PROTECTION OF GENETIC RESOURCES OF POMOLOGICAL PLANTS AND SELECTION OF GENITORS WITH TRAITS VALUABLE FOR SUSTAINABLE FRUIT PRODUCTION

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CHEMICAL COMPOSITION OF THE FRUITS OF SEA BUCKTHORN AND HOW IT CHANGES DURING THE HARVEST SEASON IN ESTONIA

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A B S T R A C T

In Estonia, the sea buckthorn is a non-traditional fruit crop. From 2001 to 2003, at the Rõhu Testing Center of the Estonian Agricultural Research Center in Southern Estonia, six sea buckthorn cultivars were evaluated in terms of their yield and average fruit weight: 'Trofimovskaya', 'Vorobyevskaya', 'Avgustinka', 'Otradnaya', 'Botanicheskaya Ljubitelskaya', and 'Botanicheskaya'. Chemical composition was investigated in 2001 and 2002. During the harvest season, sugar content increased and organic acid content decreased.

Key words: sea buckthorn, productivity, harvesting, chemical composition

INTRODUCTION

In Estonia, cultivation of sea buckthorn is rapidly increasing, with 350 hectares currently under cultivation. The soft berries are harvested by hand. One person can pick about eight to fifteen kilograms a day. The harvest season lasts three to four weeks, depending on the cultivar. If harvesting is delayed, the berries over-ripen and spoil. Therefore, it is essential to determine the optimal harvest time and to understand the chemical changes involved in the ripening process.

MATERIAL AND METHODS

The plantation for this trial was established in the spring of 1988 at the Rõhu Experiment Station of the Estonian Agricultural Research Center in

Southern Estonia. The cultivars evaluated were: 'Trofimovskaya', 'Vorobyevskaya', 'Avgustinka', 'Otradnaya', 'Botanicheskaya Ljubitelskaya', and 'Botanicheskaya'. The trial was conducted in three replicates of twenty trees each. The grass between the tree rows was mowed regularly during the summer. In 1999, there was a plentiful harvest. Trees with berries were cut back to a height of 2.5 meters. In 2000, the plantation did not yield at all because of this severe rejuvenation pruning. Data were recorded from Aug. 1 to Sept. 14, 2001, and from Aug. 1 to Sept. 6, 2002. Yield per tree was weighed with a precision of 0.1 kilograms. Chemical analyses were done in triplicate. Fruit mass was recorded as the average of three batches of one hundred fruits. Chemical changes were measured every ten days. Chemical analyses of soluble dry matter, water, sugars, total organic acids, and vitamin C were carried out at the Polli Horticultural Institute of the Estonian Agricultural University. Soluble dry matter was measured with a refractometer. Organic acids were titrated to the neutral point with 0.1 N NaOH. Vitamin C was measured by Tillman's method. Sugar was measured by the cyanide method.

RESULTS

The average yield of the six cultivars was lower in 2001 (5.7 kg per plant) and 2003 (4.2 kg per plant) than in 2002 (15.6 kg per plant) (Tab. 1). 'Trofimovskaya', 'Botanicheskaya' and the 'Botanicheskaya Ljubitelskaya' had the highest average yields. Laboratory analyses showed negligible increase in fruit mass during the harvest season. Cultivars with remarkably big berries were 'Botanicheskaya Ljubitelskaya' (0.7-1.1 g), 'Trofimovskaya' (0.7-0.9 g) and 'Vorobyevskaya' (0.7-0.8 g). During the harvest season, sugar content increased and organic acid content decreased as the berries ripened (Fig. 1). The change in sugar content depended on the cultivar and the weather during the growth season.

Table 1. Yield of sea buckthorn trees after rejuvenation pruning in 1999 (12th growing season)

Cultivar	2001 14th season	2002 15th season	2003 16th season
'Trofimovskaya'	6.5 ab	23.9 a	0.9 c
'Vorobyevskaya'	9.6 a	14.8 c	1.5 c
'Avgustinka'	4.3 ab	9.4 de	2.9 c
'Otradnaya'	3.2 ab	11.5 d	6.4 ab
'Botanicheskaya Ljubitelskaya'	4.2 ab	20.2 b	4.1 c
'Botanicheskaya'	5.6 ab	13.8 cd	8.4 a
Mean	**5.6**	**15.6**	**4.0**

Mean separation by Duncan multiple range test at 5% level of significance

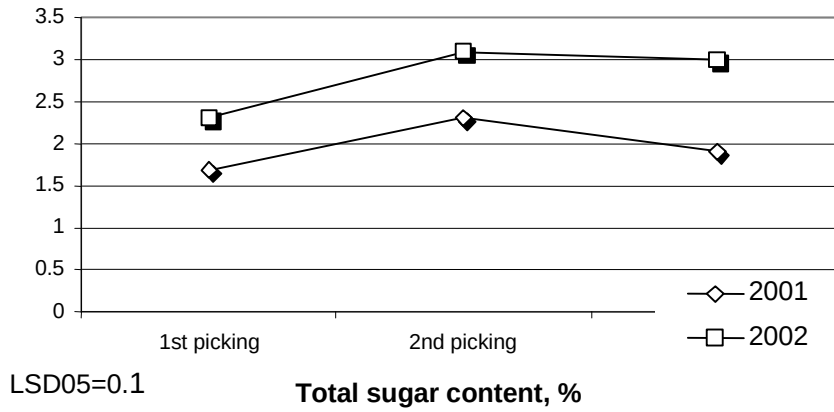

Figure 1. Total sugar content (%) in sea buckthorn berries (mean of six cultivars**)**

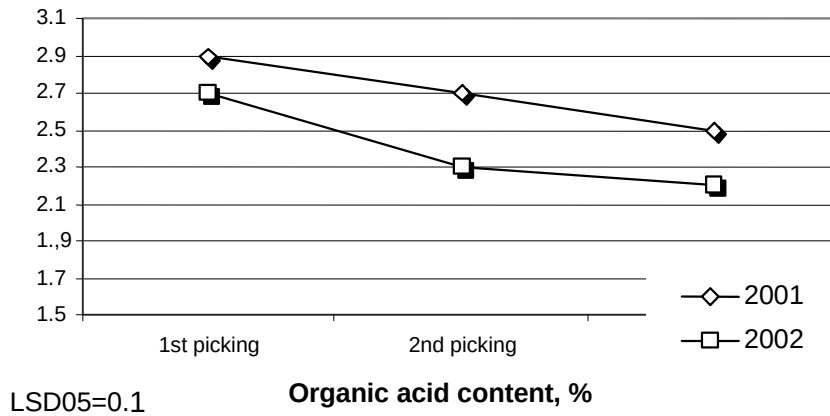

Figure 2. Organic acid content (%) in sea buckthorn berries (mean of six cultivars)

Organic acids were highest in unripe green berries and lowest in ripe berries (Fig. 2). There were differences in the dynamics of the organic acid content between cultivars. Over the course of the harvest season, organic acid content decreased by ten percent in 'Trofimovskaya' and 'Botanicheskaya Ljubitelskaya', and by 20 to 30 per cent in 'Vorobyevskaya', 'Avgustinka' and 'Otradnaya'. The ratio of sugars to organic acids affects palatability and increases in the autumn. The highest sugar/acid ratios were found in 'Trofimovskaya' (1.4), 'Vorobyevskaya' (1.5) and 'Otradnaya' (1.2). The

lowest sugar/acid ratios were found in ‘Avgustinka’ (0.6), ‘Botanicheskaya Ljubitelskaya’ (0.6) and ‘Botanicheskaya’ (0.5).

In 2001, vitamin C content varied from 44 to 80 mg/100 g. In 2002, it varied from 60 to 113 mg/100 g. Vitamin C content decreased during the course of harvest season (Fig. 3). The highest vitamin C levels were measured in ‘Trofimovskaya’ (82 mg/100 g), ‘Otradnaya’ (82 mg/100 g), and ‘Vorobyevskaya’ (77 mg/100 g). Vitamin C content was negatively correlated with fruit mass ($r = 0.56$; $p < 0.05$).

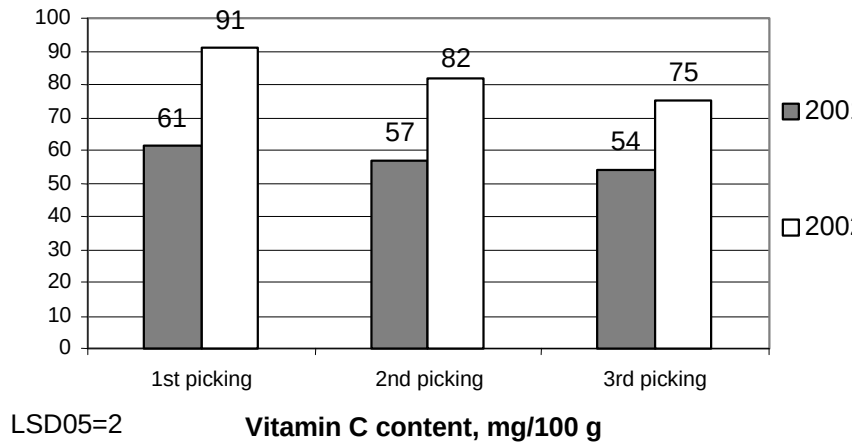

Figure 3. Vitamin C content (mg/100 g) in sea-buckthorn fruits (mean of six cultivars)

DISCUSSION

Cultivars from Siberia and Moscow were tested in Estonia (Piir, 1996). Cultivars from the Siberian Research Institute of Horticulture grew low, and had high yields of good-quality fruit in the first two bearing seasons. However, the Siberian cultivars were not very winter and disease resistant. The cultivars from the Botanical Garden of the Moscow State University were productive and showed good winter and disease resistance (Siimisker, 1998).

The twelve-year-old sea buckthorn trees selected for this study were four to six meters tall. In the autumn of 1999, shoots with berries were cut off. Before pruning, yield ranged from 11.7 to 21.4 kg/per tree (Siimisker, 1998). In the year after pruning, there was no yield at all. In the third year after pruning, yield returned to its pre-pruning level.

The chemical content of sea buckthorn berries depends on the origin of plants (Yao, 1994). Vitamin C content ranges from 28 to 310 mg/100 g in the European subspecies *rhamnoides*, from 460 to 1330 mg/100 g in the

subspecies *fluviatis*, and from 200 to 2500 mg/100 g in the subspecies *sinensis* (Tang, 2002). In Estonia, the highest levels of vitamin C are observed in cultivars of Altai origin, such as in 'Oranzhevaya' (360 mg/100 g) and 'Vitaminaya' (214 mg/100 g) (Piir and Kelt, 1998). Vitamin C content is also high in cultivars of Finnish origin, such as 'Terhi' (155-200 mg/100 g) and 'Tytti' (215-360 mg/100 g) (Prokkola and Lehto, 2001). In this study, vitamin C levels were not that high. To prevent vitamin C loss, the berries should be picked as quickly as possible. On the other hand, the sugar/acid ratio increases during the picking season, so that fruits picked earlier will be less palatable (Jeppson and Gao., 2000; Bieniek et al., 2001; Tang, 2002). When establishing the optimal collecting time, a difficult compromise has to be struck between vitamin C content and palatability.

REFERENCES

Bieniek A., Kawecki Z., Piotrowicz-Cieślak A.I., Szałkiewicz M. 2001. Sugars and organic acids of the fruit of the sea buckthorn (*Hippophae rhamnoides L.*). Scientific works. HORT. AND VEGET. GROW. 23(3): 2.

Jeppson N., Gao X. 2000. Changes in the contents of kaempherol, quercetin and L-ascorbic acid in sea buckthorn berries during maturation. AGRIC. FOOD SCI.FINLAND 9(1): 17-22.

Piir R. 1996. Astelpaju viljapuuna. AGRAARTEADUS VII (2): 162-174.

Piir R., Kelt K. 1998. Chemical composition of *Hippophae rhamnoides* fruits in Estonia. METSANDUSLIKUD UURIMUSED XXX: 134-139.

Prokkola S., Lehto M. 2001. Tyrnin lajiketestaukset ja -jalostus. Pohjoisen laatumarjat – mansikka, tyrni, mesimarja ja jalomaarain, pp. 46-57.

Siimisker T. 1998. Sea buckthorn cultivar trials at Rõhu Testing Station. METSANDUSLIKUD UURIMUSED XXX: 162-168.

Tang X. 2002. Intrinsic change of physical and chemical properties of sea buckthorn (*Hippophae rhamnoides*) and implications for berry maturity and quality. J. HORT. SCI. BIOTECH. 77 (2): 177-185.

Yao Y. 1994. Genetic diversity evolution and domestication in *sea* buckthorn (*Hippophae rhamnoides L.*). Department of Plant Biology University of Helsinki. Helsinki,104 p.

SKŁAD CHEMICZNY OWOCÓW ROKITNIKA I JEGO ZMIANY PODCZAS ZBIORU W ESTONII

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STRESZCZENIE

Rokitnik jest powszechnie uprawnym gatunkiem w Estonii. W Stacji Doświadczalnej (Rõhu Testing Center of the Estonian Agricultural Research Centre) w Południowej Estonii badano 6 odmian rokitnika: 'Trofimovskaya', 'Vorobyevskaya', 'Avgustinka', 'Otradnaya', 'Botanicheskaya Ljubitelskaya' i 'Botanicheskaya'. W latach 2001-2003 oceniano produktywność oraz średnią masę owoców wyżej wymienionych odmian. Skład chemiczny owoców badano w latach 2001-2002. W okresie zbioru zawartość cukrów w owocach wzrastała, podczas gdy zmniejszała się zawartość kwasów organicznych.

Słowa kluczowe: rokitnik, produktywność, zbiór owoców, skład chemiczny