ISSN print: 1224-5984
ISSN online: 2248-3942

Rom Biotechnol Lett. 2020; 25(3): 1594-1600
doi: 10.25083/rbl/25.3/1594.1600

Received for publication, July, 20, 2017
Accepted, December, 6, 2017

Original paper

Effect of the addition of pumpkin powder on the physicochemical qualities and rheological properties of wheat flour

LIVIA APOSTOL[1], CLAUDIA MOȘOIU[1*], CORNELIU SORIN IORGA[1], SANMARTIN ÁNGEL MARTÍNEZ[2]

[1]National Institute of Research & Development for Food Bioresources – IBA Bucharest, 6 Dinu Vintila Str., 021102, Bucharest 2, Romania
[2]National Technological Centre for the Food and Canning Industry CTC Spain

Abstract

Recently, the pumpkin seeds and the partially defatted pumpkin seed, a by-product of pumpkin seeds oil processing, become more and more interesting for bakery sector, because of its nutritional composition.

Pumpkin (Cucurbita sp.) and its seeds, is a significantly source of omega 3 and omega 6, fiber and amino acids (lysine, alanine, and arginine) having important nutritional propreties. Currently, pumpkin seeds have a niche market based particularly on healthyfood.

The influence of partially defatted pumpkin seeds on nutritional value of wheat flour and the rheological characteristics of doughs were studied.

The partially defatted pumpkin seeds flour has been used for enrichment of wheat flour with functional ingredients such as: bioactive carbohydrates (crude fiber), protein, fats and minerals. The analysis of the composition of partially defatted pumpkin seeds flour has been done in order to further promote their functionality in bakery products based, especially, on wheat flour.

The objective of the present study was to investigate the physicchemical and rheological properties of the samples of wheat flour enriched with different levels of defatted pumpkin seed (5%, 10% and, respectively, 15%).

Keywords Pumpkin, functional ingredients, crude fiber, mineral.

To cite this article: APOSTOL L, MOȘOIU C, IORGA CS, MARTÍNEZ SÁ. Effect of the addition of pumpkin powder on the physicochemical qualities and rheological properties of wheat flour. *Rom Biotechnol Lett*. 2020; 25(3): 1594-1600. DOI: 10.25083/rbl/25.3/1594.1600

*Corresponding author: CLAUDIA MOȘOIU, National Institute of Research & Development for Food Bioresources – IBA Bucharest, 6 Dinu Vintila Str., 021102, Bucharest 2, Romania
E-mail: claudia.mosoiu@bioresurse.ro Tel. 0741003561

Introduction

Pumpkin (*Cucurbita*) is a genus of herbaceous vines in the gourd family, *Cucurbitaceae*, also known as cucurbits, native from Andes and Mesoamerica (BURROWS G.E, 2003). Firstly cultivated in the Americas before being brought to Europe by Christopher Columbus's, pumpkin started to appear in Europe early ofthe sixteenth century.

Five species are grown worldwide for their edible fruit, variously known as squash, pumpkin, or gourd depending on species, variety[a] and for their seeds. First cultivated in the Americas before being brought to Europe by returning explorers after their discovery of the New World, plants in the genus *Cucurbita* are important sources of human food and oil.

Today, pumpkin (*Cucurbita* sp.) is an economically important species cultivated throughout the world (TAYLOR & BRANT, 2002).

The pumpkin have many culinary uses including pumpkin pie, biscuits, bread, desserts, puddings, beverages, and soups. Pumpkins are celebrated in festivals and in flower and vegetable shows in many countries.

Pumpkin seeds are used in culinary practices mainly in Europe (Austria, Slovenia, and Hungary (MURKOVI'C et al, 1996) and in many African countries (Tunisia) and roasted pumpkin seeds are a popular snack. in many African countries (L. REZIG et al, 2012).

Several studies have shown that Pumpkin seed oil has a strong antioxidant activity (STEVENSON et al, 2007) and has been identified as an exceptional preventive against hypertension and carcinogenic diseases (ZUHAIR et al, 2000; JIAN et al, 2005).

Pumpkin is consumed especially as food, but *Cucurbitaceae* representatives are also used in different countries such as Mexico, North India, China, and in the Caribbean, in ethnomedicinal applications (ALARCON-AGUILAR et al, 2002; F.J AGGARWAL H. et al, 2009). In Central Europe, pumpkin seeds are recommended for bladder and prostate diseases and several dietary supplements are commercially available for this purpose. (MEDJAKOVIC S. et al, and SVJETLANA MEDJAKOVIC et al, 2016) have evaluated the bioactivity of a hydro-ethanolic extract of pumpkin seeds on prostate cancer cells, breastcancer cells, colorectal adenocarcinoma cells and they have observed an inhibiting effect on cancer cell growth.

Pumpkin seeds (*Cucurbita* sp.) are an excellent source of proteins (25.2-37%), fibers (3.97%), oil (37.8-45.4%), tocopherols (-tocopherol – 42.27%) and considerable amounts of minerals (K, P, Mg, Mn, Ca) (LAZOS E., 1986; T.A. EL-ADAWY., 2001; L. REZIGA et al, 2012). Pumpkin seed oil is produced in the southern parts of Austria, Slovenia and Hungary (MURKOVIC, 1996). There are several reports on the nutritional values of pumpkin seeds (L. REZIGET al, 2012; AL-KHALIFA A.S., 1996; LAZOS E., 1986). However, no information has been reported related to the physico-chemical and functional properties of the by-product of the pumpkin seeds from the cold pressed oil processing.

Mixtures of wheat flour with added different ingredients are rich in many active principles (vitamins, antioxidants, enzymes, macro elements, microelements, fiber), making it a very valuable raw material for the bread industry (KIANOUSH KHOSRAVI-DARANI et al, 2017; PÎRVULESCU P. et al, 2014).

Recently, more and more attention has been paid to finding uses for by-products and waste resulting from food processing. Their use would help maximizing available resources and offers more new foods on the market. It would also contribute to avoid waste disposal problems. However, no information has been reported related to the physico-chemical and functional properties of by-product of the pumpkin seeds remaining from the cold pressed oil.

The aim of this article is to report the chemical composition and other characteristics of the mixtures from wheat flour and different ratioa of partially defatted pumpkin seeds flour. In addition, the rheological properties of these mixtures are also studied.

Materials and Methods

1. Materials

Defatted pumpkin seeds flour, a by-product obtained during processing the pumpkin seeds oil, was kindly supplied by SC Hofigal Export Import SA (Bucharest, Romania). This product has been obtained from pumpkin seeds on a large scale through hulling, grinding and degreasing at low temperatures, less than 45°C. The degradation of the components of this material may be considered to be low because all steps were performed at low temperature.

Wheat flour used in the study was 550 type (ash, d.m. – 0.55%) and was provided by Titan S.A. (Bucharest, Romania).

2. Preparation of wheat flour enriched in bioactive compounds types

Four samples of mixtures from 550 type wheat flour, (ash, d.m. – 0.55%), and different proportions of partially defatted pumpkin seeds flour in the following ratios: 95:5, 90:10 and 85:15 (w/w) were obtained. The types of flour mixtures used in this study are presented in Table 1.

Table 1. Types of flours obtained by addition of partially defatted pumpkin seeds flour

P	**100% wheat flour type 550**
P1	95% wheat flour type 550+5% partially defatted pumpkin seeds
P2	90% wheat flour type 550+10% partially defatted pumpkin seeds
P3	85% wheat flour type 550+15% partially defatted pumpkin seeds

3. Chemical analysis

Moisture content was determined at 103°C (±2°C) (2 g test samples) until constant weight was attained (ICC Standard No. 110/1). The ash content was determined by incineration at 525 ± 25˚C (ICC No. 104/1). Total fat content was determined by extracting 10 g of sample with petroleum ether at 40-65˚C, using a semi-automatic Soxhlet Foss Extraction System 2055 (Foss, Sweden). Total nitrogen (N) and crude protein content (N·6.25, conversion factor) was determined by the Macro Kjeldahl Method (Kjeltec System, FOSS, Sweden). The carbohydrate content was calculated by difference: 100 - (ash content + protein content + fat content + moisture content). The crude fiber content of the samples was determined using a Fibretherm-Gerhardt apparatus. Crude fibers include cellulose, hemicellulose, and lignin. All experiments were performed in triplicate.

4. Mineral content analysis

Mineral content was determined using an atomic absorption spectrophotometer (ContrAA 700; Analitykjena). Total ash was determined by incineration at 550°C, in an oven. Analysis was performed using an external standard (Merck, multi element standard solution) and calibration curves for all minerals obtained using 6 different concentrations. Dried samples were digested in a mixture of concentrated HCl.

5. Rheological properties evaluation

The rheological behavior of doughs was analyzed using the predefined "Chopin +" protocol on Mixolab, a new equipment of CHOPIN Technologies. The international standard ICC-Standard Method No. 173, a protocol for complete characterization of flours, was used and a simplified graphic interpretation of the results was performed. The Mixolab is an equipment used to characterize the rheological behaviour of dough subjected to a dual mixing and temperature constraint. It measures in real time the torque (expressed in Nm) produced by passage of the dough between the two kneading arms, thus allowing study of rheological and enzymatic parameters: dough rheological characteristics (development time, hydration capacity, etc.), protein reduction, enzymatic activity, gelatinisation and gelling of starch. The Mixolab can work with a constant dough weight to eliminate the influence of the mixer filling ratio (www.chopin.fr).

The procedure parameters used for analysis of the rheological behavior in the Mixolab were as follows: tank temperature 30°C, mixing speed 80 min^{-1}, heating rate 2°C/min, total analysis time 45 minutes.

Table 2. Mixolab curves interpretation

Point	Significance	Associated parameters	
C1	Used to calculate water absorption	T°C 1 and T1	Dough temperature and the time taken for different types of torque to appear
C2	Measures protein weakening as a function of mechanical work and temperature	T°C 2 and T2	
C3	Measures starch gelatinization	T°C 3 and T3	
C4	Measures the stability of the hot-formed gel	T°C 4 and T4	
C5	Measures starch retrogradation during the cooling period	T°C 5 and T5	

Mixolab curves recorded (Table 2) are essentially characterized by torque values in five defined points (C1-C5, N·m), temperatures and processing times corresponding to those points. The correlation between parameters (Table 3) is tested during mixing and heating of dough by Mixolab.

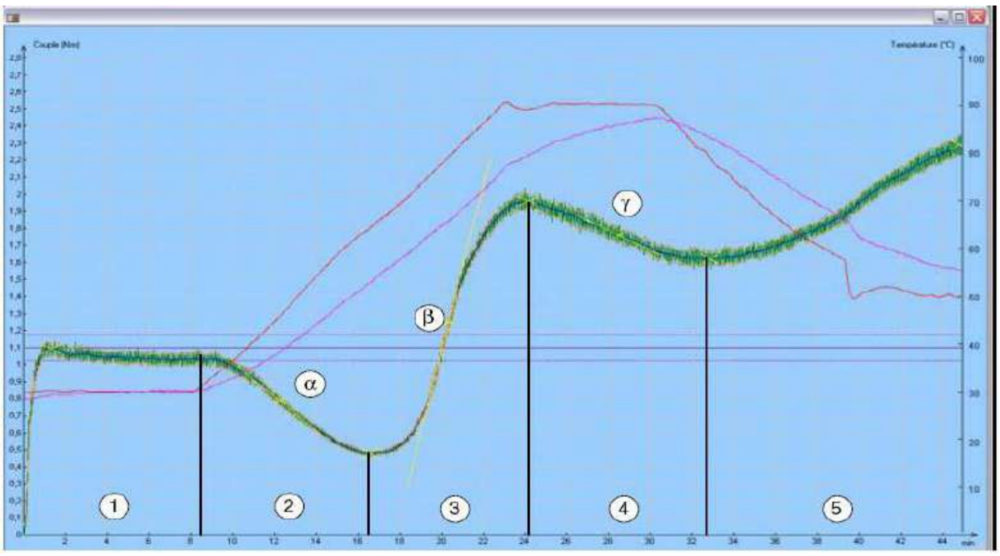

Figure 1. Mixolab curves

Table 3. Mixolab parameters correlation and significance

Parameter	Calculation method	Significance
Water Absorption (%)	Quantity of water required to obtain C1 = 1.1 Nm +/- 0.05	Quantity of water that the flour can absorb to achieve a given consistency during the constant temperature phase
Time for C1 (min)	Time required to obtain C1	Dough formation time: The stronger the flour, the longer it takes.
Stability (min)	Time during which torque is > C1 – 11% (constant T° phase)	Dough resistance to kneading: The longer it takes the "stronger" the dough.
Amplitude (Nm)	Curve width at C1	Dough elasticity: The higher the value, the greater the flour elasticity.

The parameters obtained from the recorded curves are: water absorption (%) or percentage of water required for the dough to produce a torque (C1) of 1.1 N·m, mixing stability (min) or elapsed time at which the torque produced is kept at 1.1 N·m, protein weakening (C2, N·m and the difference between points C1-2, N·m), starch gelatinisation (C3, N·m and the difference between points C3-2, N·m), amylolytic activity (C4, N·m and the difference between points C3-4, N·m), starch gelling (C5, N·m and the difference between points C5-4, N·m).

Figure 2. Mixolab for characterize the rheological behaviour of dough.

Mixolab "Chopin +" transforms the standard curve into six quality indicators, expressed on a scale of 0-9 (Mixolab index) regarding:

- Water Absorption Index (depending of the composition of the flour - protein, starch, fiber). It affects dough yield. The higher the value, the more water is absorbed by flour.
- Mixing Index represents the behaviour of the dough during mixing at 30°C (stability, development time and weakening). A high value corresponds to high dough stability in mixing.
- Gluten+ Index represents the behaviour of gluten when heating the dough. A high value corresponds to high gluten resistance to heating.
- Viscosity Index represents the increase in viscosity during heating. It depends on both amylase activity and starch quality. A high value corresponds to high dough viscosity during heating.
- Amylolysis Index, the starch's ability to withstand amylolysis. A high value corresponds to low amylase activity.
- Retrogradation Index represents the characteristics of starch and its hydrolysis during the test. A high value corresponds to a low shelf life of the end product.

6. Statistical Analysis

All analyses were performed in triplicate and the mean values with the standard deviations were reported. Microsoft Excel 2003 Program was employed for statistical analysis of the data with the level of significance set at 95%. Analysis of variance (ANOVA) followed by Tukey's test was used to assess statistical differences between samples. Differences were considered significant for a value of $P < 0.05$.

Results and Discussion

1. Chemical analysis of the wheat flour and partially defatted pumpkin mixture

Partially defatted pumpkin seeds flour should be regarded as an interesting source for enriching bread and other bakery products in carbohydrates, particularly crude fibers with known prebiotic properties, useful in the formulation of healthy foods. (M. DINU et al, 2016: S. MEDJAKOVIC et al, 2016).

The chemical composition of wheat flour and mixtures of the two flours are shown in Table 4. The ratios of the different flours that were incorporated is shown in Table 1.

Table 4. Chemical composition of wheat flour and mixtures wheat flour with partially defatted pumpkin seeds flour

Sample	g/100 g, based on dry weight				
	Total protein	Ash	Total lipids	Crude fibers	Total carbohydrates
P	13.70± 0.14	0.55± 0.05	1.10± 0.11	1.90± 0.11	84.65± 0.10
P1	15.35± 0.16	0.90± 0.08	1.66± 0.12	3.18± 0.15	82.09± 0.12
P2	17.00± 0.19	1.24± 0.09	2.23± 0.14	4.46± 0.19	79.53± 0.14
P3	18.65± 0.21	1.59± 0.10	2.79± 0.15	5.74± 0.22	76.97± 0.15

* Results given as: M ± SD (mean ± standard deviation) of triplicate trials.

It is clear that the enrichment of wheat flour with nutritionally rich of partially defatted pumpkin seeds flour enhances the nutritional qualities of bakery products, especially crude fibers. So, all three mixtures of flours contains more than 3 grams of crude fiber per 100 g total, which allow the provision of nutritional term "source of fiber".

In the present study, the contents of six biologically essential mineral elements were analysed: calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), iron (Fe) and manganese (Mn), as well as an additional two essential trace elements: zinc (Zn) and copper (Cu).

Table 5. Mineral content of wheat flour and mixtures wheat flour with partially defatted pumpkin seeds flour

Sample	Constitutes (mg/100 g):							
	Ca	Mg	Na	K	Fe	Mn	Zn	Cu
P	43.70±0.69	47.70±0.71	30.60±2.95	187±0.91	1.10±0.35	0.56±0.30	5.45±1.02	0.78±0.09
P 1	58.41±0.72	69.77±0.80	29.81±2.69	239.4±1.11	4.42±0.41	1.27±0.40	5.65±1.04	0.85±0.11
P 2	73.02±0.77	91.83±0.85	29.01±2.15	291.8±1.14	7.73±0.47	1.97±0.45	5.84±1.05	0.92±0.13
P 3	87.83±0.81	113.9±0.89	28.22±1.75	344.2±1.18	11.05±0.56	2.68±0.50	6.03±1.08	0.98±0.14

It is easily noticeable that the mixtures of wheat flour and partially defatted pumpkin seeds flour have higher contents of minerals, compared to the low mineral content of the wheat flour sample (P), in direct proportionality with the percentage increase of partially defatted pumpkin seeds flour added in the flour mixtures.

Thus, as can be seen in figure 3, potassium content increased significantly, from 187 mg/100 g (P) to 344.2 mg/100 g (P3), magnesium content increased 2.4 times from 47.7 mg/100 g (P) to 113,90 mg/100 g (P3), calcium content increased almost two times, from 43.7 mg/100 g (P) to 87.83 mg/100 g (P3) and iron content also increased ten times, from 1.1 mg/100 g (P) to 11.05 mg/100 g (P3).

2. Rheological properties of flour mixtures

The rheological behaviour of wheat flour dough (P) and of all flour mixtures during the Mixolab test is illustrated in Table 6.

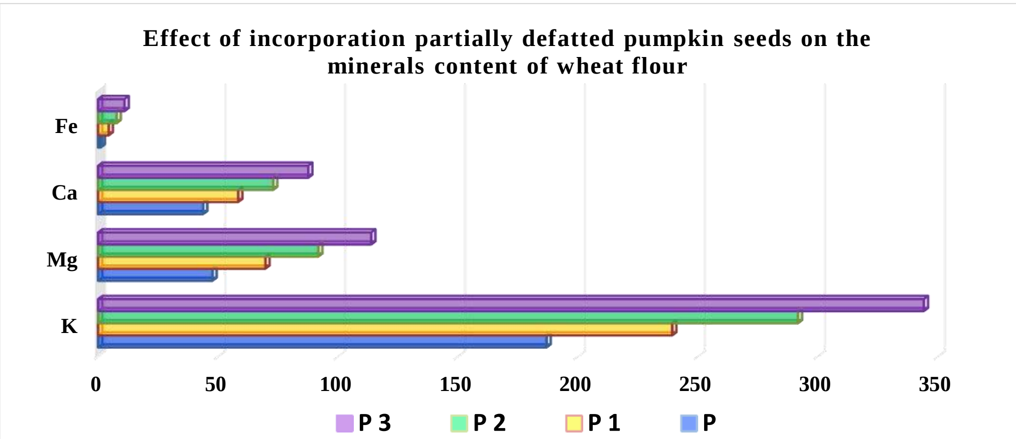

Figure 3. Influence percentage of partially defatted pumpkin seeds flour on on the mineral content of flour mixtures.

Table 6. Influence of partially defatted pumpkin seeds flour added to wheat flour in different proportions on Mixolab characteristics (rheological behavior)

Parameter	Abrev name	P	P 1	P 2	P 3
Water absorption (%)	CH	60	59,5	59,1	58,5
Stability (min)	ST	9,43	9,92	10,23	10,75
Amplitude (Nm)	-	0,073	0,087	0,093	0,096
Maximum consistency during:					
– phase 1 (N·m)	C1	1,12	1,12	1,12	1,12
	TC1	5,55	6,07	6,38	6,87
– phase 2 (N·m)	C2	0,49	0,52	0,56	0,59
	TC2	16,93	16,90	16,80	17,33
– phase 3 (N·m)	C3	1,87	1,80	1,78	1,76
	TC3	23,43	23,25	23,28	23,28
– phase 4 (N·m)	C4	1,56	1,54	1,52	1,51
	TC4	30,83	31,00	31,0	27,90
– phase 5 (N·m)	C5	2,44	2,43	2,41	2,35
	TC5	45	45	45	45

Mixolab C1-C5 values of wheat dough (P) were 1.12 N·m, 0.49 N·m, 1.87 N·m, 1.56 N·m and 2.44 N·m, respectively (Table 6). Similar Mixolab behavior was mentioned in other studies (PAPOUSKOVA et al, 2011) for three wheat varieties with small differences.

From our results, it can be seen that as the amount of added partially defatted pumpkin seed flour increases, the water absorption capacity (CH) decreases from 60% (P) to 59.5% (P1), 59.1% (P2) and 58.5% (P3), respectively. Regarding the water absorption capacity, the baking quality of flours did not decrease considerably as the percentage of partially defatted pumpkin seed flour increased. For wheat flour for baking, normal CH values are between 55%-62% (DESPINA BORDEI, 2004).

Dough stability (ST) had the following values: 9.43 min (P), 9.92 min (P1), 10.23 min (P2) and 10.75 min (P3). It can be noticed that the addition up to 15% of partially defatted pumpkin seed flour did not have a significant influence on the wheat flour dough's stability.

As the percentage of partially defatted pumpkin seed flour increased, the amplitude, i.e. the width of the curve during dough formation, increase, which suggests a higher elasticity of the dough, due to higher content of fat. This increase in fat content is due to partially defatted pumpkin seeds, with a positive influence on the dough.

A small increase of consistency (C2 – the behavior of the gluten when heating the dough) shows a higher resistance of dough as an effect of temperature. This means that some small negative qualitative changes in flour protein composition can possibly occur, i.e. dilution of gluten content and changes in gluten structures.

In phase 3, the starch gel formation where the temperature reached 50-55°C, the lowest C3 was observed for P3. The difference in C3 results between P and P3 samples was 0.11 N·m, so the influence on dough preparation recipe was low. The differences in C3 for consecutive samples are rather small, showing that the influence of percentage of partially defatted pumpkin seed flour for the mixtures on the rheological quality of flour is minor.

As mentioned above, the C4 parameter corresponds to the stability of the hot-formed gel. The lowest C4 was found for P3 (Table 6). The difference for C4 results between P and P3 samples was only 0.05 N·m, being insignificant. The stability time of the gel (TC4) decreases as the percentage of partially defatted milk thistle seed flour increases.

The retrogradation stage of starch (C5) for the tested wheat flour and wheat-partially defatted pumpkin seed flour mixtures demonstrated similar differences as for starch gel stability. It can be seen that differences in C5 between consecutive samples are generally not significant, but some difference between P and P3 is noticed (2.44 and 2.35 N·m, respectively).

From all of the above data, it can be stated that, with regard to their baking quality, the flour mixtures studied can be categorized as flours suitable for bakery products.

Mixolab curves of P wheat sample and of all three wheat/partially defatted pumpkin flours mixtures are presented in Fig. 4. It can be observed a sharp approximation of the four curves.

It can be said that the mixtures of wheat flour with 5%, 10% and 15% partially defatted pumpkin seeds flour are acceptable for bread and other bakery products. However, for an improvement of the quality of bread obtained from the flour mixtures with 15% partially defatted pumpkin seeds, it is necessary to establish a technology that improves both the formation and retention of the gases.

Conclusion

The chemical composition analysed in this study proved that partially defatted pumpkin seeds flour are a valuable source of nutritional components, mainly fiber and minerals content, especially iron, potassium, calcium and magnesium.

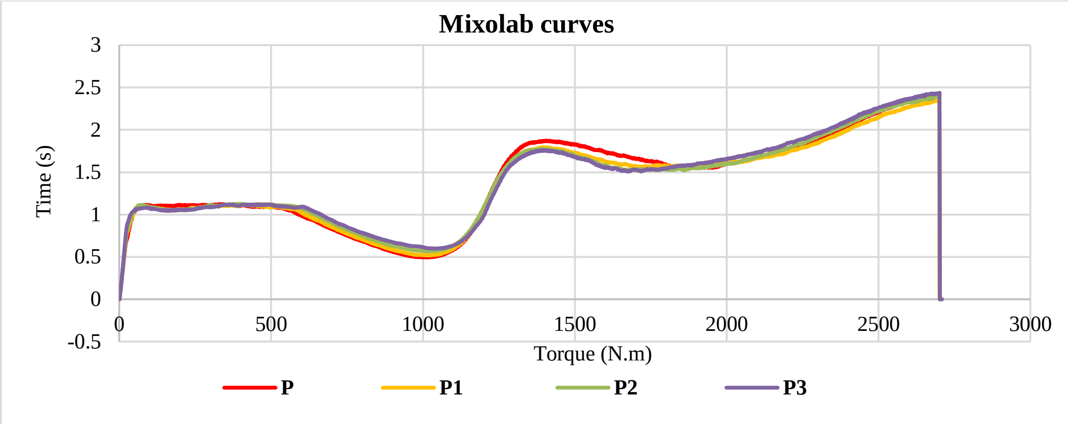

Figure 4. Mixolab torque curves (N.m) of wheat-partially defatted pumpkin seeds mixtures.

Results of the rheological properties determinations of dough (pure wheat flour and mixtures of wheat flour with partially defatted pumpkin seeds flour), underlined that P1 and P2 samples (5% and 10% partially defatted pumpkin seeds flour added to wheat flour) maintained the rheological parameters in limits. This could ensure good technological behavior in order to obtain a good quality of the bakery products.

This study suggests that partially defatted pumpkin seeds flour can be used as a nutritional improver ingredient in the bakery matrices.

Acknowledgements

This study was supported by the Ministry of National Education-State Authority for Scientific Research, Technological Development and Innovation, by Nucleu Programme, PN 16 46, contract 29N/2016, Romania.

References

1. AGGARWAL H., KOTWAL. N. Foods used as ethno-medicine in Jammu, *Ethno-Med*. 3, 65-68 (2009).
2. AL-KHALIFA A.S. Phisicochemical characteristics, fatty acid composition and lipoxygenase activity of crude pumpkin and melon seed oils, *Journal of Agricultural and Food Chemistry*, 44, 964-966 (1996).
3. ALARCON-AGUILAR F.J., HERNANDEZ-GALICIA E., CAMPOS-SEPULVEDA A.E., XOLALPA-MOLINA S., RIVAS-VILCHIS J.F., VAZQUEZ-CARRILLO L.I., ROMAN-RAMOS R. Evaluation of the hypoglycemic effect of Cucurbita ficifolia Bouche (Cucurbitaceae) in different experimental models, *J. Ethnopharmacol*. 82, 185-189 (2002).
4. BORDEI DESPINA. Tehnologia modernă a panificației, *Editura Agir*, 80-81 (2004).
5. BURROWS G.E., TYRL R.J. Toxic Plants of North America, *Oxford: Wiley-Blackwell*. pp. 389-391. ISBN 978-0-8138-2034-7 (2013).
6. DINU M., SOARE R., HOZO GH., BECHERESCU D. Biochemical Composition of some Local Pumpkin Population, 5th International Conference "Agriculture for Life, Life for Agriculture", Agriculture and Agricultural Science Procedia, 10, 185-191 (2016).
7. EL-ADAWY TAREK A., TAHA KHALED M. Caracteristics and composition of different seed oils and flours", *Food Chemistry*, 74, 47-54 (2001).
8. JIAN L., LEE A., BINNS C., DU C.-J. Do dietary lycopene and other carotenoids protect against prostate cancer? *Int. J. Cancer* 113 (6), 1010-1014 (2005).
9. KIANOUSH KHOSRAVI-DARANI, GHOLAMI ZAHRA, GOUVEIA LUISA. Effect of *Arthrospira platensis* on the shelf life, sensorial andrheological properties of strudel", *Romanian Biotechnological Letters*, vol. 22, no. 1, 12250-12258 (2017).
10. LAZOS E., Nutritional, fatty acid and oil characteristics of pumpkin and melon seed, *Journal of Food Science*, 51, 1382-1383 (1986).
11. MEDJAKOVIC S., HOBIGER S, WOELKART K.A., FRANZ BUCAR F., JUNGBAUER A. Pumpkin seed extract: Cell growth inhibition of hyperplastic and cancer cells, independent of steroid hormone receptors, *Fitoterapia* 110, 150-156 (2016).
12. MURKOVIĆ M., HILLEBRAND A., WINKLER H., PFANNHAUSER W. Variability of vitamin E content in pumpkin seeds (*Cucurbita pepo* L.). *Z. Lebensm. Unters. Forsch*. 202, 275-278 (1996).
13. PAPOUSKOVA L., CAPOUCHOVA I., KOSTELANSKA M., SKERÍKOVA A., PROKINOVA E., HAJSLOVA J. Changes in baking quality of winter wheat with different intensity of *fusarium spp*. Contamination detected by means of new rheological system Mixolab, *Czech Journal of Food Science*, 29, 420-429 (2011).
14. PÎRVULESCU PANFIL, BOTĂU DORICA, CIULCA SORIN, MADOȘĂ EMILIAN, ALEXA ERSILIA, GERGEN IOSIF. Biochemical characterization of flour obtained from germinated cereals (wheat, barley and oat), *Romanian Biotechnological Letters*, vol. 19, no. 5, 9772-9777 (2014).
15. REZIG LEILA, CHOUAIBIA MONCEF, MSAADAB KAMEL, HAMDIA SALEM. Chemical composition and profile characterisation of pumpkin (*Cucurbita maxima*) seed oil, *Industrial Crops and Products*, 37, 82-87 (2012).
16. STEVENSON D.G., ELLER F.J., WANG L., JANE J-L., WANG T., INGLETT G.E. Oil and tocopherol content and composition of pumpkin seed oil in 12 cultivars, *J. Agric. Food Chem*. 55, 4005-4013 (2007).
17. TAYLOR M.J., & BRANT J. Trends in world cucurbit production, 1991 to 2001, *In D. N. Maynard (Ed.), Cucurbitaceae*, pp. 373-379. Alexandria, VA: ASHS Press (2002).
18. ZUHAIR H.A., ABD EL-FATTAH A.A., EL-SAYED M.I. Pumpkin-seed oil modulates the effect of feloipine and captopril in spontaneously hypersensitive rats, *Pharmacol Res.* 41 (5), 555-563 (2000).