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ORIGINAL ARTICLE

Sea buckthorn: new promising varieties and using their berries for the manufacture of functional products

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Sea buckthorn (*Hippophae rhamnoides* L.) is a unique and valuable crop. Its raw materials (fruits, leaves, seeds) due to therapeutic and consumer characteristics are demanding globally. In Ukraine, the *H. rhamnoides* industry has yet to be developed. However, with recent emerging interest and increasing plantings, sea buckthorn will play a significant part in the future nutraceutical market. The widespread use of raw materials of sea buckthorn is limited due to insufficient knowledge of its biochemical composition and, as a result, the lack of effective technologies for its processing. A comprehensive study of sea buckthorn varieties on morphological, biochemical, physicochemical properties will make it possible to use raw fruit by target appointment to produce high biological products. One of the most effective solutions to food problems of the person connected with a lack of vitamins is the development of new compoundings and technologies of juice and dessert production of functional orientation. The research objects were new promising sea buckthorn varieties (of Institute of Horticulture National Academy Agrarian Sciences of Ukraine breeding: 'Lvivyanka', 'Osinnia krasunia', 'Mukshanska', 'Rapsodiia', 'Medova osin') and their berries. In the study, microbiological, biometrical, population-species, biochemical, and physicochemical research methods were used. According to morphological features (presence of thorns, shape, size, and color of fruits), pedigree and biochemical properties, the ranking of sea buckthorn varieties by ecotypic and selection-genetical affiliation of habitats into Carpathian, Carpathian x Mongolian, Jutland x Mongolian, Jutland x Siberian ecotypes were carried out. Biochemical, physicochemical analysis of fruits of new varieties of sea buckthorn breeding of the Institute of Horticulture of National Academy Agrarian Sciences (Ukraine) was presented, and recipes and technological parameters of blended juices and biscuit cakes were developed as new products with high biological value. Sea buckthorn berries have powerful bioindustrial potential, which requires further detailed study and a broader use in the food industry.
Keywords: *Hippophae rhamnoides* L.; ecotype and selection genetic affiliation; breeding; quality, blended juices; dried pomace; sponge cake.

Introduction

Sea buckthorn (*Hippophae rhamnoides* L.) is a flowering plant (Angiosperm) of the order Rosales and Elaeagnaceae family. Sea buckthorn is morphologically described from a bush to a small tree, with different growing thorns all around the plant, and it naturally grows in different locations. It is stated that its Latin name Hippophae rhamnoides comes from ancient Greece, from the words 'hippo' – horse – and 'phaos' – shine –, for the horses fed with leaves from this plant developed a shining coat and weighed more (Kallio et al., 2015; Abramowicz, et al., 2017). Sea buckthorn is a unique and valuable new crop currently being domesticated in Europe, Asia, and the USA. In Ukraine, a sea buckthorn industry has yet to be developed. However, with the recent emerging interest and increasing plantings, it will play a significant part in the future nutraceutical market.

Due to the richness of bioactive substances present in sea buckthorn fruits and leaves, now increasingly used in the production of functional and healthy food on account of the constant demand increase among potential customers (Christaki, 2012). Sea buckthorn belongs to the most nutritious, vitamin and minerals and amino acid-rich plants. The food industry used it as a preservative or food additive to enhance the nutritional and organoleptic value of food (Dumbravă et al., 2016). Obtaining and using natural biologically active substances with a complex of beneficial properties of directed action is of great scientific and practical interest. The body's need for biologically active substances is evident since they directly regulate physiological reactions and processes (Lindström et al., 2015). The use of biologically active substances as functional and technological additives are performing the role of antioxidants, structure stabilizers, natural color, and flavoring agents in food production and helps to create a diverse range of foods of high nutritional value, including products of functional and therapeutic, and preventive purposes (Singh et al., 2003). Raw materials of minor fruit and soft fruit berry crops are a source of water-soluble and fat-soluble vitamins, macronutrients and micronutrients, and biologically active substances, a beneficial and protective effect even in minimal amounts (Moskalets et al., 2019). The use of plant raw materials in the production of functional technological additives will increase the nutritional value and therapeutic properties of food (Lindström et al., 2015).

Moreover, regular use of such products reduces the harmful effects of adverse factors, both external and internal environment of the human body (Gurčík et al., 2019). However, the use of raw materials of sea buckthorn can be limited due to insufficient knowledge of its biochemical composition and, as a result, the lack of effective technologies for its processing. Because of the above, the investigation of sea buckthorn fruits of new varieties and producing of new food products of high biological value is a highly relevant issue.

Materials and Methods

Our research aimed to study new varieties of sea buckthorn breeding of the Institute of Horticulture of NAAS of Ukraine and the development of recipes for the manufacture of functional products from the fruits of these varieties. We planned to identify the morphological signs and biometric parameters of plants of different varieties of sea buckthorn, the biochemical composition of fruits, to rank the varieties according to their suitability for the intended use of their raw materials, to develop recipes for the manufacture of functional products from the fruits of these varieties, and to investigate the composition and properties of the food products according to the developed recipes.
The experimental research (biometric measurements, analytical investigations, mathematical and statistical processing of the experimental data) was carried out at the Institute of Horticulture of the National Academy of Agrarian Sciences of Ukraine and the Bila Tserkva National Agrarian University. The study of sea buckthorn plants was conducted according to the accepted methods (1986), and phenological observations over the plants' growth and development and the biometric indices were carried out following Beydemann (1974).
The biochemical analyses were conducted in the three-fold repetition in each variant of the experiment. The dry substances (solids) content was determined by the weighted method in keeping with SSU 7804:2015; sugars – using the photocolorimetric method on the photocalorimeter KFK-3-01 (SSU ISO 4954:2008); organic acids – by titration with 0.1 n NaOH in the re-calculation for the malic acid following SSU 4957:2008; vitamin C – by restoring the Tillman's reagent and by extraction of the fruits batch with the acid solution of with the further filtration of the obtained substrate using the titrometric method in conformity with SSU 7803:2015; the polyphenolic compounds – amount utilizing the Folin-Dennis reagent spectrophotometric method on the spectrophotometer Spekol 1500 under the wavelength of 270 nm with a photometric accuracy of 0.004 (SSU ISO 4373:2005).
The sugar-acid index (SAI) was calculated as the correlation of total sugars and acids. The process of obtaining juice included preparing raw materials (washing, sorting, and secondary washing). A squeeze of raw materials was performed with a basket hydraulic press with a shredder 60K RM 1.5. The fruits come to the press, from which the squeezed juice will get to the settler, and the pomace was used for the subsequent drying and receiving powder. Juice pasteurization was conducted at temperatures 70-75°C after blending with apple juice and honey or sugar. After cooling, poured into 1-liter containers and closed with a twist-off lid.
After squeezing, the fruit received juice and pomace. Sea buckthorn pomace was used to obtain a powder for making sponge dough. Drying was performed in a dehydrator dryer to the moisture content in the pomace of 11-12.5%. The temperature during drying did not exceed 60 ° C because there is an inactivation of vitamins and deterioration of organoleptic characteristics at a higher temperature. It was drying for 5-6 hours. The dried pomace was grinding, and the grinding product was passed through a sieve. The yield of the powder was 95-96%.

Results and Discussion

The study of morphological and biometric parameters of plants of new varieties of *H. rhamnoides* and taking into account the pedigree of varieties ranked them into different ecotypes (Table 1). As can be seen from Table 1, they are researched by different weights of fruit (0.37 – 0.71 g) and yield (15.9 – 24.0 kg/tree). The shape of the fruit (elliptical, rounded, elongated, oval) and the color of the fruit's skin (can vary from yellow to orange-red and even red) are indicator characteristics of the variety. The spines (length and the number, features of their placement on the shoots) are also critical indicative characteristics of plant affiliation to a particular ecotype. In particular, most of the studied genotypes refer to the Siberian and Carpathian-Siberian ecotypes ('Lybid', 'Rapsodiia', 'Osinnia krasunia'). Plants of the 'Medova osin' variety are representative of the Carpathian ecotype (they have a fruit of medium or small size; the shape of the fruit – elliptical-elongated; prickly – medium; but high resistance of plants to adverse winter factors; high drought resistance, resistance to pathogens).
The ranking of plants is essential in uncovering the biological characteristics and using artificial target breeding varieties before crossing and obtaining a new hybrid material and its successful address (targeted) introduction. The fruits of the studied varieties have firm skin, dry fruit separation, which makes it possible to reduce the loss of quality of raw materials during harvest. Biochemical analysis of sea buckthorn berries of new varieties showed some differences in their composition (Table 2).

Table 1. Morphological and biometric parameters of sea buckthorn fruits of different varieties (x ± SD), 2019-2020

Varieties	Weight of the berries, g	Productivity of one plant, kg**	Fruit shape	Fruit size ***	The fruit skin and color	Spines, degree	Ecotype and selection-genetic habitat
'Lybid' (control)	0.68 ± 0.05	18.9 ± 1.7	elliptical	medium	light orange	average	Siberian
'Lvivyanka'	0.65 ± 0.04	17.5 ± 2.0 *	oblong-oval	medium	dark yellow	insignificant	Jutland x Siberian
'Rapsodiia'	0.71 ± 0.02	22.6 ± 0.8 *	elongated	large	yellow-orange	insignificant	Carpathian -x Siberian
'Mukshanska'	0.70 ± 0.05	24.0 ± 2.3 *	elliptical	large	orange	insignificant	Jutland -x Siberian
'Osinnia krasunia'	0.63 ± 0.02	18,5 ± 2.8 *	elliptical	medium	orange	insignificant	Carpathian -x Siberian
'Medova osin'	0.37 ± 0.03	15,9 ± 1.1	elongated	small	orange	average	Carpathian

Note: *P < 0.05 compared to the control (‘Lybid’); ** – productivity in middle age generative plants; fruit (size) –*** – small (length x width – 0.5 x 0.4 cm); medium (length x width – 0.6-1.0 x 0.5 cm); large (length x width – 1.0 x 0.4 cm).

The content of soluble dry matter, which affects the quality of juice and other finished products, is an essential indicator of raw materials and depends on the varietal characteristics of sea buckthorn. Thus, the sea buckthorn fruits of the studied varieties contain 7.3 – 9.5 % of total soluble solids, the least of them in the fruits of the 'Osinnia krasunia' variety (6.7 %) (Table 2). According to the results of biochemical analysis of fruits, the content of organic acids varies in a wide range – 2.2–2.9 ('Lybid', 'Medova osin'), and 3.5–4.2 % ('Lvivyanka', 'Rapsodiia', 'Mukshanska', 'Osinnia krasunia').
Organic acids are present in raw materials and products derived from sea buckthorn, performing various functions related to the quality of food, including involvement in forming the taste and aroma of the product (Terpou et al., 2019). The high content of organic acids is undesirable in the production of juices for preventive purposes. Sea buckthorn fruits are characterized by a low content of total sugars (3.2-4.6%), compared with the control –'Lybid' variety (6.8 %) and 'Medova osin' variety (9.6%).

Table 2. Biochemical parameters of the sea buckthorn variety berries (compete for ripeness) (x ± SD), 2019-2020

Berries Biochemical Parameters	Varieties					
	'Lybid' (control)	'Lvivyanka'	'Rapsodiia'	'Mukshanska'	'Osinnia krasunia'	'Medova osin'
Solids, % wm	11.5 ± 0.8	12.7 ± 0.3*	11.0 ± 0.8	12.4± 0.5	13.5 ± 0.6*	14.1 ± 0.7*
Total soluble solidst, % wm	8.6 ± 0.6	7.3 ± 0.9*	8.0 ± 0.5	8.1 ± 0.7	6.9 ± 0.3*	9.5 ± 0.5*
Polyphenolic compounds, mg/100g	275.0 ± 9	355.4± 7.0*	287.2± 4.0	330.7 ± 8.0*	270.8 ± 10*	310.0 ± 8.0*
Ascorbic acid content, mg/100 g	51.0 ± 4.0	110.0 ± 5.0*	91.0 ± 8.0*	76.0 ± 6.0*	45.0 ± 9.0	31.0 ± 11.0
The total pectic substances, %	0.4 ± 0.0	0.4± 0.0	0.6± 0.0*	0.5± 0.0*	0.4± 0.0	0.6± 0.0*
Fiber content,%	2.7 ± 0.5	3.9± 0.2	4.2± 0.4*	4.5± 0.2*	5.1± 0.5	3.7± 0.4*
β- carotene, %	6.3± 0.2	3.0± 0.1	6.5± 0.2	8.2± 0.2	9.5± 0.3	10.4± 0.2
Mass fat fraction, mg/100 g	2.2± 0.1	2.1 ± 0.1	3.1 ± 0.1	3.8 ± 0.2	2.5 ± 0.1	2.0 ± 0.1

Note: * – significance P < 0.05 as compared to the control ('Lybid' variety); ** – significance P < 0.05 as compared between options.

Enough high polyphenols in berries (> 250 mg/100 g) (table 2) make it possible to use berries and these samples as raw materials for the production of products with therapeutic and prophylactic purposes (juices, sauces, smoothies, jellies, pastels, yogurts). Biochemical analysis showed that the berries of *H. rhamnoides* new varieties are different by accumulating ascorbic acid. Content of vitamin C varies between 40 – 110 mg/100 g. The determination of total pectic substances showed that their berries of sea buckthorn varieties do not exceed 0.6 % (table 2), and fiber from 2.9–5.1 %. These ballast substances play an essential role in the normalization of the human body. They interfere with the absorption of cholesterol and provide intestinal motility. Pectin has detoxifying properties, which allows sea buckthorn to produce food products for therapeutic and prophylactic appointments.

H. rhamnoides is one of the few plants that accumulate fatty acids in seeds and berries (Dulf, 2012; Saeidi et al., 2016). The investigated varieties of sea buckthorn are characterized by an average level of oil content (2 – 4 %). Sea buckthorn oil – a valuable source of bioactive substances and has more importance in medicine. However, in the production of juices, the presence of oil in the fruit's pulp sometimes complicates the technological process and impairs the product's organoleptic characteristics.

According to the results of biochemical researches for the production of juices, we recommend the fruits of 'Lybid' and 'Medova osin' varieties, and for blended juices – fruits of 'Lvivyanka', 'Rapsodiia', 'Mukshanska', 'Osinnia krasunia' varieties, because their oil content fruit does not exceed 4.0 %.

New product development is a technique most of the food industries use to be competitive in the market. This strategy allows them to develop food products according to consumer's wishes. Consumers are every time more aware of their lifestyle. A healthy lifestyle involves several aspects, one of which is following healthy food habits. Thus, food companies lead their new product development strategies towards more healthy and nutritious products (Vilas-Franquesa et al., 2020). *H. rhamnoides* has emerged as one of the most promising ingredients for food companies because of the already detailed physic-chemical profile and its derived health benefits (Ursache et al., 2017).

Juices and beverages are among the most popular and earliest manufactured products made of sea buckthorn (Papuc et al., 2008; Lindström, et al., 2015). In the early 40s of the 20th century, *H. rhamnoides* fruits began to be used on an industrial scale in Russia (World Health Organization ..., 2004; Rafalska et al., 2017). In 1943, a Swiss pharmaceutical company launched juices and syrups to supplement the daily diet (Stolzenbach et al., 2013). These nutritious vitamin C and carotene-rich drinks are prevalent in China, Singapore, Japan, Russia, Mongolia, Germany, Scandinavia, and other Nordic countries (Christaki, 2012; Vilas-Franquesa et al., 2020). Furthermore, in Finland, sea buckthorn is a nutritional ingredient of baby food (Yao et al.,1992; Stolzenbach et al., 2013).

Food industries seek to incorporate nutritious ingredients to bring added value to the final food products (Sturza et al., 2016; Gurčík et al., 2019). One of the most exciting options is that sea buckthorn contains high concentrations of vitamin C, carotenoids, tocopherols, polyphenolic compounds, organic acids, and other bioactive compounds, in addition to the unique lipid profile in the berry pulp, seed, and peel (Kallio et al., 2002; Gunenc et al., 2016; Ursache et al., 2017).

To obtain recipes for blended juices with sea buckthorn as functional products, we harvested, in addition to sea buckthorn fruits, such ingredients: apple juice, carrot, birch juice, chokeberry, and ginger extract mint, lemon balm, thyme, honey, sugar, water. The methods of food combinatorics allowed obtaining a variety of research samples and among the large sample to select those with the highest tasting score (4.5-5.0) and the best organoleptic properties. Test samples of blended products differed in the ratio of components and nutritional and biological value. The most successful and optimal options and their organoleptic characteristics are shown in Table 3.

They were pressing berries yielding 60 % to 85 % juice. Several researchers (Sturza et al., 2016; Guo et al., 2017; Terpou et al., 2019) have reported that protein levels are reasonably high in fruit juice which probably explains that sea buckthorn juice is a cloudy or opalescent product. Often the crushed berries were processed preparations (containing pectin methylesterase, PME) (Lui & Lui 1989; Stolzenbach et al., 2013) or hydrolytic enzyme preparations. For preservation purposes, the juice is sterilized/pasteurized. We used high-temperature-short-time (HTST) processes of 80°–90°C for several seconds because the juice is somewhat delicate and will sustain a loss of flavor and develop off-flavor if heated beyond the conditions indicated.

Furthermore, vitamin C is destroyed by heating, so maximum retention is promoted by HTST processing. Reducing storage temperatures to 4°C prolongs storage life, and enzymes and sunlight are essential sources of browning initiation. We found that the best organoleptic indicators among the samples of blended juices are apple-carrot-sea buckthorn mint, birch-apple-sea buckthorn juice with ginger due to the acidity of the varieties 'Lvivyanka' or 'Rapsodiia' proved to be better than sea buckthorn 'Lybid' and 'Medova osin' varieties.

The addition of ginger extract gives the final product a characteristic spicy aroma and taste (Table 4). This drink has an apparent tonic effect and, when consumed daily, helps to stimulate cerebral circulation, improving attention and memory, which is especially important for employees of intellectual work.

Aronia-apple-sea buckthorn juice was made by mixing freshly prepared apple puree ('Askolda' variety), carrot and sea buckthorn puree ('Medova osin' variety), and adding chokeberry syrup (volume fraction 12 %). Among the blended juices, apple-sea buckthorn thyme-mint using 'Osinnia krasunia' sea buckthorn and apples 'Golden Delicious' should be noted.

This is refreshing, with a pronounced aroma of *H. rhamnoides* thyme and mint juice with a tasting rating of 4.9. As a rule, the benefits of the product are judged by the content of fats, proteins, digestible carbohydrates, minerals, and vitamins necessary for the vital functions of the human body. We investigated the physical and chemical quality we have developed of new types of blended juices (Table 5, Fig. 1).

Table 3. Component composition of blended juices with sea buckthorn of certain varieties (ml)

Ingredients	Blended Juice			
	Aronia-apple-sea buckthorn juice (*1*)	Birch-apple-sea buckthorn juice with ginger (*2*)	Juice apple-carrot-sea buckthorn with mint (*3*)	Juice apple-sea buckthorn-thyme-mint (*4*)
Sea buckthorn juice	140	200	150	100
Aronia syrup	300	-	-	-
Apple juice	90	100	100	100
Carrot juice	110	-	150	-
Birch juice	-	200	-	-
Ginger root, extract	-	5	-	-
Mint, extract	-	-	4	3
Thyme extract	6	-	-	5
Honey, g	-	-	-	100
Sugar, g	-	50	100	-
Water	1700	650	1600	850

Note: 1 – Aronia-apple-sea buckthorn juice, 2 – Birch-apple-sea buckthorn juice with ginger, 3 – Apple-carrot-sea buckthorn-mint, 3 – Juice apple-carrot-sea buckthorn with mint, 4 – Juice apple-sea buckthorn-thyme-mint

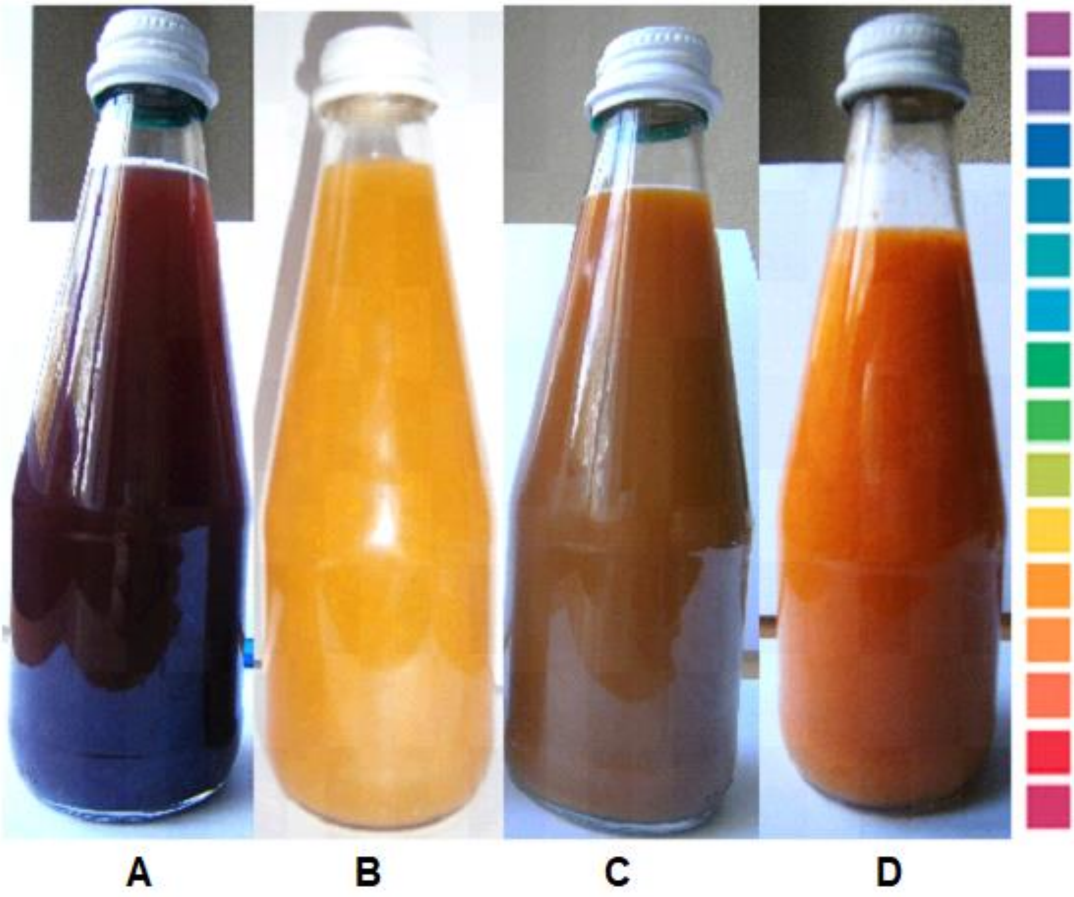

Fig. 1. Blended juices with sea buckthorn according to the developed new recipes (author's photo): A – Aronia-apple-sea buckthorn juice, B – Birch-apple-sea buckthorn juice with ginger, C – Juice apple-carrot-sea buckthorn with mint, D – Juice apple-sea buckthorn thyme-mint

Table 4. Characteristics of blended juices with sea buckthorn on organoleptic indicators

Appearance and consistency		Taste and aroma		Colour		Smell	
1*	2*	1*	2*	1*	2*	1*	2*
Dim, opaque, homogeneous	5.0	Well-expressed apple-sea buckthorn carrot taste with a light chokeberry aroma	5.0	Dark purple	5.0	Fruit and thyme	5.0
Dull, slightly transparent, homogeneous, with little sediment	4.8	Refreshing, dominated by fruity, light sea buckthorn taste and aroma	4.5	Light orange	4.5	Sea buckthorn-ginger	5.0
Of uniform consistency of orange-brown color, with a slight sediment	5.0	Refreshing with a pleasant carrot and sea buckthorn aroma and taste	5.0	Orange-brown	4.8	Fruit-mint	5.0
Dim, with a slight sediment	5.0	Refreshing, with a pronounced taste and aroma of apples and sea buckthorn, thyme, and mint	5.0	Orange	4.8	Fruit-herb	5.0

Note: 1* – characteristic, 2* – estimation; 1 – Aronia-apple-sea buckthorn juice, 2 – Birch-apple-sea buckthorn juice with ginger, 3 – Apple-carrot-sea buckthorn-mint, 3 – Juice apple-carrot-sea buckthorn with mint, 4 – Juice apple-sea buckthorn-thyme-mint.

Table 5. Quality parameters of blended juices of sea buckthorn

Parameters	Blended Juices			
	1	**2**	**3**	**4**
Mass fraction of dry matter, %	15 ± 0.5	12 ± 0.8	13 ± 0.5	14 ± 0.9
Mass fraction of sugars, %	6.5 ± 0.6	6.6 ± 0.3	7.0 ± 0.6	7.2 ± 0.5
Mass fraction of titrated acids (in the movement of malic),%	0.9± 0.1	1.3 ± 0.0	1.0 ± 0.0	1.1 ± 0.1
Mass fraction of fiber, %	2 ± 0.1	2 ± 0.2	3± 0.3	3 ± 0.4
The content of polyhenolic compounds, mg/100 g	42 ± 0.8	33 ± 0.2	48 ± 0.1	54 ± 0.3
Vitamin C, mg/100 g	21.2 ± 1.7	18.4 ± 0.9	22 ± 0.8	26 ± 0.4
β- carotene, mg/100 g	1.5 ± 0.2	0.45 ± 0.0	1.5 ± 0.2	1.2 ± 0.3

Note: 1 – Aronia-apple-sea buckthorn juice, 2 – Birch-apple-sea buckthorn juice with ginger, 3 – Juice apple-carrot-sea buckthorn with mint, 4 – Juice apple-sea buckthorn-thyme-mint.

As shown in Table 5, vitamin C and β-carotene contain the products with sea buckthorn puree. Moreover, 100 g of juice provides 25-39 % of the daily human needs in vitamin C and 40–50 % of β-carotene. The obtained juices have antioxidant properties, as evidenced by the content of polyphenolic compounds, organic acids, and vitamins with antioxidant character. The pulp has a reasonably high humidity – 75–79 % and is microbiologically unstable under the proposed technology; seabuckthorn pulp is dried at mild temperatures: temperature (55–60 °C) to the +humidity of (12.5 %). We found that at the moisture content of 9 %, there is a 20% loss of carotenoids, 12% loss of tocopherols, 18% loss of ascorbic acid, and 24% loss of bioflavonoids. Upon determining the microbiological indicators, dried sea buckthorn pulp with guaranteed stability for 12 months was established. Sea buckthorn dried pomace is a product of high biological value, containing lipids, which include essential fatty acids, proteins, vitamins, and minerals in its composition (Fig. 2). In our case, sea buckthorn cake is supposed to be used to produce a functional technological additive that serves as a stabilizer and a source of dietary fiber in emulsion food products. The biochemical composition of sea buckthorn press cake after squeezing the juice is shown in Table 6.

A B C

Fig. 2. Fruits (A), raw (B), and dried sea buckthorn pomace (C) 'Rapsodiia' variety

In our case, it was assumed that sea buckthorn press cake would be used in the production of functional additive technology, which serves as a stabilizer and a source of dietary fiber in sponge cake. In addition, in sea buckthorn press cake, the lipid complex is mainly represented by unsaturated acids (palmitoleic, oleic, linoleic), which have been found to transform gluten, making it more elastic as a result. Thus, powdered additives made from sea buckthorn cake can manufacture spongecake semifinished goods according to the recipe developed by us (Table 7).

Table 6. Biochemical composition of sea buckthorn 'Rapsodiia' variety dried pomace

Parameters	Content (mg/100 g)
Protein	2.5 ± 1.3
Lipids	8.0 ± 1.7
Pectin	6.5 ± 0.5
Cellulose	25.7 ± 0.9
Ascorbic acid	640.2 ± 85.0
Bioflavonoids	810.5 ± 17.8
Ash	1.9± 0.2

Table 7. Ingredient composition of biscuit dough with sea buckthorn powder

Ingredient	Quantity, g
Sugar	150
Flour	75
Melange (raw)	215
Sea buckthorn powder*	≥ 50
Baking powder	5

Note: * – moisture ≤ 12.5%.

An essential point in the manufacture of biscuit dough is a well-whipped melange with sugar, followed by slow addition of flour and sea buckthorn powder, lightly mixing them by hand. The addition of sea buckthorn powder (up to 10 %) for the dough preparation proved to be the best variant. The method of obtaining is proposed for the integrated processing of sea buckthorn berries allows obtaining several types of products simultaneously – juice, fruit powder additive to seeds. In addition, it enables increasing the preservation degree of biologically active substances using optimal technological parameters of the processes.

Conclusions

We found that the best organoleptic indicators among the samples of blended juices are apple-carrot-sea buckthorn mint (using the juice of apples of the 'Liberty' variety and sea buckthorn 'Osinnia krasunia' variety). Birch-apple-sea buckthorn juice with ginger due to the acidity of the varieties 'Lvivyanka' or 'Rapsodiia' proved to be better than sea buckthorn 'Lybid' and 'Medova osin' varieties. Aronia-apple-sea buckthorn juice was made by mixing freshly prepared apple puree ('Askolda' variety), carrot, and sea buckthorn puree ('Medova osin' variety) and adding chokeberry syrup (volume fraction 12 %). Among the blended juices, apple-sea buckthorn thyme-mint using 'Osinnia krasunia' sea buckthorn and apples 'Golden Delicious' should be noted. Vitamin C and β-carotene contained in the products with the addition of sea buckthorn puree. Moreover, the content of vitamin C in 100 g of juice provides 25-39 % of the daily human needs, and 40-50 % of β-carotene needs. The obtained juices have antioxidant properties, as evidenced by the content of polyphenolic compounds, organic acids, and vitamins with antioxidant character. These juices drink have an apparent tonic effect, and when consumed daily, are reliable products of a balanced diet.

The method of obtaining is proposed for the integrated processing of sea buckthorn berries allows obtaining several types of products simultaneously – juice, fruit powder additive to seeds. In addition, it enables increasing the preservation degree of biologically active substances using optimal technological parameters of the processes. *H. rhamnoides* dried pomace is a product of high biological value, containing lipids, which include essential fatty acids, proteins, vitamins, and minerals in its composition. In our case, sea buckthorn cake is supposed to be used to produce a functional technological additive that serves as a stabilizer and a source of dietary fiber in emulsion food products. Its powder was used in sponge cake baking. A comprehensive study of sea buckthorn new varieties on morphological, biochemical, physicochemical properties will make it possible to use raw fruit by target appointment to produce products of high biological value.

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