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Review Article

HIPPOPHAE SALICIFOLIA D DON- A PLANT WITH MULTIFARIOUS BENEFITS

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ABSTRACT

Hippophae salicifolia (commonly known as Seabuckthorn) can be regarded as a rich natural source of multivitamins. High amounts of vitamins A, B1, B12, E, K and polyphenols account for its vast nutraceutical properties. Some studies have established the superiority of *H. salicifolia* over other close relatives in terms of bioactive components. Despite all its valuable properties, the plant has an ignored status- both commercially and ecologically. The pharmaceutical, nutraceutical and cosmetic industries continue resorting to other *Hippophae* species which have comparatively lower nutrient content. To add to it, lack of information about the importance of *H. sailcifolia* among the growers is leading to degradation of natural populations in some regions. The article aims to provide an insight into different aspects of *H. salicifolia* and highlight the need for research and development pertaining to the species.

Keywords: *Hippophae salicifolia,* Vitamin, Medicinal properties, Nutraceutical value, Nitrogen fixation, Commercial value.

INTRODUCTION

The genus Hippophae (family Elaeagnaceae) comprises of five species viz. *H. rhamnoides* L., *H. salicifolia* D. Don, *H. neurocarpa* Liu & He, *H. tibetana* Schlecht and *H. goniocarpa*. However, as per the classification reported by [1, 2, 3, 4] the genus is divided into seven species and nine subspecies based on morphological variations. Among them, *H. salicifolia* can be considered as one of the most valuable in terms of high vitamin C content high quality fruit, high yield and less thorns [5, 6]. Fruits and vegetables viz. Citrus fruits, kiwi fruit, tomatoes etc. are regarded as excellent sources of vitamin C. However, none of these available plant species are at par with significantly high vitamin content of *Hippophae salicifolia* fruit. As shown in table 1 *H. salicifolia* possesses a considerably high amount of vitamin C as compared to *Citrus aurantifolia* (lime) which is most commonly used vitamin C source. Like other Seabuckthorn species *H. salicifolia* is also a rich source of carotenoid, minerals, vitamin B, vitamin E and vitamin K [7]. This adds to advantage of *H. salicifolia* in terms of its nutritional value [7, 23].

Habit, Habitat and Morphology

H. salicifolia grows widely in regions of China and Russia with large but uneven distribution in Eurasia between 27 and 69°N latitude and 7°W and 122°E longitudes. In India, *H. salicifolia* is most common and widely distributed *Hippophae* species which is restricted to the Himalayan region, between 1500-3600 m a. m. s. l. including the north-west Himalayan region of Himachal Pradesh, Uttarakhand and eastern India [7-12]. *H. salicifolia* prefers to grow in low humidity, alluvial gravel, wet landslips and riverside. However, it can also grow in arid to very wet conditions [7, 13]. It is hydrophilous in nature; growing preferably in areas receiving an annual precipitation of 400-600 mm. It has also been reported to grow in regions with annual moisture-range of 600-700 mm. Though, the ideal temperature conditions are -10^0C (in winter) to 30^0C (in summer), the plant has also been growing in areas of Finland at a temperature range of $+40^0$C to -40^0C, though better germination rates are observed only at a temperature of 24^0C -26^0C [7]. Thus, the species can be regarded as stress-tolerant which can survive a range of temperatures, high soil pH (about 8.0) and increased soil-salinity.

H. salicifolia commonly known as wonder plant, green hope or 'cold desert gold willow leaf, arboreal or Chuk, Tarwa [14], is a dioecious shrub or a small tree, about 2m to 6m high and 50 cm in diameter with a thick grey crown. The bark is brown or black in colour with a rough appearance (fig. 1a). The leaves are alternate, narrow, lanceolate with a greyish appearance [15]. Flowering occurs only in about 3 –4 years old plant. Male inflorescence has 4 to 6 apetalous flowers which release pollens at a temperature of about 6^0C to 10^0C. In case of female inflorescence, there is only a single apetalous flower with one ovary and one ovule. Pollination via insects is impeded by the fact that both the male and female flowers lack nectarines which are instrumental for attracting insects. The pollination is, thus, extensively wind – dependent. The fruits (5.51 to 7.24 mm size) are generally round but may also be ovate in some cases. They are initially pale green in colour and turn golden-brown on ripening around the month of September [16] (fig. 1b). The berries have a tough skin covering the juicy pulp and a small, hard, oval seed (fig. 1c). The review aims to provide an insight into the pharmacological, commercial and ecological potentials of *H. salicifolia* – the undermined multipurpose plant.

Table 1: It shows comparison in Vitamin C content of primary vitamin rich fruits [7, 23].

Species	Vitamin C (mg/100g fruit)	Vitamin K (mg/100g)
Hippophae salicifolia	2984.0 ± 18.5	100-200
Actinidia chinensis	120-180	-
Citrus sinensis	50.0	-
Lycopersicon sp	11.8	-
Citrus aurantifolia	29	-

Table 2: It shows a comparative estimation of vitamin C and polyphenol content in the berries of three Seabuckthorn species [23].

SB species	Vitamin C (mg/100g)	Polyphenols (mg/100g)
H. rhamnoides	230.5 ± 2.9	521.3 ± 3.2
H. salicifolia	2984.0 ± 18.5	591.3 ± 4.2
H. tibetana	878.9 ± 6.5	571.9 ± 3.5

Fig. 1: (a-c) *Hippophae salicifolia* D. Don. (a) Naturally growing *H. salicifolia* plant (b) Fruits of *H. salicifolia* (c) Seeds of *H. salicifolia*

Ecological Impact

H. salicifolia is useful in reclaiming and conserving soil, especially on fragile slopes, due to its extensive root system. Because it is resistant to drought and tolerates soil salinity and low temperatures, it is suitable for many situations that are simply too demanding for most plants. Riverbanks, lakeshores, steep slopes and other susceptible terrain can benefit from the establishment of seabuckthorn. Windbreaks made up of *H. salicifolia* are effective at preventing wind erosion in open areas [17].

The root system of *H. salicifolia* is an extensive, sub-terranean rhizomatous type that help in strong soil -binding, soil stabilization and water retention. The roots are in symbiotic association with *Frankia* in its nodules and nodulation varies with plant height [18]. This *Frankial* association accounts for atmospheric nitrogen fixation, hence adding to the soil-fertility [7, 19]. The expanded root-system helps to fix atmospheric nitrogen @60 - 80kg/ha/ annum. This property aided by rapid growth, strong coppicing, wide ecological adaptations of the plant makes it efficient for soil conservation, improvement and restoration of degraded land in hilly areas [20]. Enhanced nitrogen supply from the plant has also been shown to augment the growth of trees like poplar, pine etc. [21, 22].

Chemical constituents and nutritive value

Pharmacological investigations on *H. salicifolia* have established the species to be a rich source of vitamins, the content being 5-100 times higher than in other fruits/vegetables (Table 1). The fruits are particularly rich in vitamins A, B_1, B_{12}, C, E (including α, β, γ - V_E), K and are a rich source of a large number of polyphenols (flavanoids: isorhamnetin, quercetin, myricetin, kaempferol and their glycoside compounds and non-flavanoids) [7, 23]. A comparative estimation of vitamin C and polyphenols content in the berries of three sea buckthorn species (*H. rhamnoides*, *H. salicifolia* and *H. tibetana)* from India showed Vitamin C content in *H. salicifolia* to be 10-fold greater than other species (Table 2). Higher phenolic content in *H. salicifolia* as compared to *H. rhamnoides* has also been confirmed [24-23].

Sea buckthorn species have been extensively studied to contain low amounts of oil and lipophilic components like carotenoids. Similar constituents are also present in *H. salicfolia* (commonly called sea buckthorn). Major carotenoid pigments include δ and β -carotene, lycopene flavoxanthin, progestin, cryptoxanthin, violaxanthin and neoxanthin [23, 25, 26]. The seed-oil is a rich source of highest vitamin E (1290 ppm-1919 ppm) while vitamin K content ranges from 1.1 - 2.3 mg/g [7]. It also possesses high amounts of triacylglycerol [26] and β-carotene content as compared to other *Hippophae* species [23].

High nutrient and bioactive content of the fruit has yielded *H. salicifoila* a reputation of 'Super-fruit'. It has been widely used in traditional system of medicine for treatment of asthma, skin diseases, gastric ulcers, lung disorders, cough, diarrhoea and menstrual disorders [23, 27]. Towering multivitamin content, flavanoids and fatty acids in *H. salicifolia* account for its antioxidant, antibacterial, antifungal, anti-cancer, antiinflammatory, immunomodulatory, radio-protective, adaptogenic, anti-cancer, anti-atherosclerosis and anti-sterility properties [28-33].

Seed oil of *H. salicifolia* is employed in several pharmaceutical preparations and can be stored for a period of about 6 months at a temperature of 14.6°C - 26.1°C. It is used for bacterial disinfection, tissue regeneration, inhibition of platelet –aggregation, improved blood-circulation, treatment of gastric ulcers and diminishing inflammation [26, 32, 34, 35]. Vitamin K content of the seed oil makes it useful in promoting blood coagulation [7].

The high amount of triacylglycerol and fatty acids in seed-oil account for its use in a variety of skin-treatments and cosmetic preparations like moisturizers, lotions and creams for skin care [36]. It is also used in many nutraceutical formulations and as a natural preservative. The plant products are also processed for commercial preparations of a variety of oils, juices, alcoholic beverages, tea, food colors, candies, biscuits, ice-creams etc. [37, 38].

Currently more than 150 pharmaceuticals/nutraceuticals companies around the world (viz. Beijing Huiyuan Group Youyu Co., Ltd., Inner Mongolia Prosperous Earth Trade Co., Ltd., Era Biotechnology (Shenzhen) Co., Ltd., Earnest International, India) are engaged in the utilization of Seabuckthorn contents in manufacturing life saving drugs, health tonics, food, cosmetics etc. with China being the lead producer [7, 39-43].

Consequently, extensive and constantly increasing use of Seabuckthorn products has created a huge market for *H. salicifolia* species (owing to its significantly high amounts of active ingredients) and assures heavy economic returns to the providers. This widens the scope of income generation for *H. salicifolia* growers and subsequent poverty alleviation.

Other uses

Besides its efficient medicinal usage, *H. salicifolia* plant has manifold applications as an efficient source of timber, fuel and fodder. The plant as a whole is used as fences around houses and cultivated-fields for protection against wild animals. The seed cake can also be used as animal feed due to its rich protein and mineral content [44, 45]

Propagation

H. salicifolia is generally propagated by hardwood/softwood cuttings, root suckers and seeds [7, 43, 46]. Rapidly increasing human interventions, unscientific cutting and root-sucker collection practices, forest-fires and extensive grazing of animals in the forests have resulted in severe loss of forest stocks. This in turn has posed a serious problem of non-availability of sufficient quality initial planting material. Conventional approaches of propagation alone cannot guarantee mass multiplication of this species as they are beset with several constraints. Large scale propagation via cuttings and root suckers is hampered due to the problem of large-space requirement and cumbersomeness (e. .g. bulkiness and thorniness of cuttings). Moreover, propagules obtained via vegetative methods are successful only if they root. Further year round, vegetative

propagation is difficult due to seasonal specificity of material. This supplemented with short growing season have also aided in hampering mass multiplication of the species.

Comparatively, propagation of the species through seeds seems a better and easy option. Seed dormancy and poor germination rates (about 20- 30%) are known to hamper large scale multiplication via seeds. Pre-sowing treatments with chemicals like thiourea, potassium nitrate, sodium chloride, warm-water, gibberellic acid, sulphuric acid etc. Have been reported to significantly improve the germination rates [14, 32].

As a result, there is a severe lack of appropriate agro-technology packages to promote propagation of this species. In Indian Himalayan Region, anthropogenic interferences have led to degradation of natural stands of the species. This may be attributed to lack of knowledge distribution and rural sensitization on an importance of *H. salicfolia* [47].

Application of alternative reproducible micropropagation strategies through plant biotechnological interventions has become inevitable for the germplasm preservation and mass multiplication of disease-free plants of *H. salicfolia* with a clear indexing of the male and female plants. Besides, mass propagation of *H. salicifolia* will avoid ignorant mixing with other *Hippophae* species having comparatively less nutrient content. In this context, some initiatives viz phytochemical profiling of *H. salicifolia* have been taken [48]. Nevertheless, the area calls for further concerted researches.

To our knowledge, there is no published report on *in vitro* propagation of *H. salicifolia* till date and much work remains to be done in this direction.

CONCLUSION

Multipurpose usage, ecological benefits, high economic returns yet ignored status of *H. salicifolia* indicate a tremendous scope for exploring different aspects of the species. There are no established agro-techniques for promoting its cultivation. Only preliminary studies have been done to provide information regarding germination and viability of *H. salicifolia* seeds and propagation via cuttings. Biodiversity studies at morphological, biochemical and genetic levels will enable establishment of variability within the existing germplasm of the species. The screening will also enable selection of genotypes with high levels of bioactive compounds. Besides, enhanced researcher-farmer interactions to ensure effective measures for better plantations, germ plasm maintenance, utilization of existing resources, careful collection of fruits and utilization of medicinal properties need to be implemented for this valuable species.

CONFLICT OF INTERESTS

Declared None

REFERENCES

1. Sun K, Chen X, Ma R. Molecular phylogenetics of Hippophae L, (Elaeagnaceae) based on the internal transcribed spacer (ITS) sequences of nrDNA. Plant Syst Evol 2002;235(1 Suppl 1-4):121-34.
2. Bartish IV, Jeppsson N, Nybom H. Phylogeny of Hippophae (Elaeagnaceae) inferred from parsimony analysis of chloroplast DNA and morphology. Syst Bot 2002;27(1):41-54.
3. Lian YS, Chen XL, Sun K, Ma R. A new subspecies of Hippophae (Elaeagnaceae) from China. Novon 2003;13(2):200-2.
4. Aras A, Akkemik U, Kaya Z. *Hippophae rhamnoides* L: Fruit and seed morphology and its taxonomic problems in Turkey. Pak J Bot 2007;39(6):1907-16.
5. Lu R, Cao Y, Lu S. Introduction of Seabuckthorn (*Hippophae salicifolia*) from high altitude to low altitude area: In: Lu R, Cao Y and Lu S, editors. Proceedings of International Workshop on Seabuckthorn; 2001. p. 89-90.
6. Ahmed Z, Gupta SM. Seabuckthorn: a source (donor) in molecular breeding, National conference on Seabuckthorn and Environment. High Altitude Perspectives, DIHAR, LehLadakh-194101 J and K, India; 2001.
7. Lu R. Seabuckthorn: a Multipurpose Plant Species for Fragile Mountains. ICIMOD Occasional Paper No. 20, Kathmandou, Nepal; 1992. p 62.
8. Gupta VN, Nepal VP, Adhikari KJ, Ghimire S, Subedi CK. An ecological assessment of sea buckthorn resource in Dolpa and Jumla districts of Nepal. Hattisar (Nepal): TISC; 2000.
9. Yadav VK, Sah VK, Singh AK, Sharma SK. Variations in morphological and biochemical characters of Seabuckthorn (*Hippophae salicifolia* D Don) populations growing in Harsil area of Garhwal Himalaya in India. Tropical Ag Res Ext 2006;9:1-7.
10. Hooker JD. The flora of British India: Singh B and Singh MP editors; 1894;5th edition; 1894. p. 791.
11. Gaur RD. Flora of the district Garhwal Northwest Himalaya (with ethno botanical notes). Transmedia, Srinagar Garhwal, India; 1999. p. 811.
12. Uprety Y, Asselin H, Boon EK, Yadav S, Shrestha KK. Indigenous use and bio-efficacy of medicinal plants in the Rasuwa District, Central Nepal. J Ethnobiol Ethnomed 2010;6(3):1-10.
13. Yao Y, Tigerstedt PMA. Genetic diversity in Hippophae L and its use in plant breeding. Euphytica 1994;77:165-9.
14. Airi S, Bhatt ID, Bhatt A, Rawal RS, Dhar U. Variation in seed germination of *Hippophae salicifolia* with different presoaking treatments. J Forest Res 2009;20(1):27-30.
15. Synge PM. Dictionary of gardening: a practical and Scientific Encyclopedia of horticulture; 2nd Edition, Clarendon Press, Oxford; 1974.
16. Sankhyan HP, Sehgal RN, Bhrot NP. Morphological characters variation in different species of seabuck-thorn in cold desert of Himachal Pradesh. Indian J For 2004;27(2):129-32.
17. Tomar A, Singh VRR, Rattan V. Seabuckthorn a potential bioresource in himalayas for the upliftment of local livelihood. *ENVIS* Forestry Bulletin. ICFRE 2011;11(1):30-5.
18. Basistha BC, Sharma NP, Lepcha L, Arrawatia ML, Sen A. Ecology of *Hippophae salicifolia* D. Don of temperate and sub-alpine forests of North Sikkim Himalayas— a case study. Symbiosis 2010;50(1 Suppl 2):87-95.
19. Singh V. Seabuckthorn (Hippophae L.) A wonder plant of dry and temperate Himalayas. Department of Agro forestery and Environment, Himachal Pradesh Agriculture university, Palampur; 2001. p. 1760-62.
20. Gamble JS. A Manual of Indian Timbers. Singh B and Singh MP editors, 2nd edition. Dehradun, India; 1972. p. 868.
21. Lei Q, Zhong Y, Yang H. Effects of nitrogen supply from Seabuckthorn in artificial woods of simon poplar. Forest Sci Tech 1983;4:21-4.
22. Shi Z, Su B, Guo Y. Mixed afforestation with chinese pine and seabuckthorn. Ningxia Ag Forest Sci Tech 1987;5:54.
23. Ranjith A, Kumar SK, Venugopalan VV, Arumughan C, Sawhney RC, Singh V. Fatty acids, tocols and carotenoids in pulp oil of three Sea Buckthron species (*Hippophae rhamnoides, H. salicifolia, and H. tibetana*) grown in the Indian Himalayas. JAOCS 2006;83:359-64.
24. Sharma P, Kirar V, Suryakumar G, Mishra K. Phytochemical analysis of Sea buckthorn extracts and quantification of flavonoids by HPTLC. Biochem Pharmacol 2013;2(4):73.
25. Beveridge T, Li TSC, Oomah BD, Smith A. Seabuckthorn products: manufacture and composition. J Agric Food Chem 1999;47:3480–8.
26. Xing C. Health protection and processing technology of seabuckthorn tea: In: Singh V editor. Seabuckthorn (Hippophae L.)-A multipurpose wonder plant, Indus Publishing Company; 2003. p. 475–8.
27. Mingyu X. Present conditions and future research on Seabuckthorn medicinal value. J Water Soil Cons China 1991;5:38.
28. Ambaye RY, Khanolkar VR, Panse TB. Studies on tumour inhibitory activity of indigenous drugs: Part I. Tumour inhibitory activity of *Hippophae salicifolia* D Don. Proc Ind Acad Sci B 1962;2:123-9.
29. Singh V. Sea buckthorn (Hippophae L.): a multipurpose wonder plant, Advances in research and development. Daya publishing house, Delhi; 2005;3:566.
30. Singh VRK, Gupta C, Arumughan SC, Sawhney RK, Rana AS, Lal M, *et al*. Biochemical Evaluation of *Hippopahe salicifolia* and *H.*

mongolica as Horticultural Crops in Dry Temperate Himalayas. In: Proceedings of National Conference on Seabuckthorn: Emerging Trends on R&D on Health Protection and Environmental Conservation", CSK HPKV, Palampur, HP, 2011. p. 75-92.

31. Goyal AK, Basistha B, Sen A, Midhha SK. Antioxidant profiling of *Hippophae salicifolia* growing in sacred forests of Sikkim, India. Functional Plant Biol 2011;38(9):697-701.
32. Gupta SM, Gupta AK, Ahmad Z, Kumar A. Antibacterial and antifungal activity in leaf, seed extract and seed oil of seabuckthorn (*hippophae salicifolia* d. don) plant. J Plant Pathol Microbiol 2011;2(2):1-4.
33. Saikia M, Handique PJ. Antioxidant and antibacterial activity of leaf and bark extracts of Seabuckthorn (*Hippophae salicifolia* D Don) of North East India. Int J Lif Sci Biotech Pharm Res 2013;2(1):81-91.
34. Li Y, Wang L. Preliminary analysis of the clinical effects of seabuckthorn oil capsule and seabuckthorn saimaitong capsule (containing a mixture of seabuckthorn seed oil and Chinese herbs) on ischemic apoplexy. Hippophae 1994;7:45-7.
35. Johansson A, Laakso P, Kallio H. Characterization of seed oils of wild edible berries. Z Lebensum Unters Forsh 1997;2(4):300-7.
36. Parimelazhagan T, Chaurasia OP, Ahmed Z. Seabuckthorn: Oil with promising medicinal value. Curr Sci 2005;88:8-9.
37. Xu M. Present conditions and future research on Seabuckthorn medicinal use. J Water Soil Conserv 1991;5:38.
38. Xing J. Effect of seabuckthorn seed and pulp oils on experimental models of gastric ulcer in rats. Fitoterapia 2002;73(7–8):644–50.
39. Chen T. Studies of the biochemical composition of Hippophae and its quality assessment in Gansu Province. Hippophae 1988;1:19-26.
40. Thomas SCL. Product Development of Seabuckthorn. In: Janick J, Whipkey A editors: Trends in new crops and new uses. ASHS press, Alexandria; 2002. p. 393-8.
41. Venugopalan VV, Ranjit A, Sarinkumar K, Arumughan A. A Green technology for the Integrated processing of fresh Seabuckthorn Berries. Seabuckthorn (Hippophae L.): A multipurpose wonder plant, Vol. 2, Daya publishing house, New Delhi, India; 2005. p. 522-32.
42. Gayle E. Sea Buckthorn, Herb. Gram. American Botanical Council 2008;78:1-2.
43. Dhyani D, Maikhuri RK, Dhyani S. Effect of auxin treatments on male and female cuttings of *Hippophae salicifolia*. African J Biotech 2012;11(90):15712-8.
44. Ansari AS. Seabuckthorn (Hippophae Linn. sps.)–A potential Resource for Biodiversity Conservation in Nepal Himalayas. Kathmandu, Nepal; 2003.
45. Kaushal M, Sharma PC. Nutritional and antimicrobial property of seabuckthorn (*Hippophae sp*) seed oil. J Sci Indus Res 2011;7:1033-6.
46. Sankhyan HP, Sehgal RN, Bhrot NP. Standardization of presowing treatments for different seabuckthorn species in cold deserts of Himachal Pradesh. Indian Forester 2005;131:931-8.
47. Dhyani D, Dhyani S, Maikhuri RK. Assessing anthropogenic pressure and its impact on *Hippophae salicifolia* pockets in Central Himalaya. Uttarakhand J Mountain Sci 2013;10(3):464-71.
48. Ilango K, Bai NK, Kumar RM, Kumar KA, Dubey GP, Agrawal A. Pharmacognostic studies on the leaves of *Hippophae rhamnoides* L and Hippophae salicifolia D Don. Res J Med Plant 2013;7(1):58-67.