JMBFS
Journal of Microbiology, Biotechnology and Food Sciences
International peer-reviewed scientific online journal
Published by Faculty of Biotechnology and Food Sciences

BAKERY PRODUCTS WITH THE ADDITION OF SOYBEAN FLOUR AND THEIR QUALITY AFTER FREEZER STORAGE OF DOUGH

Tatiana Bojňanská[*1], *Jana Šmitalová*[1], *Alena Vollmannová*[2], *Marián Tokár*[1], *Vladimír Vietoris*[1]

Address(es): doc. Ing. Tatiana Bojňanská, CSc.
[1]*Department of Storage and Processing of Plant Products, Faculty of Biotechnology and Food Sciences, Slovak University of Agriculture in Nitra, Trieda A. Hlinku 2, 949 76 Nitra, Slovak Republic.*
[2]*Department od Chemistry, Faculty of Biotechnology and Food Sciences, Slovak University of Agriculture in Nitra, Trieda A. Hlinku 2, 949 76 Nitra, Slovak Republic.*

*Corresponding author: tatiana.bojnanska@uniag.sk

doi: 10.15414/jmbfs.2015.4.special3.18-22

ARTICLE INFO

Received 28. 11. 2014
Revised 8. 12. 2014
Accepted 9. 12. 2014
Published 2. 2. 2015

Regular article

OPEN ACCESS

ABSTRACT

The aim of this study was to observe the impact of adding 30% of flour from soya bean to the wheat flour T 650 on the quality of immediately baked products and products stored one, three and six months in a freezer at the temperature of -18° and then baked. Rheological properties of wheat and composite flour by means of Farinograph, Extensograph, and Amylograph were also evaluated. Based on the farinograph evaluation of composite flour (70% of wheat flour + 30% soybean flour) it was found that the formed mixture was hydrated more slowly than the pure wheat flour, time of dough development was about 6.5 minutes longer than that for pure wheat flour, and a value of water binding was higher by 12.4% compared with wheat flour. Created dough could be characterized as strong, holding long enough optimum of its rheological properties. By means of extensographic evaluation of composite flour it was found that it has lower extensographic energy, less resistance and lower tensibility compared to wheat dough, which led to insufficient volume of products. By amylogram it was found that composite flour has higher enzymatic activity compared to wheat flour, nevertheless both flours could be characterized as suitable for leavened bakery products. Addition of gross non-defatted soy flour at 30% had a significant impact on technological quality of loaves baked during the baking experiments. Compared with loaves of wheat flour, the lower bread volume, specific volume and volume yield, and less satisfactory cambering was found. The effect of freezing on dough in the case of wheat flour showed the gradual reduction of the quality parameters of the loaves baked from such dough after freezing time lasting for 1, 3 and 6 months. In the case of the composite flour, the decrease of quality was found only after freezing lasting 3 and 6 months. One-month freeze did not cause the declination of quality, to the contrary, even a slight increase of loaf volume was observed.

Keywords: Composite flour with soy, rheology, freezing of dough, baking experiment

INTRODUCTION

In bakery production, as in other food areas the more topical question becomes not only the production of quality foods, but also the possibility of their longer-term stability and shelf-life. One of the possibilities is freezing as an anabioz conservation method characterized as an indirect inactivation of microorganisms **(Revenue Ministry of Agriculture and Rural Development and the Ministry of Health of the Slovak Republic No 981/1996-100).** Frozen bakery dough can be considered as semi-finished products enabling manufacturers to continuously and according to needs produce bakery products in standard quality. At the same time, these bakery products should have high nutritional value, which can be ensured by adding non-bakery raw materials containing nutritionally important components (**Bojňanská, 2008; Bojňanská *et al.*, 2008; Bojňanská *et al.*, 2010**). Legumes have a very specific place from the nutritive point of view and play an important role in nourishment of world population. Pursuant to the Alimentary Codex of the Slovak republic, (part three, chapter twelve) as legumes are understood ripe eatable seeds of legume plants: pea (*Pisum sativum* L.), lentil (*Lens culinaris* Med.), common bean (*Phaseolus vulgaris* L.), soya bean (*Glycine max* L.), chickpea (*Cicer arietinum* L.), sweet pea (*Lathyrus* L.) and broad beans (*Vicia faba* L.), which are suitable after processing for consumption. In general, legumes are a source of complex carbohydrates, protein and dietary fibre, having significant amounts of vitamins and minerals (**Tharanathan and Mahadevamma, 2003**). Protein content in legume grains range from 17% to 40 %, contrasting with 7 – 13 % of cereals (**Bojňanská, 2004**), and being equal to the protein contents of meats (18 – 25%) (**Čuboň *et al.* 2011**). Addition of legumes to cereal products increases their content of fibre, resistant starch (**Utrilla-Coello *et al.*, 2007; Angioloni and Collar, 2011**), important minerals (**Dhingra and Jood, 2001; Dalgetty and Baik, 2003; Costa de Alemeida at al., 2004**) and vitamins. These products with addition of legumes have in comparison to classical bread prepared from wheat or rye higher nutritive value and lower Glycaemic index. Their consumption has positive impact on health conditions of consumers (**Goni and Valentin-Gamazo, 2002; Johnson *et al.*, 2005; Hawkins and Johnson, 2005; Pittaway *et al.*, 2007**).

Soybean (Glycine max (L.) Merrill) has among all grown legumes highest protein content in the seed (35-45%), with excellent composition of essential amino acids (**Velíšek and Hajšlová., 1999a**). The combination of soybean containing a high proportion of lysine with cereals, wherein lysine is a limiting amino acid, almost a full protein may be obtained. Soybean seeds are characterized by a content of wide range of vitamins (A, D, E, in particular group B), minerals (4% to 6%) with a significant representation of Fe, Mg, P. From the anti-nutritional substances there are trypsin inhibitors, lectins, saponins and Antivitamins in soybean, and there are eliminated and removed by heat, slicing, by acid hydrolysis or fermentation processes (**Kumar *et al.*, 2008; Velíšek and Hajšlová, 1999 b**).

From soybean it is possible to obtain a wide range of grain mill products, such as enzymatically active soya flour, mill whole debittered products (groats, meal flour and fine powder) and skimmed mill products (flour, powder, technical powder, flour special) (**Bojňanská *et al.*, 2013**). From soybean flour itself it is not possible to prepare bread, pastries, and other leavened bakery products because it contains a low proportion of starch and gluten producing proteins. Nevertheless, thanks to application of soybean flour in combination with wheat flour are bread and other products nutritionally enriched (**Mashayekh *et al.*, 2008**; **Roccia *et al.* 2012; *Dhinda et al.*, 2012)** and influence health of consumers (**Moghaddam *et al.*, 2014)**. **Simmons et al. (2012)** state that soy ingredients stabilize bread dough during frozen storage.

The aim of this study was to observe the impact of adding 30% of flour from soy bean to the wheat flour T 650 on the quality of immediately baked products and products stored one, three and six months in a freezer at the temperature of -18° and then baked.

MATERIAL AND METHODS

To prepare control loaves wheat flour T 650 was used. The second group of loaves was made from composite flour, based on wheat flour T 650 in an amount of 70% (Mlyn Pohronský Ruskov a.s., Hlavná 76, 935 62 Pohronský Ruskov, Slovakia) with an addition of non-defatted soybean flour at 30% (company Natural Jihlava JK s.r.o, Na Dolech 10, 586 01 Jihlava, Czech Republic). According to recipe fresh compressed yeast was used (Trenčianske droždie, OLD HEROLD HEFE, s.r.o., Bratislavská 36, 911 05 Trenčín, SR). In wheat and composite flour the moisture was determined (%) (**ICC Standards No. 110/1 (1976)**), as well as content of crude protein (%) (**ICC Standard No. 105/2, (1994)**) and content of ash (%) (**ICC Standard No. 104/1, (1990)**). Rheological measurements were made of prepared composite flour and wheat flour by means of *Farinograph-E*, Brabender OhG, Duisburg, Germany (**ICC - Standard 115/1, 1992, AACC Method 54-21, 1995**). Based on these measurements following characteristics were determined: farinographic flour water absorption capacity (%), dough development time (min), level of dough softening (FU), dough stability (min), farinographic quality number. By means of *Extensograph-E*, Brabender OhG, Duisburg, Germany (**ICC - Standard 114/1, 1992, AACC Method 54-10, 1995**) extensographic energy (cm^2), extenographic tensibility (mm) and extensographic maximum (EU) were determined. By means of *Amylographe-E*, Brabender OhG, Duisburg, Germany **(ICC-Standard 126/1, AACC Method 22-10,1995**) the initial gelatinization temperature (°C), the maximum gelatinization temperature (°C) amylographic maximum (AU) was determined.
Experimental loaves were prepared from a mixture of flour (350 g of wheat and 150 g of soy flour), sucrose (5 g), salt (9 g), yeast (20 g) and water addition based on farinographic water absorption capacity. Bread experiment was carried out without the use of enzyme-active substances and other improvement agents. The development of dough took place in a laboratory mixer Diosna SP 12. After that the dough was elaborated and formed into loaves that stayed yeasted in a yeasting room for 20 minutes at temperature of 30°C and were baked in an oven Miwe Condo at 240°C with steaming (baking time 20 min). The baked loaves were evaluated by objective methods and the volume of products (cm^3), a specific volume of products ($cm^3.100g^{-1}$), volume yield ($cm^3.100g^{-1}$ flour), cambering (the ratio between height and width) were determined. The analysis of baked crumb was carried out and crude protein content was evaluated (%) (**ICC Standard No. 105/2, (1994)**), as well as ash content (%) (**ICC Standard No. 104/1, (1990)**) and sourness of scrumb by titration ($mmol.kg^{-1}$). The remaining elaborated dough was immediately frozen and stored (one, three and six months) in the freezer at -18°C ± 2°C (AFG 070 AP, company: Whirlpool Slovakia spol. s.r.o., 820 09 Bratislava 29, SR). After defrosting at 22°C ± 2°C the loaves were yeasted in a yeasting room for 20 minutes at temperature of 30°C and then baked at 240°C in the steaming oven for 20 min. Baked loaves were then evaluated by the same methods as the immediately baked control products.

RESULTS AND DISCUSSION

Based on published results it can be assumed that the addition of defatted soy flour at 3% and 7% has a positive impact on improving the rheological properties of dough and is accepted by consumers as good as wheat bread, with comparable taste, aroma, appearance and texture, plus with higher nutritional value (**Mashayekh *et al.*, 2008**). **Jakubczyk and Haberowa** (**1974**) have found that addition of soy flour in an amount of 3% increased the gas forming abilities of dough by approximately 7-25%, which made it possible to use a shorter rising time, and more intensive kneading. Baked loaves were only slightly smaller compared to the control ones. **Ribotta *et al.*** (**2005**) worked with several types of soy flour and found that the farinograph characteristics of composite flour were improved, but the addition of soy flour had an adverse effect on gluten, dough tensibility, the gas production during fermentation in composite flour, and also the overall quality of bread was reduced. Very interesting research led by **Vodovotz *et al.*** (**2012**) addressed the problem of the impact of the addition of soy flour (48.5%) on the quality of dough stored at -20°C for two to four weeks. Authors have found that soy protein prevented migration of water during storage, and therefore there have been smaller structural changes in dough as well as bread in comparison to traditional wheat bread. Baked bread was very well accepted by the consumers. Similar conclusions were also confirmed by **Simmons *et al.* (2012).**
In the context of our baking experiments we compared technological quality of loaves prepared from wheat flour T 650 and composite flour consisting of 70% wheat flour T 650 and 30% soybean flour. Used wheat flour T 650 had 13.9% moisture, 0.49% ash content and 11.5% crude protein. Soy flour had 8.3% moisture, 5.27% ash content and 38.4% of crude protein. From these results it can be assumed that from the nutritional point the addition of soy flour caused increasing of the protein content and improving of their amino acid composition. **Mashayekh *et al.*** (**2008**) have found that the addition of soy flour to bread increased its nutritional value in comparison to the control sample and the soybean flour thanks to its composition represented considerable nutritional enrichment of wheat flour. This view is also supported by **Friedman and Brandon** (**2001**), who published the conclusions regarding the beneficial action of soy in the human body (anti-carcinogenic effect, lowering cholesterol, preventive effects against diabetes II. type, obesity, protective effects on kidneys).
To objectively assess the quality of flour as the most important raw material within the baking experiment rheological measurements were used. Dough properties during the kneading were evaluated by means of Farinograph and the amount of water needed to create dough with optimal properties was evaluated. Effect of addition of soy flour to flour T 650 is shown in Figure 1 and Table 1.

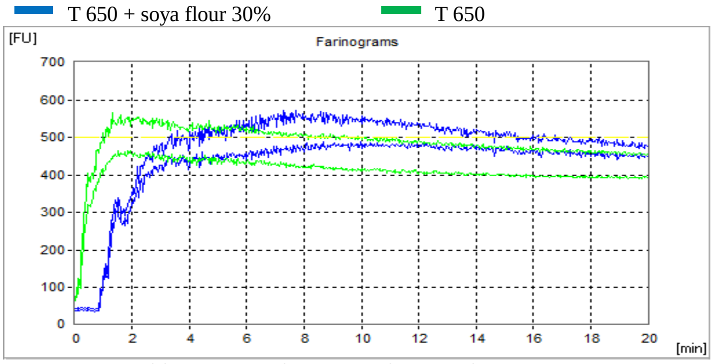

Figure 1 View of farinograms of composite flour and flour T 650

Based on the farinographic evaluation of the wheat flour T 650 and composite flour it can be concluded that wheat flour had moderately strong quality which predetermined it for individual use, but also to improve mixtures with weaker flours. The composite flour (a mixture of 70% of wheat and 30% of soybean flour) had a higher water absorption value compared to wheat flour (by 12.4%) and the time of dough development was about 6.5 minutes longer than in pure wheat flour, so the addition of soybean significantly changed rheological properties of flour. According to **Bojňanská *et al.*** (**2013**) we can classify a formed mixture as strong, which can be justified by higher protein content in the mixture due to the addition of soy flour. High dough development and stability is an expression of quality of the mixture and a sign that dough from mixture of flours has maintained optimum of its technological properties. On the other hand, too long dough development increased energy demand of kneading. The fact that the addition of soy flour increased flour water absorption capacity, prolonged period of dough development and stability was also observed by other authors (**Jakubczyk and Haberowa**, **1974**; **Rosales-Juárez *et al.*, 2008**). The value of consistency decrease was lower compared to the wheat flour, which in practice means that a dough composition of flour lost their optimal properties gradually, which is also a sign of a strong flour. However, at the end of kneading had the dough from a composite flour lower flexibility compared with dough from flour T 650.

Table 1 Farinographic evaluation of composite flour and flour T 650

Samples	**Farinographic water absorption, %**	**Dough development, min**	**Dough stability, min**	**Declination of consistency, FU**
flour T 650	60.1	2.2	8.0	65.0
composite flour	72.5	8.7	9.7	58.0

Based on comprehensive evaluation of the results of farinographic measurements it might be noted that the addition of soy flour at 30% does not affect negatively the selected flour properties. Use of moderate and strong flours with protein content of 11% to 13% brings best results when baking bread from frozen dough as stated by **Marston** (**1978**). **Wolt et al.** (**1984**) was one of the first to point out that at the production of bread from frozen dough it is the quality of the flour proteins which is very important. This has been confirmed by other authors (**Neyreneuf *et al.*, 1991**; **Inoue *et al.*, 1992**). **Doxastakis *et al.***, (**2002**) have found that addition of 5% and 10% soybean flour to moderately strong wheat flour increased the stability and resistance of dough, although at the expense of

the volume of baked products, but with sensory values comparable with the control samples.
Wheat and composite flours were then evaluated by extensograph, which allows to detect dough properties by determining the dependence of deformation from certain tension until tearing of sample (**Dodok and Szemes, 1998**). The measurement results are shown in Figure 2, which compares extensograms of both used flours after 15 minutes of dough maturing and Figure 3 after 30 minute of dough maturing. Based on the results of extensographic measurements in general we can predict the changes of dough consistency, impact of enhancing products, a total volume of products, etc., and based on this to select the appropriate type of flour, additives, and other quality-enhancing products for the final desired properties of bakery products (**Bojňanská *et al.*, 2013**).

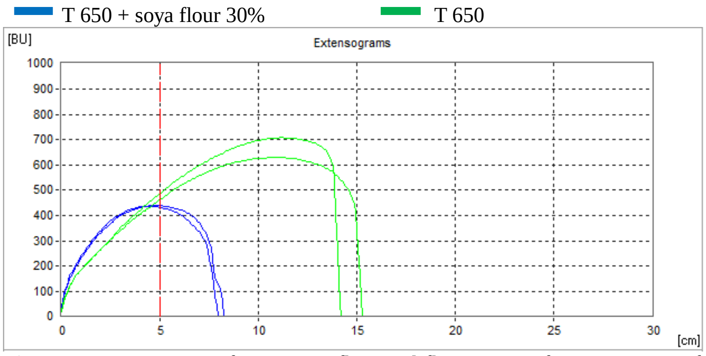

Figure 2 Extensograms of composite flour and flour T 650 after 15 minutes of dough maturing

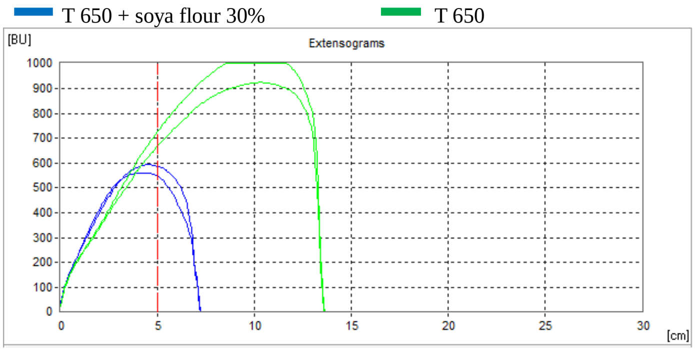

Figure 3 Extensograms of composite flour and flour T 650 after 30 minutes of dough maturing

The wheat flour dough as compared to the composite flour dough showed higher value of extensographic resistance, which in practical terms means that the dough of wheat flour is mechanically stronger and more resistant. In contrast to our results **Rosales–Juárez *et al.*,** (**2008**) report a slight increase of extensographic resistance due to the addition of defatted soy flour, but these changes were not significant. Extensographic energy of wheat flour dough was, after 15 and after 30 minutes of maturing significantly higher than with composite flour dough. This shows that the dough made of wheat flour was considerably stronger as for its deformation more energy was needed. Such types of dough predict larger volume of products. This hypothesis was confirmed by a baking experiment (Table 2 and Table 3), which had shown a greater volume of wheat loaves, compared to loaves of composite flour. The Figure 2 and 3 also show that dough made from composite flour had after 15 and 30 minutes of maturing significantly lower values of tensibility compared with dough from wheat flour, which can be based on the above facts described as suitable for the production of leavened bakery products.
The rheological analyses of evaluated flours were supplemented by results from amylograph, which is used for evaluation of flour quality and its enzymatic and mechanical damage. This information can help when deciding on the application of quality-enhancing products (**Dodok and Szemes, 1998**). Results and comparison of amylograms of wheat flour and composite flour are shown in Figure 4.

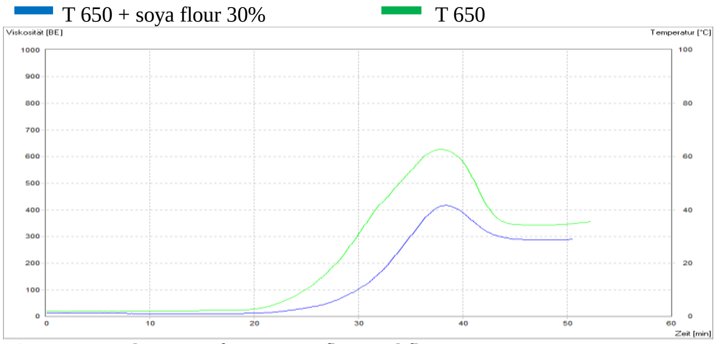

Figure 4 Amylograms of composite flour and flour T 650

Based on the evaluation of both amylograms it can be said that the beginning of gelatinization of wheat flour was 4.2°C lower compared to composite flour and amylographic maximum was by 211 AU higher in wheat flour than in composite flour. Consequently it shows that composite flour was enzymatically more active than wheat flour. Nevertheless, based on the research of several authors (**Dodok and Szemes, 1998; Bojňanská *et al.*, 2013**) it can be assumed that both flours will provide products with normal crumb with aligned pores since the flours had optimal activity of amylase required for leavened bakery products.
To verify the assumptions arising from rheological analysis and detection of bakery quality by direct methods baking experiments were implemented. The results are shown in Table 2 and Table 3.
The best technological quality was found in immediately baked wheat loaves since their volume and cambering can be described as good. After dough was stored at -18°C for one, three and six months the decrease in volume (by 8.6%, by 19.1%, by 23.8% respectively) compared to the control was observed. Volume of loaves baked after 6 months of storage we can evaluate based on recommendations by **Bojňanská *et al.*** (**2013**) as unsatisfactory. Best cambering (optimal value = 0.65) was observed in the control loaves. After the first, third and sixth month of freeze storage was the ratio between the height and width of the loaves significantly lower, and based on that the cambering was evaluated as unacceptable. **Simmons *et al.* (2012)** came to similar findings stating that the bakery products prepared from frozen dough are typically of lower quality than bread prepared from fresh dough.
Based on the evaluation of baking experiments using composite flour it can be observed that the highest volume was not found with loaves baked immediately after dough preparation, but after a one-month freeze storage. The decrease of volume was recorded only after three and six months of freezing (by 13.3% in comparison to products frozen one month).
The cambering value of all test loaves was not optimal, but it was still satisfactory. The volumes of all the baked loaves from composite flour, however, were lower than those baked from wheat flour. One possible reason was the lower portion of gluten in composite flour. Still higher addition of soy flour (up to 50%) caused the reduced flexibility of the products, as identified by **Sabinas and Tzia** (**2009). Finney *et al.*** (**1963**) previously recommended the use of soybean meal instead of soy flour as they found its more favourable effect on the volume of products compared with soybean flour.

Table 2 Results of baking experiments from flour T 650

Period of deep-freeze storage	Loaf volume, cm^3	Specific loaf volume $cm^3.100g$	Volume efficiency, $cm^3.100g$ flour	Height/width ratio (/)
Immediately baked/control	262.5	297.1	420.0	0.58
One month	240.0	264.6	384.0	0.55
Three months	212,5	231,9	340.0	0.48
Six months	200.0	230.9	320.0	0.46

Table 3 Results of baking experiments from composite flour

Period of deep-freeze storage	Loaf volume, cm^3	Specific loaf volume $cm^3.100g$	Volume efficiency, $cm^3.100g$ flour	Height/width ratio (/)
Immediately baked/control	187,5	208.2	300.0	0,65
One month	200,0	212.4	320.0	0,58
Three months	162,5	173.7	260.0	0,66
Six months	162,5	185.2	260.0	0,61

Based on the results published by several authors (**Kline *et al.*, 1968**; **Hsu *et al.*, 1979**; **Autio *et al.*, 1992**; **Pepe *et al.*, 2005**) we can assume that the most significant changes of the frozen dough were connected with the yeast cells, because dead cells damaged by ice released glutathione, which weakened the structure of gluten that subsequently led to a worse retention of gases and a prolonged time of fermentation which led to insufficient products volume.

Table 4 Analysis of baked crumbs

	Crude protein %	**Ash content %**	**Acidity of crumbs mmol.kg^{-1}**
Loaves from T 650	10.86	1.13	45.5
Loaves from composite flour	19.50	2.56	74.6

Selected indicators of chemical composition of crumbs of experimental loaves are shown in Table 4. The results show that the addition of soy flour used in an amount of 30% had a positive impact on the nutritional value of bread since the content of crude protein increased by 79.5% and ash content by 126.5% compared to wheat loaves. These results confirmed the statements of several authors (**Friedman and Brandon, 2001**; **Mashayekh *et al.*, 2008; Angioloni and Collar, 2011; Simmons *et al.*, 2012**) concerning nutrient enrichment of wheat products by soy flour or meal.

CONCLUSION

Addition of gross non-defatted soy flour at 30% had a significant impact on technological quality of loaves baked within the baking experiment. In comparison to wheat flour loaves the loaves from composite flour showed lower bread volume, specific volume and volume efficiency, and cambering was less satisfactory as well. Based on the farinographic assessment of composite flour (70% of wheat flour + 30% soybean flour) it was found that the mixture formed was slower hydrated than the pure wheat flour, which was related to high content of protein of the added soybean flour. Created dough could be characterized as strong, holdings optimum of its rheological properties long enough. By extensographic evaluation it has been found that the composite flour has lower extensographic energy, less resistance and lower tensibility compared to wheat dough, which in turn led to insufficient volume production. Analyses by Amylograph showed that composite flour was enzymatically more active than wheat flour. Nevertheless, both flours can be characterised as suitable for leavened bakery products. From a nutritional point of view it was significant that there was higher proportion of protein and ash in pastry made of composite flour.
The effect of freezing on dough in case of wheat flour showed the gradual reduction of the quality parameters of the loaves baked from such dough after deep-freeze storage lasting for 1, 3 and 6 months. In case of the composite flour, the decrease in quality was only observed after freeze storage lasting 3 and 6 months. One-month freeze storage did not decrease the quality, to the contrary, a slight increase loaf volume was observed.

Acknowledgments: The research leading to these results has received funding from the European Community under project ITEM 26220220180 Building Research Centre „AgroBioTech" and VEGA1/0308/14.

REFERENCES

ANGIOLONI, A., COLLAR, C. 2011. High legume-wheat matrices: an alternative to promote bread nutritional value meeting dough viscoelastic restrictions. *European Food Research Technology*. Publishing online: 30 November 2011 http://dx.doi.org/10.1007/s00217-011-1337-z.
AUTIO, K., SINDA, E. 1992. Frozen doughs: Rheological changes and yeast viability. *Cereal chemistry*, 69(4), 409-413. ISSN 0009-0352.
BOJŇANSKÁ, T. 2004. *Kvalita obilnín a strukovín ako surovín pre potravinárske spracovanie*. Habilitačná práca. Nitra : SUA, 139 p.
BOJŇANSKÁ, T. 2008. Possibilities of using oat, lentil, and buckwheat in bread processing. Bezpečnosť a kvalita surovín a potravín. Nitra : SPU. 48-55.
BOJŇANSKÁ, T., HORNA, A., HABÁNOVÁ, M. 2008. Buckwheat (*Fagopyrum esculentum* Moench.) - a source of rutin in human nutrition. *Vitamins 2008 - Nutrition and Diagnostics : 8th International Conference, Zlín , Czech Republic, September 9 - 11, 2008.* Zlín: Univerzita Tomáše Bati, 2008, 44-45. ISBN 978-80-7318-708-8.
BOJŇANSKÁ, T., CHLEBO, P., GAŽAR, R., HORNA, A. 2010. Buckwheat - enriched bread production ant its nutritional benefits. *The European Journal of Plant Science and Biotechnology*, 3(1) 49-55. ISSN 1752-3842.
BOJŇANSKÁ, T., MUCHOVÁ, Z., FRANČÁKOVÁ, H., URMINSKÁ, D., MENDELOVÁ, A., MAREČEK, J., SOLGAJOVÁ, M., VIETORIS, V., CZAKÓ, P. 2013. Hodnotenie surovín a potravín rastlinného pôvodu. Nitra : SPU, 335 p. ISBN 978-80-552-1086-5.
COSTA DE ALMEIDA, G. E., QUEIROS MONICI, K. S., REIS, S. M. P. M., COSTA DE OLIVIERA, A. 2006. Chemical composition, dietary fibre and resistant starch content of raw and cooked pea, common bean, chickpea and lentil legumes. *Food chemistry*, 94(3), 327-330. http://dx.doi.org/10.1016/j.foodchem.2004.11.020.
ČUBOŇ, J., KAČÁNIOVÁ, M., HAŠČÍK, P., FOLTYS, P., BALÁŽ, B., PRÍVAROVÁ, L. 2011. Analýza základného zloženia a aminokyselinovej skladby mäsa teliat z ekologickej produkcie. *Proteiny 2011* (Zborník príspevků VI. ročníku medzinárodí conference). Zlín : UTB, 2011, 40-52. ISBN 978-80-7454-022-6.
DALGETTY, D. D., BAIK, B. K. 2003. Isolation and characterization of cotyledon fibers from peas, lentils, and chickpea. *Cereal Chemistry*, 80 (3), 310-315. http://dx.doi.org/10.1094/CCHEM.2003.80.3.310.
DHINDA, F., LAKSHMI, J., PRAKASH, J., DASAPPA, I. 2012. Effect of ingredients on rheological, nutritional and quality characteristics of high protein, high Fibre and low carbohydrate bread. *Food Bioprocess Technol*, 2012(5), 2998–3006, http://dx.doi.org/10.1007/s11947-011-0752-y.
DHINGRA, S., JOOD, S. 2001. Organoleptic and nutritional evaluation of wheat breads supplemented with soybean and barley flour. *Food Chemistry*, 77(7), 479-488. http://dx.doi.org/10.1016/S0308-8146(01)00387-9
DODOK, L., SZEMES, V. 1998. *Laboratórne kontrolné metódy pre pekársku a cukrársku prax*. Gomini : Pezinok, 77 p.
DOXASTAKIS, G., ZAFIRIADIS, I., IRAKLI, M., MARLANI, H., TANANAKI, C. 2002. Lupin, soya and triticale addition to wheat flour doughs and their effect on rheological properties. *Food Chemistry*, 77(2), 219-227. ISSN 0308-8146.
GONI, I., VALENTIN-GAMAZO, C. 2002. Chickpea flour ingredient slows glycemic response to pasta in healthy volunteers. *Food Chemistry*, 81(4), 511-515. http://dx.doi.org/10.1016/S0308-8146(02)00480-6.
HAWKINS, A., JOHNSON, S. K. 2005. *In vitro* carbohydrate digestibility of whole-chickpea and chickpea bread products. *International Journal of Food Sciences and Nutrition*, 56(3), 147-155. http://dx.doi.org/10.1080/09637480500103920
FINNEY, K. F., RUBENTHALER, G., POMERANZ, Y. 1963. Soy product variables affecting bread-baking. *Cereal Science Today*, 8(5), 166-168.
FRIEDMAN, M., BRANDON, D.L. 2001. Nutritional and health benefits of soy proteins. *Journal of Agricultural and Food Chemistry*, 49(3), 1069–1086. ISSN 1097-0010.
HSU, K. H., HOSENEY, R. C., SEIB, P. A. 1979. Frozen dough II. Effects of freezing and storing conditions on the stability of yeasted doughs. *Cereal Chemistry*, 56(5), 424–426. ISSN 0009-0352.
INOUE, Y., BUSHUK, W. 1992. Studies on frozen doughs II. Flour quality requirements for bread production from frozen dough. *Cereal chemistry*, 69(4), 423-428. ISSN 0009-0352.
JAKUBCZYK, T., HABEROWA, H. 1974. Soy flour in European type bread. *Journal of the American Oil Chemists Society*, 51(1), 120-122. ISSN 1558-9331.
JOHNSON, S. K., THOMAS, S. J., HALL, R. S. 2005. Portability and glucose, insulin and satiety responses of chickpea flour and extruded chickpea flour bread eaten as part of a breakfast. *European Journal of Clinical Nutrition*, 59(3), 169-176
KLINE, L., SUGIHARA, T. 1968. Factors affecting the stability of frozen bread doughs. I. Prepared by the straight dough method. *Baker's digest*, 42(5), 44–50. ISSN 0191-6114.
KUMAR, R., SINGH, P., SABAPATHY, S. N., BAWA, A. S. 2008. Functional and edible uses of soy protein products. *Comprehensive Reviews in Food Science and Food Safety*, 7(1), 14–28. ISSN 1541-4337.
MARSTON, P. E. 1978. Frozen dough for breadmaking. *Baker's digest*, 52(37),18–20. ISSN 0191-6114.
MASHAYEKH, M., MAHMOODI, M. R., ENTEZARI, M. H. 2008. Effect of fortification of defatted xoy flour on sensory and rheological properties of wheat bread. *International Journal of Food Science and Technology*, 43(9), 1693-1698. ISSN 1365-2621.
MOGHADDAM, A. S., ENTEZARY, M. H:, IRAJ, B. , ASKARI, G., ZAHABI, E. S., MARACY, M., R. 2014. The effects of soy bean flour enriched bread intake on anthropometric indices and blood pressure in Type 2 diabetic women: A crossover randomized controlled clinical trial. *International Journal of Endocrinology*, 2014 (2014), 6 pages, http://dx.doi. org/10.1155/2014/240760
NEYRENEUF, O., VAN DER PLAAT, J. B. 1991. Preparation of frozen french bread dough with improved stability. *Cereal Chemistry*, 68(1), 60–68. ISSN 0009-0352.
PEPE, O., ANASTASIO, M., VILLANI, F. 2005. Improvement of frozen dough stability using a cryoresistant yeast strain and refreshment. *Cereal Chemistry*, 82(3), 239–241. ISSN 0009-0352.

PITTAWAY, J. K., AHUJA, K. D. K., ROBERTSON, L. K., BALL, M. J. 2007. Effect of controlled diet supplemented with chickpeas on serum lipids, glucose tolerance, satiety and bowel function. *Journal of the American College of Nutrition*, 26 (4), 334-340. ISSN 0731-5724

RIBOTTA, P. D., ARNULPHI, S. A., LEÓN, A. E., ANÓN, M. C. 2005. Effect of soybean addition on the rheological properties and breadmaking quality of wheat flour. *Jounal of the Science of Food and Agriculture*, 85(11), 1889-1896. ISSN 1097-0010. http://dx.doi.org/10.1002/jsfa.2191.

ROCCIA, P., RIBOTTA, P. D., FERRERO, C., PÉREZ, G. T., ALBERTO E. LEÓN, A. E. 2012. Enzymes action on wheat–soy dough properties and bread quality. *Food and Bioprocess Technology*. 5(4), 1255–1264, http://dx.doi.org/10.1007/s11947-010-0396-3.

ROSALES-JUÁREZ, M., GONZÁLEZ-MENDOZA, B., LÓPEZ-GUEL, E. C., LOZANO-BAUTISTA, F. *et al.*, 2008. Changes on dough rheological characteristics and bread quality as a result of the addition of germinated and non-germinated soybean flour. *Food and Bioprocess Technology*, 1(2), 152-160. ISSN 1935-5149.

SABANIS, D., TZIA, C. 2009. Effect of rice, corn and soy flour addition on characteristics of bread produced from different wheat cultivar. *Food and Bioprocess Technology*, 2(1), 68-79. ISSN 1935-5149.

SIMMONS, A., L., SMITH, K. B., VODOVOTZ, Y. 2012. Soy ingredients stabilize bread dough during frozen storage. *Journal of Cereal Science* 56(2), 232-238. http://dx.doi.org/10.1016/j.jcs.2012.05.007

THARANATHAN, R. N., MAHADEVAMMA, S. 2003. Grain legumes – a boon to human nutrition. *Trends in Food and Science Technology*, 14(12), 507-518. http://dx.doi.org/10.1016/j.tifs.2003.07.002.

UTRILLA-COELLO, R. G., OSORIO-DCAZ, P., BELLO-PCBREZ, L. A. 2007. Alternative use of chickpea flour in breadmaking: Chemical composition and starch digestibility of bread. *Food Science and Technology International*, 13(4), 323-327. http://dx.doi.org/10.1177/1082013207082537.

VELÍŠEK, J., HAJŠLOVÁ, J. 1999a. Chemie potravin I. 3. vyd. Tábor : Ossis, 602 p. ISBN 978-80-866659-15-2.

VELÍŠEK, J., HAJŠLOVÁ, J. 2009b. Chemie potravin II. 3. vyd. Tábor : Ossis, 644 p. ISBN 978-80-86659-16-9.

VODOVOTZ, Y., SIMMONS, A. L., SMITH, K. B. 2012. Soy ingredients stabilize bread dough during frozn storage. *Journal of Cereal Science*, 50(2), 232-238. ISSN 0733-5210.

WOLT, M. J., D´APPOLONIA, B. L. D. 1984. Factors involved in the stability of frozen dough II. The effects of yeast type, flour type and dough additives on frozen – dough stability. *Cereal chemistry*, 61(3), 213–221. ISSN 0009-0352.

REVENUE MINISTRY OF AGRICULTURE AND THE MINISTRY OF HEALTHNO. 1996. issuing the first part and the first, second and third head of the second PK SR. No. 981/1996-100 from 20.5.

ICC Standard No. 104/1: 1990 Determination of ash in cereals and cereal products

ICC Standard No. 105/2 : 1994 Determination of Crude Protein in Cereals and Cereal Products for Food and for Feed

ICC Standards No. 110/1 : 1976 Determination of the moisture content of cereals and cereal products (Practical method)

ICC - Standrd 115/1, 1992, AACC Method 54-21 :1995 Method for using the Brabender Farinograph

ICC - Standard 114/1, 1992, AACC Method 54-10 : 1995 Method for using the Brabender Extensograph

ICC - Standard 126/1, AACC Method 22-10,1995 : Method for using the Brabender Amylograph