Use of pumpkin seed flour in preparation of bakery products

Anastasiia Shevchenko, Vira Drobot, Oleg Galenko

National University of Food Technologies, Kyiv, Ukraine

Keywords:

Pumpkin
Flour
Bread
Dough
Gas-forming

Article history:

Received 21.06.2021
Received in revised form 19.11.2021
Accepted 31.03.2022

Corresponding author:

Anastasiia Shevchenko
E-mail:
nastyusha8@ukr.net

DOI: 10.24263/2304-974X-2022-11-1-10

Abstract

Introduction. The aim of the study was to determine the effect of pumpkin seed flour on the technological indicators of bakery products.

Materials and methods. The flour from seeds of the large-fruited, hard-skinned variety "Pink Banana" pumpkin was used in the study. Microbiological processes in the dough were characterized by the gas-forming ability of the dough and the dynamics of gas formation. Biochemical processes in the dough were investigated by kinetics of sugars in the dough. Indicators of the quality of finished products were also studied.

Results and discussion. "Pink Banana" pumpkin seed flour contains 3.8 times more protein and 3.5 times more fiber than wheat flour. The particle size of pumpkin seed flour is much larger than wheat wholemeal flour, so its application should affect the structural and mechanical properties of dough semi-finished products and finished bakery products. The water absorption capacity of pumpkin seed flour exceeds the corresponding value for wheat flour by 1.5 times. With an increase in the dosage of this additive the gas-forming capacity of the dough for bakery products decreased by 1.9–7.4% compared to the control sample without pumpkin seed flour and the amount of formed sugars decreased by 7.6–16.2%, but the amount of fermented sugars increased by 16.9–20.3%. The acidity of the crumb of products increased slightly, its specific volume decreased by 3.6–38.4% and porosity – by 1.4–4.1%. In finished bakery products, the protein content increased by 13.9–55.5% depending on the dosage of pumpkin seed flour, fiber content – by 12.07–48.7%, which indicates the ability of this raw material to significantly increase the nutritional value of products when it is included in the recipe.

Conclusions. Replacing part of wheat flour in the recipes of bakery products by pumpkin seed flour can increase the protein and fiber contents in these products, which will improve their nutritional value.

Introduction

Products for mass consumption often have insufficient nutritional value due to the low content of complete proteins, dietary fiber, vitamins and minerals (French et al., 2019; Ivanov et al., 2021). To improve the nutritional quality of foods, addition of different plant additives, including pumpkin seed products, is recommended (Stabnikova et al., 2021).

Pumpkin itself as well as its parts and processing products could be the source of proteins with high content of tryptophan, carotenoids, minerals, and unsaturated fatty acids (Kalyna et al., 2021). To enrich food products with physiological and functional ingredients, it is recommended to use pumpkin pulp, seeds (Dotto and Chacha, 2020), protein isolates and hydrolysates, flour, fiber (Vinayashre et al., 2021), and pumpkin oil (Gedi et al., 2022). However, the impact of these ingredients on the physico-chemical and technological properties of food products, including bakery, remains insufficiently studied.

Flour from seeds of gymnosperm pumpkin contains all main nutrients, % of dry matter: proteins, 43.2; fats, 17.3%; carbohydrates, 20.9% (including monosaccharides, 0.63%, sucrose, 1.84%, starch, 4.21%, fiber, 14.28%) (Jurgita et al., 2014). Pumpkin seeds and shells are potentially good raw materials for enriching food products due to the presence of antioxidant compounds such as polyphenols and high antioxidant activity (Saavedra et al., 2015). However, there is no data on the impact of the studied additives on the technological process of manufacturing different groups of food products.

The total carotene content in wheat bread increased with the addition of pumpkin products (Kampuse et al., 2015; Rakcejeva et al., 2011). However, the volume of bread decreased with the increase of dosage of pumpkin pomace and pumpkin powder. The addition of semi-finished products such as juice and puree from different varieties of pumpkin improved the sensory bread properties, but physico-chemical characteristics of bread have not been studied (Barabolia et al., 2018). Bread from a composite mixture of pumpkin and spelled flour had potassium and calcium contents 1.5 times higher than wheat, in terms of contents of phosphorus, magnesium and zinc 2–3 times higher. Altogether, prolongation of freshness of finished products was also observed (Mykolenko et al., 2017). However, there are no studies of the processes which occur in semi-finished bakery products added with pumpkin products in the manufacture of bread, as well as indicators of quality of finished products. Partial replacement of wheat flour up to 15% with pumpkin seed flour helped to improve nutritional and sensory values of cookies (Alshehry, 2020).

Pumpkin has a special attention for food product enhancement for its health promoting values. Pumpkin seeds contain biologically active substances having antidiabetic, antidepressant, antioxidant, antitumor and cytoprotective activities (Dotto and Chacha, 2020). It is considered that consumption of pumpkin products reduces the risk of gastrointestinal inflammation (Gad et al., 2019) and they are recommended in nutrient therapy for persons suffering from intestinal diseases (Dar et al., 2017). Pumpkin seeds have especially high beta-carotene content, so, consumption of food enriched with pumpkin products helps to prevent skin diseases and support vision (Lyu et al., 2021). As beta-carotene is a fat-soluble vitamin, its bioaccessibility increases in the presence of lipids. So nutritionists recommend to include in recipes of food products enriched with pumpkin seeds lipid components, in particular phospholipids, for example lecithin.

The aim of the present study was to determine the effect of pumpkin seed flour addition on the technological characteristics of bakery products manufactured from wheat flour.

Materials and methods

Preparation of dough samples

Dough samples were prepared from premium wheat flour, pressed baker's yeast, salt, sunflower lecithin as a source of phosphatidylcholine, in the amount of 3% by weight of flour (this dosage was chosen based on the recommendations for the daily intake of lecithin) (Partridge et al., 2019), pumpkin seed flour in the amount of 5, 10, 15, 20% to replace wheat flour. A sample without pumpkin seed flour and lecithin was used as a control sample.

Methods

Size of the flour particles. The size of the flour particles was determined by sieving on sieves. Sieves of different sieve fabric and different hole sizes were used: No 33/36 (35) (220 μm), No 27 (260 μm), No 067 (670), No 49/52 PA (43) (132 μm), No 41/43 (38) (160 μm) (Patwa et al., 2014).

Gas-forming ability of the dough. The indicator of gas-forming ability is the amount of cm^3 of carbon dioxide (CO_2) emitted during the fermentation and keeping of the dough from 100 g of flour at a temperature of 30 °C. This indicator was determined by the volumetric method, namely the volume of CO_2 emitted at constant temperature and pressure (Munteanu et al., 2019; Verheyen et al., 2015).

Kinetics of sugar accumulation in the dough. The amount of sugars formed during the fermentation of the dough was determined by the difference between their content in the dough without yeast immediately after kneading and after 180 minutes of fermentation. The amount of fermented sugars was determined by the difference between the sum of the amount of sugars at the beginning of fermentation of yeast dough and the amount of sugars formed in yeast-free dough and the amount of sugars contained in yeast dough after 180 minutes of fermentation. The kinetics of sugar accumulation in the dough was determined by the accelerated iodometric method (Manual of methods of analysis of food, beverages, sugar and confectionery product, 2012)

Titrated acidity of the dough. Titrated acidity in semi-finished products (dough) was determined by titration (Manual of methods of analysis of food, beverages, sugar and confectionery products, 2012).

Moisture. The moisture content was determined using the SuperPoint grain moisture meter. To measure the grain humidity, the appliance was switched on, the name of the scale of the corresponding measuring crop or product was selected on the LCD screen, the necessary sample was selected, which falls into the device, the pressure cover of the pressurizes to the level until the pressure indicator was set to the level with the upper surface of the lid. After tightening the button "TEST" was pressed and after 10 seconds the result of the measurements of humidity in% was received. Measurement was carried out with an accuracy of 0.5% with a range of humidity measurement from 8 to 45% (Manual of methods of analysis of food, beverages, sugar and confectionery products, 2012).

Total protein. A product was digested with a strong acid so that it released nitrogen which could be determined by a suitable titration technique. The amount of protein present was then calculated from the nitrogen concentration of the product.

1 g of raw material was hydrolyzed with 15 mL concentrated sulfuric acid containing two copper catalyst tablets in a heat block at 420 °C for 2 h. After cooling, H_2O was added to the hydrolysates before neutralization and titration (Mæhre et al., 2018).

Fat. The sample is placed in a thimble; once the flask is heated, the solvent is evaporated and moved up to the condenser, where it is converted into a liquid and collected into the extraction chamber containing the sample. When the solvent passes through the sample, it extracts the fats and carries them into the flask. This extraction process typically lasts several hours (6–24 h). After completion of the extraction, the solvent is evaporated, and the mass of lipid remaining is measured and used to analyze (López-Bascón et al., 2020).

Fiber. A collaborative study was conducted to determine the total dietary fiber (TDF) content in products, using enzymatic-gravimetric method (McCleary et al., 2012). TDF was calculated as the weight of the residue minus the weight of protein and ash.

Specific volume of bread. The grain was filled with the excess, which was raked with the edge of the ruler into the receiving container and removed through the hole. After that, the curtains of the main capacity with grain were opened manually and put through the hole into the bucket. This grain was used for determination. A small amount of grain was put into the main container, bread was put on it carefully, without passing the grain, and the rest of the grain was put in excess of the capacity. Grain was raked with the edge of the ruler and put into the receiving container, and then, after opening the latch – into the measuring cylinder. The volume of grain in a cylinder (cm^3) was equal to the volume of bread. Measurements were performed twice, deviations between parallel determinations should not exceed 5%. The specific volume of bread was determined by dividing the volume of bread by its weight and expressed to the nearest 0.01 cm^3/g (Zhu et al., 2016).

Porosity of bread. The porosity of bread reflects the volume of the pores in a certain volume of the crumb, expressed as a percentage to the total volume (Verheyen et al., 2015).

Statistical analysis. The statistical processing of the result values was performed by sequential regression analysis using the Microsoft Excel XP and OriginPro 8 software calculating correlation coefficients (Hinkle et al., 2003).

Results and discussions

Physico-chemical and technological characteristics of pumpkin seed flour

The chemical composition of raw materials is a major determinant in the development of new product formulations (Jurgita et al., 2014). The chemical composition of pumpkin seed flour compared to premium grade wheat flour is presented in Table 1.

Table 1

Chemical composition of wheat flour and pumpkin seed flour

Indicator	Premium grade wheat flour	Pumpkin seed flour
Moisture,% weight	11.5	15.6
Proteins,%	10.3	40.0
Fats,%	1.1	9.0
Carbohydrates,%	69.8	23.6
Cellulose,%	3.5	12.2
Ash,%	0.75	4.7

It was shown that pumpkin seed flour contains 3.8 times more protein, 3.5 times more dietary fiber, 6.3 times more ash than wheat flour. Thus, partial replacement of wheat flour with pumpkin seed flour may lead to enhancement of nutritional value of bakery products.

Microbiological and biochemical processes in the dough, its structural and mechanical properties are important in the manufacture of bakery products (Lisowska et al., 2016). They are significantly influenced by the size of the components of the recipe (Table 2) and their water absorption capacity (Figure 1).

Table 2

Size of the particles in pumpkin seed flour in comparison with wheat flour

Size indicators, No of sieve	Size of the hole, µm	Wheat flour, variety			Pumpkin seed flour
		First	Second	Whole-meal	
The residue on the sieve% , no more:					
No 33/36 (35)	220	2	-	-	28.1
No 27	260	-	2	-	63.18
No 067	670	-	-	2	6.92
Passage through a sieve,% no less:					
No 49/52 PA (43)	132	80	-	-	-
No 41/43 (38)	160	-	65	35	0.18

Estimation of the particle size distribution of pumpkin seed flour showed that it is much larger than wheat wholemeal flour, as the residue on the sieve No 067 exceeds the maximum standard value for wholemeal flour by 3.5 times.

The water absorption capacity of raw materials depends on the composition of its biopolymers, particle size, the state of their surface (Zykova et al., 2015). The water absorption capacity of pumpkin seed flour is 1.5 times higher than of wheat flour.

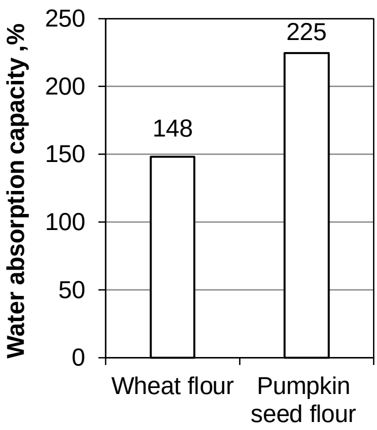

Figure 1. Water absorption capacity,%

Influence of pumpkin seed flour on microbiological processes in the dough

The intensity of dough fermentation, which was determined by the amount of carbon dioxide emitted during dough fermentation and keeping of dough pieces, is determined by the interaction of dough microflora and products of enzymatic hydrolysis of flour biopolymers and other components of the recipe. Samples with lecithin as emulsifier and a source of phosphatidylcholine and samples with different dosage of pumpkin seed flour were studied.

The gas-forming capacity of the dough (Figure 2) increased slightly with the addition of lecithin, which can be explained by the presence of choline in lecithin, which improves the enzymatic ability of yeast (Medvid et al., 2018). However, with increasing dosage of pumpkin seed flour, the gas-forming capacity decreased by 1.9–7.4% compared to the control sample. This can obviously be explained by the formation of protein complexes of pumpkin seed flour with wheat flour starch, which reduces its availability to amylolysis.

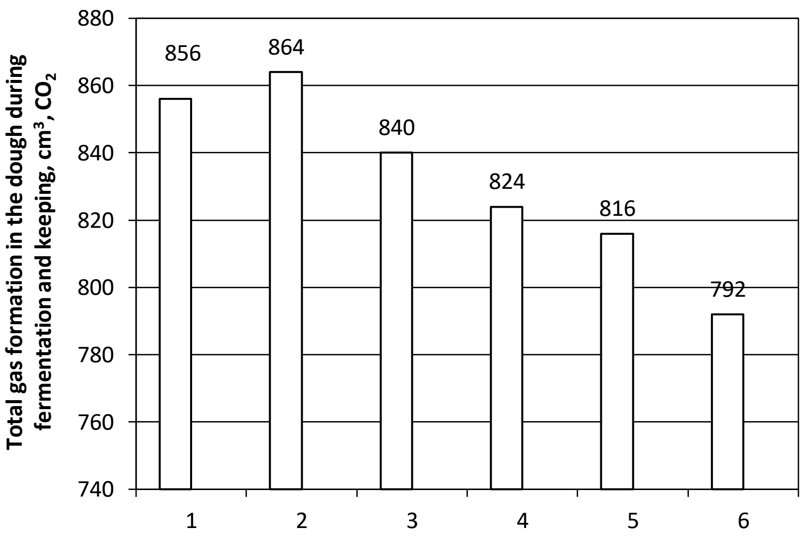

Figure 2. Total gas formation in the dough during fermentation and keeping, cm^3, CO_2 :
1 – control sample;
2 – sample with lecithin;
3 – sample with lecithin and 5% pumpkin seed flour to replace wheat flour;
4 – sample with lecithin and 10% pumpkin seed flour to replace wheat flour;
5 – sample with lecithin and 15% pumpkin seed flour to replace wheat flour;
6 – sample with lecithin and 20% pumpkin seed flour to replace wheat flour

Decreased fermentation activity of yeast affects the dynamics of carbon dioxide emission during the fermentation of the dough and the keeping of the dough pieces (Figure 3).

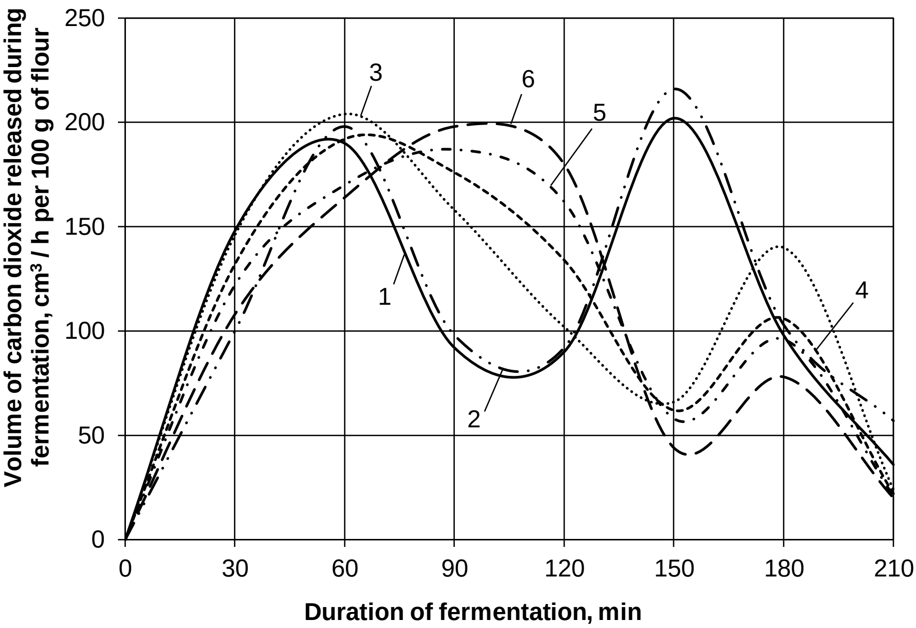

Figure 3. Dynamics of gas formation in the dough with different dosage of pumpkin seed flour:
1 – control sample;
2 – sample with lecithin;
3 – sample with lecithin and 5% pumpkin seed flour to replace wheat flour;
4 – sample with lecithin and 10% pumpkin seed flour to replace wheat flour;
5 – sample with lecithin and 15% pumpkin seed flour to replace wheat flour;
6 – sample with lecithin and 20% pumpkin seed flour to replace wheat flour

It was found that in the dough with flour from pumpkin seeds gas formation was less intense, because there was a delay in fermentation by reducing the availability of nutrients. The graph of the dynamics of carbon dioxide emissions shows that the first peak of gas formation in the dough with the replacement of 5% wheat flour by pumpkin seed flour was observed after 60 minutes, when replacing 10% – after 70 minutes, 15% – after 100 minutes, 20% – after 115 minutes of fermentation, and for wheat flour – in 50 minutes. Then the amount of carbon dioxide emitted in the dough with pumpkin seed flour decreased sharply and the second peak of gas formation was observed after 180 minutes, while in the control sample – after 150 minutes. This is due to the fact that amylolytic enzymes of pumpkin seed flour are less active than of wheat flour, which is due to the poor susceptibility of the starch of this flour to amylolysis.

Influence of pumpkin seed flour on biochemical processes in the dough

The process of gas formation in the dough is due to the sugar-forming ability (Drobot et al., 2014), which in turn is provided by the susceptibility of starch to amylolysis and amylase activity. The sugar content depends on the relationship between the intensity of sugars accumulation in the dough and their fermentation by microorganisms (Drobot et al., 2014). The depth of this process was characterized by the kinetics of accumulation and fermentation of sugars (Table 3).

Table 3

Accumulation and fermentation of sugars during the fermentation of the dough (in terms of maltose),% to dry matter

Indicators	**Control sample**	**Sample with lecithin**	**Pumpkin seed flour to replace wheat flour,%**			
			5	**10**	**15**	**20**
Yeast-free dough						
After kneading	2.10±0.10	2.10±0.10	2.10±0.10	2.00±0.10	2.00±0.10	1.99±0.09
After 3 hours of fermentation	3.15±0.13	3.39±0.17	3.32±0.15	3.21±0.14	3.20±0.14	3.12±0.12
Formed sugars	1.05±0.01	1.29±0.03	1.22±0.03	1.21±0.03	1.20±0.03	1.13±0.02
Yeast dough						
After kneading	2.12±0.10	2.15±0.12	2.13±0.11	2.08±0.10	2.02±0.10	1.98±0.09
After 3 hours of fermentation	1.69±0.06	1.78±0.08	1.62±0.06	1.54±0.05	1.46±0.05	1.33±0.04
Fermented sugars	1.48±0.05	1.66±0.06	1.73±0.08	1.75±0.08	1.76±0.08	1.78±0.08

It was found that with increasing the dosage of pumpkin seed flour, the amount of formed sugars decreased by 7.6-16.2%. This can be explained by the fact that pumpkin seed flour proteins form complexes with wheat starch and therefore impair the access of enzymes to starch grains. However, the fermentation of sugars increased by 16.9–20.3%, due to the depolymerization of carbohydrate additives (Teri et al., 2014).

The quality indicators of the finished products (Table 4) indicated an increase in the acidity of the crumb of the products with the replacement of part of the wheat flour with pumpkin seed flour due to the higher acidity of the added raw material. The shape stability of bread did not change significantly.

However, its specific volume decreased by 3.6–38.4% and porosity decreased by 1.4–4.1%, which can be explained by the specifics of swelling of pumpkin components, including fiber (Pereira et al., 2018). At the same time, the organoleptic characteristics of the products improved, in particular the taste and smell, which acquired a pleasant pumpkin hue. The bread crumb was elastic, well fluffed.

Table 4

Quality indicators of finished bread with pumpkin flour

Indicators	**Control sample**	**Sample with lecithin**	**Samples with pumpkin flour,% to replace wheat flour**			
			5	**10**	**15**	**20**
Acidity of the crumb, degrees	2.0	2.0	2.5	2.8	3.1	3.4
Specific volume of bread, cm^3/100 g	224	234	220	218	178	146
Shape stability of bread, H/D	0.56	0.61	0.60	0.58	0.55	0.53
Porosity of the crumb,%	73	75	67	65	62	54

To meet the body's needs in essential nutrients, it was important to determine the effect of different dosages of pumpkin seed flour on the nutritional value of the product (Table 5).

Table 5

Nutritional value of bread with the replacement of part of wheat flour with pumpkin seed flour

Indicators	**Control sample**	**Sample with lecithin**	**Pumpkin seed flour to replace wheat flour,%**			
			5	**10**	**15**	**20**
Proteins,%	8.10	8.10	9.23	10.35	11.48	12.60
Fats,%	1.09	3.06	3.36	3.66	3.96	4.26
Carbohydrates,%	52.97	52.97	51.20	49.43	47.65	45.88
Cellulose,%	2.65	2.65	2.97	3.30	3.62	3.94

Analysis of the chemical composition of bread prepared with partial replacement of wheat flour with pumpkin flour showed an increase in protein content by 13.9–55.5%, fiber – by 12.07-48.7% depending on its dosage in comparison with control sample made from wheat flour only that indicates enhancement of the nutritional value of products.

Conclusions

1. Pumpkin seed flour is high in protein and fiber. The use of this raw material for partial replacement of wheat flour in the bread recipe will make it possible to enrich products with protein and fiber and increase their nutritional value.
2. The gas-forming capacity of the dough with increasing dosage of pumpkin seed flour from 5% to 20% to replace wheat flour decreased by 1.9–7.4% compared to the control sample without pumpkin seed flour.
3. With the increase in the dosage of pumpkin seed flour, the amount of formed sugars decreased by 7.6-16.2%. This can be explained by the fact that pumpkin seed flour proteins form complexes with wheat starch and therefore impair the access of enzymes

to starch grains. However, the amount of fermented sugars increased by 16.9–20.3%, due to the depolymerization of carbohydrate additives.

4. The specific volume and porosity of bread decreased with increasing percentage of replacement of wheat flour by pumpkin seed flour. Therefore, from a technological point of view, it is rational to replace no more than 10% of wheat flour with this raw material.
5. The protein content in finished products with the replacement of 5–20% of wheat flour with pumpkin seed flour increased by 13.9–55.5% and fiber content increased by 12.07–48.7% that indicates enhancement of the nutritional value of the products.

References

Alshehry G.A. (2020), Preparation and nutritional properties of cookies from the partial replacement of wheat flour using pumpkin seeds powder, *World Journal of Environmental Biosciences*, 9(2), pp. 48–56, DOI: 10.24263/2304-974X-2021-10-3-8

Barabolia O. V. Kalashnyk O. V., Moroz S. E., Zhemela H. P., Yudicheva O. P., Serhiienko O. V. (2018), Vykorystannia napivfabrykativ harbuza dlia zbahachennia khliba pshenychnoho, *Visnyk Poltavskoi Derzhavnoi Ahrarnoi Akademii*, 4, pp. 76–80, DOI: 10.31210/visnyk2018.04.11

Dar A., Sofi S., Rafiq S. (2017), Pumpkin the functional and therapeutic ingredient: A review, *International Journal of Food Science and Nutrition*, 2(6), pp. 165–170. http://www.foodsciencejournal.com/archives/2017/vol2/issue6/2-5-50

Dotto J. M., Chachab J.S. (2020), The potential of pumpkin seeds as a functional food ingredient: A review, *Scientific African*, 10, e00575, DOI: 10.1016/j.sciaf.2020.e00575

Drobot V., Semenova A., Smirnova J., Mykhonik L. (2014), Effect of buckwheat processing products on dough and bread quality made from whole-wheat flour, *International Journal of Food Studies*, 3(1), pp. 1–12, DOI: 10.7455/ijfs/3.1.2014.a1

French S., Tangney C., Crane M., Wang Y., Appelhans B. (2019), Nutrition quality of food purchases varies by household income: the SHoPPER study, *BMC Public Health*, 19, DOI: 10.1186/s12889-019-6546-2

Gad K., Kholief T., Barakat H., El- masry S. (2019), Evaluation of pumpkin (*Cucurbita moschata*) pulp and seeds extracts on gastrointestinal ulcers induced by indomethacin in rats, *Journal of Scientific Research in Science*, 36(1), pp. 180-197, DOI: 10.21608/JSRS.2019.34277

Gedi A. M., Gedi M. A. (2022), Pumpkin seed oil components and biological activities, *Multiple Biological Activities of Unconventional Seed Oils*, pp. 171–184.

Hinkle D.E., Wiersma W., Jurs S.G. (2003), *Applied statistics for the behavioral sciences*, Boston, Mass: Houghton Mifflin, DOI: 10.1016/B978-0-12-824135-6.00030-1

Ivanov V., Shevchenko O., Marynin A., Stabnikov V., Gubenia O., Stabnikova O., Shevchenko A., Gavva O., Saliuk A. (2021), Trends and expected benefits of the breaking edge food technologies in 2021-2030, *Ukrainian Food Journal*, 10(1), pp. 7–36, DOI: 10.24263/2304-974X-2021-10-1-3

Jurgita K., Jariene E., Danilcenko H., Černiauskienė J., Wawrzyniak A., Hamulka J., Juknevičienė E. (2014), Chemical composition of pumpkin (*Cucurbita maxima D.*) flesh flours used for food, *Journal of Food Agriculture and Environment*, 12(3), pp. 61–64, DOI: 10.1234/4.2014.5357.

Kalyna V., Kondratiuk N., Uvarova N., Rozghon O., Bohuslavskyi V., Lytsenko M. (2021), Characteristics and composition of fractional products from pumpkin seeds, *Journal of Chemistry and Technologies*, 29(4), pp. 660–670, DOI: 10.15421/jchemtech.v29i4.243302

Kampuse S., Ozola L., Straumite E., Galoburda R. (2015), Quality parameters of wheat bread enriched with pumpkin (*Cucurbita Moschata*) by-products, *Acta Universitatis Cibiniensis Series E Food Technology*, 19(2), pp. 3–14, DOI: 10.1515/aucft-2015-0010

Lisowska T., Chorna N., Yukalo V. (2016), Study the structural and mechanical properties dough of flour mixture with extrudet corn flour, *Scientific Messenger of LNU of Veterinary Medicine and Biotechnologies. Series "Food Technologies"*, 18(2), pp. 51–55, DOI: 10.15421/nvlvet6810

López-Bascón M.A., de Castro M.L.(2020), Liquid-phase extraction, Elsevier, 11, pp. 327-354. https://www.elsevier.com/books/liquid-phase-extraction/poole/978-0-12-816911-7

Lyu Y., Bi J., Chen Q., Wu X., Qiao Y., Hou H., Zhang X. (2021), Bioaccessibility of carotenoids and antioxidant capacity of seed-used pumpkin byproducts powders as affected by particle size and corn oil during in vitro digestion process, *Food Chemistry*, 343, 128541, DOI: 10.1016/j.foodchem.2020.128541

Maehre H.K., Dalheim L., Edvinsen G.K., Elvevoll E.O., Jensen I. (2018), Protein determination—method matters, *Foods*, 7(1), pp. 5–14, DOI: 10.3390/foods7010005

Manual of methods of analysis of food, beverages, sugar and confectionery products. 2012; Lab. Manual 4. Available at: https://old.fssai.gov.in/Portals/0/Pdf/15Manuals/BEVERAGES,%20SUGARS%20&%20CONFECTINERY.pdf (accessed on 31 October 2021)

McCleary B.V., DeVries J.W., Rader J.I., Cohen G., Prosky L., Mugford D.C. Champ M., Okuma K. (2012), Determination of insoluble, soluble, and total dietary fiber (CODEX definition) by enzymatic-gravimetric method and liquid chromatography: collaborative study, *Journal of AOAC International*, 95(3), pp. 824–844, DOI: 10.5740/jaoacint.cs2011_25

Medvid I., Shydlovska O., Dotsenko V. (2018), The use of sunflower lecithin in the technology of glutenfree bread with enzymatic modification of flour starch, *Food and Environment Safety*, 17(4), pp. 352–362. http://fens.usv.ro/index.php/FENS/article/view/611

Munteanu G.M., Voicu G., Ferdeș M., Ștefan E.M., Constantin G.A., Tudor P. (2019), Dynamics of fermentation process of bread dough prepared with different types of yeast, *Scientific Study & Research*, 20(4), pp. 575–584. https://www.proquest.com/openview/441ae24785e6ae4e25ea62f950a156ac/1?pq-origsite=gscholar&cbl=716381

Mykolenko S., Hez Ya. (2017), Doslidzhennia vplyvu speltovoho i harbuzovoho boroshna na zminu spozhyvchykh kharakterystyk khliba, *Prodovolchi Resursy*, 9, pp. 228–234. https://iprjournal.kyiv.ua/index.php/pr/article/view/215

Partridge D., Lloyd K. A., Rhodes J. M., Walker A. W., Johnstone A. M., Campbell B.J. (2019), Food additives: Assessing the impact of exposure to permitted emulsifiers on bowel and metabolic health – introducing the FADiets study, *Nutrition Bulletin*, 44(4), pp. 329–349, DOI: 10.1111/nbu.12408

Patwa A., Malcolm B., Wilson J., Ambrose K. (2014), Particle size analysis of two distinct classes of wheat flour by sieving, *Transactions of the ASABE (American Society of Agricultural and Biological Engineers)*, 57(1), pp. 151–159, DOI: 10.13031/trans.57.10388

Pereira A., Krumreicha F., Ramos D., Krolow A., Santos R., Gularte M. (2018), Physicochemical characterization, carotenoid content and protein digestibility of pumpkin access flours for food application, *Food Science and Technology (Campinas)*, 40(2), pp. 691–698, DOI: 10.1590/fst.38819

Rakcejeva T., Galoburda R., Cude L., Strautniece E. (2011), Use of dried pumpkins in wheat bread production, *Procedia Food Science*, 1, pp. 441– 447, DOI: 10.1016/j.profoo.2011.09.068

Saavedra M. J., Aires A., Dias C., Almeida J. A., De Vasconcelos M. C. B. M., Santos P., Rosa E. A. (2015), Evaluation of the potential of squash pumpkin by-products (seeds and shell) as sources of antioxidant and bioactive compounds, *Journal of Food Science and Technology*, 52(2), pp. 1008–1015, DOI: 10.1007/s13197-013-1089-5

Stabnikova O., Marinin A., Stabnikov V. (2021), Main trends in application of novel natural additives for food production, *Ukrainian Food Journal*, 10(3), pp. 524–551, DOI: 10.24263/2304-974X-2021-10-3-8

Teri G., Luo L., Savage P. (2014), Hydrothermal Treatment of Protein, Polysaccharide, and Lipids Alone and in Mixtures, *Energy Fuels*, 28(12), pp. 7501–7509, DOI: 10.1021/ef501760d

Verheyen C., Albrecht A., Elgeti D., Jekle M., Becker T. (2015), Impact of gas formation kinetics on dough development and bread quality, *Food Research International*, 76(3), pp. 860–866, DOI: 10.1016/j.foodres.2015.08.013

Vinayashre S., Prasanna V. (2021), Biochemical, nutritional and functional properties of protein isolate and fractions from pumpkin (*Cucurbita moschata* var. *Kashi Harit*) seeds, *Food Chemistry*, 340, 128177, DOI: 10.1016/j.foodchem.2020.128177

Zhu F., Sakulnak R., Wang, S. (2016), Effect of black tea on antioxidant, textural, and sensory properties of Chinese steamed bread, *Food Chemistry*, 194, pp. 1217–1223, DOI: 10.1016/j.foodchem.2015.08.110

Zykova A., Pantyukhov P., Kolesnikova N., Popov A., Olkhov A. (2015), Influence of particle size on water absorption capacity and mechanical properties of polyethylene-wood flour composites, *AIP Conference Proceedings*, 1683(1), id.020242, DOI: 10.1063/1.4932932