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CONSUMER ACCEPTANCE AND SENSORY ATTRIBUTES OF SELECTED PRODUCTS PROCESSED FROM SEA BUCKTHORN

AKCEPTACJA KONSUMENCKA I CECHY SENSORYCZNE WYBRANYCH PRZETWORÓW Z ROKITNIKA

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Streszczenie. Ostatnio wzrosło zainteresowanie konsumentów żywnością, będącą źródłem substancji biologicznie czynnych. Dynamicznie rozwijający się rynek owoców i warzyw oferuje innowacyjne produkty zaliczane do grupy tak zwanych superowoców, wcześniej nieznanymi lub mało znanymi, o egzotycznych smakach, bogatych w składniki bioaktywne. Przykładem takiego produktu jest rokitnik. Celem badań było porównanie cech sensorycznych i upodobań konsumenckich wybranych produktów wykonanych z rokitnika zwyczajnego. Niektóre z badanych produktów zostały zakupione w sklepie organicznym, a niektóre przygotowano w laboratorium. Ocenę sensoryczną przeprowadzono przy użyciu trzech metod: akceptacji konsumenckiej w skali 9-stopniowej, w której oceniano wygląd ogólny, smak, zapach, klarowność i ogólną jakość sensoryczną. Dodatkowo oceniono skłonność konsumentów do zakupu testowanych produktów. Określono także profile smakowo-zapachowe badanych przetworów za pomocą ilościowej analizy opisowej (QDA). W wyniku przeprowadzonych badań stwierdzono, że soki i nektary z rokitnika nie są akceptowane przez konsumentów ze względu na cierpki smak oraz kwaśny smak i zapach, natomiast słodki owocowy smak oraz zapach dżemów zachęca konsumentów do ich zakupu.

Keywords: functional food, sensory quality, sea buckthorn, consumer acceptance.

Słowa kluczowe: żywność funkcjonalna, jakość sensoryczna, rokitnik zwyczajny, akceptacja konsumencka.

INTRODUCTION

In recent years a rapid development of the health-oriented and functional food market, both globally and in Poland, is observed. Consumers are constantly looking for new, attractive products with declared pro-health properties. Progress in the development of the nutrition science resulted in wider knowledge about an increasing number of plants, additionally health data given on products' packages have been supported by scientific research. This way, consumers are becoming more aware of how they should eat and take care to improve and protect their health (Bogacz 2009).

Antioxidants, whose main sources in the diet are fruits and vegetables, have proven beneficial effects on the human body. Fruits and vegetables are also a rich source of fibre and they are low-calorie products, which seems important as overweight and obesity and diabetes spreads in developed countries. Natural plant antioxidants include, among others, phenolic substances such phenolic acids and flavonoids (Guo et al. 2017). Many studies have demonstrated the impact of the diet rich in antioxidants on strengthening the immune system and reducing the risk of diseases associated with oxidative stress and aging of the organism, in particular cardiovascular diseases and vascular tumours (Marszałek et al. 2014).

To meet the growing demands of consumers, scientists are looking for new sources of health promoting ingredients, often finding them in unknown or undervalued fruits from the virgin, largely untouched nature. These valuable wild fruits are rarely available to the consumer in the unprocessed form. However, they are available as syrups, juices, nectars, jams and dried and frozen concentrates or powders (Cieślik and Gębusia 2012). Such fruits are so-called superfruits. The concept of super fruits has been defined only a few years ago and is gradually gaining more and more enthusiasts. The fruit, which can be described as a super fruit must meet several criteria. It must have a high content of nutrients and healing properties, much higher than regular fruit. It should stand out with a high content of antioxidants with proved activity, as well as with exotic origin and flavour and an interesting appearance. Reliable information that in some distant lands this fruit was successfully used in food and folk medicine is important. Furthermore, it must be reasonably available every year, but also not very popular (Druri 2010). Among the list of a dozen super fruits sea buckthorn (*Hippophae rhamnoides*L.) deserves special attention as it contains bioactive substances and it is also an excellent raw material for designing the food with functional properties (Marszałek et al. 2014). Sea buckthorn has been used in traditional Chinese medicine since the Tang Dynasty, going back more than 1000 years. In-depth survey and documentation of indigenous ethnobotanical knowledge this plant was traditionally utilized by local people of Asia, Nordic countries and the Baltic region in multidimensional aspects of food, medicine, veterinary, agricultural tools and bio-fencing (Suryakumar and Gupta 2011).

Sea buckthorn is a shrub from the family *Oleaceae* occurring in Asia and Europe. In Poland it grows wildy on the coast of the Baltic Sea and in Pieniny. It is also planted as decorative shrub in parks and at the peripheral streets of big cities. Currently it is cultivated in Podlasie, Pomorze and Suwalki region as a fruit shrub (Lipowski et al. 2012).

Its fruit is one seed drupe, usually heavily covering twigs. Fruit colour varies from light yellow to dark red. Juicy, aromatic fruit, with a characteristic sour-tart taste and specific smell, remains on the plant all winter, until spring. They are characterized by an abundance of vitamins, fat- and water-soluble and valuable minerals and biologically active substances. They contain vitamin C about (166 mg/100 g), carotenoids (10–11 mg/100 g), tocopherols (vitamin E), folic acid, vitamin B1, B2, B6. Except the vitamins in the fruit of sea buckthorn there are flavonoids, catechins, phospholipids, tannins, sugars, organic and phenolic acids. A valuable advantage of sea-buckthorn berries is the absence of the enzyme destroying vitamin C and therefore this vitamin is not so degradable during storage or processing

(Wilkowska et al. 2009). The most common sea buckthorn berries are used for making oil. Sea buckthorn berries are commonly used to obtain oil which contain significant amounts of carotenoids, tocopherols, oleic acid glycerides, palmitic acid, linoleic and stearic acid. Sea-buckthorn oil is a valuable raw material for pharmaceutical and cosmetic industry. Due to the high content of vitamin C in fruits, sea buckthorn is a valuable component of preparations eliminating skin discoloration. Sea buckthorn oil and sea buckthorn fruits are called the "elixir of youth" because of their strong regenerative effect. Cosmetic preparations with them possess potential anti-aging and reinforcing skin cells activity. They significantly improve the condition of skin, delay aging and wrinkle formation, improve the flexibility and strength of the skin, rejuvenating effect and restore its balance, maintain the appropriate level of skin hydration. In medicine sea buckthorn oil is used for the treatment of burns, frostbite, eczema, and skin lesions and mucous membranes by solar radiation and radioactive. Products from sea-buckthorn berries received very high popularity as functional additives, due to high content of biologically active substances (Wilkowska et al. 2009).

The pulp from sea buckthorn, after oil fraction centrifugation, is used for the production of juices and purees. However, the best from a nutritional point of view are the products obtained from whole fruits, as they contain the water-soluble phenolic antioxidants and vitamin C, folic acid and vitamin B as well as tocopherols, carotenoids, vitamin E, F, K, unsaturated fatty acids in the oil phase and medium- and low-methoxy pectin responsible for stability of juices (Teleszko et al. 2015). Very simple technique to process frozen sea buckthorn fruit into juice is to heat at the temperature 98°C for 5 minutes and press at a pressure of 300 bar. Such juice may be used without further treatment for the production of syrups. Another way of processing of sea-buckthorn berries is grinding partially defrosted fruit, brewing on at about 60°C and wiping. Final result is semi-product to the production of puree, jams and other products (Lipowski et al. 2012). The process of production of jams is based on cooking sea buckthorn fruits with addition of sugar or sweeteners. At the end of cooking an appropriate amount of the pectin in solution with the possible addition of sugar provided in the formulation is added. After obtaining the desire extract prepared jam is poured into jars and pasteurized for about 20 minutes at 85°C (Beveridge et al. 1999; Marszałek et al. 2014).

Currently sea-buckthorn berries are used rather in the pharmaceuticals and cosmetics than in food. Juices, jams, preserves and nectars from sea buckthorn are produced on a small scale. It's hard to find them on the shelves of popular supermarkets and hypermarkets, in addition to Polish jam, as they are rather available only in online-stores operated by small, usually local producers of processed fruit or companies importing foreign products (Kadzińska et al. 2013). Table 1 presents selected products from sea buckthorn available on the Polish market.

Products from sea buckthorn have appeared quite recently on the Polish market and are not very popular. Consumers have not learned yet to appreciate health benefits of these products. Therefore the aim of this study was to evaluate sensory quality of products contained sea buckthorn berries: juices, nectars and jams, both industrial, bought in on-line stores and homemade – obtained according to homemade recipes in food laboratory.

Table 1. Selected products from sea buckthorn available on the Polish market
Tabela 1. Wybrane produkty z rokitnika dostępne na polskim rynku

Product from sea buckthorn Produkty z rokitnika	Composition Skład	Producer Producent
Łowicz jam 100% fruit sea buckthorn Dżem 100% z owoców rokitnika Łowicz	sea buckthorn 47%, sugars derived from fruit, apple puree 18%, concentrated apple juice 7%, gelling agent – pectin rokitnik – 47%, cukry pochodzące z owoców, przecier jabłkowy – 18%, zagęszczony sok jabłkowy – 7%, substancja żelująca	Agros Nova Company firma Agros Nova
Jam made from sea buckthorn extra Sandokan Konfitura ekstra z owoców rokitnika	sugar, fruit puree with sea buckthorn, sea buckthorn fruit, gelling agent: apple pectin cukier, przecier z owoców rokitnika, owoce rokitnika, substancja żelująca – pektyna	Sibeco Company firma Sibeco
Juice bio 100% from sea buckthorn Sok z rokitnika 100% bio	100% natural juice from the fruit from sea buckthorn sok naturalny – 100% owoców rokitnika	Premium Rosa Company Firma Premium Rosa
Mousse from sea- -buckthorn berries Nektar z jagód rokitnika	fruits and seeds from sea buckthorn 100% owoce i nasiona z rokitnika – 100%	Sandokan Company firma Sandokan
Syrup from sea buckthorn Syrop z rokitnika	juice from sea buckthorn (70%), sugar cane sok z rokitnika (70%), trzcina cukrowa	PPHU „Szarlat” Company firma PPHU „Szarlat”
Oil from sea buckthorn Olej z rokitnika	oil from sea buckthorn 100% 100% oleju z rokitnika	Oleofarm Company firma Oleofarm
Tea from sea buckthorn Herbata z rokitnika	bio-hibiscus, apple pieces, raisins, berries, sea buckthorn 7%, orange peel 10% bio-hibiscus, cząstki jabłek, rodzynki, jagody, rokitnik – 7%, skórka pomarańczowa – 10%	Sibeco Company firma Sibeco

Source: own elaboration based on market data.

Źródło: opracowanie własne na podstawie danych rynkowych (14.11.2016).

MATERIAL AND METHODS

The material consisted of six products from the sea buckthorn: two juices (A1 – Polish production juice 100% and A2 – homemade), two nectars (B1 – German production nectar and B2 – homemade), and two jams (C1 – Polish production jam Łowicz and D1 – German production jam), nectar and jam from sea buckthorn (German production) purchased at online store and nectar and juice made from frozen sea-buckthorn berries in the laboratory, unpasteurized. The participation of fruit juice in the nectar obtained in the laboratory was set at the minimum level specified in the Code of Practice for the evaluation of fruit and vegetable juices AIJN, which should be 25% (Code of Practice 2001). Sweeteners were added to the nectar in an amount of 25 g/ 200 ml. Products from sea buckthorn were evaluated by consumer panel consisting of 30 people. The acceptance of general appearance, taste, odour, clarity and overall desirability were evaluated. The 9-point hedonic scale, where 1 means “I do not accept/dislike very much”, and 9 – “I like very much” was used. Additionally the willingness to buy tested products was evaluated. The panellists were asked to indicate one of the following answers: I would definitely not buy, I would probably not buy, I do not know if I would buy, I would probably buy, I would definitely buy.

For determination of sensory profiles Quantitative Descriptive Analysis (QDA) was applied. Objective of this method is to find the minimum number of terms, returning the maximum amount of information about the sensory properties of the product (Babicz-Zielińska et al. 2009). Descriptors definitions for evaluation of products from sea buckthorn were developed by 10 panellists. Panellists were staff and students from Gdynia Marine University who regularly participated in sensory assessments and had experience in profiling other food products. The descriptors chosen by more than 3 panellists were used. Finally 6 descriptors of smell (fruity, acid, alcohol, spices, grassy and others) and 9 descriptors of taste (sweet, sour, pungent, fruity, bitter, bland, synthetic turf, other) were selected. The intensities of descriptors were quantified in 100 point scale, from 0 to 100, where 0 means attribute not present, 100 attribute extremely intensive. Results were presented as the mean value. To assess the impact of the kind of product on the evaluated parameters, the one-way analysis of variance (ANOVA) were used. Statistical hypotheses were verified at a significance level of p values <0.05 . Calculations were performed with statistical software package Statistica 12.0 (StatSoft Inc., Tulsa, USA).

RESULTS AND DISCUSSION

The results of evaluation of consumers' acceptance are shown in Table 2.

Table 2. The results of consumers' acceptance evaluation
Tabela 2. Wyniki oceny akceptacji konsumenckiej

Product Produkt	Gen. appearance Wygląd ogólny		Taste Smak		Aroma Zapach		Transparency Przejrzystość		Desirability Pożądalność	
	mean score średni wynik	rank* ranga								
A1	3.7	6	2.0	6	3.0	6	2.8	6	2.0	6
A2	4.5	5	3.1	5	4.5	5	4.4	5	3.0	5
B1	4.6	4	6.5	3	5.4	4	5.3	4	5.6	4
B2	6.0	3	7.3	2	5.8	3	5.8	3	7.1	2
C1	7.4	1	7.4	1	7.1	1	7.3	1	7.6	1
D1	7.0	2	6.4	4	6.2	2	6.3	2	6.3	3

*9 point structured, unipolar acceptance scale was used (1 – dislike very much, 9 – like very much) – 9-stopniowa skala akceptacji (1 – bardzo nie lubię, 9 – bardzo lubię).

A1 – juice produced by a Polish company 100% – sok produkowany przez polską firmę – 100%.

A2 – homemade juice – sok domowej roboty.

B1 – nectar produced by a German company – nektar produkowany przez niemiecką firmę.

B2 – homemade nectar – nektar domowej roboty.

C1 – jam produced by the Polish company Łowicz – dżem produkowany przez polską firmę Łowicz.

D1 – jam produced by the German company – dżem produkowany przez niemiecką firmę.

The study showed that the most acceptable product was jam made from sea buckthorn with apple puree addition (C1-Polish production), which received the highest scores for all assessed attributes.

The scores ranged from 7.1 (aroma) to 7.6 (desirability), which means that consumers evaluated all the features as highly desirable. It should be noted that jam 100% made from sea buckthorn (D1-German production) was rated as the second best. Its appearance was assessed the highest, while the scores for the other features oscillated around 6 (that is consumers rather accept). 100% natural juice (A1) was assessed as the least desirable product. This product received the lowest scores for all assessed attributes – from 2.0 (taste and desirability) to 3.7 (general appearance) which means that consumers have not accepted most of the evaluated characteristics.

The home-made 100% juice (A2) was rated only slightly better with mean scores varying from 3.0 (desirability) to 4.5 (general appearance). Nectars were evaluated reasonably well, however homemade nectar (B2) received better notes. Its taste and desirability were rated highest. ANOVA results confirmed that the observed differences in the consumer's assessment of individual products were statistically significant.

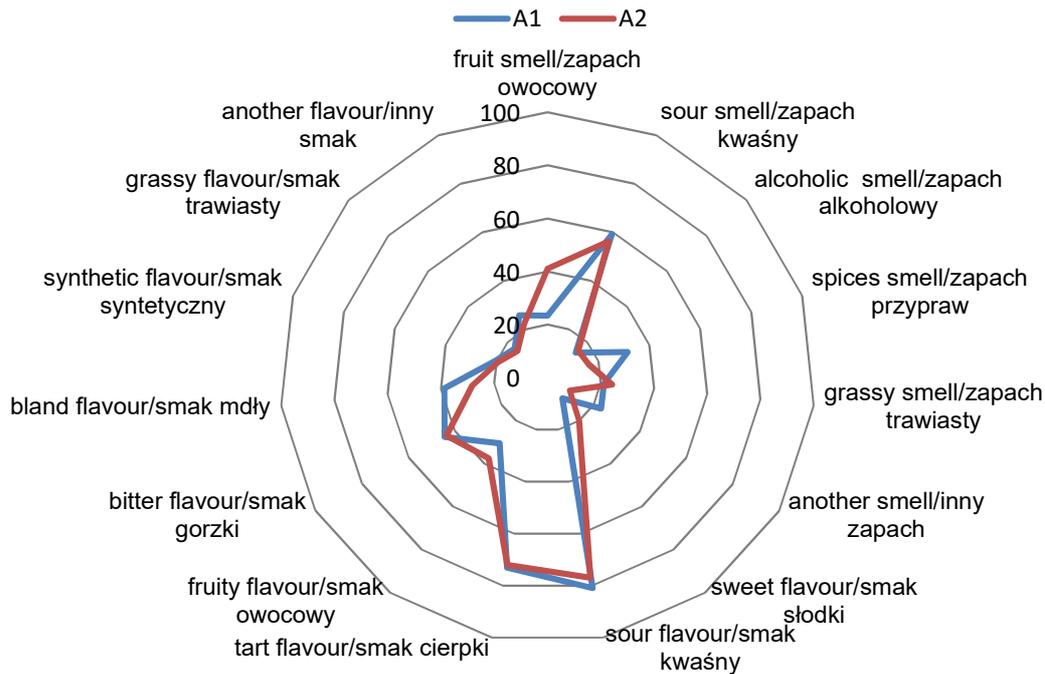
Moreover the consumers were asked to access the willingness to buy the evaluated products. The results of this study are shown in Table 3. As could be seen most consumers declared their willingness to buy Polish jam (C1) (15 of them probably would buy this product and 12 certainly would buy) and home-made nectar (respectively 12 and 6 consumers). More than 2/3 of consumers stated that they would definitely not buy 100% juice (A1) from sea buckthorn, both produced on a commercial scale, and homemade.

Table 3. The willingness to buy products from sea buckthorn
Tabela 3. Chęć zakupu produktów z rokitnika

Product Produkt	I would definitely not buy Na pewno bym nie kupił(-a)	I would probably not buy Prawdopodobnie bym nie kupił(-a)	I do not know if I would buy Nie wiem, czy bym kupił(-a) czy nie	I would probably buy Prawdopodobnie bym kupił(-a)	I would definitely buy Na pewno bym kupił(-a)
A1	24	3	0	3	0
A2	21	3	6	0	0
B1	6	18	0	6	0
B2	0	0	6	12	6
C1	0	0	3	15	12
D1	0	12	3	9	3

Type of products – see Table 2 – Rodzaje produktów – patrz tab. 2.

Due to the occurrence of significant differences in the acceptance of individual products from the sea buckthorn it was decided to investigate which of the attributes of taste or smell may have an impact on the perception of these products by consumers. Figures 1-3 below shows the results of a sensory profiling of juices, nectars and jams from sea buckthorn.



A1 – characteristics of smell – cechy zapachu, A2 – characteristics of flavour – cechy smaku

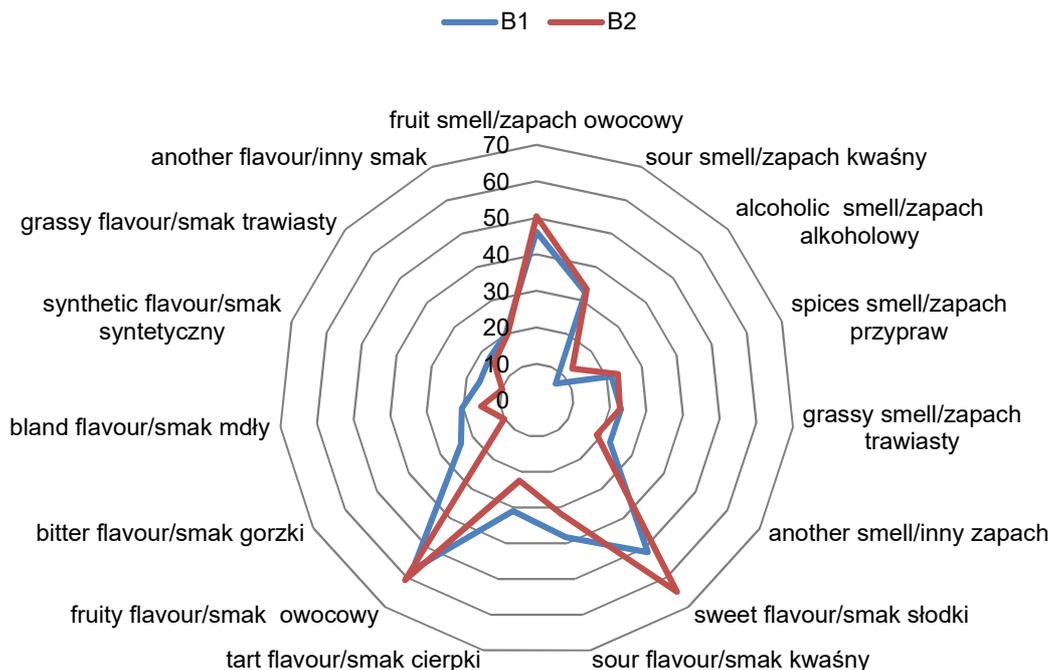
Fig.1. The sensory profile of juices from sea buckthorn
Ryc.1. Profil sensoryczny soków z rokitnika

The lowest accepted were 100% juices (A1) from sea buckthorn. In produced on commercial scale 100% juice the most noticeable were flavour descriptors: sour (81 in scale to 100), tart (73), and next bitter and bland (44 and 39 respectively) A very similar taste profile was obtained for homemade juice (A2), wherein the most perceptible were also sour and tart taste (77 and 72 in scale to 100) and next bitter (43) and fruity (37), the later was more noticeable than in the commercial juice (Fig. 1).

Both sea buckthorn juices were characterized by a strong sour smell (about 60 in scale to 100). Another identified smell was fatty odour with intensity at 59 for commercial juice (A1) and 56 for home-made (A2). The next in commercial juice the spicy smell was identified (31), and in the home-made juice – fruity (41), which in the commercial juice was almost not perceptible. Featured descriptors of taste and smell of the sea buckthorn juice such as sour, astringent and bitter, adversely affected the quality of these products resulting in low consumer acceptability.

Evaluators also sensed in both studied juices smell and taste another (foreign) at around 25 in scale to 100. The similar results of the analysis they received (Tang et al. 2001), that taste and smell like another/foreign/stranger and sourness, bitterness of usually have a negative impact on the assessment of product quality by consumers.

In both (commercial and home-made) sea buckthorn nectars the flavours sweet and fruity dominated (Fig. 2), whereby in the homemade nectar (B2) with the addition of sweeteners these flavours were a slightly more perceptible. The value of these descriptors were: sweet 65 in homemade nectar, 51 in the German productions nectar (B1), and fruity respectively 61 in homemade and 57 in the commercial nectar.



B1 – characteristics of smell – cechy zapachu, B2 – characteristics of flavour – cechy smaku

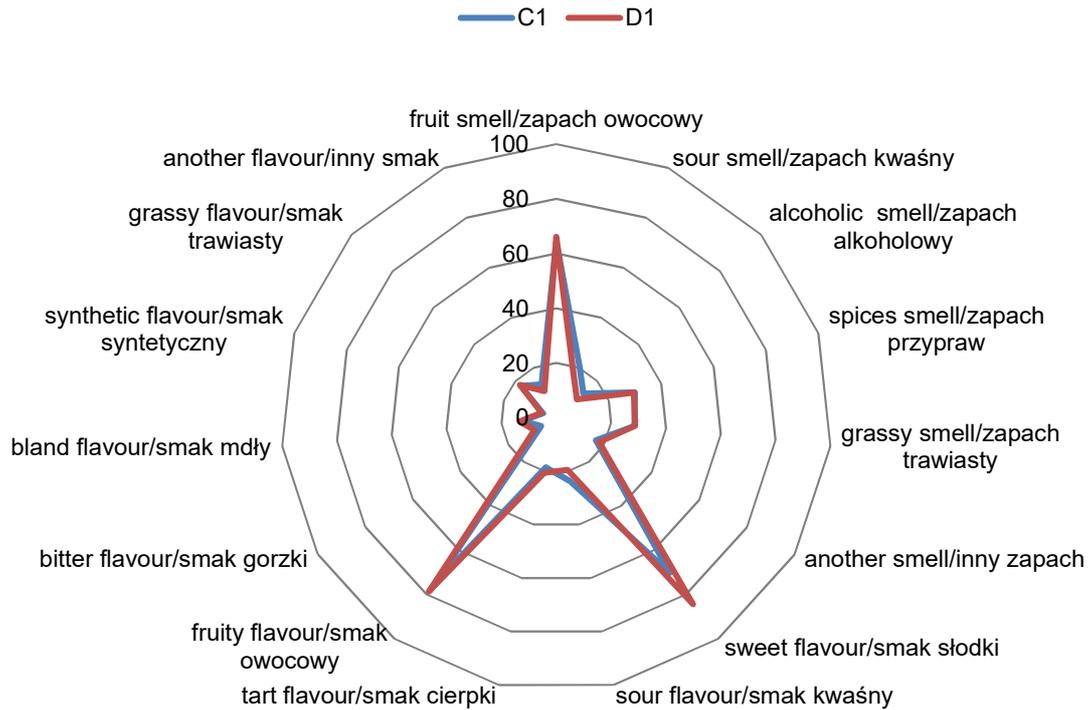
Fig. 2. The sensory profile of nectars from sea buckthorn
Ryc. 2. Profil sensoryczny nektarów z rokitnika

The most perceptible smell in both nectars was fruity, however it was a little less noticed in commercial nectar (50 in scale to 100 in homemade nectar and 46 in commercial). Moreover the sour smell was identified at level 30 in scale to 100. Also noticeable was grassy scent in the commercial nectar and scent of spices in the homemade product. Fruity scent is very desirable in fruit products, hence the presence of the discriminant has placed the smell of nectar at the average level by the evaluators.

Jams from sea buckthorn were of the highest consumer acceptability, with the highest rated taste of Polish products jam (C1). According to the evaluators, the top-perceptible tastes in this jam were sweet (74) and fruity (70), whereby in German products jam (D1), accepted slightly lower, these tastes were a little more intensive (respectively 84 sweet and 79 fruity).

The most dominated smell was fruity, perceptibility of this smell has been assessed similarly for both jams, at about 65 in scale to 100. The evaluators sensed also smell of spices (29 in scale to 100) and grassy(28) in these products.

Statistical analysis showed that kind of product had significant influence on fruity and sour smell assessment and on the perception of most flavour components: sweet, sour, tart, fruity and bitter.



C1 – characteristics of smell – cechy zapachu, C2 – characteristics of flavour – cechy smaku

Fig.3. The sensory profile of jams from sea buckthorn

Ryc. 3. Profil sensoryczny dżemów z rokitnika

The results suggest that the evaluators noted significant differences in taste and smell in all the products from sea buckthorn. The overall level of flavour, as well as the sensation of tastes: sweet, sour, tart, fruity, bitter, and another and smells: fruity, sour, alcohol, spices, grassy and another depend significantly on the type of product from sea buckthorn and degree processing. Fruit juices: commercial and homemade, obtained from fresh sea-buckthorn berries without any additives, were the least accepted most likely due to the unpleasant, dominant sour taste and smell characteristic of sea-buckthorn berries. In contrast, most acceptable were jams, in which dominated the sweet and fruity taste and fruity smell, due to the addition of sugars and other fruits during the processing. The similar results are shown in the Marszałek, Lipowski and Skąpska, in the composition of recipes tested by the jams were also other fruits to favourably influence the taste and smell. It is worthy to note that the greater perceptibility of the fruity taste and smell and sweet taste was, the higher score in evaluation of sensory quality (Marszałek et al. 2014).

CONCLUSIONS

1. The most tasty and desirable by evaluators product from sea buckthorn was Polish jam. It was characterized by perceptible sweet and fruity taste and fruity aroma. These attributes influenced most likely on willingness to buy this product.

2. The least liked product was 100% commercial juice due to its taste and desirability. The intensity of sour odour and palpable bitter and sour taste probably caused the negative feelings, which adversely impacted also on the willingness to buy this product.
3. The best rated was the sensory quality of these products, in which the share of smell and taste of the sweet fruit was the biggest. Highly rated features were general appearance, taste and overall desirability, prompting consumers to purchase these products. Sour and bitter taste and sour smell intensified unwanted sensations that adversely affect the sensory quality of the products, thus encouraging not to buy them.

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Abstract. Increased interest of consumers in healthy food, supplying large quantities of biologically active substances is noticeable recently. Dynamically developing market of fruit and vegetables offers innovative products, including the group of so-called super fruits, previously unknown or unappreciated, with exotic flavours, rich in bioactive components. An example of

such product is sea buckthorn. The aim of the study was to compare the sensory attributes and consumer liking of selected products made from sea buckthorn. The juices, nectars and jams made from sea buckthorn were analysed. Some of the tested products were purchased from the organic shop and some made from fresh fruit in the laboratory. Sensory evaluation was carried out by method. In consumer acceptance test the general appearance, transparency, aroma, taste, and overall liking were evaluated using a 9-point hedonic scale. Additionally, the willingness to buy of tested products was assessed. The sensory characteristics of tested products were evaluated using Quantitative Descriptive Analysis (QDA). As a results it was concluded that juices and nectars from sea buckthorn are not accepted by consumers because of their bitter and sour taste and smell, while the sweet and fruity taste and aroma of jams encourage consumers to purchase them.

