THE EFFECT OF THE ADDITION OF VARIOUS TYPES OF OILS ON THE TECHNOLOGICAL QUALITY OF WHEAT DOUGH AND BREAD

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ABSTRACT

The aim of this work was to evaluate the effect of the addition (0.5 %, 1 % and 1.5 %) of vegetable oils (pumpkin, rapeseed and sunflower oil) on the technological quality ( rheological properties of dough, bakery indicators and bakery experiment) of wheat dough and subsequently wheat bread. The wheat flour type T 650 was used as a base and also control. In this type was determined a dry matter of 86.65 %. By determining the bakery indicators (crude protein content, falling number, starch content, ash content, titratable acidity and Zeleny index) it is possible to summarize that this type of four was strong. The gluten properties of T 650 flour were optimal and suitable for bakery use. The specific volume, volume yield, bulk productivity, bread yield, loss during baking and shape were determined by a baking experiment. The highest specific volume was determined in a bread loaf with the addition of 1.5 % pumpkin oil – 424.2 cm³·100 g⁻¹. The volume of prepared breads increased with oil addition – the highest value was determined in sample with the addition of 1.5 % sunflower oil (volume increase of 24 % with compared to the control variant without addition. The shape of prepared breads was optimal; the bulk productivity increased in direct proportion to the addition of individual oils. The addition of vegetable oils had a beneficial effect on the rheological properties of the dough. The farinograph properties were good, but in the wheat dough with the addition of rapeseed oil, the development time of the dough gradually decreased. After the addition of pumpkin oil, it was determined development time of the dough (the difference between the maximum and minimum) higher by 55 % with compared to the control variant without addition. It was also recorded positive results for the evaluation by the extensograph properties. By a comprehensive evaluation, it can be stated that the addition of vegetable oils had positive effects on wheat dough and prepared bread.

Keywords: flour T 650, farinograph, extensograph, bakery properties

INTRODUCTION

Cereals are important mainly as a source of nutrients for humans and livestock. Their main benefit in the diet is starch, a source of energy, that is present as a storage product in the endosperm, but other nutrients such as protein, fat are also important. (Rosenstrater and Evers, 2018). Wheat is one of the most important crops consumed in the world (FAO, 2011). Wheat belongs to the genus Triticum, which has been divided into three taxonomic groups. The individual groups differ in the number of chromosomes; it is known diploid wheat, tetraploid wheat and hexaploid wheat (Tadesse et al., 2016). Wheat production fell by 5 % worldwide in 2020, FAO expects that in 2021, production of wheat will increase to 780 million tons. The major part should come from the European Union (FAO, 2021). The addition of wheat flour as the main food ingredient in the world is influenced by high agronomic adaptability, good storage adaptability and high nutritional value of wheat flour. Bread is one of the products from wheat flour. The unique highly elastic properties of wheat dough are responsible for the production of quality bread (Uthayakumaran and Wrigley, 2017). Viscoelasticity gives the wheat dough rheological properties, which are a combination of the properties of a viscous fluid and an elastic solid. The optimal rheology of the dough is a decisive factor for the quality of the bread (Zhang et al., 2020). The production of bread belongs to the centuries-old tradition crafts, production involving the mixing of wheat flour, water, yeast and other functional ingredients and an expansive mass to produce carbon dioxide. The result product quality influences the choice of ingredients and recipes (Cauvin, 2012). Most types of bread contain proteins, vitamin groups B, E and trace elements of iron, calcium, potassium, which are very beneficial to the human body (Kourkouta et al., 2017).

Except cereals, oilseeds are strategic crops in Slovakia; oilseeds are irreplaceable in the nutrition of the population and in the feed economy (Candráková, 2016). Oil crops of domesticated seed oil crops are the major agricultural commodities which are used usually for nutritional purposes, but in the recent years are also used for preparation of biofuels and in the chemical industry (Dyer et al., 2008). Cultivation of cotton, soybeans, rapeseed, peanuts, and olives is dominated in the world. The most cultivated oilseeds are sunflower and rapeseed in Slovakia as well as in Europe (Candráková, 2016). Parts of oilseeds, especially seeds contain oils in such an amount that it is rational to obtain them by suitable method (Božínská et al., 2013). Animal fats have a predominantly solid consistency, containing mainly saturated fatty acids. Plant fats are appropriate for their chemical composition – liquids, called oils. Edible vegetable oils contain, in addition to saturated, a large amount of unsaturated fatty acids (Krist, 2020). In recent decades of studies on the role of fats and oils in human nutrition, they emphasize the need for the use of fatty acids, the reduction intake of saturated fatty acids and, more recently, control using trans-fatty acids (Osuna et al., 2018). The lipids contained in oils are the main source of energy and also have a storage and protective function for the human body (Welte and Gould, 2017). Lipids are the medium for the solubility of vitamins which are soluble in fats, and are very important for the early stages of development of human life (Burlingame et al., 2009). Lipid oxidation is one of the most significant factor affects in durability of foods. Products of oxidation of lipids can affect taste, texture and flavour of food (Jacobsen, 2019).

Interaction of fats with dough components depend on the chemical composition and properties of a fat. Glycolipids participate in the formation of cellular membranes and in the formation of glucose, which determines the baking quality of flour. Under dough kneading, fats change the properties of starch as a result of the formation of complexes with an amylose fraction (Renzyaeva, 2013). The choice of fats for the preparation of bakery products is not only governed by the nutritional needs of consumers, but also influences the rheological properties. The addition of fats also affects the sensory properties of the products (Osuna et al., 2018) and has influence for technological quality of products. Technological quality consists of mall and bakery indicators together with trademarks of quality (Božínská et al., 2013). Quality is expressed in terms of quality grades. These are real parameters of cereals, which are compared with the standards (Burešová and Lorencová, 2013). The important indicator for processors and producers is technological quality. It is influenced by the variety of cultivated raw material and cultivation conditions (Zimolka et al., 2005). Suitability of the raw material for technological processing can generally be described as quality raw materials (Suková, 2012). Objective procedures and methods by which we can directly assess the characteristics of the dough determine the baking quality of the products. Indirect
methods are used, for example, to determine mill quality (Šedivý et al., 2013). Mill quality describes the physical – mechanical and structural properties of grain (Burešová and Lorenceová, 2013). Vegetable oils are good source of bioactive compounds which health benefits. Addition of fats and oils can also improve the technological quality of foods, especially breads and bakery products. So, the aim of this study was to determine effect of pumpkin, rapeseed and sunflower oil to technological quality of what dough as well as final products – bread.

**MATERIAL AND METHODS**

For analyses was used the following raw material: wheat flour T 650, obtained from the Kolárovo mill a.s., Vitaflorea (Slovak republic). Plant oils which were added to the flour in the amounts: 0.5 %, 1 %, and 1.5 % were as follows: oil from pumpkin seeds (producer from Austria), rapeseed oil (producer from Slovak Republic), sunflower oil (producer from Hungary). In the baking experiment it was used the following materials: NaCl – salt, distilled water, fresh baker's yeast, sugar purchased from local market.

**Chemicals**

Chemicals were of analytical grade and were purchased from Sigma-Aldrich (USA) and CentralChem (Slovakia).

**Evaluation of the moisture content**

For determination of moisture content (ICC standard No. 110/1, 1976) samples were drying to constant weight by gravimetric method. The weight of the sample represented a weight of 2 – 5 g with an accuracy of 0.01 g. The sample was inserted to a heated oven with forced ventilation to a temperature of 130 ± 2 °C and dried to constant weight. After cooling the sample in the desiccator, the percentage of moisture was determined and the constant weight was placed to Teflon forms and set to rise. Fermentation took place in an electronically controlled stage oven with a fermentation station (MIWE Condo, USA) during 35 minutes at 30 °C. Fermentation was followed by baking with steaming for 10 minutes at an initial temperature of 240 °C, then 25 minutes at a temperature of 220 °C. For other variants was followed the same procedure, the difference was in the input materials (Tokár et al., 2011).

**Rheological evaluation**

For farinographic determination was used Farinograph – E, Brabender OhG, Duisburg, German. The weight of the flour sample was 300 g at 14 % moisture content. The farinographic curve is an indicator of the strength of the flour. From this curve can be derived these features: development of the dough [mm], stability of the dough [mm], decrease in consistency [EU – farinographic units] (strength of the dough) and farinographic quality number (ICC-Standard 115/1, 1992; AACC Method 54-21, 1995). Extentogram was obtained by Extencoographer – E, Brabender OhG, Duisburg, Germany. Dough was prepared by standard conditions, of flour, distilled water, and of sodium chlorate (2 %) in Farinograph. Evaluated characteristics: extensographic energy [cm²], extensographic maximum [EU – extensographic units], extensographic extensibility [mm], resistance to extension (ICC-standard 114/1, 1992; AACC Method 54-10, 1995). Vegetable oils – pumpkin, rapeseed and sunflower were added in amount 0.5, 1 and 1.5 %. In farinographic evaluation it was added in the starting together with water. The experiment was performed similarly like control sample (without addition of oils) so after adding the oils, the consistency of the dough was 500 farinographic units.

**Statistical analysis**

Descriptive statistics, normality test and Kruskal-Wallis (non-parametric ANOVA) with Dunn test (pairwise comparisons) with exact p-value were performed to find the significant differences between the tested variables were performed using the MS Excel with the XLSTAT package (Addinsoft, 2014).

**RESULTS AND DISCUSSION**

**Results of dry matter/moisture content evaluation**

According to the literature sources the moisture content of the wheat flour must be in the range of 11 % to 14 %. Moisture content higher than 14 % initiates development of microorganisms and can result in higher enzymatic activity (Saied et al., 2015). In the sample of wheat flour T 650 which was used as a control was subjected to analyses to obtain bakery quality indicators (Table 1). It was analysed the content of nitrogenous substances by the reference Kjeldahl method in control with the result of crude protein 12.90 % after recalculation. Saied et al., (2015) in their study stated that higher protein content in the range of 10 % to 14.5 % indicate the strength of the flour and lower protein content in the range of 6% to 10 % indicate the softer the flour. According to the obtained results wheat flour T – 650 belongs to the stronger type of flour. Starch in wheat flour contributes to the optimal development of the bread crust and its texture. It is also responsible for the physical aging of pastries – retrogradation. The starch content mainly affects the absorption of water during the development of the dough (Calvin, 2016). Using the Ewers method, was determined the starch content in control 77.17 %, Šedivý et al. (2013) stated that starch should be present in wheat flour in the range of 75 – 79 %. It can be said that the sample had the optimal starch value according to this statement. The ash content expresses the amount of the total mineral content in the flour; it is also an important parameter of the nutritional value of cereal products (Bilge et al.,
2016). Ash is an indicator of the degree of the flour milling (Prugar et al., 2008). According to Šedivý et al. (2013) the ash content in wheat flour should be in the range of 0.4 – 1.7 %. The control (T 650) contained 0.71 % ash (Table 1), what can be evaluated as adequate.

For determination of the enzyme activity of the flour was used falling number method. As Zimolka (2005) and Prugar et al. (2008) stated α-amylase activity in flour is beneficial for yeast fermentation, but too much amylase content (lower falling number corresponds to higher activity of α-amylase) can lead to progressively worse quality of the composition of the bread and it can result in appearance of sticky bread crust and the crust may be darker after baking. In sample tested in our study was determined a falling number 453 seconds (Table 1). This result cannot be considered as optimal. High falling number can result in worse quality of final products (Zimolka, 2005; Prugar et al., 2008).

### Results of gluten indicators evaluation

It was determined a wet gluten content of 41.5 % (Table 2) under the conditions of the method. The measured value can be determined as optimal similar like extensibility which inform about mechanically stress the dough (Šedivý et al., 2013). The less content of crude protein in flour can influence of gluten extensibility (Novotný and Hublík, 2006). Gluten suitable for baking purposes should have extensibility of 8 – 14 cm. In this study was measured value 15 cm (Table 2). It corresponds to suitable gluten for bakery use. By setting the gluten swelling (Qw) with a value of 13 cm, the measurement can be evaluated as favourable. Muchová and Frančáková (2001) stated values of good gluten in range 11 – 12 cm, values above 12 cm can be indicated as very good gluten swelling.

### Results of rheological evaluation – farinography

According to studies by several authors Sun-Huei et al. (2004) the addition of olive oil resulted in a decrease of the development time of the wheat dough and in decreased stability. In our study was not observed a decrease of stability of samples (Table 4). Decrease was observed only in the sample with addition of 1 % rapeseed oil (7.8 min). It means a decrease compared to a control (8.8 min) by 11.36 %. Increasing of stability was observed in sample with addition 1.5 % of rapeseed oil (9.1 min). The development time of dough for all samples decreased (Table 4). The lowest value was evaluated for a sample with addition 0.5 % of rapeseed oil (2.7 min). It refers to a decrease by 49 % compared to control sample (5.3 min). Muchová (2001) stated that development time of dough depends mainly on the

### Table 1 Results of baking indicators and dry matter content of wheat flour T – 650

| Dry matter content [%] | Starch content [%] | Crude protein [g/100 g] | Falling Number [s] | Ash content [%] | Titratable acidity [mmol/kg] | Zeleny test [ml] |
|------------------------|-------------------|-------------------------|-------------------|----------------|-----------------------------|-----------------|
| 86.65 ±1.05            | 77.17 ±1.87       | 12.9 ±0.58              | 453 ±3.85         | 0.71 ±0.11      | 51 ±1.65                    | 32 ±2.11        |

### Table 2 Results of wet gluten and its properties in wheat flour T – 650

| Gw30 – wet gluten content [%] | T30 – extensibility [cm] | Q30 – swelling of gluten [cm] |
|-----------------------------|-------------------------|-----------------------------|
| 41.5 ±2.22                  | 15 ±1.14                | 13 ±1.74                    |

### Table 3 The results of baking experiment

| Dough weigh [g] | Bread weigh [g] | Specific volume [cm3/100 g] | Bulk productivity [cm3/100 g] | Bread volume [%] | Shape [dimensionless] | Bread yield [%] | Baking loss [%] |
|-----------------|-----------------|----------------------------|-------------------------------|-----------------|------------------------|----------------|----------------|
| Control T650    | 407.4 ±2.56     | 362.0 ±1.11               | 330.1 ±2.11                  | 484.6 ±1.63     | 1195.0 ±3.33          | 0.9 ±0.11      | 144.8 ±0.11    |
| T650 + 0.5 % PO | 406.8 ±2.89     | 361.0 ±1.85               | 339.9 ±2.12                  | 498.4 ±1.87     | 1227.5 ±3.52          | 1.0 ±0.09      | 144.4 ±1.11    |
| T650 + 1 % PO   | 401.5 ±1.82     | 361.9 ±1.56               | 362.6 ±1.99                  | 539.5 ±1.22     | 1312.5 ±3.85          | 1.1 ±0.08      | 148.8 ±1.13    |
| T650 + 1.5 % PO | 413.9 ±1.25     | 359.1 ±1.25               | 422.4 ±1.58                  | 604.0 ±2.58     | 1525.0 ±3.58          | 1.2 ±0.05      | 145.8 ±1.36    |
| T650 + 0.5 % RO | 408.1 ±2.11     | 358.1 ±1.52               | 401.4 ±1.23                  | 576.3 ±1.63     | 1437.3 ±3.12          | 1.1 ±0.11      | 143.2 ±1.25    |
| T650 + 1 % RO   | 409.6 ±2.85     | 357.9 ±0.96               | 411.0 ±1.33                  | 589.7 ±0.98     | 1471.3 ±3.33          | 1.1 ±0.11      | 143.2 ±1.22    |
| T650 + 0.5 % SO | 408.5 ±1.99     | 357.1 ±0.84               | 399.0 ±1.22                  | 570.7 ±0.64     | 1425.0 ±4.00          | 1.3 ±0.08      | 142.8 ±0.99    |
| T650 + 1 % SO   | 405.5 ±1.04     | 356.2 ±1.11               | 394.8 ±0.99                  | 563.9 ±1.11     | 1406.3 ±2.99          | 1.1 ±0.01      | 142.5 ±0.52    |
| T650 + 1 % RO   | 409.4 ±1.63     | 357.3 ±1.56               | 409.7 ±2.21                  | 584.6 ±1.34     | 1463.8 ±2.69          | 1.2 ±0.07      | 142.9 ±0.33    |
| T650 + 1 % SO   | 412.1 ±1.14     | 360.2 ±0.57               | 438.9 ±1.24                  | 632.1 ±1.87     | 1581.3 ±3.33          | 1.1 ±0.11      | 144.1 ±0.23    |

RO – rapeseed oil; PO – pumpkin oil; SO – sunflower oil

Muchová (2001) stated that the titratable acidity of wheat flour should be in the range of 40 – 80 mmol/kg⁻¹. Higher titratable acidity, which can be caused by incorrect and long – term storage of flour, is characteristic of products with a poor, bland taste. The wheat flour T – 650 (control) had an acidity of 51 mmol/kg⁻¹ (Table 1).

No less important indicator for the bakery quality of products is the sedimentation value according to Zeleny. It characterizes the quantity and quality of gluten proteins. It is affected by the variety and vintage of wheat. For good technological quality of wheat, it is not only the content of proteins or wet gluten which are important, but the visco-elastic properties of these proteins, enabling the fermentation of the dough (Burečová et al., 2003). Sedimentation value is closely connected to crude protein content. Based on the sedimentation value, was measured (wheat flour T – 650 control) sediment 32 ml (Table 1).

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**Table 1** Results of baking indicators and dry matter content of wheat flour T – 650

**Table 2** Results of wet gluten and its properties in wheat flour T – 650

**Table 3** The results of baking experiment

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**RO** – rapeseed oil; **PO** – pumpkin oil; **SO** – sunflower oil
quality and quantity of the flour gluten and also on the degree of granulation of the flour. Sun-Huei et al. (2004) noted that the addition of olive oil did not have a significant effect in water absorption. The same trend was observed in our study (Table 4). The water absorption did not vary in high scale compared to control sample. The highest water absorption was measured in the sample with addition 1 % of the rapeseed oil (59.3 %). This phenomenon could be evaluated as favourable in economic point of view. The difference between the consistency after 12 minutes and the maximum consistency expresses the degree of softening (Muchová, 2005). The range of degree of softening was from 41 FU to 55 FU (Table 4). The highest value of the degree of softening was evaluated in the sample with 1 % addition of rapeseed oil (Table 4). The lower the degree of softening is equal to more resistant dough. It can be said that lower values are needed for bakery industry. Farinographic quality number depends on the stability of dough and reduces consistency of dough (Table 4).

Table 4 The results of farinograph values with different rapeseed oil addition (RO)

| Sample          | Control (wheat flour T 650) | T 650 + 0.5 % RO | T 650 + 1 % RO | T 650 + 1.5 % RO |
|-----------------|-----------------------------|-----------------|---------------|-----------------|
| Water absorption [%] | 58.9 ±0.14a                  | 59.5 ±1.12b     | 59.3 ±0.99b    | 59.0 ±0.36c     |
| Development time [min] | 5.3 ±0.55b                 | 2.7 ±0.99c     | 3.5 ±0.23c     | 4.8 ±0.12d     |
| Stability [min] | 8.8 ±0.96c                  | 8.8 ±0.63a     | 7.8 ±0.22a     | 9.1 ±0.74a     |
| Degree of softening [FU] | 41.0 ±0.74c             | 43.1 ±1.11a    | 55.1 ±1.45a    | 45.0 ±1.2c     |
| Farinographic quality number [dimensionless] | 110 ±2.56a              | 110 ±0.87a    | 85 ±1.63a      | 109 ±2.22a     |

FU – farinographic units; min – minute; RO – rapeseed oil

Muchová (2001) published that the higher water absorption of the proteins of the flour is directly proportional to higher water absorption during farinographic evaluation. The values of water absorption of sample with addition of sunflower oil are presented in Table 5; these values ranged from 59.5 % to 60.0 %. It was measured minimal differences with compared to control sample. Development time of dough represents time needed for formation of the gluten until the consistency 500 FU will be reached (Munteanu et al., 2016). Strong flour has optimal development time of dough over 2.5 minutes. The longest development time was evaluated for the sample with addition of 0.5 % sunflower oil (4.3 min). The lowest values were measured for the control sample without addition – 2.7 min. and in sample with addition of 1.5 % sunflower oil (Table 5). Stability of the dough is given by its resistance to a mechanical stress (Muchová, 2007). The values of the stability were in the range from 8.4 min to 9.4 min (Table 5). The highest stability was evaluated in the sample with addition of 1.5 % sunflower oil. It is quoted that the dough which is more resistant against hyper-kneading during kneading, has the lower values of the softening degree (Table 5). The lowest value was determined in the sample with addition 1.5 % of sunflower oil (39 FU). The last evaluated parameter was the farinographic quality number. According to determined values (Table 5) it can be predicted that the flour T 650 was strong flour.

Table 5 The results of farinograph values with different sunflower oil supplements (SO)

| Sample          | Control (wheat flour T 650) | T 650+ 0.5 % SO | T 650+ 1 % SO | T 650+ 1.5 % SO |
|-----------------|-----------------------------|-----------------|---------------|-----------------|
| Water absorption [%] | 59.5 ±0.58a                 | 59.5 ±0.87a     | 60.0 ±1.11a    | 59.8 ±0.25a     |
| Development time [min] | 2.7 ±0.11a                 | 4.3 ±0.74a     | 3.3 ±0.87a     | 2.7 ±0.11a     |
| Stability [min] | 8.8 ±0.32a                  | 8.4 ±0.11a     | 8.6 ±0.69a     | 9.6 ±0.52a     |
| Degree of softening [FU] | 43.0 ±2.2a                | 53.0 ±0.12a    | 47.0 ±0.87a    | 39.0 ±1.12a    |
| Farinographic quality number [dimensionless] | 110 ±1.87a               | 95 ±0.11a      | 98 ±0.22a      | 115 ±1.12a     |

FU – farinographic units; min – minute; SO – sunflower oil

The results of evaluation of the samples with addition pumpkin oil are presented in the Table 6. It was not evaluated significant differences of water absorption in evaluated samples and control sample (Table 6). It can be considered the important fact that individual values are not falling. Interesting fact is that the dough development time increased significantly with increasing addition of pumpkin oil, the lowest value (2.7 min) was determined for the control sample; the maximum (6 min) was measured in sample with addition of 1.5 % pumpkin oil. For comparison, it can be stated that in the wheat dough with the addition of rapeseed oil the dough development time gradually decreased, in samples with sunflower oil was not observed significant differences with compared to control. In samples with addition of pumpkin oil was determined dough development time (difference between maximum and minimum) higher by 55 %. The flexibility of the dough after reaching the maximum consistency (500 BU – Brabender units) had an increasing tendency. With compared to the control sample (481 FU), was recorded a decrease of 0.21 % for the sample with 1.5% of pumpkin oil (Table 6). Stability of dough was increasing proximately to the increase of the addition of the pumpkin oil (Table 6). The difference between maximum consistency (500 BU – Brabender units) and the consistency after 12 minutes is identified as the degree of softening (Muchoneanu et al., 2016). The measured values of the softening had an increasing tendency (Table 6). In the control sample was determined the lowest value (43 FU). The maximal degree of softening was evaluated in the sample with addition of 0.5 % pumpkin oil (51 FU). Maximal farinographic quality number was evaluated in sample with addition of 1.5 % pumpkin oil.

Table 6 The results of farinograph values with different pumpkin oil supplements (PO)

| Sample          | Control (wheat flour T 650) | T 650+ 0.5 % PO | T 650+ 1 % PO | T 650+ 1.5 % PO |
|-----------------|-----------------------------|-----------------|---------------|-----------------|
| Water absorption [%] | 59.5 ±0.99a                | 59.2 ±0.66a     | 59.3 ±0.14a    | 59.0 ±0.56a     |
| Development time [min] | 2.7 ±0.12a                | 4.4 ±0.42a     | 5.0 ±0.12a     | 6.0 ±0.47a     |
| Stability [min] | 8.8 ±0.63a                 | 9.2 ±0.11a     | 9.0 ±0.32a     | 9.9 ±0.58a     |
| Degree of softening [FU] | 43.0 ±1.2a                 | 51.0 ±0.25a    | 48 ±0.41a     | 45 ±0.36a     |
| Farinographic quality number [dimensionless] | 110 ±0.74a              | 105 ±1.12a     | 105 ±0.89a     | 118 ±1.02a     |

FU – farinographic units; min – minute; PO – pumpkin oil

Results of rheological evaluation – extensograph

The values of extensibility ranged from 169.31 mm (T 650 + 1 % RO) to 181.57 mm (T 650 + 1.5 % RO). It was evaluated the decrease in extensibility by the increase of addition of rapeseed oil. The increase was determined only for the sample with addition 1.5 % of the rapeseed oil. This is an increase of 2.5 % with comparison to the control sample (Table 7). The area under the extensographic curve, the extensographic energy, is one of the most important indicators for bakers. The lower energy is directly proportional to a lower baking stability. Dough made from flour with solid gluten, which breaks easily, has a low value of energy (Příhoda and Hrušková, 2007). The added oils served as an emulsifier. Muchová (2007) published that fats, except favourable interaction with gluten, act as baking soda – stabilizer and homogenizator. The values of extensographic energy (Table 7) changed significantly. We measured increasing extensographic energy for all samples. It can be stated that the stability of the dough during baking was also increasing. The highest increase in energy was measured in sample with...
the addition 0.5% rapeseed oil (99.11 cm²). It required lower energy to deform the dough (lower by 5.63% in comparison with control sample). The extensographic maximum is expressed by the height of the curve in the maximum. The optimal value for the good dough should be in the range of the 450 – 650 BU. The values which are over the 800 BU can signal solid dough (Bojňanská et al., 2013). It can be stated that the individual measured values are satisfactory – based on results presented in Table 7. The ratio of the elastic component of the dough, which is represented by the height of the extensograph dough, to the plastic component of the path, which characterizes the width of the curve, is expressed by a ratio number. The ratio numbers (Table 7) increased mostly with the time of the dough resting.

Ozcan (2009) confirmed that the addition of the various types of oils increased extensibility and extensographic energy. He also proved decrease of the extensographic maximum and the resistance of the dough after addition of rosemary oil. In our case, addition of the sunflower oil increased extensographic energy (Table 8). Higher energy is desirable because with the growing energy the stability of the dough during baking also grow. Extensographic energy should be above 100 cm². Lower values of the energy can indicate not strong flour. Extensibility was mostly declining (Table 8). The largest difference was determined in sample with addition 0.5% of sunflower oil. Extensibility decreased by 5.53% with comparison to the control sample. The extensographic maximum and ratio increased with increasing addition of sunflower oil, the decrease was determined for samples with the addition of 1.5% sunflower oil (Table 8). It is true that the higher value of the extensographic maximum is directly proportional to the more flexible dough. Maximal value was evaluated for the addition 1% of sunflower oil (408 BU). This sample can be classified as the most flexible one. On the other hand the least flexible was dough with addition 1.5% of sunflower oil (Table 8). Result of division of the resistance to extensibility is the ratio number. Evaluated values were in the range of the 2.09 (T 650 + 1.5% SO) to 2.42 (T 650 + 1.0% SO).

Table 7 The results of extensograph values with different rapeseed oil supplements (RO)

| Sample                  | Energy [cm²] | Extensibility [mm] | Maximum [BU] | Ratio number [dimensionless] |
|-------------------------|--------------|--------------------|--------------|-----------------------------|
| Control (wheat flour T 650) | 93.83 ±5.23a | 177.17 ±3.07ab | 385.17 ±8.94ab | 2.18 ±0.19a                  |
| T 650+0.5 % RO          | 99.11 ±9.04a | 167.27 ±5.35a     | 392.66 ±15.61ab | 2.36 ±0.20a                 |
| T 650+1.0 % RO          | 94.63 ±3.04a | 169.31 ±7.02a     | 408.67 ±2.82a  | 2.42 ±0.29a                 |
| T 650+1.5 % RO          | 94.00 ±4.97a | 181.57 ±3.75a     | 378.27 ±8.69a  | 2.09 ±0.21a                 |

BU – Brabender units; mm - millimetre; cm²– square centimetre; RO – rapeseed oil

Ozcan (2009) confirmed that the addition of the various types of oils increased extensibility and extensographic energy. He also proved decrease of the extensographic maximum and the resistance of the dough after addition of rosemary oil. In our case, addition of the sunflower oil increased extensographic energy (Table 8). Higher energy is desirable because with the growing energy the stability of the dough during baking also grow. Extensographic energy should be above 100 cm². Lower values of the energy can indicate not strong flour. Extensibility was mostly declining (Table 8). The largest difference was determined in sample with addition 0.5% of sunflower oil. Extensibility decreased by 5.53% with comparison to the control sample. The extensographic maximum and ratio increased with increasing addition of sunflower oil, the decrease was determined for samples with the addition of 1.5% sunflower oil (Table 8). It is true that the higher value of the extensographic maximum is directly proportional to the more flexible dough. Maximal value was evaluated for the addition 1% of sunflower oil (408 BU). This sample can be classified as the most flexible one. On the other hand the least flexible was dough with addition 1.5% of sunflower oil (Table 8). Result of division of the resistance to extensibility is the ratio number. Evaluated values were in the range of the 2.09 (T 650 + 1.5% SO) to 2.42 (T 650 + 1.0% SO).

Table 8 The results of extensograph with different sunflower oil supplements (SO)

| Sample                  | Energy [cm²] | Extensibility [mm] | Maximum [BU] | Ratio number [dimensionless] |
|-------------------------|--------------|--------------------|--------------|-----------------------------|
| Control (wheat flour T 650) | 93.83 ±5.23a | 177.17 ±3.07ab | 385.17 ±8.94ab | 2.18 ±0.19a                  |
| T 650+0.5 % SO          | 89.06 ±3.93a | 167.73 ±6.45a     | 392.66 ±5.69a | 2.36 ±0.24a                 |
| T 650+1.0 % SO          | 94.63 ±4.39a | 169.31 ±5.43a     | 408.67 ±3.06b | 2.42 ±0.27a                 |
| T 650+1.5 % SO          | 94.00 ±2.99a | 181.57 ±3.09a     | 378.27 ±3.14a | 2.09 ±0.16a                 |

BU – Brabender units; mm - millimetre; cm²– square centimetre; SO – sunflower oil

Extensographic energy values range from 80.87 cm² (T 650 + 1.0 % PO) to 94.87 cm² (T 650 + 0.5 % PO). It was determined the highest energy decreased in sample with the addition 1% of pumpkin oil. Its measured energy was 80.87 cm² (Table 9). It was predicted that this sample will be more subjected to kneading. The length of the curve from the beginning of the stretching to rupture (in mm) expresses the extensibility of the dough. Extensibility is one of the most important values of the extensographic evaluation (Tokár, 2013). The values ranged from 168.83 mm (addition 1% of pumpkin oil) to 177.17 mm (control sample). Extensibility in all tested sample decreasing with compared to control sample (Table 9). Higher extensibility can characterised as less loose dough but on the other hand too low extensibility is not desirable in bakery industry (Tokár, 2013). The values of the extensographic maximum decreased with increasing addition of pumpkin oil. A slight increase was measured in a sample with the addition 0.5% of pumpkin oil (Table 9). Wheat gluten together with fats are in a positive correlation (Muchová, 2007), which means that the addition of oils increase the volume of the product. This fact was also proven by a baking experiment in this study. Ratio number was increasing in mostly all samples (Table 9). It was same in the cases of the addition of the sunflower and rapeseed oils. It was observed a little deviations of the decrease in all cases.

Table 9 The results of extensograph with different pumpkin oil supplements (PO)

| Sample                  | Energy [cm²] | Extensibility [mm] | Maximum [BU] | Ratio number [dimensionless] |
|-------------------------|--------------|--------------------|--------------|-----------------------------|
| Control (wheat flour T 650) | 93.83 ±5.23a | 177.17 ±3.07b | 385.17 ±8.94b | 2.18 ±0.19b                  |
| T 650+0.5 % PO          | 94.87 ±1.50a | 172.47 ±3.85b     | 396.73 ±5.30b | 2.31 ±0.14b                 |
| T 650+1.0 % PO          | 80.87 ±3.61a | 168.83 ±2.19a     | 343.87 ±5.62a | 2.03 ±0.09a                 |
| T 650+1.5 % PO          | 85.67 ±2.91a | 168.93 ±2.72a     | 346.1 ±3.27a  | 2.27 ±0.14b                 |

BU – Brabender units; mm - millimetre; cm²– square centimetre; PO – pumpkin oil

CONCLUSION

After evaluating the results of individual measurements, it can stated that the use of oils improves the technological quality of the dough and also contributes to the better quality of the final products. By determining the baking indicators, was proved the dry matter of wheat flour T 650 (control) – 86.65 %. It was determined the content of nitrogenous substances by the Kjeldahl method 12.7 %. Sedimentation value was 32 ml. The value of the falling number (453 seconds) was not optimal. It is possible to assume a decrease in the quality of the final products. On the contrary, it was determined the optimal values for the starch, ash content and flour acidity. The properties of gluten were favourable. It was determined wet gluten content – 41.5%, extensibility – 15 cm which indicated gluten (flour) suitable for bakery use. It was used farinograph and extensograph for rheological evaluation. Individual farinograms were favourable. The addition of individual oils did not have a significant effect on water absorption. From an economic point of view, the results were favourable, because it do not consider addition of water to be financially demanding. It was aslo determined the extensographic energy, extensibility, extensographic maximum and ratio number with an extensograph according to the ICC-Standart 1141/standard. In general, it can be said that the increasing addition of rapeseed, sunflower and pumpkin oil reduced the extensibility of the dough. On the contrary, the extensographic energy, the maximum and the ratio number had an increasing character with addition of oils. To determine the baking experiment, it was prepared the dough according to the recipe by the Farinograph. Baking losses ranged from 9 to 12 %. The highest specific volume was determined for bread with the addition 1.5% of pumpkin oil 424.2 cm³.100 g of product. The yield was reduced only by a negligible amount by the addition of individual types of oils. The volume of breads increased. The highest increase was recorded for the sample with the addition 1.5% of sunflower
oil with a volume increase of 24 % compared to the control sample. The shape were optimal, the bulk productivity increased in direct proportion to the addition of individual oils. According to obtained results, it can be stated that the use of rapeseed, pumpkin and sunflower oils could be used also in practice because the addition of these oils improves the quality of the bread and improves the quality of the dough.

Conflicts of interest: All authors declare no conflicts of interest.

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