THE INFLUENCE OF NON-TRADITIONAL FRUITS AND ELDER FLOWERS ON RHEOLOGICAL PROPERTIES OF THE DOUGH

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ABSTRACT

The influence of the addition of flowers (Flos sambuci L.) and berries of elderberry (Sambucus nigra L.), blackcurrant (Ribes nigrum L.) and chokeberry (Aronia melanocarpa L.) to wheat flour was characterized by the rheological test Mixolab (Chopin Technologies, France). Twelve types of wheat flour mixture with different fruit and elder flowers addition were prepared for evaluation in the following ratios: 95: 5, 90:10, 85:15. The control represented 100 % wheat flour. Preliminary rheological analyzes indicated a strong influence of the ingredients used on the properties of the dough. The addition of elderflowers, elderberry and blackcurrants significantly increased the values of the dough development time. In the samples with the addition of elder flowers, we also found a higher stability of the dough, on the contrary, the addition of berries of elderberry and also the 15% addition of chokeberry reduced it. The most significant effect of increasing the addition on the development time and stability of the dough was observed in the samples with the addition of blackcurrant. In contrast to the other samples, the properties of the flour with the addition of elder flowers were comparable with the control in protein strength, in starch gelatinization and in the estimated amylase activity. Samples of flour with the addition of lyophilized fruits behaved significantly differently rheologically than flour with the addition of elder flowers. The closest relationship (p <0.001) was observed between the torque C3 (starch gelatinization rate) and C4 (stability of the formed gel), also between C3 and the difference C3-C2 (r = 0.99).

Keywords: Elder flowers, Elderberry, Blackcurrant, Chokeberry, Mixolab, Chopin+ protocol, Rheological Properties

INTRODUCTION

In recent years, more attention has been focused on evaluating the quality of wheat flour and bakery products. In the technology of baking, composite flours based on wheat and other cereals and non-grain seeds have become popular (Święc and Hrušková, 2015). New non-traditional ingredients, for example amaranth, sunflower, quinoa, hemp, chickpeas, lupine, flaxseed, chia, teff, improve the rheological properties of the dough, increase the nutritional value and quality of bread (Rosell et al., 2009; Mironesea et al., 2012; Święc and Hrušková, 2015). The effect of bioactive substances of several species such as berries – black elderberry (Sambucus nigra L.), blackcurrant fruits (Ribes nigrum L.) and black chokeberry (Aronia melanocarpa L.) (Karjalainen et al., 2009) reduces oxidative stress and strengthens the body’s immune system (Aksoylu et al., 2015; Miletić et al., 2019). Polyphenol-rich plant extracts are emerging as potential ingredients in functional foods and beverages (Pepa et al., 2020). Phenolic compounds, particularly the flavonoids and phenolic acids, appears to be the major functional components of berries (Pinto et al., 2010). Numerous studies have shown that the fruits and flowers of blackberry (Sambucus nigra L.) are an important source of bioactive compounds such as polyphenols and anthocyanins with high antioxidant activity, which significantly affects its health benefits. In recent years it was found that elderberry has antibacterial, antiviral, antiprressant, antimicrobial and hypoglycemic properties, and to reduce body fat and lipolytic parameters (Duffy et al., 2016). The main anthocyanins in the black chokeberry are cyanidin 3-O-arabinoside, cyanidin 3-O-galactoside, cyanidin 3-O-glucoside, and cyanidin 3-O-xiloside. These compounds are characterized by many pharmacological effects, such as antioxidant defence, antimicrobial, antiproliferative, anti-inflammatory, and modulate hepatic lipid metabolism activities (Kim et al., 2013; Stanisavljević et al., 2015; Bhaswant et al., 2017; Denev et al., 2019). The health benefits of anthocyanins include the prevention and remedy of cardiovascular disease and liver failure, anti-obesity and anti diabetic activity (Kim et al., 2012; Ho et al., 2014; Thilavech and Adisakkattana, 2019). The dried black chokeberry fruits may be used for various applications, particularly functional food ingredients, for example chips or as food additive to improve the biological value of food (Sidori et al., 2021).

However, the stability of anthocyanins depends on many factors, such as structure, presence of solvents, temperature, oxygen and enzymes, pH, and other concomitant substances (Klursova et al., 2019). The largest amount of polyphenols is maintained by freeze-drying, which is considered to be the most desirable drying method (Sidori et al., 2021). Freeze-drying, to a large extent, allows for considerable preservation of the components in an unaltered state and prevents damage to the structure of the dried material (Calín-Sánchez et al., 2020). Wheat flour is the important ingredient in the production of various types of bakery products. Monitoring the rheological properties of dough is very important for the overall technology to estimate the mechanical properties of dough and to imitate...
its behaviour during its processing or even to anticipate the quality of the final product (Torbica et al., 2019).

The aim of this work was to characterize the rheological properties of dough prepared from wheat flour and with 5 %, 10 % and 15 % additions of flowers (Flos sambuci L.) and berries of elderberry (Sambucus nigra L.), blackcurrant (Ribes nigrum L.) and chokeberry (Aronia melanocarpa L.).

**MATERIAL AND METHODS**

**Samples**

In this study, commercial wheat flour T650 (ash 0.65 %) (MLYN ZRNO, Miroslav Grznár, Slovak Republic) were used. The elderberry (flowers and berries), black currants and chokeberry came from the Botanical Garden of the Slovak University of Agriculture (August-September 2020). Elder flowers (Flos sambuci) were harvested at the end of May 2020 (flat peak 20 cm in diameter) and loosely dried on sieves (14 days, at 23 °C), without direct sunlight, with air circulation. The fruits (berries) were harvested when they were fully ripe (colour is considered the most reliable indicator of ripeness) (Lysiak et al., 2014). In the laboratory, the berries were separated from the stems and the unripe and dry berries. The fruits of elderberry, blackcurrant and chokeberry were lyophilized for 5 days at -58 °C (iShin Lab Co., Ltd., Korea). Dried elder flower and freeze-dried elderberry, blackcurrants and chokeberry were homogenized using a stainless-steel blender (BOSCH TSM6A01, Germany).

Twelve kinds of a mixture of wheat flour with different ratios (flowers and berries of elderberry, black currant and chokeberry) were prepared for evaluation in the following ratios: 95:5, 90:10, 85:15. As a control (C) was used only pure wheat flour (energy value – 1464 kJ, carbohydrate content – 71 g/100 g of which sugars – 1.59 g/100 g, fibre content – 3.3 g/100 g, protein content – 11 g/100 g, fat content – 1.3 g/100 g of which saturated – 0.3 g/100 g). The data is guaranteed by the manufacturer. Labeling of samples: FS 5 – flour : Flos sambuci (95:5), FS 10 – flour : Flos sambuci (90:10), FS 15 – flour : Flos sambuci (85:15), SN 5 – flour : Sambucus nigra (95:5), SN 10 – flour : Sambucus nigra (90:10), SN 15 – flour : Sambucus nigra (85:15), RN 5 – flour : Ribes nigrum (95:5), RN 10 – flour : Ribes nigrum (90:10), RN 15 – flour : Ribes nigrum (85:15), AM 5 – flour : Aronia melanocarpa (95:5), AM 10 – flour : Aronia melanocarpa (90:10), AM 15 – flour : Aronia melanocarpa (85:15).

**Rheological properties testing**

The rheological properties of dough were monitored using “Chopin+” protocol on the Mixolab 2 (Chopin Technologies, Villejuif la Garenne, France) according to ICC No. 173. The experiments were made in duplicate. The Mixolab evaluates in real time the torque (Nm) that is produced by the dough between the blades. The test is based on the preparation of a constant hydrated mass of dough so as, to obtain the target consistency during the first test phase. In the “Chopin +” protocol, the dough weighs 75 g, and the target consistency is 1.1 Nm (+/- 0.05 Nm) (Chopin Technologies Application Team, 2009), Settings of the test: initial state at 30 °C for 8 min, heating to 90 °C for 15 min (4 °C/min), holding at 90 °C for 7 min, cooling to 50 °C for another 10 min (4 °C/min) and holding at 50 °C for 5 min. The mixing speed was kept constant at 80 rpm. The whole analysis takes 45 min. Figure 1 shows a typical Mixolab curve, which distinguishes the different stages of dough changes due to both temperature and mixing force. The parameters highlighted in the curve are: C1 (Nm) - maximum torque during mixing (determines water absorption); C2 (Nm) - measures the protein attenuation based on temperature and mechanical work; C3 (Nm) - expresses gelatinization of starch; C4 (Nm) - indicates the stability of the starch gel formed; C5 (Nm) - measures the retrogradation of starch during the cooling phase; differences: C1 – C2 indicates the strength of the protein network with increasing heating; C3 – C2 corresponds to the gelatinization rate of starch; C3 – C4 shows amylose activity and is linked to falling number; C5 – C4 corresponds to the anti-stalling effects (retrogradation of starch in the cooling phase), represents the shelf life of the final products (Papoušková et al., 2011).

Adding elder flowers and non-traditional fruits to wheat flour (5 %, 10 %, 15 %), resulted in differences in the viscoelastic properties of the path (Fig. 2). The Mixolab Profiler shows the standard curve of Mixolab into six indexes of flour quality factors, graded from 0 to 9 (mixing, water absorption, gluten strength, maximum viscosity, amylose resistance and retrogradation) (Chopin Technologies Application Team, 2009). As an indicator of the overall quality of flour proteins, a mixing index is used, which expresses the flour's resistance to kneading (Hadnadev et al., 2011). Flours with added chokeberry reached low mixing values. The mixing index decreased with increasing amount of ingredients (AM 5 - 3, AM 10 - 2, AM 15 - 1). Gluten+ index represents the behavior of the gluten when heating the dough and it is therefore the measure of protein strength. It has to be pointed out that Gluten+ index is not the measure of gluten content. The results showed a weakening of the gluten network in all evaluated samples, except AM 10 and AM 15.

The rheological behavior of wheat flour dough (control) and wheat flour with different additions during the Mixolab test are detailed in Tab. 1. Determined Mixolab C1 – C5 values for control flour were 1.11 Nm, 0.56 Nm, 1.92 Nm, 2.15 Nm and 1.10 Nm, 0.50 Nm, 2.06 Nm, 1.69 Nm, and 2.54 Nm. The difference in the parameter of curve C5 was shown. Banu et al., 2011 published the results of parameter C5 – 3.12 Nm (Romanian commercial samples of wheat flour). Varieties of different technological quality as well as the type of locality and weather conditions contributed to the diverse course of starch retrogradation.
Table 1 Mixolab characteristics of the flours with additions

<table>
<thead>
<tr>
<th>Sample</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>Stability ± SD (min: s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1.11 ± 0.01</td>
<td>0.56 ± 0.01</td>
<td>1.92 ± 0.03</td>
<td>2.15 ± 0.14</td>
<td>4.85 ± 0.07</td>
<td>9:58 ± 0.14</td>
</tr>
<tr>
<td>FS 5</td>
<td>1.11 ± 0.03</td>
<td>0.53 ± 0.04</td>
<td>1.94 ± 0.06</td>
<td>2.05 ± 0.13</td>
<td>4.59 ± 0.10</td>
<td>10:34 ± 0.16</td>
</tr>
<tr>
<td>FS 10</td>
<td>1.12 ± 0.06</td>
<td>0.54 ± 0.06</td>
<td>1.93 ± 0.09</td>
<td>1.84 ± 0.10</td>
<td>4.10 ± 0.30</td>
<td>10:15 ± 0.58</td>
</tr>
<tr>
<td>FS 15</td>
<td>1.14 ± 0.07</td>
<td>0.53 ± 0.04</td>
<td>1.72 ± 0.13</td>
<td>1.40 ± 0.16</td>
<td>2.97 ± 0.23</td>
<td>9:18 ± 0.57</td>
</tr>
<tr>
<td>SN 5</td>
<td>1.08 ± 0.06</td>
<td>0.33 ± 0.03</td>
<td>1.93 ± 0.10</td>
<td>1.60 ± 0.11</td>
<td>4.21 ± 0.13</td>
<td>7:02 ± 0.46</td>
</tr>
<tr>
<td>SN 10</td>
<td>1.10 ± 0.08</td>
<td>0.32 ± 0.08</td>
<td>1.95 ± 0.13</td>
<td>1.49 ± 0.17</td>
<td>4.15 ± 0.17</td>
<td>6:35 ± 0.28</td>
</tr>
<tr>
<td>SN 15</td>
<td>1.06 ± 0.07</td>
<td>0.31 ± 0.10</td>
<td>1.85 ± 0.08</td>
<td>1.24 ± 0.10</td>
<td>3.92 ± 0.15</td>
<td>6:57 ± 0.47</td>
</tr>
<tr>
<td>RN 5</td>
<td>1.11 ± 0.04</td>
<td>0.38 ± 0.09</td>
<td>1.91 ± 0.40</td>
<td>2.20 ± 0.06</td>
<td>4.50 ± 0.10</td>
<td>6:12 ± 0.51</td>
</tr>
<tr>
<td>RN 10</td>
<td>1.08 ± 0.03</td>
<td>0.37 ± 0.08</td>
<td>2.04 ± 0.21</td>
<td>2.19 ± 0.11</td>
<td>4.61 ± 0.10</td>
<td>7:47 ± 0.41</td>
</tr>
<tr>
<td>RN 15</td>
<td>1.03 ± 0.04</td>
<td>0.48 ± 0.07</td>
<td>2.15 ± 0.13</td>
<td>2.08 ± 0.13</td>
<td>4.41 ± 0.06</td>
<td>10:26 ± 0.53</td>
</tr>
<tr>
<td>AM 5</td>
<td>1.08 ± 0.03</td>
<td>0.42 ± 0.09</td>
<td>1.83 ± 0.24</td>
<td>2.00 ± 0.08</td>
<td>4.48 ± 0.08</td>
<td>9:13 ± 0.35</td>
</tr>
<tr>
<td>AM 10</td>
<td>1.13 ± 0.04</td>
<td>0.53 ± 0.07</td>
<td>4.73 ± 0.04</td>
<td>4.68 ± 0.01</td>
<td>4.74 ± 0.03</td>
<td>9:42 ± 0.51</td>
</tr>
<tr>
<td>AM 15</td>
<td>1.22 ± 0.08</td>
<td>0.61 ± 0.04</td>
<td>4.48 ± 0.37</td>
<td>4.42 ± 0.28</td>
<td>4.71 ± 0.11</td>
<td>2:26 ± 0.04</td>
</tr>
</tbody>
</table>

Legend: C – Control, FS (Flos sambuci), SN (Sambucus nigra), RN (Ribes nigrum), AM (Aronia melanocarpa)

The dough development time value for control flour was 1:55 min: s, while the additions of elder flowers (FS), elderberry (SN) and blackcurrant (RN) significantly increased this value, the addition of chokeberry reduced this value (Fig.3). We observed the most significant effect of increasing the addition on the development time of the dough in RN samples. In addition to higher time values of dough development with the addition of elder flowers, we also found higher dough stability at FS 5 and FS 10 compared to control flour. The stability of the dough is considered to be an important indicator of the quality of doughs for bakery processing, especially in connection with the technological process of bread production (leavening, translating, dough resting). We found a gradual increase in the stability of the dough with increasing addition in RN samples. Additions of elderberry reduced the value of dough stability. The dough stability values at AM 5 and AM 10 were similar to control flour, but the 15% addition of chokeberry (AM 15) significantly reduced this value (Fig.3). The increase in development time and stability of the dough was found by Bojňanská et al. (2020), who researched the effect of adding partially defatted milk thistle flour (5 %, 10 %, 15 %) to a 50:50 mixture of wheat and rye flour.

Figure 2 Mixolab profiler (For label legend, see Table 1.)
The first part of the Mixolab curve shows the behaviour of the dough during mixing. At this stage, the torque increases until it reaches the maximum (C1). The C1 value was modelled by the controlled addition of water to the required consistency value of 1.1, with minimal deviations (Tab. 1). At this point, the dough resists deformation for certain time, which determines the stability of the dough. The decrease in torque is recorded after the dough stability time, which designate the end of the first phase and the beginning of the second phase. The second phase can start during the initial mixing time, or later, depending on the quality of the flour. At this phase, the proteins are weakened. The longer is the stability time, the better is the protein quality (Hadinadov et al., 2011).

Temperature limitation and current mechanical stress (2nd stage) reduce the torque to the minimum value (C2). This value is related to the onset of destabilization of the protein structure (Rosell et al., 2010). The increase in dough temperature led to protein denaturation, which released a large amount of water. Proteins become hydrophobic. In the temperature range of the second phase, the proteolytic enzymes have an optimal activity (Haros et al., 2006, Stoicescu et al., 2010, Banu et al., 2011), represented by the slope α (recorded between C2 - C1). Proteins that are poor in sulfhydryl groups, affect dough stability. They cause dough softening or even degradation. With a higher protein content, the gluten network is stronger and has a higher resistance to shear stress (Kaur et al., 2016). The dough reaches a specific temperature for the start of starch gelatinization, at minimum torque (C2). In the case of the control sample, the minimum torque (C2) was reached faster (16:14 min: s) at a temperature of 54.60 °C. The authors (Banu et al., 2011) state that in the case of a blank sample, the minimum torque (C2) was reached faster (17:00 min: s) at a temperature of 55.4 °C compared to samples with α-amylase, where the value C2 was reached after 18:22 min: s was specific for a higher temperature (57.6 – 58.2 °C). We found a similar increase in the time to reach the minimum torque (C2) at a specifically higher temperature in samples FS 15 (17:34 min: s at 58.60 °C), AM 10 (17:26 min: s at 57.8 °C) and the highest increase at AM 15 (18:31 min: s at 60.3 °C). The first difference C1 – C2 is related to proteins quality. In the control flour, the C2 values decreased from 1.11 Nm to 0.56 Nm (the difference C1–C2 is 0.55 Nm). A similar value of torque C2 (0.50 Nm) is reported for composite flours by Švec and Hrušková (2015). Similar C2 values were found in flour with the addition of elder flowers (FS 5, FS 10, and FS 15). In flour with the addition of the fruits of elderberry (Sambucus nigera L.) and blackcurrant (Ribes nigrum, L.), the C2 values decreased on average by 0.71 Nm, and in the flour with the addition of chokeberry, the C2 values decreased on average by 0.63 Nm. The Chopin protocol from individual flour measurements with additions is shown in Figures 4 (a, b, c, d).

With increasing temperature (70 °C) starch gelatinization takes place (3rd stage) and at the same time the torque increases until a new maximum value (C3) (Ozturk et al., 2008). Swelling starch granules and hydration cause an increase in dough consistency (Rosell et al. 2007). In the third stage, the starch gelatinization rate is recorded and is defined by the β slope (Hadinadov et al., 2011). The evaluated parameters were slope-β (Fig. 5), C3 and difference C3–C2 (Tab.1). Significantly higher values of C3 torque compared to the control flour were observed in the evaluated flour with 10 % and 15 % addition of chokeberry. The difference C3–C2 decreased in flours, especially with the addition of ofyophilitized fruits (SN, RN and AM), so we evaluate the effect of the dough recipe as significant. In stage 4, a decrease in viscosity is observed due to the physical decomposition of the starch granules at temperatures above 80 °C, resulting to a minimum torque value (C4). In this step, the parameters slope-γ, C4, and C4–C3 and enzymatic activity were evaluated. The lowest value of C4, which shows the stability of the starch gel formed, we determined in samples FS 15, SN 15, RN 15 and AM 5. The same decrease in C4 was observed in the trial mixture 50:35:15 (15 % milk thistle flour) in the work of Bojhanská et al. (2020) and also from the studies of authors Švec and Hrušková (2015), where for the standard M, C4 parameter reached value of 1.59 Nm, and for others K1 hemp flour composites a gradual diminishing of 7 % was observed. In this case, was proved a dependence of determined values on dough formula. We recorded a significantly higher value of C4 in flour with the addition of chokeberry (AM 10 and AM 15). Viscous behaviour of material heated approximately to 80 °C demonstrated the highest variability. An interesting finding was that in the flour samples with the addition of elderberry (SN 15) we recorded a sudden decrease in the value of torque with an increase in temperature above 80 °C (from 29 min.). The decrease was more pronounced with increasing amount of addition (1.6 Nm, 1.49 Nm, 1.24 Nm) (Fig. 4 b) and also had a significant effect on the slope of the curve - slope-γ, which provides data on the rate of enzymatic hydrolysis (Fig. 5).

Maximum torque (C5) is result of the decrease in the temperature produces an enhancement in the dough consistency (stage 5th) (Ozturk et al., 2008). The degree of starch retrogradation for the tested flours with additions showed similar differences as the stability of the starch gel. We found the lowest C5 values in samples FS 15, SN 15 and RN 15. The lowest difference of C5–C4 compared to the control (2.696 Nm) was found in AM 10 (0.061 Nm) and AM 15 (0.287 Nm).
The properties of the flour with the addition of elder flowers (FS) were comparable to control (C) in protein strength (difference C1–C2: 0.57, 0.58, 0.61 Nm vs. 0.56 Nm), in starch gelatinization (C3–C2 between 1.20 and 1.41 Nm vs. 1.36 Nm) and in the estimated amylase activity (C3–C4 between 0.08 and 0.32 Nm vs. 0.22).

Among calculated pair subtractions of torque points the SN, RN and AM flour composites different from the control flour in protein strength (C1–C2) and in starch gelatinization (C3–C2), especially AM 10 and AM 15 (4.21 Nm, 4.48 Nm vs. 1.35 Nm).

The difference was also manifested by amylase activity (C3–C4; SN between 0.33 and 0.61 Nm vs. 0.23 Nm; AM between 0.05 and 0.16 Nm) and the rate of retrogradation of starches (C5–C4) mainly in AM 10 samples and AM 15 (0.06 and 0.29 Nm vs. 2.70 Nm).

Figure 5 documents the slopes α, β and γ during the dough mixing process. The results confirmed significantly different gelatinization characteristics and enzymatic hydrolysis compared to control flour, especially in flours with the addition of elderberry (SN 5, SN 10, SN 15) and also flours with the addition of chokeberry (AM 10, AM 15).

**Figure 4** Mixolab curve Chopin+ protocol – a: flour + elder flowers (Flos sambuci L.), b: flour + elderberry (Sambucus nigra L.), c: flour + blackcurrant (Ribes nigrum L.), d: flour + chokeberry (Aronia melanocarpa L.)
Table 2: Correlation analysis between the Mixolab curve features (torque points) – Sambucus nigra L. and chokeberry (Aronia melanocarpa L.)

<table>
<thead>
<tr>
<th>N</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C1-C2</th>
<th>C3-C4</th>
<th>C5-C4</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>1</td>
<td>ns</td>
<td>1</td>
<td>1</td>
<td>0.78*</td>
<td>ns</td>
<td>0.81**</td>
<td>1</td>
</tr>
<tr>
<td>1-C1</td>
<td>ns</td>
<td>1</td>
<td>0.85***</td>
<td>1</td>
<td></td>
<td>ns</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>C3-C4</td>
<td>0.75*</td>
<td>0.82**</td>
<td>0.97***</td>
<td>1</td>
<td>ns</td>
<td>0.99***</td>
<td>0.96***</td>
<td>ns</td>
</tr>
<tr>
<td>C5-C4</td>
<td>-0.76*</td>
<td>-0.87**</td>
<td>-0.99***</td>
<td>0.98***</td>
<td>ns</td>
<td>-0.72*</td>
<td>ns</td>
<td>-0.99***</td>
</tr>
</tbody>
</table>

Legend: *: significant at p < 0.05, **: p < 0.01, and ***: p < 0.001 respectively; ns: non-significant.

CONCLUSION

In this work we characterize the rheological properties of dough prepared from wheat flour and with 5%, 10%, and 15% additions of polyphenols from (Flos sambuci L.) and fruits of elderberry (Sambucus nigra L.), blackcurrant (Ribes nigrum L.) and chokeberry (Aronia melanocarpa L.). Preliminary rheological analyses indicated a strong influence of the additives used on the rheological properties of the dough. Adding elder flowers and non-traditional fruits to wheat flour, resulted in differences in the viscoelastic properties of the path. The addition of elder flowers, elderberries and blackcurrants significantly increased the values of the dough development time, but the addition of chokeberry decreased this value. In the samples with the addition of elderflowers, we also found a higher stability of the dough, on the contrary, the addition of elderberry fruits and also the 15% addition of chokeberry reduced it. The flour with added fruits of elderberry, blackcurrant and chokeberry differed from the pure wheat flour in protein strength and starch gelatinization (values increased). Viscous behaviour of the composite material heated to about 80 °C showed the highest variability. The difference was also manifested by amylose activity in the samples with the addition of black base (more pronounced decrease with increasing amount of addition) and chokeberry (significantly higher values with 10% and 15% addition) as well as the rate of starch retrogradation mainly in samples with 10% and 15% chokeberry. Due to the rheological properties of the dough, the results suggest that the verified flour and elder flower additives can be used for the preparation of bakery products (including sweet variants) as well as long-lasting pastries (biscuits). Even in connection with the colour of the dough, this non-traditional flour can increase the attractiveness of the products. Further evaluation is needed in this area, but the test results obtained can be an important source of information for manufacturers when designing new products with increased health benefits.

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