered in conjunction with or without atorvastatin to treat hyperlipidemia, in vitro studies have demonstrated that sea buckthorn extract can lessen the oxidative damage brought on by lipid peroxidation.

Furthermore, sea buckthorn leaf extract increases the membrane integrity and survival of PC-12 neurons by dose-dependently reducing intracellular oxidative stress.[17]

### 7.2. ANTICANCER ACTIVITY

Numerous research have currently demonstrated the anticancer properties of sea buckthorn's bioactive ingredients. The active component of kaempferol and its derivatives, sea buckthorn polyphenols, have demonstrated strong anti-colon cancer properties both in vitro and in vivo. Sea buckthorn polyphenols decrease the expression of cyclins, which stops the cell cycle in the G1 phase and prevents colon cancer from proliferating further. They accomplish this by upregulating the expression of microRNA (miR)-195-5p and miR-497-5p and downregulating the expression of miR-1247-3p. Furthermore, in xenografted BALB/c nude mice, sea buckthorn polyphenols (50 mg/kg) dramatically decreased tumor volume and controlled tumor development in vivo. Prostate specific antigen (PSA), eleven-nineteen lysine-rich leukemia 2 (ELL2), ELL-associated factor 2, and androgen response genes were all markedly downregulated by the sea buckthorn leaf aqueous extract, which also successfully targeted the androgen receptor (AR). sea buckthorn leaves have potential as a functional diet that might be crucial in preventing prostate cancer in high-risk individuals. The possible bioactive substances found in sea buckthorn leaves, however, have not yet been studied in order to create novel prostate cancer therapy approaches. suggested that sea buckthorn leaf extract at 6.2 and 62 mg/mL enhanced expression of the pro-apoptotic protein B-cell lymphoma-2 (BCL2)-associated X (Bax), inhibited the rapid proliferation of C6 glioma cells (11 and 49.5%), and significantly decreased the production of intracellular ROS by 16.3 and 42.3%, respectively.[17, 18]

### 7.3. ANTI-HYPERLIPIDEMIA ACTIVITY

One significant risk factor for cardiovascular disease is hypercholesterolemia. Phytosterols, the bioactive component found in sea buckthorn pulp's lipids, are crucial in preventing cardiovascular illnesses, including hypercholesterolemia. Spreads containing

more phytosterols have a greater cholesterol-lowering impact, lowering low-density lipoprotein cholesterol (LDL-C) levels by around 10% to 15%, according to several clinical research. Phytosterols may have a hypocholesterolemic impact by promoting the excretion of cholesterol in the form of neutral steroids and inhibiting endogenous cholesterol reabsorption. Supplementing with sea buckthorn berries or extracts significantly improved total cholesterol, triglycerides (TG), LDL-C, and high-density lipoprotein cholesterol (HDLC) in subjects with hyperlipidemia, but not in healthy subjects, according to a meta-analysis of 11 independent randomized controlled trials. Through the suppression of adipose tissue inflammation, the promotion of PPARa expression, and the inhibition of peroxisome proliferator-activated receptor gamma (PPARg) expression, FSH may enhance lipid metabolism. Furthermore, in hamsters with hyperlipemia, sea buckthorn fruit oil extract reduced metabolic dysfunction in a dose-dependent manner. This included lowering oxidative stress and liver impairment via the AMP-activated protein kinase (AMPK) and Akt pathways, as well as improving blood lipid composition (total cholesterol (TC), TG, HDL-C, and non-HDL-C levels).[18]

### 7.4. ANTI-OBESITY ACTIVITY

In order to activate brown adipocytes and enhance thermogenesis, sea buckthorn polysaccharide stimulates the production of PPARg-coactivator 1a (PGC1a), uncoupling protein-1 (UCP-1), and PR domain containing 16 (PRDM 16) in adipocytes. This prevents fat storage and weight gain. Sea buckthorn fruit oil extract, which is high in palmitic acid, lowers the weight of hypercholesterolemic hamsters and lowers the blood sugar levels brought on by dyslipidemia. Consequently, sea buckthorn fruit oil can alleviate hyperlipidemia-induced obesity. In HFD-induced obese mice, FSH at dosages of 100 and 300 mg/kg was shown to significantly lower body weight increase by 33.06 and 43.51%, respectively. Low-temperature freeze-drying technique is used to create sea buckthorn freeze-dried powder, which preserves all of the plant's beneficial nutrients and functional components. Sea buckthorn powder reduces obesity brought on by a high-fat diet by changing the structure and makeup of the gut microbiota. Sea buckthorn has the potential to become a dietary supplement and functional food for obese individuals.[18]

### 7.5. ANTIPLATELET ACTIVITY

In order to prevent and treat cardiovascular thrombotic events brought on by a variety of factors, anticoagulant and antiplatelet medications are crucial. Comparing the polyphenol and triterpenic acid-rich fractions from leaves and twigs to the polyphenol-rich fraction of sea buckthorn fruit at the maximum concentration (50 mg/mL), the latter exhibits strong antiplatelet activity. In three models of non-activated platelets, platelets activated by 10 mM adenosine diphosphate (ADP), and platelets triggered by 10 mg/mL of collagen, it has been demonstrated to suppress the production of PAC-1. The reduced expression of GPIIb/IIIa may be the cause of this suppression of platelet aggregation. According to another study, the phenolic and non-polar fractions of sea buckthorn leaves exhibited less antiplatelet activity than the non-polar fraction of sea buckthorn twigs. Platelet receptor expression, variations in ROS concentration, and the control of arachidonic acid metabolism may all be connected to this action. The adherence of thrombin-activated platelets to fibrinogen was decreased by 65 percent and that of resting platelets by 55 percent by the 50 g/mL sea buckthorn fraction.[19]

### 7.6. DERMATOLOGICAL EFFECT ACTIVITY

There have been several dermatological reports of sea buckthorn's effects. Sea buckthorn has been shown in clinical studies to have anti-psoriasis properties. Boca et al. used topical sea buckthorn fruit extract to treat ten patients with mild to moderate psoriasis. The Dermatology Life Quality Index (DLQI) and Psoriasis Area Severity Index (PASI) ratings in the treatment group improved at the fourth and eighth weeks of therapy as compared to patients receiving a placebo. In animal models, sea buckthorn also demonstrates anti-psoriatic and anti-atopic dermatitis properties. Sea buckthorn oil applied topically (20 mL) and orally (100 and 200 mg/kg) significantly decreased ear biopsy weights and inhibited ear edema (34.05 -7.65% and 30.45 _ 8.90%, respectively) in the 12-O-tetradecanoylphorbol-13-acetate (TPA)-induced psoriasis-like lesion CD-1 mouse model. There are anti-inflammatory and anti-psoriatic qualities to sea buckthorn oil. These effects might be explained by the high fatty acid content of sea buckthorn oil, which inhibits reactive nitrogen and suppresses pro-inflammatory cytokines and nuclear factor kappa-B (NF-kB) protein.[19,20,21]

### 7.7. ANTIMICROBIAL AND ANTIVIRAL ACTIVITY

Sea buckthorn has been shown to have antibacterial properties in vitro. discovered that all 67 gram-positive bacteria collected from clinical samples were strongly inhibited by sea buckthorn leaf extract. At a concentration of 5%, sea buckthorn leaf extract reduced the growth of S. aureus, S. epidermidis, S. intermedius, and S. pyogenes by nearly 50%. By suppressing several pro-inflammatory cytokines and apoptotic pathways, including ILs, TNFs, transforming growth factors (TGFs), IFNs, fibroblast growth factors (FGFs), MAPKs, matrix metalloproteinases (MMPs), shown that a mouthwash made experimentally using sea buckthorn pulp oil has the capacity to prevent the development of single-strain and multi-strain biofilms and had bactericidal effects on certain periodontal bacteria. Additionally, sea buckthorn has strong antiviral properties. Herpes simplex type 2 (HSV-2) virus multiplication was suppressed by 14-Noreudesmanes and a phenylpropane heterodimer that were isolated from the 70% methanol extract of sea buckthorn fruit.[22]

### 7.8. NEUROPROTECTIVE ACTIVITY

Neurofibrillary tangles brought on by Tau protein hyperphosphorylation and extracellular amyloid-b (Ab) deposition are common histological alterations in Alzheimer's disease, a neurodegenerative illness. Sea buckthorn powder, at 1.5 g/mL, is the most efficient in removing intracellular Ab deposits. The greater antioxidant content of sea buckthorn berry powder may be the cause of this discovery. Antioxidants have a neuroprotective effect, which inhibits Ab-induced toxicity and stops cell death. According to a different research, sea buckthorn flavonoids decreased the expression of protein tyrosine phosphatase 1B (PTP1B), increased the activation of insulin receptor substrate (IRS)/AKT, and restored insulin signaling pathways while also causing neurogenic damage. Modification of transvascular leakage brought on by hypoxia Unacclimated people may experience cerebral and pulmonary syndromes soon after ascending to high altitude, which can lead to high altitude illnesses like high altitude cerebral edema and high altitude pulmonary edema. These conditions can be brought on by fluid leaking from intravascular to extravascular space in the brain, lungs, and peripheral tissues.[20]

### 7.9. ANTI-STRESS AND ADAPTOGENIC ACTIVITY

Adaptogens are herbal compositions that can improve mental clarity, physical stamina, and the body's general tolerance to stress. Rats were used in a passive cold (5 ◦C)–hypoxia (428 mmHg)–restraint (C–H–R) animal paradigm to examine the adaptogenic activity of SBT leaf extract. Significant anti-stress and adaptogenic effect was demonstrated by SBT leaf aqueous extract when given orally to rats 30 minutes before to C-H-R exposure at a dosage of 100 mg/kg BW in both single and five treatments. The extract's impact on antioxidant markers and lipid peroxidation in the rat liver and gastrocnemius muscle was investigated. The findings indicated that rats' liver and muscle experienced less oxidative stress during C-H-R exposure and post-stress recovery when supplemented with SBT leaf extract.[20,21,22]

## 8. MEDICINAL USES

### 8.1. CANCER THERAPY:

Although there is a dearth of research on the involvement of hippocampal cells in cancer prevention and control, there is some analysis of the experimental research data on hippocampal anticancer now accessible. The positive medication was more successful than Hippophae oil in inhibiting cancer cells; for instance, phosphamide had a twice as high cancer inhibition rate as Hippophae. It has been discussed how the oil from sea buckthorn may have antimutagenic propertiesHippophae extract, an alcohol extract that mostly contains flavonoids, has been shown to have the ability to shield bone marrow against radiation-induced damage. This study also suggested that the extract may hasten bone marrow cell regeneration. A research conducted in China showed that mice given sea buckthorn oil recovered their hemopoietic system more quickly following large doses of chemotherapy. According to early lab research, the seed oil contains anti-tumor properties and improves non-specific immunity.[23]

### 8.2. CARDIOVASCULAR THERAPY:

Hippophae is used as a medication to prevent heart attacks. 128 ischemic heart disease patients received 10 mg of sea buckthorn flavonoids three times a day for six weeks as part of a double-blind research experiment. Compared to those taking the control

medication, the patients experienced fewer anginas, greater heart function, and a drop in cholesterol. Flavonoids from sea buckthorn did not have any negative effects on hepatic or renal functioning. By controlling inflammatory mediators, the mechanism of action may include less stress on the heart muscle tissue. The flavonoids of sea buckthorn were found to lower the formation of harmful thromboses in mice in another laboratory animal investigation. Recently, certain basic sea buckthorn-based formulae have been created with the goal of treating coronary heart disease and the aftereffects of heart attacks and strokes by enhancing blood flow and reestablishing cardiac pro-inflammatory mediators. function's antiulcerogenic action.[23]

### 8.3. LIVER DISEASES

Sea buckthorn extracts helped regulate liver enzymes, serum bile acids, and immune system indicators linked to liver inflammation and degeneration, according to a clinical investigation. Additionally, tests conducted in labs have shown that sea buckthorn oil shields the liver from the harmful effects of hazardous substances. Sea buckthorn is rich in vitamin A precursors, such as beta-carotene and unsaturated fatty acids, according to recent studies. shown that sea buckthorn may protect the liver from CCl-induced harm. When treating individuals with chronic hepatitis-B, a combination of sea buckthorn and an antiviral medication may reduce the time it takes for serum ALT levels to return to normal.[24]

### 8.4. SKIN DISEASES

Skin contains palmitoleic acid, a substance in the oil. It is regarded as a useful topical medication for wound healing and burn treatment. If sufficient amounts of sea buckthorn or its oil are ingested, this fatty acid can also be taken orally to feed the skin; this is a helpful treatment for systemic skin conditions like atopic dermatitis. Sea buckthorn oil is already often used topically for burns, scalds, ulcerations, and infections, either by itself or in a variety of formulations. It is a component of sunscreen. Hippophae oil contains emollient qualities, UV-blocking action, and helps to promote tissue regeneration. In a different trial, 49 patients were given 5 g of sea buckthorn seed oil, pulp oil, or paraffin oil every day for four months. Prior to, throughout, and after the course of therapy, the fatty acid contents of the patients' plasma phospholipids and neutral lipids were examined.[23,24]

### 8.5. ANTI-ATHEROGENIC EFFECTS

Nearly 23.6 million individuals worldwide die from cardiovascular diseases, which are abnormalities of the heart and blood vessels. In addition to coronary heart disease, coronary artery disease, atherosclerosis, stroke, myocardial infarction, peripheral arterial disease, and arrhythmia, hyperlipidemia and hypercholesterolemia are the two primary risk factors for cardiovascular disease. For instance, sea buckthorn has a lot of flavonoids and other bioactive substances that help cure heart conditions. Two important flavonoids included in sea buckthorn fruit and leaves, isorhamnetin and quercetin, have been demonstrated to protect against oxidative damage, cancer, aging, and cardiac ischemia and reperfusion.[24]

### 8.6. ANTI-RADIATION EFFECTS AND RADIO PROTECTIVE ABILITY

Numerous studies have demonstrated that sea buckthorn's high concentration of antioxidants and physiologically active chemicals makes it useful in the treatment of cancer. found that in mouse bone marrow, a complete extract of fresh sea buckthorn berries (H. rhamnoides RH-3; 25–35 mg/kg body wt) provides protection against radiation-induced micronuclei. Additionally, RH-3 reportedly prevented radiation-mediated hydroxyl radical production and the Fenton reaction in vitro. The Comet test demonstrated that RH-3 reduced radiation-induced and tertiary butyl hydroperoxide-induced DNA strand breaks in a dose-dependent manner.[25]

## 9. VARIOUS USES OF SEA BUCKTHORN

Sea buckthorn (Hippophae rhamnoides L.) has gained widespread attention because to its healthful and therapeutic properties, as well as its contemporary legitimacy. Numerous bioactive substances, including as vitamins, unsaturated fats, basic components, amino acids, and other nutrients, may be found in sea buckthorn berries. The information that is now accessible on the composition of sea buckthorn has been gathered in order to discover elements of particular origins and assortments that are significant both medicinally and artificially.

**9.1.1. Potential as food**

The sea buckthorn berry, which is composed of pulp (68%) seed (23%), and strip (7.75%), is the most significant and nutrient-dense portion of the plant. The amounts of these several bioactive combinations differ according on the species, kind, size, location, maturity, color, and extraction method of the fruit. Its wonderful scent and acidic nature make it useful for flavoring culinary products. Berries include carbohydrates (glucose and fructose), minerals, vitamins (C, K, and E), unsaturated fats (BFAs), amino acids, natural acids, flavonoids (isorhamnetin, kaempferol, and quercetin), carotenoids, and tocopherols.[22,25]

**9.1.2. Potential as medicine**

In both Asia and Europe, sea buckthorn has long been used medicinally. In Russia, restorative application clinical studies started in the 1950s (Gurevich, 1956). Its main phytochemicals, which include flavonoids, carotenoids, unsaturated fats, and others, have been responsible for its healing properties. But the sea buckthorn (Hippophae rhamnoides L.) is a prickly plant with small, delicious berries that are dark orange to yellow. Berries' hydrophilic and lipophilic components have led to their usage as food and medicine. Numerous medical conditions, including as cancer, heart disease, skin conditions, inflammation, diseases of the central nervous system, and many more, can be treated using this plant's various herbal treatments.[25]

**9.1.3. Potential as cosmeceuticals**

Numerous cosmeceutical firms employ sea buckthorn to create their medications due to the significance of the fatty acid it contains. In dry skin, linolic acid improves the lipid membrane of the epidermis, regulates skin metabolism, and guards against trans-epidermal water loss. Sebum has been shown to contain linolic acid, which keeps the skin hydrated and helps heal it. It has been demonstrated that a person with acne has less linolic acid in their sebum, which causes spots and blackheads to form.[21,22]

**9.2. TRADITIONAL USES**

A popular ingredient in traditional Asian medicine is Hippophae rhamnoides Linn. This herb was traditionally used to treat menstruation disorders, colds, coughs, and gastrointestinal ailments. Many Sea Buckthorn (SBT) pharmaceutical formulations have been utilized in medicine to treat radiation damage, oral irritation, burns, and stomach ulcers. The Chinese Pharmacopoeia included sea buckthorn berries as a treatment for coughing, digestion, and blood circulation. It has been documented that sea buckthorn oil is used to treat eye disorders in Russia. Sea buckthorn oil was used to treat a variety of eye ailments, including visual acuity, dark adaptation, and corneal ulcers. Sea buckthorn has long been used to treat a number of ailments, such as dry eye, platelet aggregation, and atopic dermatitis.[24]

**9.3. ECOLOGICAL USES**

Seabuckthorn has been utilized in a variety of ways to preserve the Himalayan environment because of its distinctive biological characteristics.

**Unique Biological Features o f Seabuckthorn :**

- Robust root systems and self-propagation capabilities: A five-year plant has a 3-meter taproot and 6–10-meter horizontal roots. Through root turions, a three-year-old plant can yield ten to twenty next generation plants.
- Nitrogen-fixing capacity: An 8 to 10-year old seabuckthorn forest can fix 180 kg of nitrogen/ha/year .
- Capability to create biomass: 18 tons of fuel wood can be produced from a seabuckthorn plantation that is 6 years old. Seabuckthorn wood has a heat value of 4785.5 cal/kg. 0.68 tons of regular coal are equivalent to one ton of seabuckthorn wood. [24]

**9.3.1. AS SOIL ENHANCER :**

Because of its large root system, seabuckthorn is helpful in recovering and preserving soil, particularly on slopes that are susceptible to erosion. It is appropriate for many conditions that are just too demanding for most plants since it can withstand low temperatures, salt in the soil, and drought. Seabuckthorn may grow well on steep slopes, lakeshores, riverbanks, and other vulnerable areas. Seabuckthorn windbreaks are a good way to stop wind erosion in wide spaces. The prickly shrub has also been

shown to be useful in keeping foot traffic from trampling on delicate flora. Because of its capacity to fix nitrogen, seabuckthorn not only stops soil erosion but also improves deteriorated soils. As a result, less fertilizer is required.[24]

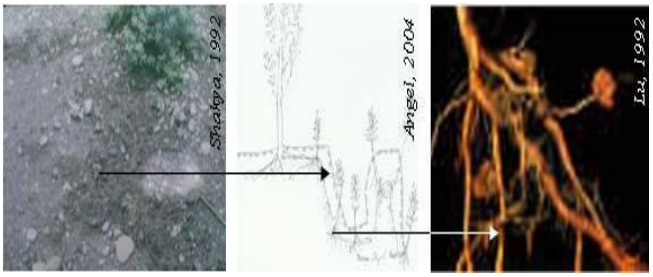


**Figure 2. Sub-terrain Rooting System of Seabuckthorn.**

### 9.3.2. AS POLLUTION REDUCER:

Because seabuckthorn may be utilized to re-vegetate a variety of mining wastes, it can help reduce pollution caused by erosion of polluted mine waste. Seabuckthorn requires less pesticides that might harm the environment because it is inherently pest-resistant. It has been planted as cover along highways in places of North America where de-icing salt inhibits the development of many other woody plants. Seabuckthorn thereby aids in halting roadside erosion and pollution discharge.[25]

### 9.3.3. AS A LANDSCAPE MANAGEMENT TOOL:

Seabuckthorn is one of the plants that has been successfully employed on a broad scale for re-vegetation, which is one of the most promising methods to reduce land degradation. It can assist in preventing desertification, conserving water and land, and combining ecological restoration with commercial exploitation. A live windbreak is a straight line of plants, mostly trees and shrubs, planted to lessen the negative impacts of high winds, including soil erosion. Additionally, it aids in managing snow buildup, protecting crops, and establishing habitat for wildlife. Windbreak plants need to be able to withstand the physical harm and drying impacts of wind, and seabuckthorn is a good choice for this purpose region.[24,25]

**Figure 3. Seabuckthorn Regeneration over Landslides.**

## 10. FOOD APPLICATIONS

Sea buckthorn has considerable economic value and is utilized extensively in food in addition to its biological and medicinal uses. In addition to being high in nutrients, sea buckthorn has a number of physiologically active substances. Nowadays, sea buckthorn is employed in many food items as a natural ingredient, antioxidant, and antibacterial. Sea buckthorn oil, freeze-dried powder, fruit juice, fruit wine, milk tablets, fruit vinegar beverages, tea (94), preserved fruit, yogurt, and jam are only a few of the increasingly varied uses of sea buckthorn in the food business. The maximum utilization of sea buckthorn to improve the sensory properties and nutritional value of sea buckthorn products is currently being pursued by food industry manufacturers and researchers. All in all, sea buckthorn has a promising future as a natural food additive. The bioactive compounds contained in sea buckthorn, such as polyphenols (especially flavonoids), ascorbic acid, vitamins, carotenoids, and antifreeze proteins exert antioxidant, antibacterial and antifreeze effects. In the future, it will be necessary to investigate these mechanisms of action in depth for better application in food production.[26]

## 11. CLINICAL STUDIES

Only a small number of findings from contemporary clinical studies support the majority of SBT's therapeutic applications in humans, which are based on anecdotal or historical accounts. Laboratory studies validate the effectiveness of seed oil for the traditional usage of SBT in treating stomach ulcers. In therapeutic settings, SBT seed oil has been used to treat ulcers and chronic cervicitis. used topically applied SBT seed oil to treat 30 patients with partial cervical erosion. The high concentration of natural carotenoids and tocopherols in seed oil may be the reason for its beneficial effects on mucosal injuries. Additionally, five women with urogenital tract diseases participated in a research investigation. All five cases of chronic vaginal inflammation improved after the patients received six capsules of standardized SBA25 Omega 7 SBT oil (extracted by supercritical CO2) containing three grams of SBT oil daily for 12 weeks. In a placebo-controlled, double-blind, cross-over study, 25 female Sjogren's syndrome patients (average age 52.2) with typical vaginal tract symptoms of burning, itching, liquid discharge, and dryness were examined.[27]

## 12. TOXICITY AND SAFETY STUDIES

Even though sea buckthorn has a lengthy history of use in medicine and nutrition, little is known about its safety and toxicity. found that the oil from sea buckthorn berries was neither teratogenic nor genotoxic. At exposure dosages ranging from 8 to 5,000 mg/plate, he discovered that sea buckthorn berry oil had no carcinogenic effect against Salmonella typhimurium isolates that were reliant on histidine. The shape of sperm and the micronucleus rate of polychromatic erythrocytes in mice were not significantly affected by sea buckthorn berry oil at doses up to 9.36 g/kg body weight. Furthermore, no maternal toxicity nor embryotoxicity were seen in pregnant mice when 4.68 g/kg of sea buckthorn fruit oil was administered. It was found that the rats' no-observed-adverse-effect level (NOAEL) was 4.68 g/kg of body weight. According to a 90-day safety investigation, rats' NOAEL for sea buckthorn aqueous fruit extract was 100 mg/kg body weight per day.[28]

## 13. CONCLUSION AND OUTLOOKS

Spread across over 2 million hectares of land globally, sea buckthorn is a rare and extremely important plant. The health advantages of sea buckthorn have been shown in in vitro, in vivo, and clinical investigations during the last five years. It contains about 200 bioactive components. Antioxidant, anticancer, anti-inflammatory, antihyperlipidemic, anti-obesity, antibacterial and antiviral, dermatological, neuroprotective, and hepatoprotective properties are some of these biological actions. In addition to the health food processing industries worldwide, sea buckthorn has recently become one of the most sought-after plants in the pharmaceutical and cosmetics sectors. The promise of SBT for improving livelihoods and protecting the environment is being used both economically and environmentally in a number of nations. Additionally, sea buckthorn is a promising dietary source of bioactive components and has generated significant commercial value in the food sector. Sea buckthorn is an economically and ecologically diverse shrub with a promising future. This ancient herb has greatly benefited humanity and has strong medicinal synergy. Sea buckthorn has a remarkable capacity to support both ecological and economic growth. The development of mechanical harvesting and suitable preservation technologies should be the main goals of future research in order to grow and use sea buckthorn resources in a sensible manner.

## 14.REFERENCE

[1] Shah RK, Idate A, Comprehensive Review On Sea Buckthorn: Biological Activity And Its Potential Uses, *The Pharma Innovation Journal*, 2021; 10(5): 942-953.

[2] Keerthana Sethunath, Jyothi Bhaskar, Seabuckthorn: A review on the hidden treasure of the temperate, *Journal Of Agriculture And Ecology Research International*, Volume 25, 2024; Issue 4, Page 98-106.

[3] Zhen Wang, Fenglan Zhao, Panpan Wei, Phytochemistry, Health Benefits, And Food Applications Of Seabuckthorn (*Hippophaerhamnoides* L.): A comprehensive review, *Frontiers in Nutrition*, 10.3389/fnut.2022.1036295, Page No-1-20.

[4] Suryakumar G, Gupta A, Medicinal and therapeutic potential of Sea buckthorn (*Hippophae rhamnoides L.) Journal of Ethnopharmacology*, 138 (2011), 268– 278.

[5] Natalia Sławin ska, Jerzy Z˙ uchowski, Extract from Sea Buckthorn Seeds- A Phytochemical, Antioxidant, and Hemostasis Study; Effect of Thermal Processing on Its Chemical Content and Biological Activity, *In Vitro Nutrients* 2023, 15, 686. https://doi.org/10.3390/nu15030686 Page No 1-13.

[6] Prakash S, Hurmat, Yadav S, Phytochemistry, Pharmacological Actions and Market Formulations of Sea buckthorn (*Hippophae rhamnoides* L.): A Comprehensive Review *Pharmacognosy Reviews*, Vol 18, Issue 35, Jan-Jun, 2024; 18(35):2-13.

[7] Jerzy Z, uchowski, Phytochemistry and pharmacology of sea buckthorn (Elaeagnus rhamnoides; syn. *Hippophae rhamnoides*): progress from 2010 to 2021, *Phytochem Rev* (2023) 22:3–33.

[8] Singh IP, Singh V, Sea buckthorn: A wonder bush, *Indian Farming*, *72* (12): 10-14; December 2022.

[9] Alam Zeb, Important Therapeutic Uses of Sea Buckthorn (*Hippophae*): A Review, *Journal of Biological Sciences* 4 (5): 687-693, 2004.

[10] Rajwant K, Rohtas S, Rai MK, Biotechnological interventions in seabuckthorn *(Hippophae L.). Curr Status Future Prospects* , 2011;25: 559-75.

[11] Rousi A., The genus Hippophae L. A taxonomic study, *Ann Bot Fennici* 1971; 8:177-227.

[12] Subedi CK, Adhikari K., Propagation Techniques of Sea Buckthorn (Hippophae Linn.) in Manang and Mustang Districts. A *Report Submitted to ISC*, Hattisar, Kathmandu ; 2001.

[13] Goel HC, SamantaN, Kannan K, Kumar IP, Bala M. Protection of spermatogenesis in mice against gammaray induced damage by Hippophaerhamnoides. *Andrologia*, 2006; 38:199-207.

[14] Rongsen L. Seabuckthorn: Mountain Farming System (MFS) Series No.12. Kathmandu,Nepal: ICIMOD;1990.

[15] Rajchal R. Sea Buckthorn (Hippophaesalicifolia) Management Guide. Submitted to the *Rufford Small Grants for Nature Conservation;*2009.

[16] Rongsen L. Sea buckthorn: A Multipurpose Plant Species for Fragile Mountains. Vol. 20. Kathmandu, Nepal: ICIMOD;1992.p.6-7.

[17] Li C, Xu G, Zang R, Korpelainen H, Berninger F. Sex-related differences in leaf morphologicaland physiological responses in Hippophaerhamnoides along an altitudinal gradient. *Tree Physiol* 2007;27:399-406.

[18] SchroederWR, YaoY. SeaBuckthorn: A Promising Multipurpose Crop for Saskatchewan. *Canada: PFRA Shelter belt Centre Publication;*1999.

[19] Antoond AL, Oelofsenja MR, Lom NB, Erstinh UD, Reinth A. Utilization of carbon and nitrogen compounds by Frankiain synthetic media and in root nodules of Alnusglutinosa, Hippophaerhamnoides, and Datisca cannabina.*CanJ Bot* 1983; 61: 2793-800.

[20] Oakley B, North M, Franklin JF, Hedlund BP, Staley JT. Diversity and distribution of Frankias trains symbiotic with Ceanothusin California. *Appl Environ Microbiol* 2004;70:6444-52.

[21] Jeppsson G. Changes in the content sofk aempherol, quercetinandL-ascorbicacidin seabuckthorn berries during maturation. *Agric Food Sci Finland* 2000; 9:17-22.

[22] Banjade MR. Sea buckthorn: Gift for the Fragile Mountains. A Project Paper Submitted to the Partial Fulfillment of the Requirement of B.Sc. Forestry Degree. Institute of Forestry, Pokhara, Nepal; 1999.

[23] Basistha BC. Vivipary in Sea buckthorn (H. Salicifolia D. Don). J Hill Res 2001;1:14 67.11.

[24] Schroeder WE. Planting and establishment of shelterbelts in humid severe-winter regions. *Agric Ecosyst Environ* 1988;23: 441-63.

[25] Deepak D, Maikhuri RK, Rao KS, Lalit K, Basic nutritional attributes of Hippophaerhamnoides (Seabuckthorn) populations from Uttarakhand Himalaya, *India.Curr Sci* 2007;92:1148-52.

[26] Wang H, LiuH, YangM, BaoL, GeJ. Phylogeographic study of Chinese seabuckthorn reveal stwodi stinctha plotype groups and multiple micro refugia on the Qinghai-Tibet *Plateau*. *Ecol E* vol 2014;4:4370-9.

[27] Dwivedi SK, StobdanT, SinghSB. Seabuckthorn in Ladakh. In: SeaBuckthorn (Hippophaespp.): The Golden Bush. Delhi: Satish Serial publishing House;2009.p.35-51.

[28] WuZY, Raven PH, HongDY. In:Floraof China.St.Louis: Science Press, Beijingand Missouri Botanical Garden Press; Vol 13, 2007, p.271-272.