III. A Multipurpose Plant Species for Mountain Farming Systems

Seabuckthorn is described as the most appropriate multipurpose option for mountain areas because: (i) it helps in reconciling high productivity through intensive land use in the mountains with land-extensive usages dictated by the fragility and marginality of mountain slopes. It has the potential to support high value-added products which can be integrated within the market economy, as well as to support the rehabilitation and upgrading of marginal or fragile slopes through soil-binding and building in mountain areas.

Depending on the circumstances and development priorities, either or both categories (i.e., resource conservation versus economic productivity) may be emphasised. In the present chapter, we deal with the possibilities of harnessing seabuckthorn for mountain farming systems. The latter, as is well-known, covers a combination of different land-based activities, including cropping, forestry, and animal husbandry. Accordingly, first we discuss the natural potential of seabuckthorn to support various product (and processing) - based, income-generating activities. Experiences in harnessing this potential in countries such as China and the former USSR are discussed. The section concludes with other countries where seabuckthorn is used largely as a source of biomass for fuel, fodder, etc.

Purpose

Seabuckthorn has been used by human beings for at least 12 centuries now, as recorded in the Tibetan medicinal classics - "the *rGyud bzi*" (i.e., the Four Books of Pharmacopoeia), completed in the Tang Dynasty (618-907 A.D.). However, it is only in recent decades that people have had a better understanding of seabuckthorn. The scholars who are engaged in scientific research on seabuckthorn in various countries have revealed the important values of seabuckthorn to human beings by carrying out a large number of scientific experiments. With the gradually worsening quality of the environment and the overriding poverty in many countries today, seabuckthorn has attracted a great deal of attention from scientists and engineers all over the world because of its concentrated ecological, social, and economic benefits.

Some countries have already adopted measures to protect natural seabuckthorn resources, carried out large-scale, artificial seabuckthorn afforestation, and have also produced seabuckthorn drinks and chemical products. In depth scientific research on medicines and further exploitation and usage of seabuckthorn is developing quickly. Today, as the following discussion shows, seabuckthorn is used in many countries in many ways, e.g., in food industries, medical industries, in cosmetic preparations, and as forage, fuel, and ornamental plants.

Natural Potential: The Basic Composition of the Fruit

A typical seabuckthorn plant usually consists of a bush bearing clusters of juicy fruit. The fruit is generally about the size of a small pea and is greenish in colour in the beginning but turns orange or red as it matures. Chemical analytical data show that seabuckthorn fruit is rich in nutrients such as carbohydrates, organic acids, amino acids, and vitamins. The vitamin content of seabuckthorn is much higher than any other fruit or vegetable (see Table 1).

The Vitamin C content of seabuckthorn is 3 to 16 times higher than that of the Kiwi fruit (*Actinidia sinensis*) which is very famous for its high Vitamin C content. This is the reason why the fruit of seabuckthorn is usually used to make soft drinks and other similar food products. Because of its various rich nutrients, the seabuckthorn beverage is considered to benefit people such as sportsmen, manual workers, children, the aged, and pregnant women by building up their strength.

Another feature of the seabuckthorn fruit is that both the pulp and the seed contain high quality oil which is considered to be a carrier of many concentrated bioactive substances. By determination, the oil content accounts for 1.5 to 3.5 per cent in the pulp and 9.9 to 19.5 per cent in the seeds respectively. Comparative qualities of seabuckthorn oil and other nutrient oils are shown in Table 2. From Table 2, it can be seen that unsaturated acid makes up more than 80 per cent of the total fatty acids. In unsaturated

acids, more than 60 per cent are linoleic and linolenic acids and these are considered to be indicators of the good quality of seabuckthorn oil. In addition, β-carotene and Vitamin E contents in seabuckthorn oil are much higher than those of other nutrient oils. For this reason, the oil of seabuckthorn is thought to be a valuable nutrient oil or medicinal material.

Table 1: Comparison of the Vitamin Contents of Seabuckthorn and Other Fruits and Vegetables (mg/100g)

	V_A	V_{B1}	V_{B2}	V_P	V_C	V_K
Seabuckthorn	11.00	0.04	0.56	1000.0	300-1600	100-200
Cili (*Rosa roxburghii*)	4.83	0.05	0.03	2900.0	1000-3000	-
Kiwi fruit (*Actinidia sinensis*)	-	-	-	-	100-470	-
Hawthorn	0.82	0.02	0.05	-	100-150	-
Orange	0.55	0.08	0.03	-	50.0	-
Tomato	0.31	0.03	0.02	-	11.8	-
Carrot	4.00	0.02	0.05	-	8.0	-

Source: Xu Zhonglu 1956, Tian Houmou 1985, Wang Guoli 1987, and Luo Dengyi 1984, Lu Rongsen 1990

Table 2: Comparison of the Composition of Fatty Acid, Vitamin E, and β-Carotene in Seabuckthorn Oil and Other Selected Nutrient Oils

	Fatty Acid Component (%)				
	Saturated Acid	Unsaturated Acid	Linoleic and Linolenic Acid	Vitamin E (mg/100g)	β-Carotene (mg/100g)
Seabuckthorn oil	13.7	86.0	64.6	202.9	248.90
Wheat embryo oil	-	-	-	144.5	-
Safflower oil	8.0	92.0	81.4	3.3	-
Maize oil	15.2	84.8	48.3	34.0	0.81
Soyabean oil	14.8	83.7	62.8	7.5	0.11

Source: Wang Guoli 1986, Lu Rongsen 1988, Zhang Fushun 1987, and Zhong Chongju 1989

In the beginning of the 1980s, seabuckthorn's broad economic and ecological possibilities gained the attention of the Chinese. Farmers and rural entrepreneurs in the northern mountain areas of China began collecting and processing the fruit from natural seabuckthorn bushes and producing various beverages. The evaluation of the results stimulated many researchers to study seabuckthorn and to produce significant achievements.

From 1983 to 1986, Ma Zhiben systematically analysed the chemical composition of the Chinese seabuckthorn fruit (*H. rhamnoides L.*, subsp. *sinensis*) collected from Shanxi, China, and obtained many interesting data. From Table 3, it can be seen that the main composition of seabuckthorn juice (or pulp) is soluble sugar, organic acids, and vitamins. The soluble sugar content accounts for 7.1 per cent, which is less than that found in the common apple (8-15%) or

orange (8-13%), thus it is rather insignificant. But the organic acid content accounts for 4.4 per cent which is more than that found in most fruits (for example, lemon is well known for its high acid content and it only contains 1-2%). The most prominent feature of its juice is that it is rich in Vitamin C (780.0mg/100g). This content is higher than that of any fruit or vegetable (see Table 1). Vitamin E and carotene account for 1.1mg/100g and 7.7mg/100g respectively, and these are also higher than those of most fruits and vegetables. Because of its abundant organic acid and Vitamin C content, seabuckthorn juice is considered to be suitable for making various beverages. In addition, there is some tannic acid in the juice (0.5%) and this causes the beverage to have a special, pleasant taste.

Table 3: Chemical Composition of Different Parts of the *H. rhamnoides*, Subsp. *Sinensis* Fruit

Fruit Part	Dry Matter Content (%)	Soluble Sugar (%)			Vitamin (mg/100 g)			Organic Acid (%)	Oil Content (%)	Protein Content (%)	Tannic Acid Content (%)
		Reducing	Non-reducing	Total sugar	V_C	V_E	Carotene				
Pulp	22.9	6.95	0.22	7.17	780.9	1.10	7.7	4.40	2.05	0.4	0.50
Seed	82.8	1.60	4.24	5.84	149.0	6.35	3.3	0.95	8.36	19.6	3.96
Fruit	26.0	6.05	0.24	6.29	741.0	1.79	7.3	4.35	2.20	1.2	0.57

Source: Ma Zhiben 1987

The other component of seabuckthorn juice is free amino acid (Chen Tigong 1988, see Table 4). From Table 4, it can be seen that there are 18 kinds of free amino acid in seabuckthorn juice, among these 8 are necessary for the human body. They are threonine (6.24 mg/100g), valine (2.85), methionine (1.12 mg/100g), leusine (1.94 mg/100g), lysine (3.49 mg/100g), trytophane (0.51 mg/100g), isolencine (0.97 mg/100g), and phenylalacine (3.21 mg/100g).

Micro-elements are considered to play an important role in living things and the human body. They display a high catalytic activity in some biochemical reactions and they are parts of enzymes which activate or passivate the reactions.

In 1988, Chen Tigong determined 27 elements in the Chinese seabuckthorn fruit. These elements and their contents are given in Table 5.

Table 4: Contents of Various Free Amino Acids in *H. rhamnoides L.*, Subsp. *Sinensis* Juice

Free Amino Acids	mg/100g	Free Amino Acids	mg/100g
Aspartic acid	3.72	Isoleucine	0.97
Threonine	6.24	Leusine	1.94
Serine	5.31	Tyrosine	1.79
Glutamic acid	2.65	Phenylalacine	3.21
Clycinin	0.64	Histidine	1.06
Alanine	2.50	Lysine	3.49
Cysterine	0.82	Arginine	0.47
Valine	2.85	Proline	12.28
Methionine	1.12		
Trytophane	0.51	Total	51.57

Source: Chen Tigong 1988

Table 5: Contents of the Elements in *H. rhamnoides L.*, Subsp. *Sinensis* Dried Fruit

Elements and their Contents (mg/kg)					
Ba	11.66	Be	0.095	Cr	2.535
Cu	-	La	6.655	Mn	93.68
Nb	-	Ni	4.985	P	959.62
Sr	5.15	Ti	44.91	V	2.725
Y	0.97	Zn	30.44	Zr	0.875
Al	2593.93	Fe	3264.28	Mg	2222.2
Ca	3119.33	Si	83.775	As	24.803
Mo	7.285	Sn	8.663	B	-
Pb	1.215	Cd	-	Se	5.015

Source: Chen Tigong 1988

Among the 27 elements, the Al, Ca, Fe, Mg, P, Mn, Ti, Zn, Si, As, and Ba contents are good, but the Be, Zr, Y, and Pb contents are poor. No traces of Cu, Nb, Cd, or B were found.

Usually, the pulp oil and the seed oil are extracted one after the other. At room temperature, the pulp oil is a light gold-coloured fluid but the seed oil is an orange or orange-red liquid. Their properties are shown in Table 6.

Table 6: Properties of *H. rhamnoides L.*, Subsp. *Sinensis* Oil

	Pulp Oil	Seed Oil
Specific gravity D_4^{20}	0.92	0.93
Refractive index N_{20}^{D}	1.4698	1.4763
Specific optical activity	+ 30°	+ 35°
Acid value (mg KOH/g)	4.3	6.4
Saponification value (mg KOH/g)	195	180
Iodine value	65	124
Sulfocyanic value	47.3	88.1
Unsaponificable matter %	1.47	0.92

Source: Chen Tigong 1988

From Table 6, it can be observed that the physical and chemical properties of seabuckthorn are different from each other. The specific gravity of the pulp oil (0.92) is a little lower than that of the seed oil (0.93). The refractive index of the pulp oil (1.4698) is also a little lower than that of the seed oil (1.4763). The iodine value of the pulp oil and the seed oil are 65 and 124 respectively, which means that the unsaturated compounds of the pulp oil are less than those of the seed oil, and this can be proved by the fatty acid analysis (see Table 2). Unsaponificable matter mainly implies fat-soluble vitamins (V_E, V_K, and so on), pigments (such as carotene and lycopene), steroids, alcohols, and hydrocarbons. The unsaponificable matter of the pulp oil is 1.47 per cent and this is more than that of the seed oil (0.92%). This means that the pulp oil contains more bioactive substances than the seed oil does.

Differences between pulp oil and seed oil also exist in the oil content, the fatty acid compositions, and the bioactive substances.

Ma Zhiben analysed the fruit oil of seabuckthorn from Shanxi, China, and his results are shown in Tables 7 and 8.

Table 7: Principal Chemical Components of *H. rhamnoides L.*, Subsp. *Sinensis* Oil

Part of Fruit Analysed	Oil Content (%)	Iodine Value	Acid Value	Carotene (mg/100g)	Vitamin E (mg/100g)
Pulp	6.8 - 7.5	47.7	6.3	54.0 - 102.6	40.1 - 62.8
Seed	10.2 - 12.4	14.0	6.2	27.8	65.7 - 104.1
Fruit	7.4 - 8.0	86.0	6.3	56.0 - 97.2	45.9 - 93.2

Source: Ma Zhiben 1987

Table 8: Fatty Acid Components of *H. rhamnoides*, Subsp. *Sinensis* Oil (%)

Part of Fruit analysed	Lauric Acid	Myristic Acid	Palmitic Acid	Hexa-decenoic Acid	Stearic Acid	Oleic Acid	Linoleic Acid	Linolenic Acid	Other Acid	Saturated Acid	Unsaturated Acid
Pulp	0.1	1.0	31.2	35.0	0.5	25.2	4.5	2.1	0.4	32.8	66.8
Seed	0.1	0.2	8.7	0.6	2.0	23.7	37.0	27.6	0.1	11.0	88.9
Fruit	0.1	0.8	26.9	30.5	0.7	24.4	9.2	7.1	0.3	28.5	71.2

Source: Ma Zhiben 1987

From Table 7, it can be seen that the oil content of the pulp and the seed are respectively 6.8 - 7.5 per cent and 10.2 - 12 per cent; these are normal and representative of the northern mountain areas of China.

Although the oil content of seabuckthorn is not as much as the amount found in most oil crops, its nutritive and medicinal values are much more than those of most oil crops because it contains a lot of fat-soluble bioactive substances. From Table 7, it can be seen that the carotene content of the pulp oil is 54.0 - 102.6mg/100g, which is more than that found in any fruit or vegetable (see Table 1), and the Vitamin E content of the seed oil is 65.7 - 104.1mg/100g, which is more than that found in any oil crop (see Table 2).

Besides carotene and Vitamin E, Vitamin K and phospholipin, in both the pulp and the seed oil, were determined by Zhang Fushun et al. (1987).

The Vitamin K content is about 109.8 to 230.0mg/100g (seed oil) and 58.9 to 64.4mg/100g (pulp oil), which are more than those contained by most horticultural crops. Vitamin K is called the coagulation vitamin because it plays a catalytic role in forming prothrombin; it can promote normal coagulation of the blood. The phospholipid content is about 0.69 - 1.77 per cent (seed oil) and 0.24 - 0.27 per cent (pulp oil). It is said that the membrane contains phospholipid which plays an important role in regulating the membrane's osmotic function.

The fatty acid composition of seabuckthorn is shown in Table 8 and it also shows that the fatty acid contents of the pulp oil and the seed oil vary.

The pulp oil contains unsaturated acids of 68.8 per cent and among the 9 fatty acids, nexadecenoic acid (35.0%), oleic acid (25.2%), and linoleic acid (45%) are dominant, and the seed oil contains unsaturated acids of 88.9 per cent, among which oleic acid (23%), linoleic acid (37.0%), and linolenic acid (27.6%) are dominant. According to medical theory, unsaturated acids are beneficial to the health of the human body, especially linoleic acid and linolenic acid which are

often used for curing diseases relating to the cardiovascular system and to high blood fat content. In this case, the seed oil is better than the pulp oil because the former contains 64.4 per cent of linoleic acid and linolenic acid, whereas the latter contains only 6.6 per cent.

Besides the above-mentioned basic components of the juice and oil many other components have been found over the past 20 years. Although the contents of these components are not great in quantity, they have important nutritional and medicinal functions.

Carotenoids

β-carotene is dominant in carotenoid. Its content varies depending upon place of origin and the part analysed, for example, the seed oil from Longxi, Shaanxi, contains β-carotene 159.8mg/100g but that from Hetain, Xinjiang, contains 1159.6mg/100g. The highest carotene content is 9059.6mg/100g, found in the pulp oil from Hetain, Xinjiang (Zhang Fushun 1987).

The other carotenoids are α-carotene, γ-carotene, zeaxanthin, polyzlycopene-3, and lycopene. It has been proved that lycopene can also prevent Vitamin A deficiency in human beings and animals and also stimulate their growth.

Flavonoids

Seabuckthorn fruit is rich in flavonoids. In 1979, Xiao Zhuyin et al. studied the flavonoid constituents of the Chinese seabuckthorn fruit from Western Sichuan, China. They found that the juice and dried fruit residue contained flavonoid of 0.2 per cent and 0.55 per cent respectively. By means of thin layer chromatographic analysis, 7 different flavonoids were found. In addition, two main monomers were separated from others and identified as isorhamnetin and quercetin. Later, the flavonoids extracted from seabuckthorn fruit were proved to be effective for curing high blood fat content, coronary heart diseases, and angina pectoris, especially in reducing serositic ceride.

Harnessing of Potential

Despite the scientifically proven potential of seabuckthorn for manufacturing several high value products for human consumption, its harnessing is constrained by the lack of appropriate technologies and facilities to process the same. There are a few countries, such as China and the former USSR, which very effectively harness seabuckthorn in industries relating to food, medicinal, and other items.

Use in Food Industries

Although the Russians began to use seabuckthorn fruit for making wine, jam, and jelly in the 19th century, this was not on an industrial basis but merely for domestic use. When seabuckthorn as a fruit tree was introduced into orchards and cultivated on a larger scale, especially after the Second World War, many nutritionists and pharmacologists proved that the seabuckthorn fruit contained many kinds of nutrient and bioactive substances and could be used in food and medicines. This encouraged the establishment of modern seabuckthorn food industries.

Since the 1940s, many factories have been built that produce seabuckthorn food, seabuckthorn beverages, and other products. Products, such as juice, jam, jelly, and syrup have become very popular in the former USSR. It is estimated that, currently, in areas of the former USSR, the seabuckthorn orchards produce 50 thousand tons of fresh fruit, worth 115 million Rbl. (2,300 Rbl. per ton) annually.

Along with the traditional products, various new ones, such as seabuckthorn condensed juice, mixed juice, seabuckthorn carrot jam, candied fruit, seabuckthorn "cheese", assorted seabuckthorn candies, seabuckthorn butter, seabuckthorn tea, and seabuckthorn health protection drinks, have been produced and marketed. In addition, according to the literature of the former Soviet Union, seabuckthorn fruit and oil have been included in the diet of astronauts (Besschetnov, V.P. et al. 1989).

Although seabuckthorn cultivation is very common in the former USSR, the demands for seabuckthorn products still have not been met. For example, in the free market of Moscow, fresh seabuckthorn fruit costs 5 Rbl. per kg which is as much as three times the price of apples. In the State-owned shops, the seabuckthorn fruit and its products are often out of stock. It is believed that the profits derived from seabuckthorn are often more than those from other fruits. For example, in processing factories the cost of production for one bottle of jam is 0.8 Rbl. and the selling price is 1.80 Rbl. This means the factory gains a profit of 1.0 Rbl. per bottle.

In the former USSR, the residues of seabuckthorn (after extracting juice and oil) have been used as food additives and are often added to bread, candies, cakes, and seabuckthorn butter. The residues have also been used as feed additives to raise animals for the fur trade. It has been proven that the seabuckthorn feed additives improve the quality of fur.

Because the demand for seabuckthorn in food and medicinal industries is so high, more than 6,200 ha of cultivated seabuckthorn plantation, which account for 15.1 per cent of the total seabuckthorn area of 41,000 ha, have been established up to now. But this too has not been able to satisfy the demand. In order to increase the productivity of seabuckthorn, the former Government of the USSR allowed horticulturists to establish private plantations not exceeding 0.1 ha. Running such an orchard, the owner makes an income of more than 1,000 Rbl. per year.

In the European part of the former USSR, amateur cultivation of seabuckthorn prevails. In the villas in the suburbs of Moscow, there are only a few residents who do not grow seabuckthorn and the saplings sell well. Almost all seabuckthorn farms are engaged in the production of saplings. Because sapling production is a profitable business, many horticulturists have built greenhouses to propagate saplings.

In Barnaul, Altay Border Region, an amateur grower built a greenhouse with 20 square metres of seedbed in which more than 13,000 seabuckthorn saplings were grown. Two years later, about 10,000 standard saplings were produced which cost 5,000 Rbl. This means a cash income of 2,500 Rbl. per year and this equals the average income per year of a worker in the former USSR.

In China, for a long time, seabuckthorn plants were used as soil and water conservation and firewood plants in most regions. However, the Tibetans and the Inner Mongolians used them as medicinal plants as well. After the establishment of New China, the afforestation scale of seabuckthorn expanded and now its plantation area has reached about 300,000 ha (see Table 21, p.45).

However, there were no food industries based on seabuckthorn fruit before the 1980s. At the beginning of the 1980s, some information about the research and use of seabuckthorn in the former USSR reached China. People realised that there were a lot of seabuckthorn resources in China that could be used. In China, the first batch of factories for making juice from seabuckthorn fruit was established in Fangshan and Youyu counties, Shanxi Province, during 1983 to 1984. Since that time, repeated tests and improvements have been carried out on the methods of picking seabuckthorn fruit, extracting raw juice, preservation, concentration technologies, and drinking formulas. After several years of tests, seabuckthorn drinks have now come on to the markets. Seabuckthorn processing factories have increased to more than 150 and are distributed in 19 provinces and autonomous regions of the country. Twenty-nine products that can be classified under 8 types have been developed with seabuckthorn as the main raw material (see Table 9).

By the end of 1990, the productive capacity of raw seabuckthorn products amounted to over 5,000 tons per year, the total output of various seabuckthorn products reached more than 150,000 tons per year, and the total output value was more than 100 million *yuan* (about 21,184,322 US$) (see Table 10).

The processing technologies and the quality of products have been continuously improved upon and seabuckthorn products have begun to capture some markets, especially in Northern China (Xian of Shaanxi, Taiyuan, Datong of Shanxi, Lanzhou, Tianshu of Gansu, and Beijing) These products are welcomed by the common people. Details of some cases are provided below.

- Seabuckthorn Food Experimental Factory, Shaanxi, produced a total output of products valued at 724,000 *yuan*, from which the taxes and profits amounted to 54,000 *yuan* in 1988. This factory produced seabuckthorn aerated water and milk with seabuckthorn juice, and they are in great demand in Xian City.

- Xian Brewery produced seabuckthorn beer in 1988. This kind of beer has a good taste and fruity fragrance and is very popular among the residents of Xian City. The most significant indication is a 38 per cent saving in grain by using seabuckthorn juice.

- Xiaojin Seabuckthorn Beverage Factory, which is located in Aba Tibetan Autonomous Prefecture, Sichuan, produced drink granules "Shajijin" which are much liked by the local people, especially the Tibetans in the mountain areas.

Table 9: Seabuckthorn Products Developed in China

Types	Varieties of Seabuckthorn Products
Raw materials	Clean raw juice, thick juice, condensed juice, pulp oil, seed oil, residue oil, raw powder, pigment, and flavone
Soft drinks	Syrup juice, fruit juice drinks (including thick juice and clean juice), carbonated juice drinks, soda water
Hard drinks	Sweet wine, medium dry wine, carbonated (bubbling) wine, champagne, and beer
Drink granules	Seabuckthorn crystals
Functional drinks	Sports' drinks, seabuckthorn syrup
Jam, sweets	Seabuckthorn jam, seabuckthorn chocolate sweets
Cosmetics	Shampoo, hair conditioner, hair dye, cosmetic beauty cream
Medicines	Medicines for treatment of cough, flavonoid liquid, compound oil suppositories, seabuckthorn extracts, etc.

Source: Pan Ruiling 1989

Table 10: Statistical Figures of Some Seabuckthorn Processing Factories in China, 1988

Name of the Processing Factories	Main Products	Output (ton)	Output Value ('000 *Yuan*)	Profit/tax ('000 *Yuan*)
Xinghuachun Fin Distillery, Shanxi	Seabuckthorn wine	450	1410	180
Zhuolu General Distillery, Hebei	Seabuckthorn wine	810	1460	600
Lifu Seabuckthorn Production Company, Beijing	Beverage	800	2100	340
Taiyuan Food and Drink Factory, Shanxi	Beverage	835	2920	280
Jianping Health Food Factory, Liaoning	Solid Drink	42	2400	200
Jianping Seabuckthorn Factory, Liaoning	Raw juice	130	270	27
Chengdu Fruit Processing Factory, Sichuan	Raw juice Beverage	150	750	60
Datong Beverage Factory, Shanxi	Beverage Champagne	1085	660	160
Nileke Seabuckthorn Factory, Xinjiang	Raw juice Beverage	683	1820	216
Gannan Milk Product Factory, Gansu	Beverage	1130	1921	230
Wutai Seabuckthorn Factory, Shanxi	Raw juice	384	500	76
Seabuckthorn Experimental, Shaanxi	Beverage	500	1500	300

Source: Sun Zhenhua et al. 1989

Because of the improved quality of some seabuckthorn drinks, more than 50 varieties have received awards at the provincial level, ministry level, and State level. Some cases in point are given below.

- "Shawikang" beverage, produced by Taiyuan Integrated Food Factory, was selected as the designated beverage for the Chinese Physical and Cultural Delegation to the Olympic Games in Seoul, 1988.
- "Zhonghua Seabuckthorn Aerated Wine", made at Zhuolu General Distillery, Heibei, was awarded prizes 10 times in national competitions.
- "Seabuckthorn Fresh Juice", from Beijing Lifu Seabuckthorn Company, was given an award for being among the Ten Best Sport Beverages in the national selection in 1989.
- "Jianlibao" seabuckthorn sport beverage, made by the Jianlibao Group Corporation, Guangdong, was selected as the beverage for the Chinese Physical and Cultural Delegation to the Asian Games in Beijing, in 1990.

Seabuckthorn's multipurpose function and its various products have drawn the attention of many foreign businessmen from Europe, America, Japan, the former USSR, South Korea, Singapore, Taiwan, and Hong Kong. On the one hand, they purchase seabuckthorn raw juice, oil, cosmetics, wines, and other products from China (for example, until 1989, Shanxi Province exported various products worth up to US$ 400,000); on the other hand, foreign businessmen come to China to invest in joint ventures for seabuckthorn production. For example, the Tianjin Yousheng Food Corporation, a Chinese-American joint venture, produced "Boshang" Seabuckthorn Drink and the Beijing Lifu Seabuckthorn Group Corporation joined with the Japanese Shajian Corporation and produced Seabuckthorn Tea Bags and Seabuckthorn Medicated Diets.

Use in Medicinal Industries

Modern analysis and testing methods are becoming better and approaching perfection day by day. Through this the medical value of seabuckthorn is being constantly revealed. In 1966, The Pharmacologic Committee of the Ministry of Public Health of the former USSR approved of seabuckthorn oil for clinical use in hospitals. Now some ten varieties of seabuckthorn drugs have been developed. These drugs are available in different forms, e.g., liquids, powders, plasters, films, pastes, pills, liniments, suppositories, aerosols, etc and sometimes in compound state. They may be used externally or can be taken orally. These drugs can be used for treating oral mucositis, rectum mucositis, vaginal mucositis, cervical erosion, radiation damage, burns, scalds, duodenal ulcers, gastric ulcers, chilblains, skin-ulcers caused by malnutrition, and other skin damages.

The most important pharmacological functions of seabuckthorn oil, as discovered by the scientists of the former USSR, can be summarised as diminishing inflammation, disinfecting bacteria, relieving pain, and promoting regeneration of tissues; this implies that seabuckthorn oil can also be used for skin grafting, cosmetology, and operational treatment of corneal wounds. Using local seabuckthorn oil, the Organic Chemistry Institute, Kirghizia Academia of Sciences, developed the new drugs "Kiplekos", "Kipkos", and "Dawughir" that enhance the endurance capacities of human beings.

In the former USSR, the demand from medicinal industries is so large that the currently available output of seabuckthorn oil cannot meet the increasing requests. Seabuckthorn oil, therefore, becomes a very rare product, and the price of raw materials and oil goes up quickly. In 1980 the purchasing price of the fruit was 0.9 Rbl./kg but in 1986 it went upto 1.24 Rbl./kg. In 1986 the purchasing price of seabuckthorn oil was 40 Rbl./kg but in 1989 it went up to 67.4 Rbl./kg.

During the past 40 years, Biysk Vitamin Factory, the biggest seabuckthorn oil factory in the former USSR, doubled its output again and again. In 1989 the output reached 125 tons, and it was bottled into 25 million bottles (each bottle contains 50ml). From this output, one in every 250 people could get one bottle, but this only met one-sixth of the demand (750 tons) of the Ministry of Public Health of the former USSR. If the output of Biysk is added to the output (65 tons) of Ulan-Ude Alcohol Drink Factory, and the output of other smaller factories, there still would be a lack of oil to the tune of at least 300 tons in the former USSR. Some experts consider that the currently available seabuckthorn oil and its series of drugs can only meet one-tenth of the general demand in the country. Because these drugs have evident functions in health protection, they also attract people who are not patients. It is difficult to find seabuckthorn oil and its products in the shops; these products are only provided to people who hold a certificate which is issued by the State Medicine Bureau.

In the free markets of the former USSR, sometimes seabuckthorn oil can be found but the price is double that of the State price (6.74 Rbl./100ml).

It is reported that among the 50 varieties of food products of the Soviet Astronauts, a number of them were made of seabuckthorn oil. In recent years, Soviet scientists achieved significant progress by discovering that, like the fruit, the tender branches and leaves of seabuckthorn also contain some bioactive substances. On the basis of this discovery, Biysk Vitamin Factory extracted some oil from the branches and leaves. It is said that cosmetologists are very interested in this kind of oil.

The largest seabuckthorn plantation is located in Guskhrustalnyy, Viladimir State, in the European part of the former USSR. On this plantation, there is a processing factory that extracts oil from tender branches and leaves. This kind of oil is called seabuckthorn cream and is distinct from the fruit oil.

All the seabuckthorn cream is provided to a pharmaceutical factory in Riga City where it is processed into an ointment for treating burns. Because seabuckthorn oil is very profitable, many Soviet State farms, such as the Siberian State Farm, Flora State Farm, and Gusihrustali Seabuckthorn Farm, established their own workshops to extract seabuckthorn oil. For example, in Surtov State Farm, located in the Mali Autonomous Republic, there is a workshop for extracting seabuckthorn oil. The workshop is equipped with some machines developed by the Soviet Institute of Pharmaceutical Chemistry and Technology and it is run by two mechanics and one laboratory technician. They extract oil by using freon as a solution. The oil quality has been tested and it is of medical standard. Details regarding some seabuckthorn drugs sold in the former USSR are discussed below.

"Gibozoli" Seabuckthorn Oil Aerosol. The registered number of the drug is 84-677-5. It was given approval by the Administration and Extension Bureau for New Drugs and New Medical Apparatus and Instruments, the Ministry of Public Health of the former USSR, on February 12, 1986.

Gibozoli is a foam liquid contained in a glass bottle. The main ingredients are seabuckthorn oil, methyluracil, and sodium sulfanamide. The net weight is 57gm and it is valid for two years. It is made at Biysk Vitamin Factory. Each bottle costs 2.40 Rbl.

This drug can be used for treating oral mucositis, rectum mucositis, and vaginal mucositis.

"Olazoli" Seabuckthorn Oil Aerosol. The registered number of the drug is 81-610-4. It was given approval by the Administration and Extension Bureau for New Drugs and New Medical Apparatus and Instruments and the Pharmacological Committee, the Ministry of Public Health of the former USSR, on 8 June, 1981.

Olazoli is a compound drug in which the main effective ingredients are seabuckthorn oil, P-aminobenzoic acid, ethyl ester, elvomycin, and boric acid. The net weight is 60g and it is valid for one year. It is made at Biysk Vitamin Factory. Each bottle costs 2.0 Rbl.

This drug can be used for treating wound infections, burns, malnutrition, ulcers, eczema caused by bacteria, scab-dermatitis, and for skin-grafting.

Ointment for Burns. The registered number of the drug promulgated by the Ministry of Public Health of the former USSR is 18-21-81. The drug is an emulation contained in a plastic bag. The main ingredient is seabuckthorn cream which is extracted from tender branches and leaves. It is made at a pharmaceutical factory in Riga, the capital of Latvia. Each bag contains 20g and costs 1.10 Rbl.

Seabuckthorn Glue Plate. The registered number of the drug is 83-914-7. It is a kind of aseptic glue plate with an area of 5x5 cm. Every 100g of dried substance contains 99g of collagen and 1gm of seabuckthorn oil. This drug should be maintained in a dry, cool, and dark place. The validity is for 2 years. It is made at Biysk Vitamin Factory. Ten pieces of glue plate are contained in one plastic bag which costs 2 Rbl. The drug is mainly used for curing burns.

Seabuckthorn Fruit Oil and Leaf Oil. The registered number of the drug is 87-673-4. Usually, the oil is kept in a bottle. The temperature of the storage place should be less than 10°C. The drug is characterised by a high content of carotenoid (more than 130mg/100g). It is made at Biysk Vitamin Factory and on the Siberian State Farm. Every 100ml costs 6.10 Rbl. and the validity is for one year.

Seabuckthorn Oil. The registered number of the drug is 71-273-10. In this drug the carotenoid cannot be less than 180mg/100g. It is also preserved in a bottle and the temperature of the storage place should not be higher than 10°C. Every 100ml of the oil costs 6.74 Rbl., but it is only

sold on doctor's prescription. It is made at Biysk Vitamin Factory, the Beverage without Alcohol Factory in Ulan-Ude, the former Buryat Autonomous Republic, and at Surtov State Farm of the Mali Autonomous Republic.

Protective Ointment (Hands). The drug contains a universal, atoxic component with a polymerised capacity. When it is spread on the surface of the hand, it forms an invisible, impenetrable protection membrane that can be washed with hot water and soap solution. The drug is scented with pine and peppermint. The drug can be made in three formulas. Formula 1 can be used for protecting the skin from abrasion caused by salt, acids, and alkalis. Formula 3 can be used for protecting the skin from abrasion caused by organic solvent, resin, and paint. Formula 2 synthesises the features of Formula 1 and 3 and has a comprehensive protective function.

The drug can be stored at room temperature. Like common cosmetics, it can prevent the skin of the hand from cracking and enhances the elasticity of the skin. Because this drug contains seabuckthorn oil, it protects the skin. The Ministry of Public Health of the former USSR gave approval for the drug to be used for the purposes mentioned above.

This drug can be used for protecting the skin of the hand from abrasion caused by organic solvents, petroleum products, paints, resin, acids, and alkalis. It has also been proved that this drug is effective in protecting the hands from damage in daily life, for example, house repairs, using daily equipment, fixing cars or trucks, and operating pesticide-spreading machines, and so on. The drug is made in Biysk Vitamin Factory.

"Gipulekos" Seabuckthorn Sweet Pill. This sweet pill was developed jointly by the Institute of Organic Chemistry and the Institute of Biomedicine, Tadzhik Academy of Science. It was given the Soviet State Patent in 1982. The main ingredients (weight percentage) are seabuckthorn juice (24-26%), seabuckthorn fruit skin (18-24%), extraction from walnut shell (4-6%), rose jam (8-12%), starch (4-6%), and sugar (26-42%).

Because the drug contains a series of natural bioactive substances, it can promote digestion and assimilation of food, impel normalisation of the metabolism of cholesterol, activate the process of oxidation and reduction in tissue, consolidate the blood vessel wall, and improve the whole metabolism. The sweet pill is considered to be a broad spectrum tonic and a strong drug (Wu Fuhen, 1991). This is a tonic and a robust drug because it is an enriched mixture with a lot of nutrients and bioactive substances. The following are its basic components:

Vitamin C	2-3%	Flavonoid	0.8%
Organic acids	1-1.2%	Volatile Oil	0.4-0.5%
Fat	5-6%	Pectin	3-4%
Carotene and Caretenoid	10-15mg/100g	Vitamin B_2	5-6mg/100g
Vitamin B_1	0.01mg/100g	Vitamin K	0.5mg/100g
Vitamin B_6	0.015-0.02mg/100g	Quinone	50-55mg/100g
Vitamin E	8-10mg/100g	Amino acids	high quality
Pigment	100mg/100g		

Compared to the former USSR, China's experiences in using seabuckthorn products for medicinal uses are as follows. Although China was one of the earliest countries in the world to use seabuckthorn as a medicinal plant, it was only used in limited regions, e.g., Tibetan and Mongolian doctors used it to treat some common diseases. It had never been considered an important medicinal resource to be studied and used in modern hospitals until the mid-1980s. Since then, a substantial amount of information has been transferred from the former USSR to China. This has encouraged Chinese researchers and doctors to study the biochemistry of seabuckthorn and its clinical practices, and some remarkable progress in research has been made during recent years.

Compared to the long experience of the former USSR in seabuckthorn medicines, China's study and achievements are relatively few. Nevertheless, some products and effective drugs have been developed. They are discussed below.

Seabuckthorn Oil. In 1988, China's first modernised seabuckthorn oil production line was built in Yongshou County, Shanxi Province. This production line is run by Qin Yong Seabuckthorn Corporation, Shaanxi, and it produces 20 tons of seabuckthorn oil, which meets the State standard each year. The oil output of this factory can meet the demands of Chinese markets on the whole, and some of the oil products have been shipped abroad to countries such as Japan, England, Hungary, Singapore, Hongkong, and Taiwan.

Seabuckthorn Flavone Tablet. This drug was developed by the Pharmaceutical Factory of West China Medical University, Chengdu, Sichuan, in 1986. It obtained a permit for production and sale from the Public Health Department of Sichuan Province and the Approval Document Number is (86)-3877.

Seabuckthorn Flavone Tablet is a new drug for the treatment of coronary diseases and it may improve myocardial performance, myocardial ischemia, and remit stenocardia.

The drug is prepared from dry berries of seabuckthorn and its ingredients are isorhamnetin, quercetin, and their glucosides.

Seabuckthorn Sweet Granule. This drug was developed in 1985 by Lanzhou Pharmaceutical Factory, Gansu Province, by adopting traditional Chinese medicinal techniques. Permission was given for production and sale by the Public Health Department of Gansu Province, and the Approval Document Number is (85) - 595-1.

Seabuckthorn Sweet Granule is used to relieve coughing, reduce sputum, help digestion, and promote blood circulation by removing blood stasis. It also may increase the metabolism, build up the physique, and delay the ageing of tissue.

This drug is prepared from the extraction of seabuckthorn fruit and sugar. It is used both in medicines as well as drinks and is well received in both domestic as well as foreign markets, for example, tons of Seabuckthorn Sweet Granules were exported to Europe in 1987.

Seabuckthorn Dried Emulation. This drug was jointly developed in 1990 by Yongshou Pharmaceutical Factory, Shaanxi Province, and the Shaanxi College of Traditional Chinese Medicine. Permission to produce and sell was given by the Public Health Department of Shaanxi Province and the Approval Document Number is (90)-00301.

This drug is prepared from the extraction of fresh seabuckthorn fruit and it contains all bioactive substances. Clinical experiments have shown that the drug can be used for the treatment of blood-deficiency, cardiopathy, coronary diseases, stenocardia, and to reduce blood fat and blood pressure. It may improve the brain function and bring about remission in cases of memory loss.

Use in Cosmetic Industries

More than one hundred kinds of active elements have been identified in various parts of the seabuckthorn plant. Based on its nutrients, many medical studies, testing its effect on the skin, showed that seabuckthorn extracts could effectively improve the micro-circulation of blood capillaries and nourish skin and hair. It was also proved that the extracts can retard peroxidation of the lipide and are better than Vitamin E and Bunge Swallow Wort (*Cynanchum bungei*, a Chinese traditional medicine). After several years of study, many kinds of seabuckthorn cosmetics have been developed and tested in hospitals.

Clinical Effects of Seabuckthorn Cosmetics

The practical efficacy on 350 patients treated in Guangdong Provincial People's Hospital and Guangdong Provincial Institute of Medicine was observed, and the results showed that seabuckthorn beauty cream had positive therapeutic effects on xanthopsis, melanosis, senile skin wrinkles, keratoderma, keratosis, desquamation, senile plaque, palm skin rhagades, xeroderma, face-acne, recurrent dermatitis, chemical corrosin, and ichthyosis, as well as freckles.

It was gratifying to find that seabuckthorn beauty cream could make the tested patients' skin become fair, clear, and delicate. The cases of acne recovered and their pigment changes disappeared soon after using seabuckthorn beauty cream. Several post-partum women found that the large pigment patches on their faces completely disappeared after applying seabuckthorn beauty cream for 1-2 months and the face skin became normal (He Xuejiao et al. 1989).

Clinical experiments made in Shantow Tropical Disease Hospital and the Shanxi Pharmaceutical Research Institute showed that cosmetics containing seabuckthorn extracts can improve metabolism and retard skin maturation. Application of this cosmetic on the skin made the skin smooth and soft. Hair care with this cosmetic had the effect of retarding baldness and improving hair growth.

Out of 537 patients, 88.1 per cent demonstrated that the cosmetic can cure 16 tropical diseases. They are pityriasis sicca, seborrhea sicca, alopesis, prickly heat, summer dermatosis, scabies, impetigo, acne vulgaris, pustule vulgaris, contact allergic reactions, xanthopsis, xeroderma, verruca, and lentigo (Zhong Chongju et al. 1989).

Products of Seabuckthorn Cosmetics

In the international cosmetics' market, there appears to be a striking preference for natural cosmetics, especially those

containing plant compositions. According to investigations carried out in recent years in the departmental stores of some large Chinese cities, cosmetics are the favorite commodities and the volume of business in cosmetics has increased more than in other commodities. Since seabuckthorn oil was proven to contain many bioactive substances that can improve, protect, and nourish human skin and hair, many dozens of new cosmetics based on seabuckthorn oil and flavones have been produced and marketed.

There is no definite statistical figure to show how many seabuckthorn cosmetics are available, but it is very easy to find seabuckthorn cosmetics in any big Chinese city. Some factories built up a remarkable reputation after producing seabuckthorn cosmetics. For example, Datong Daily Chemical Plant, Shanxi Province earns a profit of about 700,000 *yuan* (134,625 US$) annually from selling seabuckthorn cosmetics.

Use of the Leaves and Residues

Nutritional Value of the Leaves

The leaves of seabuckthorn have been proved to contain many nutrients and bioactive substances. Table 11 shows the contents of the nutritive components in the leaves of some species and sub-species of *Hippophae* in China. From Table 11, it can be seen that all species and subspecies are rich in protein. However, the contents are quite different. Among them, *H. rham.*, spp. *gyantsensis* contains the highest amount of protein (22.92%) and fat (96.10%). The lowest contents of protein (11.47%) and fat (3.68%) occur in *H. neurocarpa*. The leaves, of either female or male plants, have similar nutritive compositions (see Table 12). In the natural groves of seabuckthorn, it is often found that the quantity of male plants is larger than female plants. Because male plants do not bear fruit, their leaves and tender branches can be used for forage.

Table 11: The Contents of the Nutritive Components in the Leaves of Some Species of *Hippophae* in China (%)

Species	Altitudes (m)	Occurrence	Crude Protein	Crude Fat	Crude Fibre	Ash	N-Free Extracts
H.rham. ssp. *sinensis*	2700	Xiaojin, Sichuan	16.59	4.41	15.20	9.02	57.78
H. rham. ssp. *yunnanensis*	3200	Zhongdian, Yunnan	19.28	4.36	14.28	5.06	48.26
H. rham. ssp. *turkestanica*	800	Huocheng, Xinjiang	15.18	5.61	17.37	5.10	56.76
H. rham. ssp *gyantsensis*	3700	Zedang, Xizang	22.92	6.10	16.52	6.20	48.36
H. thibetana	3200	Chuona, Xizang	18.79	4.08	16.43	4.57	56.13
H. neurocarpa	3400	Hongyuan, Sichuan	16.44	5.46	16.66	3.36	58.08
H.neurocarpa	3500	Daocheng, Sichuan	11.47	3.68	19.72	3.38	61.30

Source: Lu Rongsen 1991
Note: The content of nutritive components is calculated on the basis of dried substance weight.

Table 12: Comparison of Contents of Nutritive Components between Seabuckthorn and Clover

Plate name	Part Analysed	Crude Protein	Crude Fat	Crude Fibre	Ash	N. Fee Extracts
H. rham. ssp. *sinensis*	Female leaves	17.1	4.6	16.9	5.9	55.7
-do-	Male leaves	16.2	4.2	13.0	4.1	62.5
Trifolium pratensis	Stem+leaves	17.1	3.6	21.5	10.2	47.6
Trifolium repens	Stem+leaves	24.7	2.7	12.5	13.0	47.1

Source: Lu Rongsen 1991 and Shu Jiakai 1983

From Table 12, it can be seen that the content of protein (16.2-17. 1%) in seabuckthorn is almost equal that (17.1%) found in red flower clover (*T. pratensis*) but less than that (24.7%) found in white flower clover (*T.repens*). The fat content (4.2-4.6%) in seabuckthorn leaves is more than (2.7-3.6%) in the above-mentioned species of clover. The conclusion is that seabuckthorn leaves are good for forage. In fact, the farmers in mountain areas often drive their sheep and cows into seabuckthorn bushes to graze. Seabuckthorn leaves promote the growth of livestock and have even helped increase fertility.

Residues of Fruit and Seeds and their Uses

When the fresh fruit is squeezed and juice extracted, a lot of residue remains, and also when the oil is extracted from seeds, a lot of seed residue remains. The residues of both fruit and seeds account for about 20 per cent of the total weight while fresh. These residues are rich in protein, fat, amino acids, Vitamin C, fat-soluble Vitamins A,D,E, carotenoids, flavonoids, micro-elements, sterol, choline, and betaine (Chen Tigong et al. 1988). In order to determine the effects of seabuckthorn leaves and the residues of fruit and seeds on animals and poultry, a series of experiments have been conducted by the Traditional Chinese Veterinary Medicine Institute, Chinese Academy of Agricultural Sciences, Lanzhou, China. The results are discussed below.

1. It has been proven that seabuckthorn leaves and the residues of fruit and seeds used as a supplementary feed can promote the growth of animals and poultry and increase their productivity. For example, feeding on supplementary seabuckthorn leaves, pigs increased their weight by 9.38-21.27 per cent and milch goats raised their output of milk by 6.24-6.88 per cent, and by feeding on supplementary seabuckthorn leaves and the residues of fruit and seeds, chickens enhanced their egg laying rate by 8.7-13.3 per cent and their laying output by 24.9-28.7 per cent. In addition, the content of carotene óbviously increased and the content of cholesterol decreased in chickens and broiler chicks increased in weight by 3.9-5.7 per cent.

2. Toxicological experiments have proven that the maximum tolerant dose is 50,000 mg/kg when mice are given extracted liquid from seabuckthorn leaves and residues of fruit and seeds. It seems that seabuckthorn supplementary additives are non-toxic. It has also been proven that there is no accumulated toxicity, no carcinogenesis, and no induced tumours observed over a long period of feeding and that these supplementary additives do not affect the normal propagation of animals and no deformation of embryos has been seen. On the contrary, long-term feeding with these supplementary additives may promote the growth and development of immune organisms, enhance immune activity, and increase the disease-resistivity of animals (Liu Xuchuan et al. 1989).

Seabuckthorn as a Food Additive

The pigment of seabuckthorn is widely used as food additive. Because many synthetic chemical pigments have been proved to be harmful to the health of human beings, natural pigments are preferred. Seabuckthorn fruit contains rich yellow substances. However, until recent years, the fruit residue was often thrown away as waste. A food pigment called "Seabuckthorn Yellow" has been developed by the Institute of Biophysics, Academia Sinica. At present, the productive capacity of the powdered pigment is over several tons per year. Seabuckthorn Yellow consists of flavones (usually more than 95%), carotene, and Vitamin E. Its physicochemical properties are given below.

1. Appearance: brown yellow or orange yellow powder.

2. Solubility: it is readily soluble in alcohol, either, chloroform, acetone, petroleum, oil, etc.

3. Colour Value: $E \overset{1\%}{\underset{1cm}{-----}} 445\ nm > 20$

4. Heat Stability: its orange yellow colour is quite stable. It can tolerate 220^0 C for 20 minutes in powder and 100^o C for 2 hours in solution.

5. Light Stability: its orange-yellow colour is quite stable.

6. Effect of pH: in the range of pH 3.6-9.3, its orange yellow colour was effected slightly.

7. Effects of Metallic Ions, Oxidizing Agents, and Reducing Agents: F^{+++}, Ca^{++}, and Vitamin C had greater effects (absorptivity decrements were about ½ respectively) and Cu^{++}, Mg^{++}, Na^{+} and H_2O_2 had merely slight effects (Liu Duohua et al. 1989).

Seabuckthorn Use in Other Countries

Europe

Finland. Historically, there were large areas of natural seabuckthorn in Finland. Because of the extension of the forests, seabuckthorn growth moved to the seashore. Now natural forests are only distributed along the Baltic Coast and the Aland Islands. According to Rousi (1971), this seabuckthorn belongs to the species *Hippophae rhamnoides L.*, subsp. *rhamnoides* which can grow well and bear fruit in soil containing 0.4-0.5 per cent of salt. There are two main institutions in charge of the development of seabuckthorn. One is the Joensu Research Station of the Finnish Forestry Research Institute, which introduces and domesticates wild seabuckthorn plants and establishes vegetative plantations introduced from the former USSR. The other is the Institute of Horticulture of the Agricultural Research Centre, which is now spreading new varieties that are expected to adapt to Finnish conditions. This institute did introduce some cold-resistant varieties from the former USSR, but these died under conditions of -33°C in winter time. The indigenous varieties are still surviving and have been bearing fruit for 18 years (Junnila et al. 1989).

Though there is a tradition of making jams and juices from seabuckthorn fruit on the Finnish coast, along the Gulf of Bothnia, the modern industrial processing of seabuckthorn in Finland is in its early stages. However, there is a seabuckthorn wine factory which is located at Kokkola in the Gulf of Bothnia. The factory produces a yellow wine with a typical seabuckthorn smell, containing 11 per cent of alcohol, and this is marketed in Finland and abroad.

Sweden. Seabuckthorn is also distributed on the Swedish coast along the Gulf of Bothnia and along the west coast of Sweden. Seabuckthorn, as a forest resource, is used commercially in Sweden. There are also some institutes engaged in studying seabuckthorn. For example, the Department of Horticultural Plant Breeding of the Swedish University of Agricultural Sciences now has a programme that aims to introduce some minor crops as commercial berry crops in Sweden. Through this programme some species and subspecies of seabuckthorn have been introduced into Sweden, including plant materials originating in the former Soviet Union. It is expected that new varieties suitable to Swedish conditions will be propagated in future.

Poland. Natural Seabuckthorn forest is found on the Baltic Coast of Poland. However, there are some possibilities for its cultivation in other difficult regions, for example, on wastelands, on post-industrial dumps, and even in highly industrialised towns.

Kluczynski (1989), of the Institute of Biology, University of Szezecin, Poland, studied the effects of seabuckthorn cultivated on post-industrial wastelands and analysed the results: seabuckthorn can grow well on the sediments from energised ashes of pit-coal; the dump of brown-coal, cap-rock, and post-flotation zinc sand, but it failed on the sediment from brown-coal ashes and on the slope of a pit sand mine.

Furdyna and Sendal (1973) compared the results of waste-dump investigation in the Upper Silesian Industrial Region, Poland. They experimented with afforestation on 65 different dumps, 1,505 ha in area, with various species such as *Betula pendum*, *Fraxinus excelsior*, *Robinia pseudoacacia*, *Alnus glutinosa*, *Quercus rubra*, *Populus sp.*, *Acer sp.*, *Rosa sp.*, *Padus serotina*, and *Sorbus aucaparia*. All species failed to survive, but seabuckthorn was found growing on 3 dumps of barren rock retrieved from the deep mining of pit coal (total area 8.5 hectares).

Hungary. Seabuckthorn cultivation in Hungary is in the early stages and is still on a small scale. Following the excellent results achieved from the breeding of Altaic Seabuckthorn in the Siberian Fruit Research Institute in the former Soviet Union, Hungary introduced 9 cultivars with large fruits, rich in bioactive substances, and without thorns for a cultivation experiment in 1984. They established more than 10 ha for trial. The first yield appeared in 1987. The tendency of yields was measured and the quality of fruit was compared with those of indigenous varieties as well. The final results are still pending. In Hungary,the aluminum industry is of great importance. As a by-product, red mud, sometimes called bauxite residue, is obtained in mass. The red mud consists mainly of oxides of metals without any humus content. The red mud impoundment often causes serious pollution problems. After several years of experiment, it appears that seabuckthorn is a suitable plant for reclamation of the red mud impoundment. Seabuckthorn not only survived on the red mud but also bore good fruit (Balink et al. 1989).

Asia

India. Seabuckthorn is widely distributed throughout the Indian Himalayas. There are three species and subspecies scattered at different altitudes and throughout different

climatic zones. *Hippophae rhamnoides* L., Subsp. *turkestanica* (in Hindi, it is called *Dhurchuk*) is mainly found in the Punjab, Ladakh, Lahul, and other areas. *Hippophae thibetana* is usually found at high altitudes (more than 4,000 masl) in Kinnaur, Lahul, Kumaon, and so on. *Hippophae salicifolia* (in Hindi, it is called *Chuma, Kalabis*) commonly occurs in the temperate Himalayas at altitudes of about 1,500-3,000 m, for example, in Kumaon, Kinuaur, and Lahul and Spiti.

The people who live in the Indian Himalayas began to use the fruit of seabuckthorn as a food and medicine a long time ago. Because the fruit is too sour, it is often made into a jelly with sugar. A syrup prepared from the fruit is used for lung complaints. A decoction is used for cutaneous eruption. Indian scientists, Ambaye et al. (1962), found a tumour-inhibiting activity in the bark of *H.Salicifolia* and it has given promising results as a cure for certain types of cancer.

In the high mountain areas, local people grow seabuckthorn for hedges and fences. In some places, natural seabuckthorn forests are used for fuelwood and for making charcoal. However, seabuckthorn has not yet been cultivated for commercial purposes in India.

Pakistan. One subspecies (*H. rhamnoides L., subsp. turkestanica*) is found in the northern part of Pakistan. Normally it is spread throughout the Karakorum Ranges at altitudes of 2,000-4,200 m (Chitral and Gilgit). There are no reports available on local uses of seabuckthorn.

Afghanistan. Because of the similarity in natural conditions with Pakistan, Afghanistan has the same subspecies, e.g., *H. rhamnoides* L., subsp. *Turkestanica*, and this is distributed throughout a wide range of mountains at altitudes of 2,300-3,000 m, including Bamian, Kabul, Parvan, Gulbahar, and Nuristan. It is reported that the seabuckthorn bush is sometimes used for hedges around fields and as fuelwood as well.

Nepal. Two species (*H.thibetana* and *H. salicifolia*) are identified in the high mountain areas of Nepal. Relatively, *H. thibetana* is limited to a small area, because the population of the species only occurs at 4,000 m and above. *H. salifcifolia* has a wider distribution, from the Far Western Region to the Eastern Region, at altitudes of about 2,000 m - 3,700 m.

Seabuckthorn (in the Sherpa language, it is called *Khurpu*) has long been used in various ways in Nepal. Its fruit is edible and sometimes made into a chutney or a pickle. Because the fruit is rich in acidic juices, it is often used for making vinegar in mountain homes. Some farmers grow seabuckthorn as a fence around the house or fields in order to keep the cattle and sheep away.

Bhutan. Seabuckthorn distribution in Bhutan is similar to Nepal. *H. thibetana* is found at high altitudes, ranging from 4,000 to 5,000 m, and *H. salicifolia* is located in the Trans-Himalayas at altitudes of 1,500 - 3,500 m.

For a long time, the Bhutanese have used the fruit of *H. thibetana* as a medicine for stomach ache and the fruit of *H. salicifolia* is used for polishing gold and silver.