SEA BUCKTHORN – AN INNOVATIVE RAW MATERIAL FOR THE FRUIT AND VEGETABLE PROCESSING INDUSTRY

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A B S T R A C T

The aim of the study was to verify the usability of sea buckthorn (*Hippophae rhamnoides* L.) fruit from the cultivars grown in Poland for the manufacturing fruit and fruit-vegetable puree juices. Juices were made from sea buckthorn puree which had been obtained by straining the scalded fruit pulp. Juices with the best organoleptic properties were obtained under laboratory and pilot-plant conditions. The sea buckthorn content in juices never exceeded 16%. The scope of investigation covered the analysis of key qualitative features of the buckthorn puree and of selected juice samples, which were later stored in darkness at room temperature. Composition of four different sea buckthorn cultivars were analysed in the study: 'Prozracznaja', 'Botaniczeskaja-Lubitelskaja', 'Luczistaja' and 'Botaniczeskaja'. 'Botaniczeskaja-Lubitelskaja' turned out to have the highest total sugar (3.71%) and ascorbic acid content (82.3 mg/100 ml), as well as the highest antioxidant capacity (9.85 µmol Trolox/100 ml). The highest content of carotenoids was noted in 'Prozracznaja' (9.97 mg/100 ml).

Orange-sea buckthorn juice had the most ascorbic acid (31.56 mg/100 ml) and phenolic compounds (62.5 mg/100 ml). Tomato-sea buckthorn juice was richest in carotenoids content (5.15 mg/100 ml).

Key words: sea buckthorn, purees, carotenoids, ascorbic acid, antioxidant capacity

INTRODUCTION

Sea buckthorn (*Hippophae rhamnoides* L.) is a shrub belonging to the *Elaeagnaceae* family. It is found in Asia and Europe. This plant grows wild on the Polish Baltic Sea coast and in the Pieniny Mountains, but it has been gaining popularity as a cultivated fruit plant. Sea buckthorn fruits are orange or yellow, oval berries with a seed inside. They become ripe between August and October. They have a distinctive aroma and characteristic bitter-sour taste with a slight aftertaste of oil. In terms of its richness in components of high physiological value, sea buckthorn scores higher than many fruits that are considered to be rich in vitamins. This is particularly true of ascorbic acid (260 mg/100 g), β--carotene (0.9-18.0 mg/100 g) and tocopherol (3.0-18.0 mg/100 g) (Albrecht and Sanddorn, 2004; Beveridge et al., 2002; Heilscher and Mörsel, 2002; Ożarowski and Jaroniewski, 1989). Due to its high content of ascorbic acid, carotenoids and polyphenolic antioxidants, sea buckthorn possesses powerful antioxidant properties, which have already been widely investigated (Cenkowski et al., 2006; Ecclesten et al., 2002; Zadernowski et al. 2003 and 2005).

Sea buckthorn fruit have long been known for their health-promoting properties. Therapeutic capabilities of sea buckthorn have been exploited since antiquity, and its brews were used to cure gastric and duodenal ulcer, gout, anaemia, diarrhoea, hypertension, and diseases brought on by old age. The bioactive compounds of sea buckthorn fruit are said to enhance vision, provide protection from arteriosclerosis, delay the ageing process and increase immunity to radioactive radiation (Albrecht, 2004; Mörsel and Mörsel, 2003). Interest in this plant is currently on the rise, as is evident by the growing number of studies seeking to explain these medicinal properties of sea buckthorn by its chemical composition.

The aim of this work was to investigate the usability of the sea buckthorn fruit which grow in Poland, in the production of fruit and fruit-vegetable juices. The aim of this work was also to design several exemplary sea buckthorn-based products with high health-promoting potential.

MATERIAL AND METHODS

The material for investigation consisted fruits of four cultivars of sea buckthorn: 'Prozracznaja', 'Botaniczeskaja-Lubitelskaja', 'Luczistaja' and 'Botaniczeskaja', and a mixture of fruits of unknown cultivar composition, which were harvested in 2006 and 2008. They were harvested from a plantation near Janów Podlaski and kept frozen until processing. Puree juice made from sea buckthorn (with peels and seeds removed) was used for technological testing. The puree was obtained by straining fruits that were first crushed and heated to 50°C for 10 min without the addition of water, and then de-aerated at 0.07 MPa.

As supplementary raw materials and semi-products, fruit juices (reconstituted from concentrated juices) and homogenates from carrot and apples of the 'Champion' cultivar were used. Homogenates were produced from fruits bought on the retail market.

The following variables were analyzed: total and reducing sugar content using the Lane-Eynon method, polyphenol content using the Folin-Ciocalteau method, carotenoid content according to PN-90/A-75101/12, ascorbic acid content according to PN-A-04019:1998 and total antioxidant activity using $ABTS^+$ radicals (expressed as µmol of Trolox equivalents) (Re et al., 1999).

RESULTS

The results of the analysis of these four cultivars of sea buckthorn: 'Prozracznaja', 'Botaniczeskaja-Lubitelskaja', 'Luczistaja' and 'Botaniczeskaja' and the mixture of fruit of various cultivars harvested in 2008 are presented in Table 1. The highest total sugar and ascorbic acid content, as well as the highest antioxidant capacity were detected in fruits of the 'Botaniczeskaja-Lubitelskaja' cultivar. The 'Prozracznaja' cultivar was richest in carontenoids, while 'Luczistaja' turned out to be the poorest in these compounds.

The study also measured the content of selected bioactive compounds in the sea buckthorn puree (Tab. 2). The puree was obtained from fruits of various cultivars, harvested in 2007 and was tested for its total polyphenols, soluble solids, total carotenoids and ascorbic acid content, as well as its overall antioxidant capacity.

The next stage of the study consisted of investigating changes in these variables taking place in the designed products after 10 months of storage (Tab. 2). The following juices were examined: orange-sea buckthorn juice, apple-sea buckthorn juice, carrot-apple-sea buckthorn juice and tomato-sea buckthorn juice. The highest preservation of total antioxidant capacity was observed in the carrot-apple-sea buckthorn juice (96%), while the lowest in the apple--sea buckthorn juice (60%). Significant losses were noted in the ascorbic acid content of the investigated juices (87-94%). There was a much lower loss in the carotenoid and polyphenol content: 4-25% and 10-15%, respectively.

DISCUSSION

The study showed that the 'Botaniczeskaja-Lubitelskaja' cultivar contained the most ascorbic acid (82.3 mg/100 ml). This cultivar also showed the highest total antioxidant capacity (9.85 µmol/g), as well as the highest total sugars and reducing sugars content (3.71% and 1.43% respectively). The highest carotenoid content was found in the mixture consisting of four sea buckthorn cultivars (10.81 mg/100 g).

The analysis of sea buckthorn cultivars coming from the territory of the former USSR revealed an ascorbic acid content of 29-176 mg/100 g in the fresh mass (Tiitinen et al., 2005). In other studies of 25 cultivars from this region, the ascorbic acid content was between 27-138 mg/100 g. In contrast, fruits of three German cultivars ('Askora', 'Hergo' and 'Leikora')

Table 1. Characteristics of individual cultivars of sea buckthorn

Cultivar	Total sugar [%]	Reducing sugars [%]	Ascorbic acid [mg/ 100 ml]	Carotenoids [mg/100 ml]	Total antioxidant capacity [µmol of Trolox equivalents/ml]
Botaniczeskaja-Lubitelskaja	3.71	1.43	82.3	7.97	9.85
Botaniczeskaja	2.65	1.02	70.1	8.87	9.72
Luczistaja	2.95	1.17	71.4	6.32	8.85
Prozacznaja	2.35	0.89	69.9	9.97	6.46
Mixture	3.06	1.16	62.4	10.81	9.64

Table 2. Characteristics of puree and juices made from sea buckthorn and changes they underwent during storage

Smple	Ascorbic acid [mg/100 ml]		Carotenoids [mg/100 ml]		Polyphenols [mg/100 ml]		Total antioxidant capacity [µmol of Trolox equivalents /ml]	
	after production	after 10 months	after production	after 10 months	after production	after 10 months	after production	after 10 months
Puree (9.3% s.s.)	53.0	-	7.4	-	101.0	-	4.8	-
Carrot--apple-sea buckthorn	4.63	1.1	4.58	3.81	50.1	42.6	1.72	1.62
Apple--sea buckthorn	7.40	0.6	0.82	0.62	56.1	49.0	2.53	2.20
Orange-- sea buckthorn	31.56	2.1	2.29	2.08	62.5	53.4	2.50	1.97
Tomato--sea buckthorn	7.20	1.1	5.15	4.98	40.2	36.2	1.86	1.11

contained 180-370 mg/100 g ascorbic acid (Mörsel and Mörsel, 2003; Zadernowski et al., 2007). Similar high values (250-333 mg/100 g) were received for sea buckthorn harvested in various parts of Northern Pakistan.

As discovered by Univera, the content of particular components in sea buckthorn was dependent not only on the time of harvest but also on the weather conditions in a given period. These factors can vary significantly (Univera et al., 2004).

Puree obtained from the mixture of fruits of different (unknown) cultivars showed a significantly lower content of the components under investigation as compared to the raw material: ca. 15% decrease for ascorbic acid, ca. 30% decrease for total carotenoids and nearly 50% decrease in the total antioxidant capacity. The soluble solids content of the puree was 9.3%, titratable acidity 2.27%, and pH 2.8. These results were similar to the ones obtained by Wilkowska et al. (2009) and slightly lower than the results noted for the raw material. This can be justified by the impact of high temperature and aeration to which the fruits were subjected as part of the puree production process (heating, straining) (Wilkowska et al., 2009).

The content of sea buckthorn in the investigated juices was 10-16% depending on the juice composition. The highest level of ascorbic acid and polyphenols in the mixed juices was observed in the orange-sea buckthorn juice (31.56 mg/100 ml and 62.5 mg/100 ml, respectively), and the lowest ascorbic acid content was found in the carrot-apple-sea buckthorn juice (4.63 mg/100 ml). The tomato-sea buckthorn juice was richest in carotenoids (5.15 mg/100 g). As to the preservation of the total antioxidant activity, which is an indicator of the content of bioactive components, the highest value was found in the carrot-apple-sea buckthorn juice. After 10 months of storage the loss was merely 6%, while in the tomato-sea buckthorn juice a loss of 40% was noted. The content of ascorbic acid in juices after storage was from 4 times (for the carrot-apple-sea buckthorn juice) to 16 times (for the orange-sea buckthorn juice) lower than immediately after their production. The losses in carotenoids as well as total polyphenols in all mixed juices were much lower and ranged from 3% to 24%, and from 10% to 15%, respectively, depending on the juice composition.

Considering the distinctive taste and aroma of the sea buckthorn, it was essential to establish what amount of its puree can be used with the various juices in order to preserve a balance with the other components. All the investigated juices showed good overall sensory acceptance.

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ROKITNIK – INNOWACYJNY SUROWCIEC DLA PRZEMYSŁU OWOCOWO-WARZYWNEGO

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STRESZCZENIE

Badano przydatność owoców rokitnika (*Hippophae rhamnoides* L.) odmian uprawianych w Polsce do produkcji owocowych i warzywno-owocowych soków przecierowych. Rokitnik używano w postaci przecieru otrzymanego przez przetarcie rozparzonej miazgi owocowej. W warunkach laboratoryjnych i mikrotechnicznych wyprodukowano soki o najkorzystniejszych cechach organoleptycznych. W opracowanych sokach ilość przecieru z rokitnika nie przekraczała 16%. Zbadano podstawowe jakościowe wyróżniki przecieru z rokitnika oraz wytypowanych próbek soków, które były następnie przechowywane w temperaturze pokojowej bez dostępu światła. Spośród badanych odmian rokitnika: ‘Prozracznaja’, ‘Botaniczeskaja-Lubitelskaja’, ‘Luczistaja’ i ‘Botaniczeskaja’, najlepszą pod względem zawartości cukrów ogółem (3,71%), witaminy C (82,3 mg/100 ml) oraz pojemności przeciwutleniającej (9,85 µmol Trolox/100 ml) była ‘Botaniczeskaja-Lubitelskaja’. Największą ilość karotenoidów (9,97 mg/100 ml) stwierdzono w odmianie ‘Prozracznaja’.

Wśród soków z udziałem rokitnika najwyższą zawartość witaminy C (31,56 mg/100 ml) oraz związków fenolowych (62,5 mg/100 ml) miał sok pomarańczowo-rokitnikowy, natomiast najbogatszy w karotenoidy (5,15 mg/100 ml) okazał się sok pomidorowo-rokitnikowy.

Słowa kluczowe: rokitnik, przecier, karotenoidy, witamina C, pojemność przeciwutleniająca