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## EVALUATION OF QUALITY PARAMETERS OF BAKERY PRODUCTS ENRICHED WITH SEA BUCKTHORN POWDER (*HIPPOPHAE RHAMNOIDES*)

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**Abstract.** There is an increased interest for sea buckthorn berries because they are characterized by a wide area of cultivation and they are rich in antioxidants, vitamins and minerals. The sea buckthorn berries are natural concentrate of vitamins (C, P, B<sub>1</sub>, B<sub>2</sub>, E, K), carotenoids, folic acid, volatile oils, etc. Were performed the evaluation of the antioxidant capacity of the berry powder and the analysis of the impact of the bioactive compounds on the quality parameters of the bakery products. Results obtained through analysis of different methods of research has found that bakery products enriched with sea buckthorn powder are characterized by increased quality parameters compared to blank samples.

**Keywords:** berries, carotenoids, muffin, fruit powder, quality.

Studies on berry powders are increasing as it becomes a valuable ingredient rich in bioactive compounds for bakery products [1-3]. Within this research, we studied mainly local sea buckthorn berries which are characterized by rich bioactive profile.

Foods containing large quantities of phytochemicals are associated with a reduced risk of human diseases such as cancer, atherosclerosis, heart disease, osteoporosis, and obesity. The protective role of these foods is partly attributed to constituents such as phenolic compounds, carotenoids, tocopherols and dietary fiber [4].

Muffins are the most popular bakery food products consumed worldwide at all economic levels. This is mainly due to their ready-to-eat nature, their availability in different varieties, and affordable cost [5].

The aim of this research was to evaluate the effects of incorporating two amounts (5 and 10 %) of sea buckthorn powder on the quality of muffins. Muffin carotenoid and phenolic compounds content, as well as sensorial and textural parameters, were used as parameters for comparison.

In order to study the impact of berry powders on the bakery products were determined the antioxidant activity, the total carotenoid content and total polyphenol content of the sea buckthorn powder. The results obtained are presented in the table 1.

Table 1. Quality parameters of sea buckthorn powder

Quality Parameters	Sea buckthorn powder
Antioxidant activity, %	82,05±1,90
Total carotenoid content, mg/L	18,63±0,05
β-carotene content, mg/L	6,41±0,06
Lycopene content, mg/L	7,37±0,22
Zeaxanthin content, mg/L	7,18±0,39
Chlorophylls content, mg/L	3,30±0,04
Total polyphenol content, mg AG/100 g	947,14±12,0

The analysis of berry powder with DPPH free radicals allows the evaluation of the antioxidant capacity of the bioactive compounds. The antioxidant capacity of the sea buckthorn powder vary between 72,05...90,84±1,90%. The increased antioxidant activity of the powder is due to the physico-

chemical composition, rich in carotenoids, vitamin C and phenolic compounds that have the ability to capture the free radicals. The total carotenoid content for sea buckthorn powder vary between 12,29...18,63±0,05mg/L and the total polyphenol content vary between 305,35...947.14 mg AG/100g.

To investigate further the quality parameters of enriched bakery products were prepared muffin samples to a preset recipe. In order to analyze the organoleptic parameters was made a sensory evaluation and the results are shown in the figure 1.

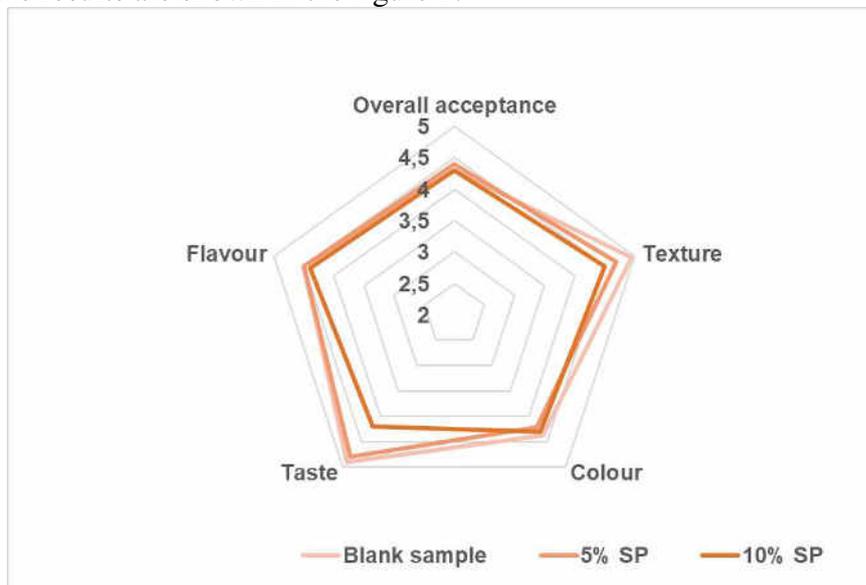


Figure 1. Sensory analysis of enriched muffins

It was carried out that the samples prepared with the addition of 5% and 10% sea buckthorn powder are characterized by pleasant taste and flavor characteristic for muffins close to the blank sample. The aspect is homogeneous and very good. The color is characteristic for the product and vary according to the amount of plant based addition. 5-point hedonic scale ranged from 4,70 to 5,00 for the studied bakery products.

Following the estimation of the sensory parameters, it was established that muffins enriched with the addition of sea buckthorn powder have a pleasant colour and flavor and can be proposed to potential consumers.

Carotenoids have been found to be responsible for several human health benefits. In particular,  $\alpha$ -carotene,  $\beta$ -carotene and  $\beta$ -cryptoxanthin are important for their activity as provitamin A. Adequate intake of carotenoids can prevent degenerative eye damage such as night blindness, xerophthalmia, ulcerations and corneal damage [6]. In addition, carotenoids act as antioxidants and their intake has been associated with a reduced risk of several chronic diseases. Xanthophylls, such as lutein and zeaxanthin, are the major components of macular pigments; they act as antioxidants against free radicals and reactive oxygen species, thus protecting the retina against peroxidation and photooxidation and preventing age-related macular degeneration [7], which is the main cause of blindness [8]. Lycopene improves endothelial function and reduces the incidence of coronary heart disease [9], while  $\beta$ -carotene, lycopene, and retinol have been shown to prevent Alzheimer's disease symptoms [10]. An association between the consumption of carotenoid-rich foods and reduced risk of type 2 diabetes, colorectal cancer and obesity has also been reported [11-13].

Unfortunately, carotenoids are very sensitive to exposure to heat, oxygen, light, acids and transition metals, as well as oxidative enzymes, and there is evidence that storage and food products can have a negative impact on carotenoid content; thus, this loss should be considered when studying the potential health benefits of complex products with added plant powders [14].

Following the research of the muffins with sea buckthorn powder, the content of zeaxanthin,  $\beta$ -carotene, lycopene, chlorophyll was determined spectrophotometrically. The results are presented in table 2.

Analyzing this diagram, we can conclude that the analyzed complex food products with the addition of berry powder have a rich content of carotenoids. Chlorophyll is the green pigment of plants and one of the most important organic substances that in the researched muffins obtained the following values: chlorophyll varies between 3.88 and  $5.06 \pm 0.04$  mg/L; zeaxanthin varies between 29.23 and  $44.71 \pm 0.07$  mg/L;  $\beta$ -Carotene ranges from 34.36 to  $52.48 \pm 0.04$  mg/L and Lycopene ranges from 33.29 to  $48.32 \pm 0.05$  mg/L. The results obtained (Table 2) confirm the increased content of carotenoids in muffins enriched with sea buckthorn powder, that increases its bioactivity and thus improves its nutraceutical properties [15-17].

**Table 2. The content of carotenoids in muffins with fruit powder**

Quality Parameters	5% Sea buckthorn powder	10% Sea buckthorn powder
$\beta$ -carotene content, mg/L	$34.36 \pm 0.01$	$52.48 \pm 0.04$
Lycopene content, mg/L	$33.29 \pm 0.02$	$48.32 \pm 0.05$
Zeaxhantin content, mg/L	$29.23 \pm 0.01$	$44.71 \pm 0.07$
Chlorophylls content, mg/L	$3.88 \pm 0.02$	$5.06 \pm 0.04$

The analysis of the results presented in table 3, can be observed that with the increase of the powder content added to the product, the mass fraction of moisture is decreasing, ranging from  $22.30 \pm 0.01\%$  to  $20.80 \pm 0.01\%$ . This fact is explained by the addition of fruit powder, which has a lower moisture content compared to wheat flour, which leads to an increase in the total content of dry matter in the composition of the muffins.

**Table 3. Moisture content of muffins enriched with berry powder**

Samples	Moisture, %
Blank sample	$22.30 \pm 0.01$
5% Sea buckthorn powder	$22.25 \pm 0.02$
10% Sea buckthorn powder	$20.80 \pm 0.01$

According to the data presented in regulations regarding basic quality parameters of muffins can be mentioned that the results obtained are within admissible quality limits and do not exceed the interval of 12.0-24.0% according to these regulations.

The elasticity of the core is characterized by its property to return to its initial shape, after the cessation of the action of the compressive force [18]. Within this research was determined the elasticity of the muffins enriched with sea buckthorn powder. The obtained results are presented in figure 2.

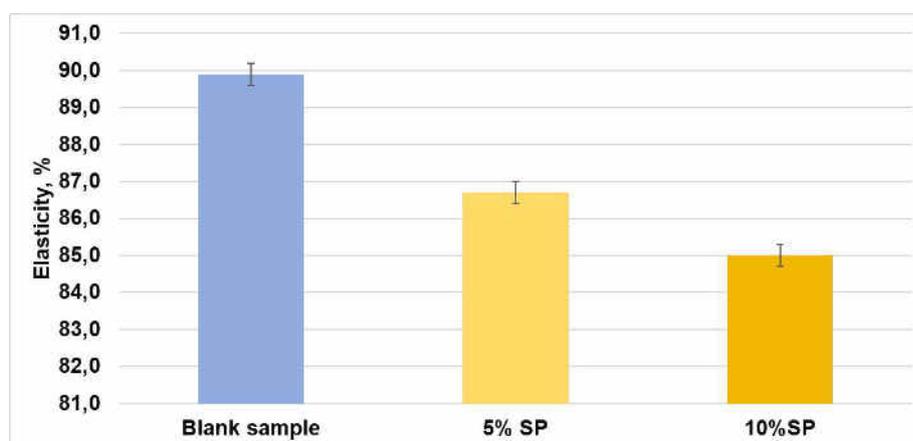


Figure 2. Elasticity values of muffin samples

The muffins with the addition of plant powder are characterized by the following values: for the blank sample – 86.00 – 88.00%; for the sample with 10% powder (10% SP) – 75.50 % and for the sample with 5% powder (5% SP) - 81.35%. Based on the results obtained, an essential decrease in the elasticity of the muffins with the addition of plant powder is attested, proportional to the amount

of substituted plant powder. This fact can be explained by the decrease in gluten content in the composition of the dough as a consequence of the substitution of wheat flour with sea buckthorn powder.

Porosity represents the total amount of air pockets formed in the muffin core which can be influenced by several factors: quality and quantity of gluten, flour power, the capacity of the flour to retain fermentation gases [19]. The porosity of the muffins with the addition of plant powder was analyzed, and the results obtained are presented in figure 3.

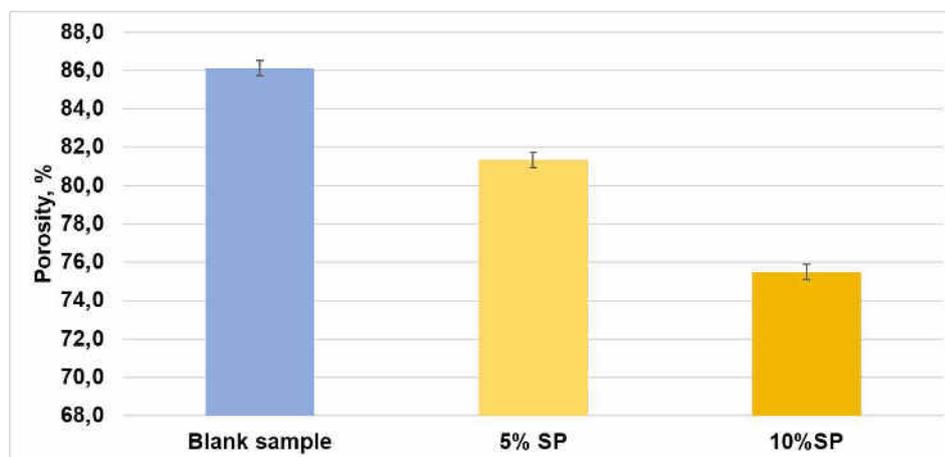


Figure 3. Porosity values of muffin samples

After the analysis of the results in the diagram above, it was established that the porosity of the analyzed samples includes the values that ranges between 81.35...75.50%.

It was observed that increasing the content of substituted powder decreases the porosity of the investigated muffins. This fact can be explained by the weak gluten network formed during the formulation of the dough and its baking, thus the CO<sub>2</sub> formed during fermentation will not be retained and as a result a product with a smaller volume and low porosity is obtained [20]. The CO<sub>2</sub> generated during fermentation can partially dissolve in the liquid phase and diffuses to the nuclei generated during the mixing step due to the gas concentration gradient that determines the changes in the dough structure causing physico-chemical changes in the network of gluten and other proteins that give the characteristic porosity of the porous texture of the dough [21, 22]. Dough expansibility during fermentation can be determined mainly by viscoelasticity. The viscous components of the dough massively allow the gas cells to expand to equalize the pressure, where the elastic components of the dough provide the relevant strength to prevent the dough from over expanding and collapsing. Heat and mass transfer phenomena occur simultaneously during baking, which causes physical, chemical and structural transformation [23], including water evaporation, volume expansion, starch gelatinization and protein denaturation, and including the establishment of porous structure [24], which leads to the establishment of the final structure of bakery products [25].

For muffins with sea buckthorn powder, it is recommended to replace wheat flour with 5% sea buckthorn powder.

### Conclusions

Muffins enriched with sea buckthorn powder represent good sources of antioxidants and bioactive compounds. Berry addition improved the quality parameters of bakery products by increasing the amount of bioactive compounds and could be considered as being bakery products ingredients with healthy nutritional profiles. This research demonstrates the possibility to use local berry powders in the functional food products production. An important benefit is the possibility to use natural antioxidants and biologically active compounds obtained from local resources in order to substitute the synthetic ones. This way food products enriched with natural bioactive compounds will be safe and healthier for consumption.

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