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The yield and fruit quality of sea buckthorn (*Hippophae rhamnoides* L.) after rejuvenation cutting

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Abstract. The yield and fruit quality of 6 sea buckthorn (*Hippophae rhamnoides* L.) cultivars of a Moscow breeding programme were studied at the Rõhu Experimental Station in South Estonia. The chemical contents of fruits of sea buckthorn were analysed after 3 months of cold-storage at –18°C. 'Trofimovskaya' appeared to have more sugars (2.9%) than the other cultivars. 'Otradnaya' had the lowest acid content (2.1%). 'Vorobjevskaya', 'Trofimovskaya' and 'Otradnaya' had higher ascorbic acid contents (about 65 mg/100 g) than the other tested cultivars. 'Vorobjevskaya' gave the highest yield (9.6 kg/tree) in the 3rd year after cutting down the trees to 2.5 m height. In the following year, the yield of the experiment was significantly higher, whereas cultivars Trofimovskaya and Botanicheskaya had the biggest yields.

Key words: sugars, titratable acids, ascorbic acid, yield

INTRODUCTION

In Estonia, the first experiments with sea buckthorn (*Hippophae rhamnoides* L.) were performed in the middle of the 20th century for the revegetation of alvars and sand lands (Kaar, 1969). Later, the sea buckthorn was planted in the wastelands of oil shale open mines in the region of Kohtla-Järve.

In 1957–1970, interest arose for the cultivation of sea buckthorn as a new fruit plant in Estonia (Kask, 1961). The sea buckthorn fruit is a small stone fruit of up to 1 g in weight, juicy and soft like a berry. The first cultivars were imported to Estonia from the Siberian Institute of Horticulture, Barnaul, in 1973 by K. Kask, and planted at the Polli Horticultural Institute.

In 1981, the Southern Estonian Cultivar Testing Farm (at present: Rõhu Experimental Station) planted an experiment with 10 cultivars of Siberian origin. These cultivars appeared to be very productive. However, they did not adapt to the Estonian climate of alternating winter temperatures, where frosts interchange with thaws, even at 10°C and higher. First of all, the stems were damaged. Many plants were killed by fungal diseases (Siimisker, 1997a). At the same time, new cultivars, originating genetically from the Prussian ecotype, from the present Kaliningrad district of Russia, were bred in the Moscow Botanical Gardens of the Moscow University and given to the state institutions for cultivar testing. In 1988, a new sea buckthorn plantation, with Moscow cultivars, was established at Rõhu. These cultivars appeared to acclimatise successfully to the Estonian climate of alternating winter frosts and thaws (Siimisker, 1993, 1997b) and have good productivity. These plants are higher, with more thorns, and fruits as valuable as those of the Siberian cultivars.

The chemical contents of the fruits were analysed at the beginning of the 1920s (Trofimov, 1976). In Estonia, Robert Piir, a researcher of the Polli Horticultural Institute, analysed the fruits during many years (Piir, 1996; Piir & Kelt, 1998).

At the beginning of 1995, great interest arose for commercial production of sea buckthorn fruits in Estonia. Many growers have established small plantations. After harvesting, fruits will be frozen for use in food production or medicine factories. The aim of this research was to elucidate the influence of the cultivars on the yields and chemical contents of frozen fruits of sea buckthorn after rejuvenation cutting.

MATERIALS AND METHODS

The experimental plantation was established at Rõhu in 1988. Plants were rejuvenated in 1999 by using heavy pruning. The fruits were harvested manually in 2001 (between 10 August and 10 September) and in 2002 (between 31 July and 3 September) and frozen during 24 h at –18°C. A chemical analysis of the fruits in the present experiment was performed in the laboratory of the Polli Horticultural Institute in 2001. Three months after harvesting, fruits of the following cultivars were chemically analysed: Avgustinka, Botanicheskaya, Otradnaya, Botanicheskaya Ljubitelskaya, Trofimovskaya and Vorobjevskaya. All these originated in the Moscow Botanical Gardens.

The content of organic acids was determined by the titration of NaOH, 0.1% solution. For determining sugar content, cyanide method, and for determinig ascorbic acid, method of Tilmans was used. The analysis of variance was used to examine the data.

RESULTS AND DISCUSSION

The plants were heavily cut back in 1996 and repeatedly in 1999. Therefore, no yield was gathered in 2000. The first yield after pruning was in 2001, and in that year the yield of the examined cultivars was 3.2–9.6 kg per tree (Fig. 1). The yield of ‘Vorobjevskaya’ was three times higher than that of ‘Otradnaya’ (9.6 kg and 3.2 kg, respectively). In the following year, the yield of the experiment was significantly higher. The yield per tree was 9.4–23.9 kg, whereas the ‘Trofimovskaya’ and ‘Botanicheskaya’ had the biggest yields. In the 3rd year after its establishment, the same experimental plot gave an average of 8.3–13.2 kg fruits per tree (Siimisker, 1998). The highest yield was measured in ‘Botanicheskaya’. In the following years, the average yield of the experiment was 7.6–15.4 kg per plant. In a commercial plantation, the first crop of cultivars Avgustinka, Botanicheskaya, Gibrid Perchika, Trofimovskaya and Vorobjovskaya was up to 0.1 kg and the second crop was 4–6 kg per plant (Kikas, 2000). On the basis of experiments carried out with sea buckthorn in Byelorussia, it has been reported that the average yield of 3- and 4-year-old trees was 3.5–7.6 kg per tree (Shalkewich, 1997). The highest yield was recorded in ‘Trofimovskaya’ and the lowest in ‘Otradnaya’. The comparison between the present experiment results and earlier results enables us to make the following conclusions: (1) after rejuvenation cutting of trees it is possible to get yield comparable to young plants; (2) the yield of the 4th year can be equal to that of fully cropping trees.

In 2001 the experiment results showed that the titratable acidity was between 2.1–3.0%. The cultivar Otradnaya had the lowest acid content 2.1% in 2001, and 'Avgustinka' and 'Botanicheskaya Ljubitelskaya' the highest one (2.9% and 3.0%) (Fig. 2).

The sugar content in the sea buckthorn fruit is very small. The sugar content in the examined cultivars ranged between 1.1–2.9% (Fig. 3). 'Avgustinka' and 'Botanicheskaya' had the lowest contents (1.1%). 'Trofimovskaya' and 'Vorobjevskaya' had substantially more sugars (2.9% and 2.5%, respectively).

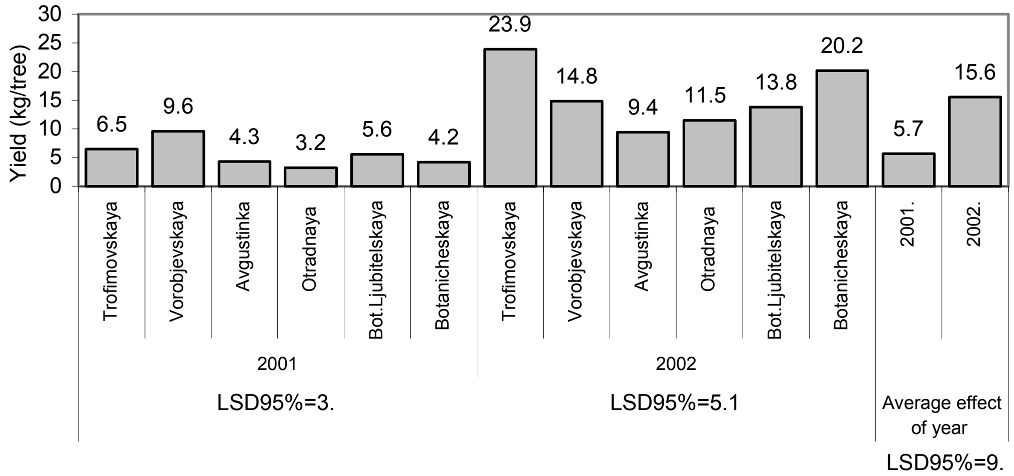

Fig. 1. Yield (kg/tree) of sea buckthorn in 2001 and 2002.

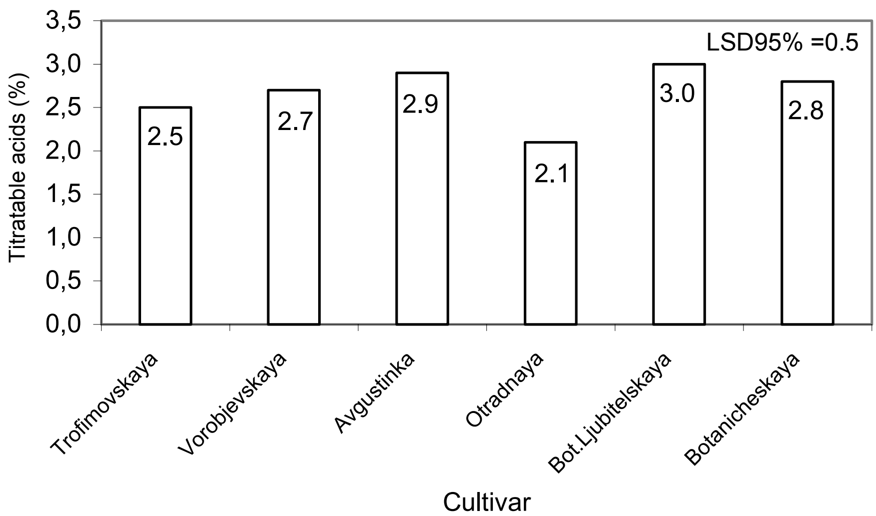

Fig. 2. Content of titratable acids (%) of fruits in 2001.

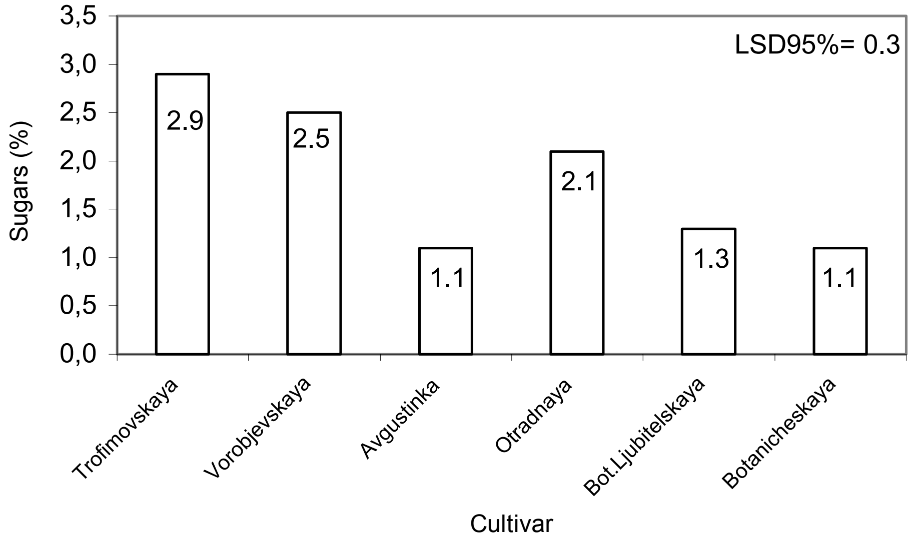

Fig. 3. Sugar content (%) of fruits in 2001.

The sugar/acid ratio was the lowest in 'Avgustinka', 'Botanicheskaya Ljubitelskaya' and 'Botanicheskaya' (0.4%, 0.5% and 0.4%, respectively) (Fig. 4).
The content of ascorbic acid was between 49–65 mg per 100 g of fruits (Fig. 5). The content was the highest in 'Otradnaya' (65 mg per 100 g), 'Trofimovskaya' (64 mg per 100 g and 'Vorobjevskaya' (65 mg per 100 g fruits). It appeared that cultivars with yellow- coloured fruits had a higher content of ascorbic acid.

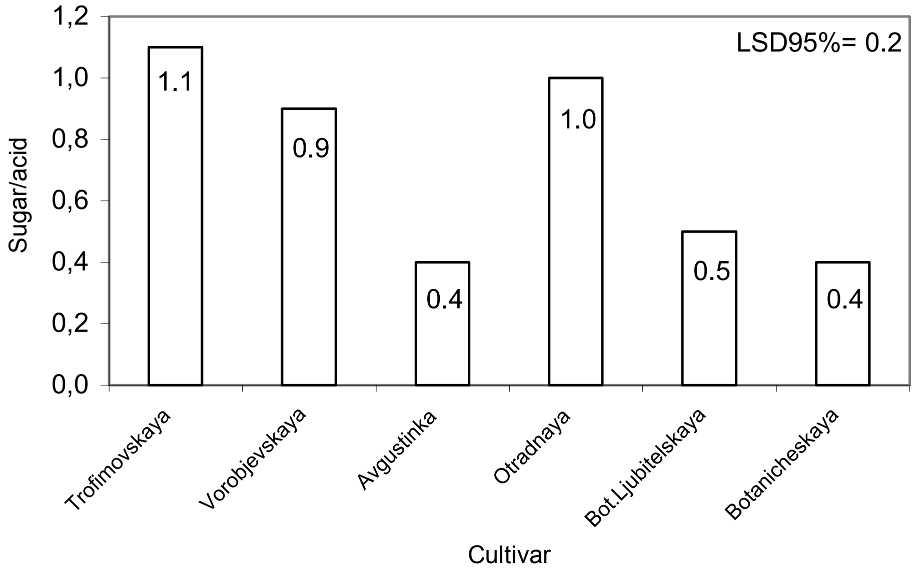

Fig. 4. Ratio of sugars/acids of fruits in 2001.

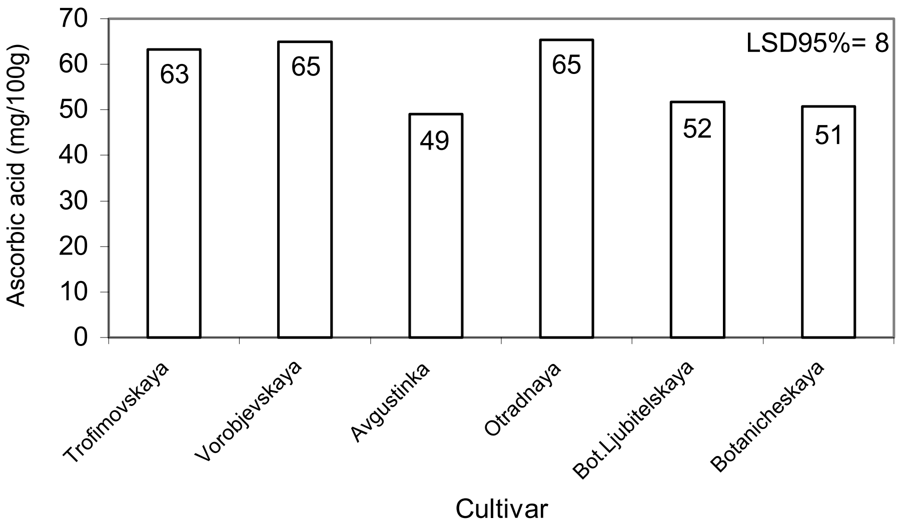

Fig. 5. Content of ascorbic acid (mg/100g) of fruits in 2001.

While comparing the data presented here, one must consider whether the fruits were frozen or not. As a rule, unfrozen fruits are more acidic (including ascorbic acids) than frozen fruits (Petrova, 1987; Trofimov, 1988; Piir, 1996; Shalkevich, 1997, Wahlberg & Jeppson, 1990). According to the data of a breeding programme in Finland, the new cultivars Terhin and Tytin contain, respectively, 185–250 and 215–360 mg of ascorbic acid per 100 g of unfrozen fruits (Karhu, 2000).

The research work will be continued, and during the following years, the recurrence of trees and the chemical content of fruits will be studied. In the future, the influence of harvesting period and storing time on the chemical content of frozen fruits will be investigated.

CONCLUSIONS

After rejuvenation, the first yield, comparable to that of young plants, was obtained in the 3rd year, and, in the 4th year, the yield was equal to that of fully cropping trees.

In processing fruits, it is necessary to take into account their chemical composition. Among the 6 tested cultivars of sea buckthorn, the 'Trofimovskaya' contained more sugars (2.9%) than the other cultivars. The content of titratable acidity was the highest in 'Botanicheskaya Ljubitelskaya' and 'Avgustinka' (2.9–3.0%) and the lowest in 'Otradnaya' (2.1%). The content of ascorbic acid was the highest (about 65 mg per 100 g) in 'Vorobjevskaya', 'Trofimovskaya' and 'Otradnaya'. The consumers are interested in purchasing frozen fruits. The results should be regarded in the realisation of frozen fruits for the population.

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