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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 $cm^3.100\ g^{-1}$. 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 extenzograph 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. **(Rosentrater 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 **(Cauvian, 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 **(Candrákova, 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 **(Candrákova, 2016)**. Parts of oilseeds, especially seeds contain oils in such an amount that it is rational to obtain them by suitable method **(Bojňanská *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 construction of cellular membranes and in the formation of gluten, 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 amylase 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 mill and bakery indicators together with trademarks of quality **(Bojňanská *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 Lorencová, 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., Vitaflora (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 evaporated water was determined and subsequently, the dry matter content (moisture content) of the sample was determined.

Evaluation of the bakery indicators

The principle of the determination of crude protein is to determine the nitrogen content by using the Kjeldahl method **(ICC Standard No. 105/2, 1994)**. The determined nitrogen content is converted to proteins by a factor of 5.7.
After burning the sample in a muffle furnace at 900 ± 25 ° C, was determined mineral content (ash content) **(STN EN ISO 2171, 2008; ICC Standard No.104 / 1, 1990)**. The ash remains in the muffle furnace. The ash forms a non-flammable inorganic residue.
The starch content was determined by the hydrochloric acid dissolution **(ICC Standard No. 123/1, 1994)**. This chemical method is based on the principle of the conversion of starch into optically active substances, which has been carried out by hydrolysis in the presence of dilute hydrochloric acid under boiling. This was followed by polarimetric determination of the angle of rotation of the plane of polarized light in °S. For calculation we used factor for wheat starch [%] = ºS x 1.898.
Titratable acidity was determined by titration. The weight was 10 g of sample and was titrated by 0.1 mol.dm^{-3} NaOH. Used indicator was phenolphthalein. Determination of titratable acidity was obtained by recording the volume of NaOH used during titration.
Determination of the sedimentation value was realised according to Zeleny test **(ICC Standard No. 116/1, 1994)**. The method is based on the ability of wheat proteins to swell in lactic acid. Better quality of gluten and higher content of gluten result in the slower sedimentation.
For determination of the falling number was used method in which of saccharide-amylase complex of grain affected activity of amylolytic substances **(ICC Standard No. 107/1, 1995)**.

Evaluation of gluten properties

Determination of wet gluten in wheat flour (G_{30}) was realised using **STN 56 0512, 1973; ICC Standard No. 106/2, 1, 1984**. The weight of the sample was 10 g. In to the sample was added 5 cm^3 of NaCl (2 %). Compact ball was created. After 30 minutes of resting, the ball was washed under running water (20 °C) for 15 minutes. Obtained wet gluten was weighed and converted to dry matter content. Wet gluten obtained from the flour was tested for extensibility – it was created a roller about 2 cm long of wet gluten. For measurement a ruler was used, a roller of wet gluten was stretched over the ruler. The value was read on the scale at the moment of the rupture of the roller. The value indicated extensibility of gluten (T_{30}) **(STN ISO 46 1011, 1998)**.
Gluten swelling was determined from the washed gluten (Q_{30}) using **STN ISO 46 1011, 1998**. It was cut 1 g from wet gluten and divided to 30 pieces. Pieces were put into the volumetric flask, 80 cm^3 of lactic acid (0.3 mol.dm^{-3}) was added. The flask with pieces was placed to the thermostat (32 °C; 90 minutes). After that the flask was removed from the thermostat, stoppered and turned upside down. The value of gluten swelling was obtained in cm^3, after the settling of the last piece of gluten in the neck of the flask.

Realization of bakery experiments

Experimental baking was performed under laboratory conditions. The weight of sample represented 1000 g of basic raw materials (in the control of 100% wheat flour T-650, yeast 4%, sugar 1%, common salt 1.8% and water by water absorption; sample was mixing in a laboratory mixer Diosna SP12, Germany (program – 10 seconds at 20 Hz; 120 seconds at 25 Hz and 300 seconds at 50 Hz). After mixing, the dough was removed from the mixer and divided into 4 pieces (rolls) of the same weight. The rolls were placed in Teflon forms and let 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 raw 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 [min], stability of the dough [min], decrease in consistency [FU – farinographic units] (softening of the dough) and farinographic quality number **(ICC-Standard 115/1, 1992; AACC Method 54-21, 1995)**.
Extenzogram was obtained by Extenzograph – E, Brabender OhG, Duisburg, Germany. Dough was prepared by standard conditions, of flour, distilled water, and of sodium chlorate (2 %) in Farinograph. Evaluated characteristics: extenzographic energy [cm^2], extenzographic maximum [EU – extensographic units], extenzographic 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 **(Saeid *et al*., 2015)**. In the sample of wheat flour T – 650, was determined the dry matter content of 86.65 % (Table 1), which shows that the moisture content of the flour was 13.35 %. The measured value can be considered to be acceptable.

Results of bakery indicators evaluation

Příhoda *et al*., (2003) characterize bakery quality as a set of characteristics, influenced mainly by the content of proteins, starch and their reactions in suspension or in the way that occur during flour processing in bakery technology processes. This characteristics influence especially the finished product, in its porosity and in its volume. A 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. **Saeid *et al*., (2015)** in their study stated that higher protein content in the range of 10 % to 14.5 % indicate the stronger 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 *α*-amylase (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 resulted in appearance of sticky breadcrumb 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)**.

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 the 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 **(Burešová *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).

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

Dry matter content [%]	Starch content [%]	Crude protein [%]	Falling Number [s]	Ash content [%]	Titratable acidity [mmol.kg^{-1}]	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

s – seconds; ml – millilitre; mmol.kg^{-1} – millimoles per kilogram

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 influenced of gluten extensibility **(Novotný and Hubík, 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 (Q_{30}) with a value of 13 cm^3, the measurement can be evaluated as favourable. **Muchová and Frančáková (2001)** stated values of good gluten in range 11 – 12 cm^3, values above 12 cm^3 can be indicated as very good gluten swelling.

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

G_{30} [%]	T_{30} [cm]	Q_{30} [cm]
41.5 ±2.22	15 ±1.14	13 ±1.74

G_{30} – wet gluten content; T_{30}extensibility; Q_{30} – swelling of gluten

Chin *et al*. (2010) stated that the addition of palm oil up to 10 % had an effect on the density and volume of bread. The addition of palm oil reduced the density of the bread and increased its volume. They also found that the addition of palm oil extended the shelf life of the bread and caused a paler coloration of the crust. The results from bakery experiments values are presented in Table 3. According to the obtained results it can be stated that the volume of individual loaves increased with an increasing percentage of individual types of oils, in almost all analysed samples. The highest volume was measured in a loaf with 1.5 % addition of sunflower oil – 1581.3 cm^3. Compared to the control bread with a volume of 1195 cm^3, it resulted in an increased about almost 24 %. The economic aspect and one of the main indicators of production is the yield of the bread It informs us about the consumption of flour **(Bojňanská *et al.*, 2013)**. After comparing the control sample with other samples, it can be stated that the addition of different types of oils in our case of pumpkin, rapeseed and sunflower oils did not have a significant effect on final yield of breads. The addition of oil reduced the highest bread yield, only in negligible amounts. The highest bread yield was determined by 144.8 % (control T – 650) and the lowest was measured for T – 650 + 0.5 % sunflower oil (142.5 %). Literature sources stated that baking losses should vary optimally from 9 – 12 %. In our study was measured the highest baking loss for the sample with addition of 1.5 % pumpkin oil – 13.1 % (Table 3). For this sample was also measured the highest increase in the volume of product at the same time (1525 cm^3), which represents an increase of 21 % compared to control T – 650 (1195 cm^3). The lowest loss (9.9 %) was paradoxically measured in the sample with the addition of 1 % of pumpkin oil. The shape of the bakery product should be arched, rounded when passing through the crust, as well as having a high ratio of height and width. Low quality of flour can cause a flat shape of the product, on the contrary, a round shape indicates a too stiff dough and short fermentation **(Bojňanská *et al*., 2013).** The values higher than 0.7 can be considered as optimal result. Our samples can be considered as suitable (Table 3). The specific volume of the sample loaves control T – 650 – (330.1 cm^3.100 g^{-1} of product) and (339.9 cm^3.100 g^{-1} of product) T 650 + 0.5 % pumpkin oil are evaluated as a good result. The remaining values from Table 3 can be defined as very good. Specific volumes are mostly rising with increasing content of individual oils. The highest values were measured after the addition of 1.5 % of pumpkin oil (424.2 cm^3.100 g^{-1} of product), and 1.5 % sunflower oil (438.9 cm^3.100 g^{-1} of product). It was determined the highest specific volume after the addition of the rapeseed oil with addition of 1% of rapeseed oil (411 cm^3.100 g^{-1} of product). The bulk productivity increased with increasing oil content. Very good values were found after addition 0.5% of oilseed rape (576.3 cm^3.100 g^{-1} flour) and sunflower oil (563.9 cm^3 .100 g^{-1} flour) (Table 3). The highest bulk productivity was measured for sample with addition 1.5 % of sunflower oil (632.1 cm^3 .100 g^{-1} of flour). In comparison to control (486.6 cm^3.100 g^{-1} of flour) it reflected the increase by 30 % (Table 3).

Table 3 The results of bakery experiment

	Dough weigh [g]	Bread weight [g]	Specific volume [cm^3.100 g^{-1}]	Bulk productivity [cm^3.100 g^{-1}]	Bread volume [%]	Shape [dimensionless]	Bread yield [%]	Baking looss [%]
Control T650	407.4 ±2.56^{bc}	362.0 ±1.11^{ab}	330.1 ±2.11^{a}	484.6 ±1.63^{a}	1195.0 ±3.33^{a}	0.9 ±0.11^{a}	144.8 ±0.11 ^{a}	11.1 ±0.11^{a}
T650+0.5%PO	406.8 ±2.89 ^{abc}	361.1 ±0.85^{ab}	339.9 ±2.12^{a}	498.4 ±1.87^{a}	1227.5 ±3.52^{a}	1.0 ±0.09^{ab}	144.4 ±1.11 ^{a}	11.3 ±1.32^{a}
T650+1 % PO	401.5 ±1.82^{a}	361.9 ±1.56^{ab}	362.6 ±1.99^{a}	539.5 ±1.22^{a}	1312.5 ±3.85^{a}	1.1 ±0.08^{ab}	144.8 ±1.13 ^{a}	9.9 ±0.85^{a}
T650+1.5%PO	413.9 ±1.25^{c}	359.5 ±1.12^{ab}	424.2 ±1.58^{a}	604.0 ±2.58^{a}	1525.0 ±3.58^{a}	1.2 ±0.05^{ab}	143.8 ±1.36 ^{a}	13.1 ±1.02^{a}
T650+0.5%RO	408.1 ±2.11^{ab}	358.1 ±1.52^{ab}	401.4 ±1.23^{a}	576.3 ±1.63^{a}	1437.5 ±3.12^{a}	1.1 ±0.11^{ab}	143.2 ±1.25 ^{a}	12.3 ±1.01^{a}
T650+1%RO	409.6 ±2.85^{abc}	357.9 ±0.36^{ab}	411.0 ±1.33^{a}	589.7 ±0.98^{a}	1471.3 ±3.33^{a}	1.1 ±0.11^{ab}	143.2 ±1.22 ^{a}	12.6 ±1.58^{a}
T650+1.5%RO	408.5 ±1.99^{abc}	357.1 ±0.84^{ab}	399.0 ±2.12^{a}	570.7 ±0.64^{a}	1425.0 ±4.00^{a}	1.3 ±0.08^{ab}	142.8 ±0.99 ^{a}	12.6 ±1.78^{a}
T650+0.5%SO	405.0 ±1.14^{abc}	356.2 ±1.11^{a}	394.8 ±0.99^{a}	563.9 ±1.11^{a}	1406.3 ±2.99^{a}	1.1 ±0.01^{ab}	142.5 ±0.52 ^{a}	12.1 ±1.11^{a}
T650+1%SO	409.4 ±1.63^{abc}	357.3 ±1.56^{ab}	409.7 ±2.21^{a}	584.6 ±1.34^{a}	1463.8 ±2.69^{a}	1.2 ±0.07^{ab}	142.9 ±0.33 ^{a}	12.6 ±0.99^{a}
T650+1.5%SO	412.1 ±1.14^{bc}	360.2 ±0.57^{ab}	438.9 ±1.24^{a}	632.1 ±1.87^{a}	1581.3 ±3.33^{a}	1.1 ±0.11^{b}	144.1 ±0.23 ^{a}	12.6 ±1.47^{a}

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

Results of rheological evaluation – farinograph

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 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 with 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 ±0.14[a]	59.5 ±1.12[a]	59.3 ±0.99[a]	59.0 ±0.36[a]
Development time [min]	5.3 ±0.55[b]	2.7 ±0.99[a]	3.5 ±0.23[a]	4.8 ±0.12[ab]
Stability [min]	8.8 ±0.96[a]	8.8 ±0.63[a]	7.8 ±0.22[a]	9.1 ±0.74[a]
Degree of softening [FU]	41 ±0.74[a]	43 ±1.11[a]	55 ±1.45[ab]	45 ±0.12[b]
Farinographic quality number [dimensionless]	110 ±2.56[b]	110 ±0.87[b]	85 ±1.63[a]	109 ±2.22[ab]

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 to 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 ±0.58[a]	59.5 ±0.87[a]	60.0 ±1.11[a]	59.8 ±0.25[a]
Development time [min]	2.7 ±0.11[a]	4.3 ±0.74[a]	3.3 ±0.87[a]	2.7 ±0.11[a]
Stability [min]	8.8 ±0.32[ab]	8.4 ±0.11[a]	8.6 ±0.69[ab]	9.6 ±0.52[b]
Degree of softening [FU]	43 ±0.22[ab]	53 ±0.12[c]	47 ±0.87[bc]	39 ±0.12[a]
Farinographic quality number [dimensionless]	110 ±1.87[a]	95 ±0.11[ab]	98 ±0.22[b]	115 ±1.12[a]

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 **(Munteanu *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 ±0.99[a]	59.2 ±0.66[a]	59.3 ±0.14[a]	59.0 ±0.56[a]
Development time [min]	2.7 ±0.12[a]	4.4 ±0.42[ab]	5.0 ±0.12[ab]	6.0 ±0.47[b]
Stability [min]	8.8 ±0.63[a]	9.2 ±0.11[ab]	9.0 ±0.32[ab]	9.9 ±0.58[b]
Degree of softening [FU]	43 ±0.12[a]	51 ±0.25[c]	48 ±0.41[bc]	45 ±0.36[ab]
Farinographic quality number [dimensionless]	110 ±0.74[ab]	105 ±1.12[a]	105 ±0,89[a]	118 ±1.02[b]

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 extenzographic curve, the extenzographic 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 – stabilizator and homogenizator. The values of extenzographic energy (Table 7) changed significantly. We measured increasing extenzographic 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 cm^2). It required lower energy to deform the dough (lower by 5.63 % in comparison with control sample). The extenzographic 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 extenzograph 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.

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

Sample	Energy [cm^2]	Extensibility [mm]	Maximum [BU]	Ratio number [dimensionless]
Control (wheat flour T 650)	93.83 ±5.23[a]	177.17 ±3.07[ab]	385.17 ±8.94[ab]	2.18 ±0.19[a]
T 650+0.5 %RO	99.11 ±9.04[a]	167.27 ±3.55[a]	392.66 ±15.61[ab]	2.36 ±0.29[a]
T 650+1.0 %RO	94.63 ±3.04[a]	169.31 ±7.02[a]	408.67 ±2.82[b]	2.42 ±0.29[a]
T 650+1.5 %RO	94.00 ±4.97[a]	181.57 ±3.75[b]	378.27 ±8.69[a]	2.09 ±0.21[a]

BU – Brabender units; mm - millimetre; cm^2 – square centimetre; RO – rapeseed oil

Ozcan (2009) confirmed that the addition of the various types of oils increased extensibility and extenzographic energy. He also proved decrease of the extenzosgraphic maximum and the resistance of the dough after addition of rosemary oil. In our case, addition of the sunflower oil increased extenzographic energy (Table 8). Higher energy is desirable because with the growing energy the stability of the dough during baking also grow. Extenzographic energy should be above 100 cm^2. 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 extenzographic 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 extenzographic 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 extenzograph with different sunflower oil supplements (SO)

Sample	Energy [cm^2]	Extensibility [mm]	Maximum [BU]	Ratio number [dimensionless]
Control (wheat flour T 650)	93.83 ±5.23[a]	177.17 ±3.07[ab]	385.17 ±8.94[ab]	2.18 ±0.19[a]
T 650+0.5 %SO	89.06 ±3.93[a]	167.73 ±6.45[a]	392.66 ±5.69[ab]	2.36 ±0.24[a]
T 650+1.0 %SO	94.63 ±4.39[a]	169.31 ±5.43[a]	408.67 ±4.06[b]	2.42 ±0.27[a]
T 650+1.5 %SO	94.00 ±2.99[a]	181.57 ±3.09[b]	378.27 ±3.14[a]	2.09 ±0.16[a]

BU – Brabender units; mm - millimetre; cm^2 – square centimetre; SO –sunflower oil

Extenzographic energy values range from 80.87 cm^2 (T 650 + 1.0 % PO) to 94.87 cm^2 (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 cm^2 (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 rapture (in mm) expresses the extensibility of the dough. Extensibility is one of the most important values of the extenzographic 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 extenzographic 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 extenzograph with different pumpkin oil supplements (PO)

Sample	Energy [cm^2]	Extensibility [mm]	Maximum [BU]	Ratio number [dimensionless]
Control (wheat flour T 650)	93.83 ±5.23[b]	177.17 ±3.07[b]	385.17 ±8.94[ab]	2.18 ±0.19[ab]
T 650+0.5 %PO	94.87 ±1.50[b]	172.47 ±3.85[a,b]	396.73 ±5.30[b]	2.31 ±0.14[b]
T 650+1.0 %PO	80.87 ±3.61[a]	168.83 ±2.19[a]	343.87 ±5.62[a]	2.03 ±0.09[a]
T 659+1.5 %PO	85.67 ±2.91[a,b]	168.93 ±2.72[a]	346.1 ±3.27[a]	2.27 ±0.14[ab]

BU – Brabender units; mm - millimetre; cm^2 – 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 extenzograph 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 extenzographic energy, extensibility, extensographic maximum and ratio number with an extenzograph according to the ICC-Standard 114/1 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 extenzographic 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 $cm^3.100\ g^{-1}$ 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 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.

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