Slovak Journal of Food Sciences

Potravinarstvo Slovak Journal of Food Sciences
vol. 12, 2018, no. 1, p. 195-201
doi: https://doi.org/10.5219/887
Received: 9 February 2018. Accepted: 1 March 2018.
Available online: 21 March 2018 at www.potravinarstvo.com

ISSN 1337-0960 (online)

UTILIZATION OF PUMPKIN POWDER IN BAKED ROLLS

Lucia Minarovičová, Michaela Lauková, Jolana Karovičová, Zlatica Kohajdová

ABSTRACT
Bakery products are good vehicles for dietary fiber incorporation. Traditionally, the source of dietary fiber has been mainly from cereals. However, vegetable can be used as potential source of dietary fiber. Pumpkin powder was characterized with good hydration properties (water holding and water retention capacity and swelling capacity), but fat absorption capacity was very low. Wheat flour was substituted with pumpkin powder at different level (2.5; 5; 7.5; and 10%). Addition of pumpkin powder modified the farinographic properties in various ways (water absorption and dough development time increased, while dough stability and mixing tolerance index decreased). Also it was concluded, that addition of pumpkin powder affected the qualitative properties of baked rolls. Enriched baked rolls had lower volume and specific volume. Moreover, the cambering values were significantly decreased as contain of pumpkin powder increased. The effect of incorporation of pumpkin powder in baked rolls on firmness values was also evaluated. It was also observed that enriched rolls were firmer during storage compared to control sample. Baked rolls containing pumpkin powder at higher addition levels had vegetable taste and flavour. From the results also concluded that the overall acceptance of baked rolls with 2.5 and 5% addition levels of pumpkin powder were comparable with control sample (without pumpkin powder).

Keywords: pumpkin powder; hydration property; Farinograph; bakery product; texture

INTRODUCTION
Bakery products are widely consumed as staple food all over the world. In last few decades, bakery products have been explored extensively for development of functional foods via fortification of active ingredients such as dietary fiber, bioactive peptides, minerals, vitamins etc. to increase its therapeutic values **(Mudgil et al., 2016)**. Bakery products are varied by addition of value added ingredients. Among the added ingredients, dietary fibre has gained tremendous attention **(Noor Aziah and Komathi, 2008)**.

Dietary fibre is naturally present in cereals, vegetables, fruits and nuts. The amount and composition of fibres differ from food to food. A fibre-rich diet is lower in energy density, often has a lower fat content, is larger in volume and is richer in micronutrients. This larger mass of food takes longer to eat and its presence in the stomach may bring a feeling of satiety sooner, although this feeling of fullness is short term. It is suggested that healthy adults should eat between 20 and 35 g of dietary fibre each day **(Dhingra et al., 2012)**. The use of specific fibres in food products is largely determined by their functionality, which depends on physicochemical properties, and by food processing conditions. Additional factors that must be considered in many applications include fibre colour and flavour because of their impact on sensory characteristics **(Tosh and Yada, 2010)**.

Fibre can even be produced from sources that might otherwise be considered waste products. For example, wheat straw, soy hulls, oat hulls, peanut and almond skins, corn stalks and cobs, spent brewer's grain and waste portions of fruits and vegetables processed in large quantities can be converted into fibre ingredients, which may be highly functional in certain food applications. Dietary fibre holds all the characteristics required to be considered as an important ingredient in the formulation of functional foods, due to its beneficial health effects **(Dhingra et al., 2012)**.

Pumpkin is consumed in a variety of ways such as fresh or cooked as well as being stored, frozen or canned. Pumpkin is a good source of β-carotene, fibre, pectin, mineral salts, vitamins and other substances that are beneficial to health. These facts lead to the processing of pumpkin into various food products **(Kuchtová et al., 2016)**. Pumpkin can be processed into flour which has a longer shelf-life. Pumpkin flour is used because of its highly-desirable flavour, sweetness and deep yellow-orange colour. It has been reported to be used to supplement cereal flours in bakery products like cakes, cookies, bread, for soups, sauces, instant noodle and spice as well as a natural colouring agent in pasta and flour mixes **(Minarovičová et al., 2017)**.

Scientific hypothesis

The purpose of this study was to evaluate the effect of pumpkin powder addition on rheological properties (water absorption, dough development time, dough stability and mixing tolerance index) of wheat dough and qualitative parameters of baked rolls.

MATERIAL AND METHODOLOGY

Fine wheat flour (wet gluten 24.16%, dry gluten 8.75% and moisture 11.32%) and other ingredients (vegetable oil, salt, sugar and yeast) were obtained in local market. Pumpkin powder (PP) was prepared according **Minarovičová et al. (2017)**.

Functional properties

Hydration properties of PP were determined according to methods described by **Sowbhagya et al. (2007)** with slight modifications. Water holding capacity (WHC) was determined by accurately weighing dry sample (1 g) into a graduated test tube, and adding around 30 mL of water, and it was allowed to hydrate for 18 h at ambient temperature. The supernatant was removed, the hydrated residue weight was recorded and it was dried at 105 °C for 2 h to obtain the residue dry weight. WRC was expressed as grams of retained water per gram of sample.

Water retention capacity (WRC) was determined by accurately weighing dry sample (1 g) into a graduated centrifuge tube, adding 30 mL of water and it was hydrated for 18 h, centrifuged (3000 g, 20 min)and the supernatant solution was removed by passing through a sintered glass crucible (G4) under applied vacuum. The hydrated residue weight was recorded and then sample was dried at 105 °C for 2 h to obtain its dry weight. WHC was expressed as grams of retained water per gram of sample **(Sowbhagya et al., 2007)**.

Swelling capacity (SC) is defined as the ratio of the volume occupied when the sample is immersed in excess of water after equilibration to the actual weight. Accurately weighed dry sample (0.2 g) was placed in a graduated test tube, around 10 mL of water was added and it was hydrated for 18 h, and the final volume attained by the sample was measured. SC was expressed as mL of swollen sample per gram of sample **(Sowbhagya et al., 2007)**.

Fat absorption capacity (FAC) was measured according to method used by **Adeleke and Odedeji (2010)** with slight modifications. The 10 mL of refined corn oil was added to 1 g of the flour in a weighed 25 or 80 mL centrifuge tube. The tube was agitated on a vortex mixer for 2 min and kept at room temperature for 1 h. It was centrifuged at 2500 rpm for 20 min. The volume of free oil was recorded and decanted. FAC is expressed as mil of oil bound by 1 g dried sample.

Dough rheology

Farinographic parameters (water absorption - WA, dough stability - DS, dough development time - DDT and mixing tolerance index - MTI) of wheat dough with addition of pumpkin powder (2.5, 5, 7.5, and 10%) was determined using Farinograph Brabender (Duisburg, Germany) according to method **ISO 5530-1:2013**.

Rolls preparation

Wheat rolls were prepared using a recipe described by **Kohajdová and Karovičová (2007)**. The control recipe included: wheat flour 300 g, vegetable oil 7.5 g, yeast 12.06 g, salt 5.63 g, sugar 3.22 g and water to farinographic consistency 400 Brabender units (BU). The dough was prepared and mixed during 6 min in farinographic mixing bowl. After first fermentation (20 min), the dough was divided into 100 g loaves and formed on dough former (Extensograph Brabender, Duisburg, Germany). After second fermentation (45 min), the loaves were baked during 13 min at 230 °C. The rolls were cooled and after 2 h were packed in plastic bags. Baked rolls are presented in Figure 1.

Qualitative parameters of baked rolls

Qualitative parameters of baked rolls were evaluated 2 h after baking. The volume of baked rolls was measured by rapeseeds displacement method **(AACC Method 10-05.01)**. Specific volume (cm^3 per 100 g of loaf) was calculated by dividing the values of volume by weight. Cambering of baked rolls was calculated as a ratio of loaf height and width **(Lauková et al., 2016a)**. Baking loss (%) is characterized as the bakery product weigh reduction after baking. It is determined according to dough weight before baking and product weight, which was detected one hour after baking **(Korczyk-Szabó and Lacko-Bartošová, 2012)**.

Textural analysis

Baked rolls firmness was determined according to method described by **Al-Saleh and Brennan (2012)** using a texture analyzer (TA-XT Plus, Stable Micro Systems, Godalming, Surrey UK). The results were calculated using Exponent Texture Analysis software 2011. Firmness (the maximum force obtained during compression) was recalculated using macro and measurement was repeated 8

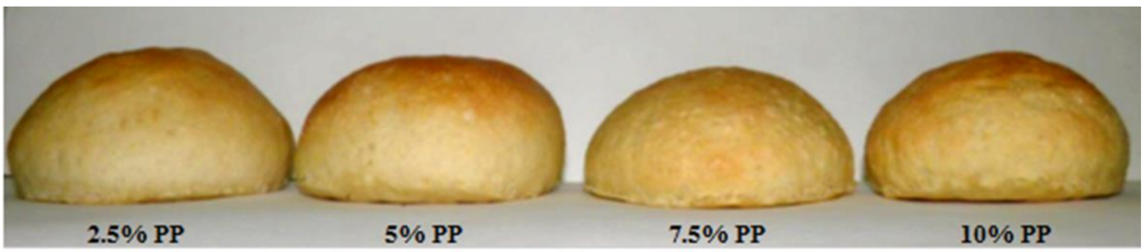

Figure 1 Baked rolls enriched with PP. Note: PP – pumpkin powder.

Table 1 Functional properties of PP.

	WHC ($g.g^{-1}$)	WRC ($g.g^{-1}$)	SC ($mL.g^{-1}$)	FAC ($g.g^{-1}$)
WF	1.78 ±0.08	0.65 ±0.03	2.47 ±0.10	0.94 ±0.04
PP	9.29 ±0.34	3.62 ±0.01	8.49 ±0.31	1.01 ±0.05

Note: FAC – fat absorption capacity, PP – pumpkin powder, SC – swelling capacity, WF – wheat flour, WHC – water holding capacity, WRC – water retention capacity.

times. Baked rolls were sliced mechanically into 12.5 mm slice thickness. Two slices were stacked together for each test, discarding two end slices of the rolls. Rolls firmness was measured with a probe P/36 R (setting: pre-test speed 1.0 $mm.s^{-1}$, test speed 1.7 $mm.s^{-1}$, post-test speed 10.0 $mm.s^{-1}$) at 40% compression on three successive days. Baked rolls were stored in plastic bags at 25 °C during 72 h.

Sensory evaluation

The sensory evaluation of final products was evaluated by 11 trained judges using 9-point hedonic scale. The scale of values ranged from a high score of 9, "like extremely", to a low score of 1, "dislike extremely" **(Gómez et al., 2011)**. The attributes evaluated were: shape of product, crust and crumb colour, flavour and taste of baked rolls, adhesiveness to palate on longer chewing. Overall acceptability of baked rolls was assessed using 100 mm graphic non-structured line segment with the description of extremes (100% - maximal intensity and 0% - minimal intensity) **(Kuchtová et al., 2016)**.

Statistic analysis

All analyses were carried out in triplicate unless otherwise stated and the average values were calculated. The results were expressed as mean value ± standard deviation. Significant differences between mean values at significance level $p = 0.05$ were establish using the One way analysis of variance and Student`s test. Microsoft Excel version 2010 was used as the statistical analysis software.

RESULTS AND DISCUSSION

The chemical composition of pumpkin powder and fine was presented in previous study by **Minarovičová et al. (2017)**.

Plant fibres show some functional properties, such as WHC and SC which have been more useful for understanding the physiological effect of dietary fibre, than the chemical composition alone **(Sharoba et al., 2013)**. These properties are also important for stating the usefulness of fiber fractions obtained as bulking, swelling and/or thickening agents in formulations or foods of relatively high water activity **(de Escalada Pla et al., 2007)**. The maximum amount of water that the fiber may hold is dependent on the fiber source, method of measurement and preparation as well as its physico-chemical and structural characteristics. The hydration properties of dietary fiber determine their optimal usage levels in food because a desirable texture must be retained **(Raghavendra et al., 2006)**. Hydration properties of PP are summarized in Table 1.

WHC is defined by the quantity of water that is bound to the fiber without the application of any external force (except for gravity and atmospheric pressure) **(Sowbhagya et al., 2007)**. The PP was characterized by high value of WHC (9.29 $g.g^{-1}$) which was higher than those described for spinach (6.40 $g.g^{-1}$) and apple pomace powder (8.54 $g.g^{-1}$) observed by **Saraç and Dogan (2016)** and **O´Shea et al. (2015)**. WRC is defined as the quantity of water that remains bound to the hydrated fiber following the application of an external force (pressure of centrifugation) **(Sowbhagya et al., 2007)**. It was observed that WRC value of PP (3.62 $g.g^{-1}$), which was higher than those published by **Kuchtová et al. (2016)** for PP. SC indicates how much the fiber matrix swells as water is absorbed **(de Escalada Pla et al., 2007)**. SC value of PP (8.49 $mL.g^{-1}$) was lower than was described for potato (12.0 $mL.g^{-1}$) and cabbage powder (16.37-21.41 $mL.g^{-1}$) by **Kaack et al. (2006)** and **Jongaroontaprangsee et al. (2007)**.

FAC is an important property as it improves the mouth feel and retains the flavor **(Kaur et al., 2015)**. The PP was characterized by low FAC value (1.01 $g.g^{-1}$) (Table 1).

Dough rheological characterization is imperative for both the milling and baking industry. It predicts flour dough characteristics during processing and the quality of end products. Rheological studies are extensively utilized and acknowledged by cereal technologists as useful techniques in evaluation of flour quality **(Iqbal et al., 2015)**. The influence of fibres on dough consistency and elasticity could be due to their effect on the internal structure of doughs **(Martínez et al., 2014)**. The rheological parameters of dough with addition of PP are presented in Table 2.

Table 2 Farinographic parameters of dough.

	Water absorption (%)	Dough development time (min)	Dough stability (min)	Mixing tolerance index (BU)
WF	54.48 ±0.00	3.00 ±0.00	16.11 ±0.08	38.00 ±0.00
PP 2.5%	54.42 ±0.05	4.05 ±0.13*	13.68 ±0.16 *	30.10 ±0.50*
PP 5%	57.45 ±0.14 *	3.77 ±0.03 *	10.67 ±0.14 *	36.97 ±0.55*
PP 7.5%	57.55 ±0.05 *	4.60 ±0.10 *	12.55 ±0.05 *	31.17 ±1.04*
PP 10%	57.61 ±0.11 *	4.48 ±0.08 *	10.55 ±0.05 *	20.13 ±0.23*

Note: BU – brabender units, PP – pumpkin powder, WF – wheat flour, * denotes statistically significant difference at $p < 0.05$ level.

Table 3 Qualitative parameters of baked rolls.

	Volume (cm^3)	Specific volume ($cm^3.100g^{-1}$)	Cambering	Baking loss (%)
control	294.25 ±7.37	327.20 ±6.93	0.66 ±0.02	10.12 ±0.50
PP 2.5%	195.25 ±2.22*	214.38 ±2.39*	0.58 ±0.02*	9.97 ±0.12
PP 5%	155.50 ±4.73*	169.65 ±5.33*	0.42 ±0.02*	8.37 ±0.20*
PP 7.5%	131.00 ±1.15*	144.13 ±1.05*	0.42 ±0.01*	9.13 ±0.45*
PP 10%	129.25 ±4.99*	141.52 ±5.61*	0.43 ±0.00*	8.73 ±0.12*

Note: PP – pumpkin powder, * denotes statistically significant difference at p <0.05 level.

WA is the amount of water required to make dough of proper consistency for bread baking when mixed to optimum conditions based on the feel and appearance of the dough. Water absorption is an important quality factor to the baker as it is related to the amount of bread that can be produced from a given weight of flour **(Bojňanská and Mocko, 2014)**. From the results concluded that addition of PP significantly increased the WA. The highest WA value (57.61%) was recorded at addition level 10%. The increase in WA could be explained by the important number of hydroxyl groups existing in the fiber structure, which allow more water interactions through hydrogen bonding **(Lauková et al., 2016b)**. High WA is important from the economical point of view and avoiding staling **(Mosharraf et al., 2009)**. These results were in agreement with those described by **Turksoy and Özkaya (2011)** after addition pumpkin and carrot powder to wheat dough.

DS is related to the quality of the protein matrix, which is easily damaged by the incorporation of other ingredients, due to gluten dilution **(Minarovičová et al., 2017)**. It is an indicator of the strength, which higher values suggesting stronger dough **(Kohajdová et al., 2011)**. It was observed that addition of PP significantly decreased the DS from 16.11 (control) to 10.55 min (10% PP). The decrease in DS value could be due to dilution of gluten **(Rawat and Darappa, 2015)**.

DDT is the time from water addition to the flour until the dough reaches the point of the greatest torque. During the mixing phase, water hydrates the flour components and the dough is developed **(Lauková et al., 2016b)**. The DDT values of dough with addition of PP ranged from 4.05 min (2.5% PP) to 4.48 min (10%). This change could have been due to differences in physiochemical properties between the constituents of pumpkin powder and wheat flour **(Kundu et al., 2012)**.

MTI value is the difference in BU from the top of the curve at the peak to the top of curve measured at 5 min. after the peak is reached **(Kundu et al., 2012)**. From the results concluded that addition of PP significantly decreased MTI from 38.00 BU (control) to 20.13 BU (10% PP). MTI is inversely proportional to the strength of the dough, higher values indicate lower strength or tolerance to mixing **(Rawat and Drappa, 2015)**. Similar decrease in MTI was also described when PP was added in semi coarse wheat flour **(Minarovičová et al., 2017; Kuchtová et al., 2016)**.

Qualitative parameters of baked rolls are summarized in Table 3. Loaf volume is used as a criterion to measure the quality of fresh bread in the industrial quality control, and by consumers. Specific volume of loaves of bread provides a uniform basis for comparing results of various studies. It is an indication of the gluten content of the bread but other constituents such as starch and fibre also contribute to the specific volume of bread **(Lauková et al., 2016a)**. It was observed that with increasing addition level significantly decreased the volume and specific volume of baked rolls from 294.25 cm^3 (control) to 129.25 cm^3 (10% PP) and from 327.20 $cm^3.100\ g^{-1}$ (control) to 141.52 $cm^3.100\ g^{-1}$ (10% PP), respectively. Similar effect on loaf volume was described by **Gül and Şen (2017)** when rosehip seed powder was used as flour substituent. In general, breads obtained from dough with a lower consistency achieved higher specific volumes, whereas more consistent dough produced breads with lower specific volumes **(Martínez et al., 2014)**. This phenomenon was possibly a result of the fiber weakening or crippling dough structure and reducing CO_2 gas retention. Moreover, appreciable amounts of water could have strongly bound to the added fibers during bread-making, so less water was available for the development of the starch-gluten network, causing an underdeveloped gluten network and reduced loaf volume **(Sivam et al., 2010)**.

Cambering (loaf height/width ratio) shows the loaf height to width ratio of loaves. Its higher value is desirable and predicts the product with better shape. Ideally the loaf should have an arched shape, rounded at transition from the bottom to the upper crust, and have a high ratio of width to height **(Bojňanská and Mocko, 2014)**. It is known that cambering values between 0.60 and 0.70 are deemed to be good and cambering values below 0.50 are considered insufficient **(Kohajdová et al., 2013)**. From the results concluded that increasing of proportion level of PP

Table 4 Sensory parameters of baked rolls with addition of PP.

	Appearance	Crumb colour	Crust colour	Flavour	Taste	Adhesiveness	Overall acceptance
control	8.40 ±0.39	8.35 ±0.41	8.16 ±0.34	8.12 ±0.27	8.21 ±0.22	8.05 ±0.37	87.50 ±4.25
PP 2.5%	8.20 ±0.13	8.32 ±0.15	8.21 ±0.07	7.52 ±0.12*	8.11 ±0.10	7.31 ±0.17*	88.60 ±3.13
PP 5%	8.39 ±0.22	8.78 ±0.16	8.49 ±0.06	7.43 ±0.08*	8.14 ±0.10*	7.54 ±0.07*	87.20 ±1.75
PP 7.5%	8.07 ±0.09*	8.31 ±0.13	8.20 ±0.13	7.30 ±0.18*	7.40 ±0.15*	7.05 ±0.11*	82.40 ±2.95*
PP 10%	7.70 ±0.08*	8.20 ±0.13*	8.03 ±0.08*	7.40 ±0.15*	7.52 ±0.12*	6.76 ±0.19*	82.00 ±2.05*

Note: PP – pumpkin powder, * denotes statistically significant difference at p <0.05 level.

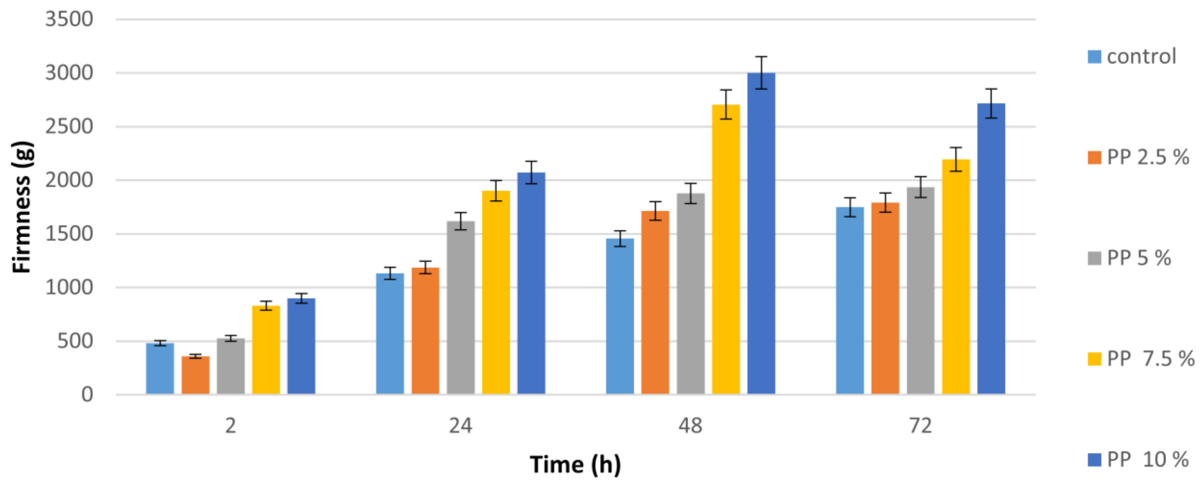

Figure 2 Firmness of PP enriched rolls during storage. Note: PP – pumpkin powder.

in caused lower values of cambering. Similar findings were described by **Kohajdová et al. (2012)** for carrot powder enriched bakery products.

Determining the actual baking losses is very important as the finished product after baking must have a defined weight. The loss by baking is influenced mainly by the weight of the product, by shape and moisture content **(Bojňanská and Mocko, 2014)**. It can be noticed that baking loss decreased with addition of PP.

Crumb texture is an important attribute of bread quality, and the protein fraction plays a key role in the formation of the structure, gas retention, and volume of breads **(Conte et al., 2016)**. Firming of bread crumb during storage is a common phenomenon and leads to a crumbly texture, and lower consumer acceptance. This parameter is the preferred parameter used to evaluate staling development **(Kohajdová and Karovičová, 2007)**. The textural properties of baked rolls are presented in Figure 2. From the results concluded that incorporation of PP increased the rolls firming 2h after baking. Moreover, firmness of rolls increased during storage. The hardening effect observed after addition of DF results from the dilution of gluten content and also due to the thickening of the walls surrounding the air bubbles in the crumb **(Kohajdová et al., 2012)**.

The effects of PP incorporation on sensory properties of baked rolls are showed in Table 4. It was observed that addition of PP in baked rolls had no significant effect on sensory attributes. The rolls enriched by PP had acceptable shape and crust colour. The highest score of crust colour was observed at 5% addition level. It was also concluded that PP enriched rolls had pleasant taste and flavour. On the other hand, incorporation of PP caused higher values of adhesiveness. The overall acceptances of enriched rolls were comparable with control sample. Furthermore, products with addition of 2.5% PP were the most acceptable for assessors.

CONCLUSION

This study showed that pumpkin powder had good hydration properties (high water holding and swelling capacity). Incorporation of pumpkin powder caused higher water absorption and longer dough development time. Addition of pumpkin powder significantly (p <0.05) affected the qualitative parameters of baked rolls (volume, cambering and baking loss decreased). Firmness of baked rolls increased with increasing level of pumpkin powder. Moreover, firmness values increased during 72 h. Sensory evaluation showed that most acceptable baked rolls were obtained by addition of 2.5% pumpkin powder. Enriched rolls were characterized with pumpkin flavour and after taste.

REFERENCES

AACC (2000). Method 10-05.01 Guidelines for measurement of volume by rapeseed displacement.

Adeleke, R. O., Odedeji, J. O. 2010. Functional properties of wheat and sweet potato flour blends. *Pakistan Journal of Nutrition*, vol. 9, no. 6, p. 535-538. http://dx.doi.org/10.3923/pjn.2010.535.538

Al-Saleh, A., Brennan, C. S. 2012. Bread wheat quality: some physical, chemical and rheological characteristics of Syrian and English bread wheat samples. *Foods*, vol. 1, no. 1, p. 3-17. http://dx.doi.org/10.3390/foods1010003

Aziah, N. A. A., Komathi, C. A. 2009. Acceptability attributes of crackers made from different types of composite flour. *International Food Research Journal*, vol. 16, p. 479-482.

Bojnanská, T., Mocko, K. 2014. Bread-making quality of Slovak and Serbian wheat varieties. *The Journal of Microbiology, Biotechnology and Food Sciences*, vol. 3, no. 3, p. 190-194. Available at: http://www.jmbfs.org/wp-content/uploads/2014/01/54_jmbfs_bojnanska_2014_fs.pdf

Conte, P., Fadda, C., Piga, A., Collar, C. 2016. Techno-functional and nutritional performance of commercial breads available in Europe. *Food Science and Technology International*, vol. 22, no. 7, p. 621-633. http://dx.doi.org/10.1177/1082013216637724 de Escalada Pla, M. F., Ponce, N. M., Stortz, C. A., Gerschenson, L. N., Rojas, A. M. 2007. Composition and functional properties of enriched fiber products obtained from pumpkin (*Cucurbita moschata Duchesne ex Poiret*). *LWT-Food Science and Technology*, vol. 40, no. 7, p. 1176-1185. http://dx.doi.org/10.1016/j.lwt.2006.08.006

Dhingra, D., Michael, M., Rajput, H., Patil, R. T. 2012. Dietary fibre in foods: a review. *Journal of food science and technology*, vol. 49, no. 3, p. 255-266. http://dx.doi.org/10.1007/s13197-011-0365-5

Gómez, M., Jiménez, S., Ruiz, E., Oliete, B. 2011. Effect of extruded wheat bran on dough rheology and bread quality. *LWT-Food Science and Technology*, vol. 44, no. 10, p. 2231-2237. http://dx.doi.org/10.1016/j.lwt.2011.06.006

Gül, H., Şen, H. 2017. The influence of rosehip seed flour on bread quality. *Scientific Bulletin. Series F. Biotechnologies*, vol. 21, p. 336-342. Available at: http://biotechnologyjournal.usamv.ro/pdf/2017/Art54.pdf

Iqbal, Z., Pasha, I., Abrar, M., Masih, S., Hanif, M. S. 2015. Physico-chemical, functional and rheological properties of wheat varieties. *Journal of Agricultural Research*, vol. 53, no. 2, p. 253-267.

ISO 5530-1:2013. Wheat flour – Physical characteristic of doughs – Part 1: Determination of water absorption and rheological properties using a farinograph.

Jongaroontaprangsee, S., Tritrong, W., Chokanaporn, W., Methacanon, P., Devahastin, S., Chiewchan, N. 2007. Effects of drying temperature and particle size on hydration properties of dietary fiber powder from lime and cabbage by-products. *International Journal of Food Properties*, vol. 10, no. 4, p. 887-897. http://dx.doi.org/10.1080/10942910601183619

Kaack, K., Pedersen, L., Laerke, H. N., Meyer, A. 2006. New potato fibre for improvement of texture and colour of wheat bread. *European Food Research and Technology*, vol. 224, no. 2, p. 199-207. http://dx.doi.org/10.1007/s00217-006-0301-5

Kaur, M., Sandhu, K. S., Arora, A., Sharma, A. 2015. Gluten free biscuits prepared from buckwheat flour by incorporation of various gums: physicochemical and sensory properties. *LWT-Food Science and Technology*, vol. 62, no. 1, p. 628-632. http://dx.doi.org/10.1016/j.lwt.2014.02.039

Kohajdova, Z., Karovicova, J. 2007. Effect of incorporation of spelt flour on the dough properties and wheat bread quality. *Żywność Nauka Technologia Jakość*, vol. 53, no. 4, p. 36-45. Available at: http://www.pttz.org/zyw/wyd/czas/2007,%204(53)/03_Kohajdova.pdf

Kohajdová, Z., Karovičová, J., Magala, M. 2013. Effect of lentil and bean flours on rheological and baking properties of wheat dough. *Chemical Papers*, vol. 67, no. 4, p. 398-407. http://dx.doi.org/10.2478/s11696-012-0295-3

Korczyk-Szabó, J., Lacko-Bartošová, M. 2012. Direct baking quality of spelt wheat (*Triticum spelta* L.). *Research Journal of Agricultural Science*, vol. 44, no. 1, p. 86-89.

Kuchtová, V., Karovičová, J., Kohajdová, Z., Minarovičová, L. 2016. Chemical composition and functional properties of pumpkin pomace-incorporated crackers. *Acta Chimica Slovaca*, vol. 9, no. 1, p. 54-57. http://dx.doi.org/10.1515/acs-2016-0009

Lauková, M., Kohajdová, Z., Karovičová, J. 2016a. Effect of incorporating potato dietary fibre to wheat dough on the quality of baked rolls. *Acta Chimica Slovaca*, vol. 9, no. 1, p. 14-18. http://dx.doi.org/10.1515/acs-2016-0003

Lauková, M., Kohajdová, Z., Karovičová, J. 2016b. Effect of hydrated apple powder on dough rheology and cookies quality. *Potravinarstvo Slovak Journal of Food Sciences*, vol. 10, no. 1, p. 506-511. http://dx.doi.org/10.5219/597

Martínez, M. M., Díaz, Á., Gómez, M. 2014. Effect of different microstructural features of soluble and insoluble fibres on gluten-free dough rheology and bread-making. *Journal of Food Engineering*, vol. 142, no. 12, p. 49-56. http://dx.doi.org/10.1016/j.jfoodeng.2014.06.020

Minarovičová, L., Lauková, M., Kohajdová, Z., Karovičová, J., Kuchtová, V. 2017. Effect of pumpkin powder incorporation on cooking and sensory parameters of pasta. *Potravinarstvo Slovak Journal of Food Sciences*, vol. 11, no. 1, p. 373-379. http://dx.doi.org/10.5219/743

Mosharraf, L., Kadivar, M., Shahedi, M. 2009. Effect of hydrothermaled bran on physicochemical, rheological and microstructural characteristics of Sangak bread. *Journal of cereal science*, vol. 49, no. 3, p. 398-404. http://dx.doi.org/10.1016/j.jcs.2009.01.006

Mudgil, D., Barak, S., Khatkar, B. S. 2016. Optimization of bread firmness, specific loaf volume and sensory acceptability of bread with soluble fiber and different water levels. *Journal of Cereal Science*, vol. 70, no. 7 p. 186-191. http://dx.doi.org/10.1016/j.jcs.2016.06.009

O'Shea, N., Ktenioudaki, A., Smyth, T. P., McLoughlin, P., Doran, L., Auty, M. A. E., Arendt, E., Gallagher, E. 2015. Physicochemical assessment of two fruit by-products as functional ingredients: Apple and orange pomace. *Journal of food engineering*, vol. 153, no. 5, p. 89-95. http://dx.doi.org/10.1016/j.jfoodeng.2014.12.014

Raghavendra, S. N., Swamy, S. R., Rastogi, N. K., Raghavarao, K. S. M. S., Kumar, S., Tharanathan, R. N. 2006. Grinding characteristics and hydration properties of coconut residue: a source of dietary fiber. *Journal of Food Engineering*, vol. 72, no. 3, p. 281-286. http://dx.doi.org/10.1016/j.jfoodeng.2004.12.008

Rawat, N., Darappa, I. 2015. Effect of ingredients on rheological, nutritional and quality characteristics of fibre and protein enriched baked energy bars. *Journal of Food Science and Technology*, vol. 52, no. 5, p. 3006-3013. http://dx.doi.org/10.1007/s13197-014-1367-x

Saraç, M. G., Dogan, M. 2016. Incorporation of dietary fiber concentrates from fruit and vegetable wastes in butter: effects on physicochemical, textural, and sensory properties. *European Food Research and Technology*, vol. 242, no. 8, p. 1331-1342. https://dx.doi.org/10.1007/s00217-016-2637-9

Sharoba, A. M., Farrag, M. A., Abd El-Salam, A. M. 2013. Utilization of some fruits and vegetables waste as a source of dietary fiber and its effect on the cake making and its quality attributes. *Journal of Agroalimentary Processes and Technologies*, vol. 19, no. 4, p. 429-444.

Sowbhagya, H. B., Suma, P. F., Mahadevamma, S., Tharanathan, R. N. 2007. Spent residue from cumin–a potential source of dietary fiber. *Food chemistry*, vol. 104, no. 3, p. 1220-1225. http://dx.doi.org/10.1016/j.foodchem.2007.01.066

Tosh, S. M., Yada, S. 2010. Dietary fibres in pulse seeds and fractions: Characterization, functional attributes, and applications. *Food Research International*, vol. 43, no. 2, p. 450-460. http://dx.doi.org/10.1016/j.foodres.2009.09.005

Turksoy, S., Özkaya, B. 2011. Pumpkin and carrot pomace powders as a source of dietary fiber and their effects on the mixing properties of wheat flour dough and cookie quality. *Food Science and Technology Research*, vol. 17, no. 6, p. 545-553. http://dx.doi.org/10.3136/fstr.17.545

Acknowledgments:

This work was supported by grant VEGA No. 1/0487/16.

Contact address:

Ing. Lucia Minarovičová, PhD., Slovak University of Technology in Bratislava, Faculty of Chemical and Food Technology, Institute of Food Science and Nutrition, Department of Food Technology, Radlinského 9, 812 37 Bratislava, Slovakia, E-mail: lucia.minarovicova@stuba.sk

Ing. Michaela Lauková, Slovak University of Technology in Bratislava, Faculty of Chemical and Food Technology, Institute of Food Science and Nutrition, Department of Food Technology, Radlinského 9, 812 37 Bratislava, Slovakia, E-mail: michaela.laukova@stuba.sk

doc. Ing. Jolana Karovičová, PhD., Slovak University of Technology in Bratislava, Faculty of Chemical and Food Technology, Institute of Food Science and Nutrition, Department of Food Technology, Radlinského 9, 812 37 Bratislava, Slovakia, E-mail: jolana.karovicova@stuba.sk

Ing. Zlatica Kohajdová, PhD., Slovak University of Technology in Bratislava, Faculty of Chemical and Food Technology, Institute of Food Science and Nutrition, Department of Food Technology, Radlinského 9, 812 37 Bratislava, Slovakia, E-mail: zlatica.kohajdova@stuba.sk