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THE EFFECT OF SASKATOON BERRY (*AMELANCHIER ALNIFOLIA* NUTT.) ADDITION ON THE TECHNOLOGICAL PROPERTIES OF WHEAT FLOUR AND THE QUALITY OF BISCUITS

Anna Kolesárová[1], Miriam Solgajová[1], Tatiana Bojňanská[1], Jana Kopčeková[2], Lucia Zeleňáková[1], Jana Mrázová[2]*

Address(es): Ing. Anna Kolesárová, PhD.

[1] Slovak University of Agriculture in Nitra, Faculty of Biotechnology and Food Sciences, Department of Technology and Quality of Plant Products, Trieda A. Hlinku 2, 949 76 Nitra, Slovakia.

[2] Slovak University of Agriculture in Nitra, Faculty of agrobiology and Food Resources, Department of Human Nutrition, Trieda A. Hlinku 2, 949 76 Nitra, Slovakia.

*Corresponding author: anna.kolesarova@uniag.sk

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ABSTRACT

Nowadays, it is very popular to enrich biscuits with less typical ingredients and thus increase their nutritional value. The aim of this work was to monitor the effect of the addition of lyophilized Saskatoon berries (*Amelanchier alnifolia* Nutt.) mixed with wheat flour T650 in different proportions on the technological quality of the flour (moisture, ash, falling number, crude protein, wet gluten, acidity) and to compare the chemical (aw, dry matter, crude protein, ash) and sensory parameters (appearance, aroma, taste, consistency, overall perception) of biscuits prepared without and with 5, 10 a 15 % additions of this fruit. With the increased addition of Saskatoon berry to the flour mixture, its moisture content decreased. Compared to the control sample, the ash content increased from 0.59% (control) to 0.87 % (15%) with the addition of fruits, as did the acidity of the flour ($p < 0.05$). On the contrary, with the increasing proportion of the addition of the powder of this fruit in the mixture with wheat flour, some technological parameters decreased ($p < 0.05$) (gluten content and its quality, falling numbers). The ash content of the biscuits increased from 0.88 (control) to 1.14 % (15 %), but the crude protein content decreased with increasing Saskatoon berry addition. In biscuits with the addition of this fruit, the value of water activity was significantly reduced from 0.57 (control) to 0.31 (15 %) ($p < 0.05$). Based on organoleptic evaluation, the replacement of up to 10 % and 15 % of wheat flour with Saskatoon berry powder improved the sensory properties (appearance and taste) of the prepared biscuits compared to control wheat biscuits. We can recommend this non-traditional fruit for application in the production of biscuits (adding 10 and 15 %), for its color and nutritional composition it can increase biscuits attractiveness and become a perspective when designing new products.

Keywords: bakery product, Saskatoon berry, wheat flour, technological quality, sensory quality

INTRODUCTION

The demand for healthy products has significantly affected consumer habits (**Martinsen et al., 2020**). Biscuits belong to the most popular cereal products nowadays.They are consumed by almost all consumer groups around the world, so we can consider them as a suitable supplement to improve nutrition. In order to increase the nutritional value of biscuits, biscuits could be enriched with functional ingredients (**Chauhan et al., 2016**). Biscuits can be considered as a form of confectionery with very low moisture content. The main ingredients of simple biscuits are wheat flour, water, sugar, fat and eggs, which we mix into the dough **(Chioma and Chizoba, 2015**). A composite component can be defined as a mixture of different ratios of non-wheat components obtained from roots and tubers, cereals, legumes, etc., with or without the addition of wheat. Such a composite material is mainly used in developing countries because it reduces wheat imports and promotes the use of locally grown food crops (**Peter-Ikechukwu et al., 2020).** Recently, it has become very popular to enrich biscuits with less typical raw materials such as mushrooms **(Forzana and Mohajan, 2015)**, melon peel and flour mixture from orange pomace (Ogo et al., 2021), bergamot by-products (Citrus bergamia, Risso) **(Lagana et al., 2022)**, Banana Peel Flour **(Alshehry, 2022)**, red corn powder **(Nguyen and Nguyen, 2022)**, cricket powder (**Smarzyński et al., 2021**). Red fruits are popular for its pleasant appearance, attractive taste, and bioactive composition **(Martinsen et al., 2020)**. Red fruits (known as berries), are a small fruit that is highly prized for its red-purple color, sour-sweet taste and health benefits. This fruits are good sources of nutrients and low calories and consumed raw or processed into products such as pulp, juices, jams, desserts or fermented beverages (**Albuquerque et al., 2020**). Their use is also in the development of various foods (chocolate, puree, pulp, vinegar, ice cream, jelly, cereal bars and others) **(Schulz et al., 2019**), also cosmetics (shampoos, conditioners, soaps, creams) (**Cefali et al., 2019**; **Ifuku 2017)**.

The Saskatoon berries (*Amelanchier alnifolia* Nutt., also known as Saskatoon, chuckley pear, juneberry, western juneberry, serviceberry, pacific or western serviceberry, prairie berries, alder-leaf shadbush, pigeon berry) belongs to the family Rosaceae and come from the areas of the southern Yukon, Canadian prairies, and the northern plains of the United States **(Mazza and Cottrell, 2008**; **Zhao et al., 2020).** Saskatoon berries have an appearance and taste similar to blueberries, but they have a thicker skin and juice. They are considered a functional food because they are an excellent source of minerals and fiber. Fresh fruit appear to be an excellent source of manganese, magnesium and iron and a relatively good source of calcium, potassium, copper and carotene (**Mazza, 2006**; **Fang, 2020**). The fruits of Saskatoon is also a rich source of vitamins, in particular vitamin C, tiamines, riboflavins, vitamins B6, A, E and folic acid (**Mazza and Cottrel, 2008).** In the last two decades, Saskatoon berry agriculture was expanded from North America to other European countries, including Poland, Finland, and the Czech Republic (**Moyo et al., 2018**; **Lachowicz et al., 2017a**). Recently, saskatoon berries have mostly been eaten fresh, baked in cakes or processed into jams and spreads. At present, new and innovative methods of processing, freezing and packaging have significantly increased the use of berries **(Mazza and Cottrell, 2008).** Up to now *Amelanchier alnifolia* has been used as an ornamental plant species in Slovak and Czech Republic. Recently, the cultivation of Amelanchier combining decorative quality and high biological value of fruit has been gaining in popularity **(Juríková et al., 2013)**.

Saskatoon berry (*Amelanchier alnifolia* Nutt.) is interesting due to its positive health-related properties (**(Huang et al., 2009; Lachowicz et al., 2017a**) and nutraceutical value (**Żurawicz et al., 2014).** These fruits contain biologically active compounds, more specifically polyphenolic compounds including phenolic acids, triterpenoids, anthocyanins, carotenoids and chlorophylls **(Lavola et al., 2012; Lachowicz et al., 2017a; Lachowicz, et al., 2017b)**. Because of this, saskatoon berries are powerful antioxidants with health-promoting effects as they display antifungal, anti-inflammatory, antiviral, anti-hypertensive, anti-allergic, anti-carcinogenic and anti-atherosclerotic activity (**Loza-Mejía and Salazar, 2015; Oszmian´ski and Lachowicz, 2016).** Saskatoon berry have an excellent sweet, nutty-almond flavor, and appear on the market as fresh fruit or processed jam (**Zhao et al., 2020).** The most popular cultivars are 'Smoky', 'Honeywood', 'Thiessen', 'Northline' and 'Martin' (**Mazza and Cottrell, 2008; St-Pierre et al., 2005).** Their fruits can be used for the food processing industry, for the production of health beneficial products (**Lachowicz et al., 2017a**).

The aim of this work was to monitor the effect of the addition of lyophilized Saskatoon berries (*Amelanchier alnifolia* Nutt.) mixed with T650 wheat flour in

different proportions on the technological quality of the flour and thus compare the chemical and sensory parameters of biscuits without and with different addition of this fruit.

MATERIAL AND METHODS

Origin of biological material and its preparation

Fruits of Saskatoon berry (*Amelanchier alnifolia* Nutt.) used as addition in this experiment came from the locality Nitra - Chrenová, Slovak Republic. Fruits were harvested after reaching full maturity (June 2021). Maturity was assessed on the basis of color, which is one of the most reliable indicators of maturity. The berries of the Saskatoon were separated from the stems, or overripe, the dried fruits were discarded, and then the fruits were lyophilized for 5 days at -58 ° C (Shin Lab Co., Ltd., Korea). The lyophilized fruits were homogenized using a stainless steel mixer (BOSCH TSM6A01, Germany). T-650 wheat flour (Miroslav Grznár MLYN ZRNO, SR) was used to prepare the mixed flour and other ingredients used for the bakery experiment were purchased at the local market, including: powdered sugar, butter, salt, eggs, baking powder and vanilla sugar.

Preparation of samples of mixed flours

The following mixtures (samples) weighing 150 g were prepared:
Sample C (control): wheat flour (T-650 without the addition of Saskatoon berries)
Sample V5: wheat flour T-650 (142.5 g) + 5 % addition of Saskatoon berries (7.5 g)
Sample V10: wheat flour T-650 (135 g) + 10 % addition of Saskatoon berries (15 g)
Sample V15: wheat flour T-650 (127.5 g) + 15 % addition of Saskatoon berries (22.5 g)

Preparation of biscuits

During the baking experiment, four types of biscuits (without the addition of Saskaton berry and with the addition of 5 %, 10 % and 15 % of this lyophilized fruit) were prepared in the number of 24 pieces from each batch. The basic recipe was the same, the individual samples differed by the addition of different proportions of wheat flour and Saskaton berry. Recipe for sample composition (per 150 g of flour): butter, powdered sugar, baking powder, vanillin sugar, eggs, salt (see table 1). Each type of biscuit was prepared separately. All ingredients were mixed well and the dough was rolled to a thickness of 0.5 cm and the cut biscuits were 5 cm in diameter. The biscuits were baked at 180 ° C for 18 minutes (oven MIWE condo, Germany).

Table 1 Sample composition (per 150 g of flour) and denomination of biscuits

samples	Flour (g)	SB (g)	Butter (g)	Sugar (g)	Eggs (g)	Vanillin sugar (g)	Baking powder (g)	Salt (g)
Control	150	0	75	50	20	10	3	0.25
B5	142.5	7.5	75	50	20	10	3	0.25
B10	135	15	75	50	20	10	3	0.25
B15	127.5	22.5	75	50	20	10	3	0.25

SB: Saskaton berry, B5 – biscuits with 5 % addition SB, B10 – biscuits with 10 % addition SB, B15 – biscuits with 15 % addition SB

Evaluation of samples of mixed flours and freeze-dried Saskatoon berries

The following quality indicators were determined in wheat flour and individual flour mixtures with lyophilized and homogenized Saskatoon berries (*Amelanchier alnifolia* Nutt.): Moisture content in dry matter in % (ICC Standard No. 110/1), Ash content in % (ICC Standard No.104/1), Falling Number in seconds determined on the FN 1800 (Perten) (ICC Standard No. 107/1), Gluten test, Determination of gluten ductility (cm) and swelling capacity ($cm^{3)}$ (STN ISO 46 1011-9), Flour acidity by titration method (TITRATOR DL 15, METTLER TOLEDO, Canada), Sedimentation test (Zeleny index) in cm^3 (ICC Standard No. 116/1). The following parameters were determined in the lyophilized fruit: Moisture content in dry matter in % (ICC Standard No. 110/1), Ash content in % (ICC Standard No.104/1), Falling Number in seconds (ICC Standard No. 107/1).

Evaluation of biscuits

The following indicators were determined in the biscuits: Ash content (ICC Standard No.104/1), Crude protein content by the Kjedahl method (ICC Standard No. 105/2) by which amount of the protein was calculated using a factor 5.7, Moisture content in the dry matter in % (ICC Standard No. 110/1) and Water activity (a_w) of the samples was determined with an apparatus for water activity measurement (LabMaster.aw, Novasina AG, Switzerland).

Sensory analysis

Sensory evaluation of bakery products in accordance with ISO 6658 was carried out by a sensory panel (commission), which consisted of a group of 12 trained evaluators (in age from 18 to 60, 6 women and 6 men). The task of the evaluators was to evaluate 9 sensory features of biscuits, namely: overall appearance / attractiveness, aroma (overall, intensity), foreign aroma, consistency (texture), taste (overall, intensity), overall impression. All parameters were compared to a control sample without the addition of lyophilized Saskatoon berry. The ratings were on a 9-point hedonic scale ranging from 9 (like extremely) to 1 (dislike extremely) for each characteristic.

Statistical analysis

The analyses were performed in triplicate. The experimental data were subjected to analysis of variance (Duncan's test), at a confidence level of 0.05. Statistical significance was determined to be $p < 0.05$. Statistical analysis was performed using Statistica Cz version 14 (TIBCO Software, Inc., Palo Alto, CA, USA) and MS Excel 2007 (Microsoft Corporation, Redmond, WA, USA).

RESULTS AND DISCUSSION

Evaluation of mixed flours samples

The results of the characteristics of wheat control flour and mixtures of this flour with the addition of Saskatoon berries powder in amounts of 5%, 10% and 15% are shown in Table 2.
In the analysis of freeze-dried Saskatoon fruits, the moisture content was 8.64±0.18 % (dry matter 91.36±0.18 %), the ash content was 2.77±0.03 % and the Falling number was 62 s. According to the analyzes of mixed flours, the moisture content of the samples decreased with increasing addition of fruit (12.46 %, 12.35 %, 12.18 %), respectively, the dry matter content increased due to the low moisture content of Saskatoon berries (control sample 12.52 %).

Table 2 Evaluation of mixed flours samples

Sample	Dry matter (%)	Falling number (s)	Ash (%)	Gluten content (%)	Gluten ductility (cm)	Gluten swelling capacity ($cm^{3)}$	Sedimentation test (cm^3)	Flour acidity ($mmol.kg^{-1}$)
C	87.48±0.07a	495.3±37.6c	0.59±0.01a	40.01±0.5a	13±1b	24.3±0.6b	65±1.0c	76.73±6.4a
V5	87.54±0.08a	401±15.5b	0.65±0.005b	35.41±0.4b	10±2a	19.8±0.8a	51±3.0a	86.77±5.8b
V10	87.65±0.13ab	322.3±29.8a	0.67±0.01c	30.80±0.9c	9.3±0.6a	18.8±1.3a	50±1.0a	99.80±3.01c
V15	87.82±0.08b	288±7.8a	0.87±0.003d	25.05±0.5d	7.7±1.2a	18.7±0.6a	46±1.0b	109.68±2.8d

Values are means ± standard deviation of 3 replications. Means within a column with different superscripts are significantly different at $p < 0.05$ by Duncan Multiple range test, SB – Saskatoon berry

The moisture content affects the taste, weight, texture, appearance and shelf life of food. The lower the moisture content of flour is, the better is its stability during storage, as well as the reduction of spoilage regarding baking quality. Flour that is less than 14 % can also resist microbial growth (**Butt et al., 2004; Nguyen and Nguyen, 2022).** Our samples fall between 0 – 14 % moisture content, which is acceptable for efficient storage of flour for further processing without the risk of contamination by microorganisms.

The highest enzymatic activity was recorded in sample V15 (288 s.) We can consider values in the interval of 220 – 260 seconds as the optimal value of Falling number **(Bojňanská et al., 2013)**. The control sample (flour without addition) did not have the optimal value of the Falling Number and therefore the results in the samples with the addition of sasaktoon were also higher. However, we can conclude that with the increasing addition of Saskatoon to wheat flour, the enzymatic activity of *alpha* amylases of the experimental mixtures also increased ($p < 0.05$), which may ultimately result in a decrease in the volume of the product. **Přihoda et al. (2004)** stated in their work that bread doughs that were prepared from mixtures with high enzymatic activity were very liquid, which was reflected in the low volume of products.

The gluten content of the mixed flours and its quality decreased with the addition of Saskatoon berry powder ($p < 0.05$) due to the absence of gluten-forming proteins in this fruit. Only wheat proteins are able to form gluten. In sample V3, the gluten content was 14.96 % lower than in the control sample. Similar conclusions were reached by **Gažar and Bojňanská (2010)**, who added different amounts of oat, buckwheat, lentil and chickpea flour to T-650 wheat flour. The addition of Saskatoon berries in the mixtures reduced ($p < 0.05$) the gluten ductility, gluten swelling capacity (the lowest values were shown by samples V10 and V15), and the hydration ability of proteins expressed as the Zeleny index, which can be considered an unfavorable and unwanted effect.

Ash content in samples with increasing addition of Saskatoon berries powder increased significantly ($p < 0.05$) compared to the control sample (0.59 ± 0.01%). Ash content indicates the level of minerals contained in the samples **(Ape et al., 2016)**. The upward trend can be attributed to the difference in the mineral content of wheat flour (0.59±0.0) and Saskatoon lyophilized powder (2.77±0.03), which is the reason why the addition of this fruit to wheat flour can improve the nutritional composition. Also, the authors **Nguyen and Nguyen (2022)**, who mixed wheat flour with red corn powder, found that red corn flour has a high ash content, which is about 3.49 ± 0.31 %, that is steadily different from the wheat flour (0.87 ± 0.29 %).

Evaluation of biscuits

Durable bread is a bakery product whose water activity (a_w) is less than or equal to 0.65 **(Vyhláška MPaRV SR, 2014).** Water activity influences the biological and microbiological ability to preserve food **(Linkešová and Paveleková 2007)**. The shelf life of products with low water activity is limited mainly by fat oxidation and water activity above 0.2 by non-enzymatic browning (Maillard reaction) **(Rödel 2001).** The water activity values of commercial biscuit samples (manufacturers: Václav & Ježo, Ilava, Slovak Republic and Opavia LU, Prague, Czech Republic) Slovak Republic) tested at different temperatures (20, 25 and 30 °C) were in the interval of aw between 0.10 and 0.23. Higher a_w values of 0.46 – 0.53 were measured for two samples (sweet biscuits for children and confectionery biscuits). These products also contained more moisture (6 –7 %). In the other biscuit samples, the moisture content was in the range of 2 – 4 % **(Červenka et al., 2006).** The decrease of the value aw with the increasing temperature is typical of some low-molecular substances such as crystalline sugar or salt or foods containing large amounts of dissolved substances (such as dried fruits) **(Schmidt, 2004).** In our biscuits, the value of water activity (a_w) in the control sample was 0.57, and in the samples with the addition of Saskatoon berries powder, the a_w values decreased to 0.31 (V15), the moisture content of the cookies was 4.69 % - 4.41 % (C – B15), what can predict better microbiological durability of products. **Laganà et al. (2022)** reported that the value of aw increased ($p < 0.001$) with increasing concentrations of bergamot in biscuit flour between 0.228 (C - wheat flour only) and 0.281 (15 % bergamot substitute for flour), actually related to the different fiber content and pectins in BPF (Bergamot Pastazzo Flour). Its hygroscopicity causes the absorption and retention of water in food **(Einhorn-Stoll, 2018)**. The dry matter content in the biscuits ranged from 95.31 % (C) to 95.67 % (B15). Biscuits without the addition of freeze-dried fruit (control sample) had lower dry matter and ash content than mixed flours samples, but higher crude protein content on the other hand. The results of water activity, dry matter content, crude protein and ash content are shown in Table 3.

Table 3 Results of biscuits chemical evaluation

	Aw	Dry matter content (%)	Crude protein (%)	Ash content (%)
C	0.57 ± 0.01 c	95.31 ± 0.03 a	8.34 ± 0.08 c	0.88 ± 0.04 a
B5	0.46 ± 0.03 a	95.67 ± 0.08 b	8.15 ± 0.07 a	0.93 ± 0.06 a
B10	0.45 ± 0.004 a	95.42 ± 0.05 a	8.13 ± 0.06 a	1.15 ± 0.81 b
B15	0.31 ± 0.005 b	95.59 ± 0.07 b	7.92 ± 0.05 b	1.14 ± 0.04 b

B5 - biscuits with 5 % addition SB, B10 - biscuits with 10 % addition SB, B15 - biscuits with 15 % addition SB. Values are means ± standard deviation of 3 replications. Means within a column with different superscripts are significantly different at $p < 0.05$ by Duncan Multiple range test.

Between sample C and B15, we recorded a 0.26 % decrease in moisture content ($p < 0.05$), but e.g. the results of the authors **Nguyen and Nguyen (2022**) showed that adding of red corn powder (5 %, 10 %, 15 %) to the prepared cookies caused a significant ($p < 0.05$) increase in their moisture contents ranging from 3.00 % to 3.32 % compared to the control biscuit, (2.66 %). The difference between them is mostly due to different baking conditions and the ability of ingredients to absorb moisture in different conditions.

The ash content which indicates the level of mineral content of a food material, increased significantly after the addition of lyophilized Saskatoon berries. The ash content was highest in the biscuits with its 10% and 15% addition ($p < 0.05$), while the lowest was in the control samples. Gained results show that that an increased addition of SB had to be responsible for the improved of mineral content in the new biscuit products, in comparison to the samples made only from wheat flour. **Nguyen and Nguyen (2022)** also recorded a dramatic increase in ash content by 1.72 % in cookies with 15% addition of red corn powder compared to the control sample with 0.86 %. Also **Ivanišová et al**. **(2020)** recorded the highest of ash content in biscuits with 5 % chicory fiber (0.84), while the lowest in the control samples (0.67 %). Similar results have been described in work by **Ogo et al. (2021**) in biscuit samples made from mixtures of wheat, watermelon rind and orange pomace in the following ratio 100: 0: 0 (A); 90: 5: 5 (B); 80:10:10 (C); 70:15:15 (D) and 60:20:20 (E). The ash content increased significantly ($p <0.05$) from 4.11% - 14.75% in samples B - E compared to A 1.31%. In contrast, increase in substitution with the formulated blends resulted in marginal reduction in crude protein content of the biscuits from 11.80% in sample A to about 10% among samples B - E.

Crude protein content in cookies with the addition of powder from freeze-dried Saskatoon berries decreased significantly ($p < 0.05$). The lowest content compared to the control was found in biscuits with 15 % addition of this fruit, but samples B5 and B10 do not differ significantly from each other. On the contrary, the combination of different proportions of red corn flour and wheat flour in biscuits promoted a slight increase in protein content, which may appear desirable from the point of view of essential amino acid content **(Nguyen and Nguyen, 2022).**

Sensory evaluation

Sensory characteristics such as overall appearance, aroma, aroma intensity, presence of foreign smell and consistency of biscuits did not show any significant differences ($p > 0.05$) in the sensory evaluation (Table 4, Figure 1).

C B5 B10 B15

Figure 1 Biscuits with the addition of Saskatoon berry (*Amelanchier alnifolia* Nutt.)

The overall appearance of the cookies was best rated by the respondents in the B15 sample, and the lowest rating was given to the control sample, which was considered less attractive compared to the other samples, which could be due to the non-traditional/interesting burgundy-purple coloring of the cookies with the addition of fruit. Colour is an important parameter that affects consumer acceptance of foods in general **(Spence, 2015)** and of biscuits in particular **(Bajaj et al., 2006; Jan et al., 2018)**. Some studies suggest that untrained evaluators prefer a lighter colour for the appearance of the biscuits. Traditionally people consider light yellow colour related to rich-butter colour as amazing, and with a dark colour they assume a bitter taste **(Nguyen and Nguyen, 2022).** Color is a very important parameter when judging correctly baked biscuits, which reflect not only the appropriate raw materials used for preparation, but also it provides information about the composition and quality of the product (**Ikpeme et al., 2010).** In general, all prepared biscuits were evaluated as pleasant, harmonious. The highest rating was achieved by samples B10 and B15, which were evaluated as significantly pleasant, with a less strong intensity, even though the overall aroma and its intensity were relatively balanced in all samples. In the samples with the highest

addition of Saskatoon berries (B15), the evaluators observed a weak presence of foreign aroma. We noticed significantly more significant differences ($p < 0.05$) in the evaluation of taste properties. The best evaluated was the sample with the highest addition of Saskatoon berries (B15), which achieved the highest score of 8.42, the taste was evaluated as excellent, delicious and also characterized by the highest intensity of taste 8.58, which is assumed that it is due to the amount of addition. Similarly, **Lachowicz et al. (2021),** added Saskatoon berries powder and found that a lower addition of fly ash powder had no effect, but significant differences were found when adding 4%, 5% and 6% pure fly ash powder. The bread from this experiment with a lower addition (4% and 5%) had a slightly bitter taste. In contrast, the bread with 6% addition of functional ingredient already had a sweet fruity taste.

The results of sensory evaluation research by **Ogo et al. (2021**) have shown that wheat flour can also be replaced by melon peel flour and orange pomace flour up to 10 % without adversely affecting the overall quality properties of the biscuits. **Laganà et al. (2022)** observed a lower acceptance of samples formulated with a higher concentration of Bergamot Pastazzo Flour (10 and 15 %), which revealed a strong bitterness. Other authors have demonstrated the effect of flour composition on consumer perception and overall acceptability and how excessive content of a functional ingredient can reduce consumer acceptability **(Chauhan et al., 2016; Zbikowska et al., 2017; Man et al., 2021)**, which was not confirmed in our samples.

The best overall acceptability was achieved by samples with 10 % and 15 % addition of Saskatoon berries powder ($p < 0.05$), while the overall impression can be described as very good. Also, the addition of fig seed powder to the biscuit formulation up to 10 % increased the sensory scores of the biscuits in terms of odor, flavor, and overall impression **(Bölek, 2021)**. The authors of **Lachowicz et al., (2021)** state that the powder from *Amelanchier alnifolia* Nutt. as a fruit ingredient in bread significantly influenced the colour of the crust and the crumb of wheat bread. The higher this functional additive was used, the more red and less yellow pigment was contained in the mixture. Pigments such as anthocyanins belonging to cyanidin derivatives were determined in this fruit powder. Due to the high content of natural colors (anthocyanins) in *Amelanchier* spp. fruits, this species could be useful in the future for the food industry, since synthetic coloring could be replaced by saskatoon fruit extracts **(Mikulic-Petkovsek et al., 2020).**

Based on the organoleptic evaluation, we can conclude that the higher the substitution of wheat flour with powder from Saskatoon berries is, the more positively the individual sensory characteristics were evaluated, especially the appearance of the product and the taste properties, including intensity.

Table 4 Mean sensory scores of biscuits prepared from different ratios of wheat flour and Saskatoon berries

Samples	Appearance	Aroma (overall)	Aroma (intensity)	Foreign smell	Consistency	Taste (overall)	Taste (intensity)	Overall perception
C	7.42±1.4a	8.58±0.9a	7.75±0.9a	8.50±1.7a	8.08±1.2a	7.25±1.2b	6.75±1.6a	7.33±1.1b
B5	7.58±1.1a	8.42±0.9a	7.67±0.9a	8.33±1.5a	8.00±0.9a	7.83±0.8ab	7.25±1.2ab	7.75±0.8ab
B10	7.67±0.9a	8.67±0.7a	7.83±0.6a	8.17±1.8a	8.25±0.8a	8.25±0.8a	7.83±0.9bc	8.33±0.8a
B15	8.08±0.8a	8.670.8a	7.83±0.8a	8.00±2.0a	8.33±0.8a	8.42±0.8a	8.58c±0.5c	8.33±0.7a

C – control, B5 – biscuits with 5 % addition SB, B10 – biscuits with 10 % addition SB, B15 – biscuits with 15 % addition SB. Means within a column with different superscripts are significantly different at $p < 0.05$

CONCLUSION

With the increasing addition of Saskatoon fruit powder (5, 10 and 15 %) in the mixture with wheat flour, some technological parameters (gluten content and its quality, falling numbers) decreased, but for products such as biscuits, these parameters were not significantly influenced. The ash content with the addition of Saskatoon berries in mixed flours samples increased, which was also reflected in increase of ash content in the products themselves (biscuits with 10 and 15 % Saskatoon berry addition). Therefore the nutritional value of investigated biscuits was thus positively influenced. In biscuits with the addition of this fruit, the value of water activity was significantly reduced, which can have a positive effect on the shelf life of the products. Based on organoleptic evaluation it can be concluded that the replacement of up to 10 % and 15 % of wheat flour with Saskatoon berry powder improved the sensory properties (appearance and taste) of the prepared biscuits compared to control wheat biscuits. As a verified fruit ingredient it can be recommended for the preparation of long-lasting pastries, respectively biscuits. Even in connection with the colour of the dough, this non-traditional fruit can increase the attractiveness of products and could be a perspective when designing new products with increased potential for health benefits.

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