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Seabuckthorn Resources and Its Underexploited Potential in the Himalayan Region

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Economic Significance and Ecological Value of Seabuckthorn

Seabuckthorn (*Hippophae* spp.), a deciduous shrub or tree which belongs to Elaeagnaceae, is widely distributed in the temperate zones of Asia and Europe and at high altitudes of the sub-tropical zone of Asia. The berries of seabuckthorn are rich in nutrients and bio-active substances such as sugar, organic acid, amino acid, vitamins (B, C, E, K and P), carotene, and flavone (see Table 12.1). The vitamin C content is 5 to 100 times higher than in fruits and vegetables. The pulp and seeds of seabuckthorn have a high content of oil also (see Table 12.2). Therefore, seabuckthorn is being used as food and in the medicine industries.

In the 19th century, Russians began using seabuckthorn berries for making wine, jam, and other food. At the beginning of the 20th century, interest in this plant obviously increased. Horticulturists began to introduce it into orchards as a fruit tree. In the 1940s, especially after the World War II, nutritionists and pharmacologists analysed the vitamin composition and found that seabuckthorn could be used not only as food, but also as medicine. Many countries, such as the USSR, Mongolia, Poland, West Germany, Finland, Italy, Norway, Hungary, Canada, the United States, and Japan have been studying this wonderful plant.

Growing at altitudes between 60 and 5200 m, *Hippophae* is distributed widely in various geographical areas of the world. *Hippophae* can resist low temperature of $-60°C$ and does not wither in the summer

TABLE 12.1
Comparison of the vitamin content of seabuckthorn and fruits and vegetables (mg/100 g)

	A	B_1	B_2	P	K	C
Seabuckthorn	11.00	0.04	0.56	1000.0	100–200	300–1600
Cili (*Rosa roxburghii*)	4.83	0.05	0.03	2909.0	—	1000–3000
Hawthorn	0.82	0.02	0.05	—	—	100–150
Kiwi fruit	—	—	—	—	—	100–470
Orange	0.55	0.08	0.03	—	—	50
Tomato	0.31	0.03	0.02	—	—	11.8
Carrot	4.00	0.02	0.05	—	—	8.0

Source: Xu Zhonglu, 1956; Tian Houmou, Wang Guoli, 1987; Luo Dengyi, 1983.

TABLE 12.2
Comparison of the composition of fatty acid, Vitamin E, and Vitamin A of seabuckthorn oil and other nutrient oils

	Fatty acid components(%)			Vitamin E (mg/100 g)	Vitamin A (mg/100 g)
	Saturated acid	Unsaturated acid	Linoleic and linolenic acid		
Seabuckthorn oil	13.7	86.0	64.6	93.2	4.35
Wheat embryo oil	—	—	—	33.8	—
Safflower oil	8.0	92.0	81.4	3.3	—
Maize oil	15.2	84.8	48.3	34.0	0.81
Soybean oil	14.8	83.7	62.8	7.5	0.11

Source: Wang Gouli, 1987; Lu Rongsen, 1989.

heat of 40°C. Some species can grow well in regions with only 300 mm precipitation and others can endure inundation. Some species even grow in soil with pH 9.5 and soil which contains 1.1 per cent salts.

Hippophae shows high ability to fix atmospheric nitrogen. A six-year-old seabuckthorn plant has 180 g of root nodules or 100–140 nodules/m^3 of soil. A hectare of seabuckthorn can fix 45 kg nitrogen or more, which is twice that of soybean in the same area.

The farmers in the loess plateau of China often dig out seabuckthorn instead of planting potato. Because seabuckthorn bushes make the soil

more fertile, the yield of potato is much greater than in a field without any seabuckthorn bushes.

The root system of seabuckthorn can secrete certain acid compounds which improve alkaline soil.

In many cases, by sexual and asexual propagation, Seabuckthorn often forms mass bushes in hillslopes or along riverbanks. With its luxuriant foliage and strong root system, it can retain surface run-off and prevent soil erosion by wind and water. Moreover, the massed bushes can increase the content of organic matter in the soil and improve the physical and chemical properties of the soil. For example, in Youyu country, Shanxi province of China, 15 years ago, there was no vegetative covering along the Changtou river and thousands of tons of soil were washed into the Yellow river. Then on the banks of the Changtou river dense bushes of seabuckthorn were planted, and three to five million tons of soil were saved from being washed into the Yellow river every year. With the planting of seabuckthorn bushes, more than 80 per cent of surface run-off was decreased and erosion by surface water decreased by 75 per cent.

Seabuckthorn is a good resource for firewood. The calorific value of the wood is more than 4000 large calories/kg.

An Appraisal of *Hippophae* Resources in the Himalayan Region

Hippophae plants can be found in all countries of the Hindu Kush-Himalaya, the distribution extending over 3500 km from east to west of this vast mountainous area and the plants growing abundantly. *Hippophae* has four species and nine sub-species, of which four species and four sub-species are in the Himalaya and the other five sub-species are in the other part of Eurasia. It is believed that the Hindu Kush-Himalaya and the Qinghai-Tibetan Plateau are the main centres of distribution and origin of this genus.

Tables 12.3 and 12.4 contain data on the uses of *Hippophae* in the Hindu Kush-Himalaya, and its use and potential are discussed.

Hippophae rhamnoides L. ssp. *sinensis* Rousi occupies the largest area, and is distributed in Shanxi, Shaanxi, Gansu, Qinghai, Sichuan, Nei Mongol, Hebei, and Liaoning at 60–3800 m above sea level. Because it is most widely distributed in China, the plants are commonly found bearing berries which vary in shape, size, and colour, indicating that it is a typical diverse sub-species. The data in Table 12.3 indicate that this sub-species is rich in Vitamin C and organic acid, very suitable for making soft drinks. From the data in Table 12.4 it may be seen that the pulp and seeds are rich in oil and the linoleic and linolenic acid in total fatty acids account for more than 60 per cent. Therefore, this sub-species is most valuable for comprehensive use. Nowadays, seabuckthorn products

TABLE 12.3

Chief chemical composition of the juice of seabuckthorn in the Himalaya (China)

Species	Collecting places	Weight per 100 fruit (gm)	Rate of juice (fresh weight %)	Soluble sugar (%)	Organic acid (%)	Vitamin C (mg/100 g)	Free amino acid (mg/100 g)
H. rhamnoides L. ssp. *gyantsensis* Rousi	Zedang, Xizang	6.5	33.5	3.7	2.2	23.4	65.7
H. rhamnoides L. ssp. turkestanica Rousi	Huocheng, Xinjiang	19.5	80.8	7.2	3.5	471.5	122.0
H. rhamnoides L. ssp. *yunnanensis* Rousi	Zhongdian, Yunnan	16.5	78.1	6.1	4.6	1129.0	108.0
H. rhamnoides L. ssp. *sinensis* Rousi	Xiaojin, Sichuan	18.3	79.1	6.8	6.2	1289.5	83.6
H. salicifolia D. Don	Chuona, Xizang	19.0	76.6	10.3	8.3	1709.5	264.0
H. thibetana Schlechtend	Hongyuan, Sichuan	40.0	82.5	8.9	3.0	159.8	76.4
H. neurocarpa S.W. Liu et T.N. He	Daocheng, Sichuan	4.5	trace	2.1	1.6	3.5	666.6

Source: Author.

TABLE 12.4

Chemical composition of fatty acid in seabuckthorn in the Himalaya (China)

Species	Collecting Place	Fruit part analysed	Oil content (%)	Fatty acid Component (%)		
				Saturated	Unsaturated	Linoleic and linolenic acid
H. rhamnoides	Xiaojin, Sichuan	seed	9.87	13.7	86.6	64.6
L. ssp.		Pulp	2.02	27.3	71.2	11.4
Sinensis Rousi						
H. rhamnoides L. ssp.	Huocheng, Xinjiang	Seed	12.86	11.1	88.9	74.2
turkestanica Rousi		Pulp	2.03	31.7	64.8	15.4
H. rhamnoides L. ssp.	Zhongdian, Yunnan	Seed	10.21	16.9	83.0	62.3
yunnanensis Rousi		Pulp	2.59	25.1	74.9	17.9
H. rhamnoides L. ssp.	Zedang, Xizang	Seed	9.82	16.0	83.9	60.0
gyantsensis Rousi		Pulp	4.03	27.7	72.3	44.4
H. salicifolia	Chuona, Xizang	Seed	10.85	17.3	82.7	63.0
D. Don		Pulp	1.58	26.3	73.7	8.2
H. thibetana	Hongyuan, Sichuan	Seed	19.51	11.7	88.2	64.9
Schlechtend		Pulp	3.50	16.1	81.3	8.0
H. neurocarpa	Daocheng, Sichuan	Seed	16.12	14.0	85.9	65.5
S.W. Liu et T.N. He		pulp	8.60	24.1	75.8	47.7

Source: Author.

are mainly made from natural groves. However, these natural groves being very scattered, the yield is unstable. It is necessary to collect good seedlings with properties such as big berries, high content of vitamin C, dwarf size, and no thorns from these natural groves. These seedlings should then be propagated through asexual reproduction. In order to raise the commercial value of *H. rhamnoides* L. ssp. *sinensis*, artificial plantations should be established.

Hippophae rhamnoides L. ssp. *turkestanica* Rousi is grown on the terraces of river valleys, open slopes, and riverbanks at altitudes of 800–3000 m in western Xinjiang, Tibet, the USSR, Afghanistan, northern Pakistan, and northwestern India. It is grown in the arid regions of Xinjiang and central Asia. From Table 12.3 it can be seen that Vitamin C content of this sub-species is much lower than that of *H. rhamnoides* L. ssp. *sinensis*, so it is not so good for making soft drinks. But the seed oil content is 12.86 per cent, which is higher than in other sub-species. The arid climate of Xinjiang, abundant sunshine, and wide temperature range are advantageous for oil formation.

Hippophae rhamnoides L. ssp. *Yunnanensis* Rousi is distributed in the gorges and along riverbanks in northwestern Yunnan, southwestern Sichuan, eastern Tibet, and northern Burma. Its characteristics are very similar to those of *H. rhamnoides* L. ssp. *sinensis*. It is often found that the two sub-species are mixed in the southern part of Sichuan and the eastern part of Tibet and it is difficult to identify them by plant morphology. From Tables 12.3 and 12.4 it may be seen that there are no distinct differences in berry quality between the two sub-species. Both are used to make soft drinks.

Hippophae rhamnoides L. ssp. *gyantsensis* Rousi is grown on terraces and riverbanks at 3200–3800 m along the Yalu Tsangpo river in Tibet and Sikkim. The berries have several ridges. Table 12.3 shows that the rate of juice is only 33.5 per cent, which is just half that of other sub-species. The vitamin C content is much lower so it is not suitable for making juice, but the pulp and seed oil can be used. This sub-species is distributed in the arid region of Tibet and grows well in river valleys where the precipitation is below 300 m. It is believed that it can be introduced to other arid or semiarid regions. It is quite different from other sub-species in morphology, biological features, geographic distribution, and chemical composition. A. Rousi identified it as a sub-species under *H. rhamnoides*. The author of this paper considers that it needs to be studied again.

Hippophae salicifolia D. Don is found in gorges and the edges of forests in alpine mountains with altitudes 2800–3700 m in southern Tibet, northwestern India, Nepal, Sikkim, and Bhutan. It is an endemic species in the Himalayan region with vigorous growth and few thorns. The quality and content of vitamin C, total sugar, organic acid, and free

amino acid is higher than that of *H. rhamnoides* L. ssp. *sinensis*. The content of vitamin C amounts to 1700 mg/100 ml, which is higher than in any of the others. This species is now distributed in the southern Himalaya. It is necessary to introduce it to other seabuckthorn production regions and it is good material for breeding.

Hippophae thibetana Schlechtend is distributed in grassland, meadow, and riverbanks in Qinghai, Gansu, Tibet, Sichuan (China), Sikkim, Nepal, and northern India at altitudes of 3000–5200 m. It is a short species with a height of 8–60 cm and few thorns. The plant can withstand cold and grows well in grassland with an annual average temperature of 0°C. From Tables 12.3 and 12.4 *H. thibetana* can be seen to have, the largest berry and the richest juice. Although the content of vitamin C is lower than in *H. rhamnoides* L. ssp. *sinensis*, the content of pulp and seed oil is higher, so it is useful for producing oil. It is convenient to pick and suitable for close planting. In alpine mountains and plateau grassland this species has both economic and ecological significance and is a precious resource for cultivation and breeding.

Hippophae neurocarpa S.W. Liu et T.N. He is grown in the river valleys or plateau at altitudes 2800–4300 m in Qinghai, Gansu, Sichuan, and Tibet. Tables 12.3 and 12.4 illustrate that this species has the smallest berries, little juice, and a low content of sugar, organic acid, and vitamin C. The pulp and seed, however, contain oil of which the unsaturated fatty acids account for more than 75 per cent. Its pulp oil content of linoleic and linolenic acid is higher than that of other species. In areas above 3500 m, where it is difficult to find trees other than the willow, *H. neurocarpa* can grow well to a height of 3 m. Moreover, it can resist strong wind and forms mass natural groves, so it has important ecological value.

All the seven species and sub-species have their own advantages and are a precious resource for introduction and breeding. Because of the rich juice and vitamin content, *H. rhamnoides* L. ssp. *sinensis* and L. ssp. *yunnanensis* and *H. salicifolia* are suitable for making soft drinks and other products. With their high content of oil, *H. rhamnoides* L. ssp. *turkestanica* and *H. thibetana* are suitable for oil production, as are *H. rhamnoides* L. ssp. *gyantsensis* and *neurocarpa*. Each has different ecological adaptability and can be grown in quite different natural conditions in the Hindu Kush-Himalaya.

The Present Situation and Prospect of Seabuckthorn Exploitation

China was the first country to use seabuckthorn berries. In ancient times under the Tang Dynasty, a book named *Si Bu Yi Dian* described seabuckthorn berries as a medicine. Similar descriptions are to be found in ancient Mongolian medicine and Tibetan medicine.

Present Situation

Since 1983, some provinces and autonomous regions of north, northwest, and southwest China, such as Shanxi, Shaanxi, Neimeng, Gansu, Qinghai, Sichuan, and Xinjiang, have begun to exploit seabuckthorn with good results. Now, the exploitation of seabuckthorn is not only a way to develop the mountain region economy, but also a promising integrated enterprise.

According to statistics, the total natural seabuckthorn area in China is 670,000 hectares and 49,000 hectares are scattered in the east Himalaya (including east Tibet, west Sichuan, northwest Sichuan, and northwest Yunnan). A recent survey shows that about 22,000 tons of seabuckthorn berries lie hidden and undeveloped in the east Himalaya.

By the end of 1987, 150 seabuckthorn processing plants were built in China. The primary processing (such as the crushing and concentration of juice) is done in the places of origin. The product is then transported to big cities for further processing. For example, in western Sichuan, three primary processing plants (located in Xiaojin, Jinchuan, and Muli counties) produce raw products and sell them to Chengdu, Chongqing, Wuhan, and other cities where products such as soft drinks, wine, jam, juice and medicine are made and sold in the market.

Economic and Ecological Benefits

Seabuckthorn exploitation has made farmers who live in the mountain regions richer and the many processing factories bring in income. From 1985 to 1987, along the middle reaches of the Yellow river, farmers earned an annual income of more than five million yuan by picking seabuckthorn berries. For example, there is a small village with 42 farmer households in Fangshan county, Shanxi province. In the autumn of 1984, each household got an income of 160 yuan by selling seabuckthorn berries. In Qingshui county, Gansu province, there is an alcohol distillery which was running at a loss until it turned in 1983 to the production of seabuckthorn products. In 1985 it met the deficit and by 1987 had made a profit of 164,900 yuan. In Sichuan province seabuckthorn exploitation came later but still did well. Table 12.5 gives the statistics.

Besides profitability, the ecological benefit is very important. China now has a vast programme of shelter forest in northeast, north and northwestern China. After many years of practical experiments, forestry experts believe that shrubs must be planted first in the shelter forest system, of which seabuckthorn is the most important. The main step in harnessing the mountains and rivers of Youyu county, Shanxi province, has been to plant seabuckthorn shrub on a large scale. Since the 1950s

TABLE 12.5

Seabuckthorn processing in Sichuan province, China

Name of factory	Annual capacity of production	Varieties of production	Annual value of output (yuan)	Annual profit (yuan)
Xiaojin Seabuckthorn Beverage Factory	Processed 100 tons berries	Crushed Juice, Condensed juice Solid juice, wine	135,000	20,000
Jinchuan Seabuckthorn Beverage Factory	Processed 100 tons berries Solid juice	Crushed juice,	135,000	18,000
Muli Seabuckthorn Beverage Factory	Processed 100 tons berries	Crushed juice, Syrup	130,000	15,000
Chengdu Fruits Processing Factory	Processed 250 tons	Crushed juice, Condensed juice, Syrup, Soft drinks	1,000,00	150,000
Chongquing Jiangbei Beverage Factory	Processed 50 tons berries	Crushed juice, Syrup, Soft drinks	150,000	50,000

Source: Author.

Note: There were 4.73 yuan to the dollar in 1989.

more than 15,000 hectares of seabuckthorn shrub have been established in the county and water and soil has been controlled to a high degree.

Problems

At present, seabuckthorn berries are collected from natural forest shrubs. It is difficult to pick the berries from trees because of the many thorns on the stems and branches. Some farmers fell the trees in order to pick the berries. Such a method damages the seabuckthorn resources.

Seabuckthorn plant is a dioecious plant. In the natural forest, the ratio of male to female is not equal. The quantity of males is often higher and the female plants are scattered and difficult to harvest.

In the east Himalaya, specially in east Tibet and western Sichuan, most of the seabuckthorn resources are far away from transportation and cities, making it difficult to exploit seabuckthorn resources fully.

In order to best use these resources the Chinese government has formulated a policy to protect resources and set up new plantations. The main belongs to the state, which is collectively or individually owned; protect seabuckthorn groves; give hill forest and wasteland to orchards and farmer households and contract with them; grant benefits to whoever reforests, and this cannot be changed for 50 years; forbid felling of seabuckthorn trees or digging it out for cultivation; and strictly enforce, the forest law and water and soil conservation regulations.

Through the efforts of the last five years more than 150,000 hectares of seabuckthorn groves have been set up in north and northwest China.

Seabuckthorn is a new horticultural crop with tremendous potential. It is and will be playing an important role in making mountain farmers richer and sustaining the stable development of mountain regions. There are rich resources of *Hippophae* in the Hindu Kush-Himalaya Region. It is suggested that the countries of this region work out a programme to survey their resources and exploit them.

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