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Heavy Metal Accumulation in Sea Buckthorn Cultivars in Siberia*

Wudeneh Letchamo, Roman Klevakin, and Irina I. Lobatcheva

Sea buckthorn (oblepiha, seaberry, Siberian pineapple, Sanndorn, argroise, sha-ji) (*Hippophae rhamnoides* L., Elaeagnaceae) is a source of raw materials for nutraceutical, cosmeceutical, pharmaceutical, and veterinary applications. The berries, leaves, cork, and roots of sea buckthorn are highly appreciated for the rich content of vitamins, carotenoides, flavonoids, steroids, minerals, enzymes, amino acids, essential oils, essential fatty acids, and serotonin. These constituents, separately or combined, may have unique health-supporting or healing properties

Sea buckthorn oil is one of the most frequently prescribed phytomedicines by Russian and Chinese physicians for a plethora of ailments, including stomach ulcers, burns, hemorrhoids, and as an ingredient for skin and hair care products. In traditional Siberian medicine, the seed oil and leaf extracts of sea buckthorn are frequently used to maintain eye sight, hearing ability, fight off cataracts, cure exzema, improve physical performance, and ward off winter depression. Dozens of sea buckthorn cultivars were developed for their agronomic traits, chemical composition, and adaptation to poor dry and sandy soils, higher altitudes, wasted lands, and extremely cold areas in Russia. Each cultivar is known to have its own unique morphological traits, color, flavor, carotenoids, oil composition (mostly unsaturated essential fatty acids), and vitamin content (Yao and Tigerstedt 1992; Letchamo and Lobatcheva 1997; Lobatcheva et al. 2002).

The level of heavy metal concentration in sea buckthorn is a matter of health, as well as an important factor defining processing technology. Success in controlling heavy metal uptake through the choice of plant cultivars has been reported by Davis and Lewis (1985). The concentration of Cu and Fe is one of the major parameters for evaluating sea buckthorn berry processing quality (Glazunova 1983). The method of processing, culinary properties, and length of storage may depend on the amounts of these metals. Zn, one of the most mobile metals, is often accumulated in plants and has been found to be a source of toxicity for humans and animals. Cd is poisonous to humans (Chirgawi and Harrison 1989). Pb is potentially very damaging to health and frequently considered as the universal indicator of atmospheric pollution in industrialized regions (Linderner 1989). There has been no published information regarding the accumulation of heavy metals in berries of sea buckthorn cultivars. The objective of this study was to determine whether differences exist in heavy metal accumulation among different sea buckthorn cultivars cultivated in the Altai region of Southern Siberia, Russia.

METHODOLOGY

Three different cultivars of sea buckthorn [‘Chuiskaya’, ‘Zhivko’, and ‘Chechek’ (Fig. 1)] developed by the Lisavenko Fruit Tree Research Institute of Siberia were selected based on their suitability for fresh consumption. The three cultivars had similar ripening dates and were grown in similar soil conditions using standard agronomic practices. The samples for the analysis of the content of heavy metals were collected, according to the established Russian standard methods (harvesting of medicinal raw materials GOST 6076) (Anon. 1974).

Berry samples were hand harvested in mid October from the top, middle, and bottom of bushes, and samples combined. During and after harvest, the berries were transported and stored in non-metallic dishes. Unwashed berries were separated from the branches using wooden blades, and stored in glassware.

The biochemical profile and the content of Cd, Cu, Pb, and Zn, were determined in pulp using inversion voltammetry, based on a mercury film electrode and voltameter-amperometric TA-1 analyzer. Fe was ana-

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lyzed using atomic absorption flame spectroscopy and compared with an atomic absorption spectrophotometer AAS-1 after full decomposition of organic substances by burning and the addition of nitrogen acid and hydrogen peroxide before dry ashing. The contents of the metals in the fruits were measured in three parallel tests for each cultivar and results were averaged.

RESULTS

There were distinct variations in flavor, oil content, and berry appearance (Fig. 1). 'Chuiskaya' is characterized by large berries (80 g/100 fruits) with the best flavor (Panteleeva and Shishkina 1991). 'Zhivko' has average size berries (57 g/100 fruits) and is used as raw material by the Russian natural vitamin-processing industry (Panteleeva and Shishkina 1991). 'Chechek' has been recently introduced into cultivation (65–70 g/100 fruits) and is under field trials.

The content of all heavy metals tested in sea buckthorn cultivars (Table 1) did not exceed the minimum levels established for health or hygienic studies in Russia (Anon. 1996). The data obtained suggest that various cultivars, under similar growing conditions differ in the ability to accumulate heavy metals in fruit (Table

Table 1. Variation in metal concentration of fresh sea buckthorn berries grown in Siberia.

Metal	Concentration (mg/kg)	Maximum allowable concn. in fruits and berries (mg/kg)
Cd	0.001–0.02	0.05
Pb	0.004–0.20	0.5
Cu	0.002–2.00	5
Zn	0.010–20.00	10
Fe	0.030–10.02	15

Table 2. Heavy metal content in the berries of three cultivars of sea buckthorn grown in Siberia.

	Content (mg/kg ±SE)				
Cultivar	Cd	Pb	Cu	Zn	Fe
Chuiskaya	ND[z]	0.019±0.005	0.164±0.040	ND	7.0±0.5
Zhivko	0.0016±0.0005	0.002±0.0004	ND	0.021±0.002	0.3±0.05
Chechek	trace	ND	0.007±0.001	0.026±0.003	3.1±0.26

[z]ND = not detected

Fig. 1. Sea buckthorn cultivars grown in Siberian Fruit Crops Research Institute. (A) 'Chuiskaya' berries are large and leaves are silver green. (B) 'Zhivko' berries are medium sized and lightly clustered and leaves are light green. (C) 'Chechek' berry clusters are dense.

2). ‘Chuiskaya’ accumulated the highest concentrations of Pb, Cu, and Fe, but Cd and Zn were not found. ‘Zhivko’ had the highest Cd content, the lowest Fe content, and no Cu, while ‘Chechek’ accumulated the highest Zn, trace amounts of Cd, and no Pb (Table 2). Genetic differences in accumulation of heavy metals suggests that heavy metal accumulation in sea buckthorn cultivars is a factor that needs to be taken into consideration during selection, introduction, and processing.

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