

The object of this study is the production technology of bread with pumpkin paste. The task to enrich bread with pumpkin paste was resolved.

The influence of different amounts of pumpkin paste on the technological parameters of the quality of wheat bread and culinary quality was investigated. It was established that the addition of pumpkin paste influenced the technological parameters of the quality of bread. Bread baking loss decreased from 10.8 % to 9.9 with the addition of 5 % pumpkin paste. In the variant with 60 % pumpkin paste, the bread baking loss was 3.8 %. With the addition of 5–25 % of pumpkin paste to the bread recipe, bread shrinkage increased significantly to 4.2–4.3 % compared to control (3.5 %). A significantly larger volume was obtained by adding 25–30 % pumpkin paste. With this amount of paste, this indicator was 207–211 cm<sup>3</sup>/100 g of dough and 346–348 cm<sup>3</sup>/100 g of flour. With the addition of 35–60 % of pumpkin paste, the volume of bread was 330–338 cm<sup>3</sup>/100 g of flour. A significantly higher specific volume was obtained by adding 25–30 % of pumpkin paste – 2.0 cm<sup>3</sup>/g of dough and 2.3–2.4 cm<sup>3</sup>/g of bread. The addition of pumpkin paste increased the mass of bread from 133 to 135–166 g.

It was established that the organoleptic assessment of bread did not change from the amount of pumpkin paste. The smell, taste, pores in size and uniformity correspond to the highest level of assessment – 9 points. The elasticity and consistency of the crumb was at the level of 7 points. The surface of the crust corresponded to 3 points, the glossy surface – 3 points.

A distinctive feature of the research results is that in the technology of bread it is necessary to add 25–30 % of pumpkin paste. The use of this amount of pumpkin paste provides bread with a volume of 346–348 cm<sup>3</sup>/100 g of flour. The smell and taste of bread according to this recipe is high – 9 points.

The recommendations reported here can be used by small and medium size enterprises for the production of bakery

**Keywords:** pumpkin paste, bread, physical-chemical indicators, sensory indicators

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# DEVELOPMENT OF WHEAT BREAD RECIPE WITH PUMPKIN PASTE

**Vitalii Liubych**

Doctor of Agricultural Sciences, Professor\*

**Volodymyr Novikov**

Corresponding author

PhD, Associate Professor\*

E-mail: 1990vovanovikov1990@gmail.com

**Olexandr Pushka**

PhD, Associate Professor

Department of Agroengineering\*\*

**Iryna Pushka**

PhD, Associate Professor

Department of Horticulture\*\*

**Vladyslav Cherchel**

Doctor of Agricultural Sciences, Director

Institute of Grain Crops of the National Academy of Agrarian Sciences of Ukraine

Volodymyra Vernadskoho str., 14, Dnipro, Ukraine, 49009

**Mykola Kyrpa**

Doctor of Agricultural Sciences, Professor

Laboratory of Methods of Grain Storage and Standardization

Institute of Grain Crops of the National Academy of Agrarian Sciences of Ukraine

Volodymyra Vernadskoho str., 14, Dnipro, Ukraine, 49009

**Tetyana Kolibabchuk**

PhD, Senior Researcher

Verkhniatka Research and Breeding Station of the Institute of Bioenergy Crops

and Sugar Beet of the National Academy of Agrarian Sciences of Ukraine

Shkilna str., 1, Verhnyachka, Ukraine, 20022

**Viktor Kirian**

PhD, Deputy Director for Research, Head of Laboratory

Laboratory of Cereals

Ustymivka Experimental Station of Plant Production

Akademika Vavylova str., 15, Ustymivka, Ukraine, 39074

**Valentyn Moskalets**

Doctor of Agricultural Sciences, Senior Researcher\*\*\*

**Tetiana Moskalets**

Doctor of Biological Sciences, Associate Professor\*\*\*

\*Department of Food Technology\*\*

\*\*Uman National University of Horticulture

Instytutska str., 1, Uman, Ukraine, 20305

\*\*\*Department of Selection and Technological

Institute of Horticulture of the National Academy of Agrarian Sciences of Ukraine

Sadova str., 23, Novosilky vil., Kyiv reg., Ukraine, 03027

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## 1. Introduction

The human diet should include all components for the normal functioning of the body [1]. Carbohydrate deficien-

cy in the diet is lower compared to vitamins and dietary fiber [2]. The actual task of modern development is to improve production technologies with the maximum use of local resources. Pumpkin is a storehouse of vitamins and

dietary fiber. It is characterized by low-cost agrotechnology and low cost of production. However, it is not included in the products of daily consumption due to its specific smell and taste [3]. It is proved that the addition of fresh pulp or semi-finished products to flour products helps reduce the expression of the sensory properties of pumpkin [4]. In order to reduce vitamin deficiency, it is necessary to enrich the products of the daily diet by adding functional supplements [5].

Bread refers to products with stable demand among many segments of the population in the world. Thus, the volume of the bread and bakery market in the EU countries in 2018 amounted to 19.6 million tons [6]. In many countries, this indicator occupies a significant share in the market [7]. At the same time, bread is a carbohydrate-containing product. Consumption of 100 g of bread almost by half satisfies the needs of the human body with carbohydrates, by a third – proteins, by half – vitamins of group B. Bread satisfies the body's need for energy by 30 % [8]. Products from flour of the highest grade have a high energy capacity and low biological value. This is due to the fact that flour of the highest grade during grinding loses more than half of the biologically active compounds [9]. The authors of work [10] note that a significant consumption of bread contributes to an excessive intake of carbohydrates. This can provoke the development of a number of diseases. Therefore, the enrichment of bread with vitamins and dietary fiber is an important socio-economic task.

Pumpkin contains  $2.4 \pm 0.10$  % sugars,  $0.26 \pm 0.09$  vitamin C,  $0.50 \pm 0.08$  % carotenoids for the raw mass [11]. In addition, pumpkin carotene has antioxidant properties that can neutralize free radicals and prevent the development of malignant tumors [12]. Therefore, the addition of pumpkin processing products will contribute to the enrichment of useful components of bread.

Scientific research into the use of pumpkin-containing semi-finished products (pumpkin paste) is important for baking production. The results of such studies are necessary for practice since it will make it possible to effectively apply pumpkin paste in bread technology. In addition, the use of pumpkin paste will help enrich bread with vitamins and dietary fiber, expand its range. So, improving the quality of bread using natural raw materials of high biological value is an urgent task. Therefore, the use of pumpkin paste is an appropriate component for the development of bread recipes.

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## 2. Literature review and problem statement

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Pumpkin-containing semi-finished products are widely used in the technology of flour products [13]. Fruit and vegetable flour is usually preferred. This is due to easier storage and use in the formulation of products of such a product [14]. However, the cost of drying pumpkins is much higher compared to the production of pumpkin paste [15]. This is due to the high water content in the pumpkin pulp – 85–90 %, which must be removed [16]. It should be noted that regardless of the type of pumpkin processing product, the finished product is enriched with biologically active substances [17]. At the same time, culinary indicators of the quality of flour products change significantly.

Study [18] found that the addition of 10 % of pumpkin paste to the bread recipe significantly increased the content of  $\beta$ -carotene, thiamine, riboflavin, niacin, and ascorbic acid. The content of mineral elements also increased. However,

the research did not study the formation of the sensory properties of bread with pumpkin paste. In addition, it should be noted that the values of the integrated score were not determined for micro components.

Replacing 20 % of wheat flour with pumpkin paste helped improve the color of cookies [19]. Thus, with so much paste, the score of the color of the cookies increased from 5.8 to 7.7 points. If 30–40 % of wheat flour was replaced with pumpkin paste, this indicator was at the level of 7.1–7.4 points. In cookies, the amount of biologically active substances increased. However, the investigated amount of pumpkin paste concerns cookies. Their manufacturing technology is different from the production of bread.

In [20], the issue of the influence of extracts of some vegetables and fruits on the rheological properties of dough and wheat bread was investigated. It is proved that the use of extracts reliably increases the biological value of bread. At the same time, the volume of bread also changes. Adding pumpkin, pepper, and cabbage extract increased the volume of bread. With the addition of pomegranate extract and purple cabbage, this indicator decreased. However, the research results cannot be applied since the properties of the extract differ from pumpkin paste. In addition, studies have not studied different amounts of extract for the rheological properties of bread. The high biological and nutritional value of pumpkin and seeds is confirmed in the research by other scientists [21].

It should be noted that it is not always that the sensory indicators of products with pumpkin-containing products contribute to the improvement of physical and chemical indicators. Thus, in [22] it was found that the replacement of 10–40 % of wheat flour with pumpkin flour significantly reduced the volume of bread. At the same time, the organoleptic evaluation of bread with the addition of pumpkin flour deteriorated. Thus, in the version without pumpkin flour, the total culinary quality was 7.6 points, and when replacing wheat flour – 4.8–5.9 points. It is noted that the optimal is to replace wheat flour with 20 % of pumpkin flour. Nevertheless, the results of the cited paper can not be applied to pumpkin paste because it differs in properties from pumpkin flour.

Experimental studies [23] confirmed that the use of wheat flour and pumpkin seed flour in the ratio of 2:2, 1.5:2, 1:2, and 1:1 did not reliably affect the culinary quality of cookies. At the same time, for a ratio of 2:1, this indicator significantly decreased. However, the results of these studies can not be applied to bread because they relate to the technology of cookies. In addition, the technological properties of pumpkin seed flour are significantly different from pumpkin paste.

Hence, most scientific studies concern the use of flour from seeds or pumpkin pulp. Nevertheless, regardless of the type of pumpkin-containing semi-finished product, in the end, the finished product has a higher biological value. The schemes of experiment of works given above [19–22] do not always contain the minimum and maximum influence of the investigated factor. This makes it impossible to establish the optimal amount of pumpkin-containing semi-finished product in the finished product. The influence of different amounts of pumpkin paste on the organoleptic quality indicators of the finished product has not been reasonably established. In addition, the issue of the level of smell and taste of pumpkin in products was not studied. Therefore, we require additional research into the technology of enriching bread with pumpkin paste. Thus, it is advisable to develop a recipe for enriching bread with pumpkin paste, based on the

principles of obtaining a finished product with high organoleptic characteristics.

### 3. The aim and objectives of the study

The aim of this study is to devise a recipe for bread by enriching it with pumpkin paste. The use of pumpkin paste will expand the range of bakery with the products of high biological value.

To accomplish the aim, the following tasks have been set:

- to determine the physical and chemical indicators of the quality of bread with the addition of pumpkin paste;
- to establish the sensory properties of bread with pumpkin paste;
- to determine the indicators of the generalized function of desirability with the addition of pumpkin paste.

### 4. Materials and research methods

#### 4.1. The object and hypothesis of research

The object of our study was the technology of bread production. The main hypothesis of the research was based on a change in the rheological properties of bread and its sensory properties as a result of the addition of different amounts of pumpkin paste.

The main assumptions of the work concerned changes due to the addition of different amounts of pumpkin paste. This could potentially affect the physicochemical and organoleptic parameters of the finished product. We required clarification of the assumption regarding the sensory properties and appearance of the finished product depending on the amount of pumpkin paste as an important factor in its further implementation.

#### 4.2. Raw materials

For the study, wheat flour of the highest grade was used (gluten content – 28.5 %, gluten deformation index – 92 units GDM (gluten deformation meter)). We used large-fruited pumpkin (*Cucurbita maxima* Duch.), the variety Atlantic giant (Ukraine). The production technology of pumpkin paste included cleaning the pulp from the peel and cooking until a homogeneous mass is formed. After that, the paste was packaged in jars and sterilized in an autoclave at  $t=100\pm 2\text{ }^\circ\text{C}$  for 40 min. Before use, the paste was crushed in a blender until smooth.

#### 4.3. Program, methodology, equipment

The research was carried out in the laboratory at the Department of Food Technologies of the Uman National University of Horticulture (Ukraine).

The dough for bread was prepared according to a recipe that included wheat flour of the highest grade 100 g, kitchen salt 1.5 g. Water and pumpkin paste were added according to the recipe (Fig. 1). First, wheat flour, yeast was added to the dough mixing machine, then pumpkin paste and salt. The temperature of the products is 28–30 °C. We kneaded the dough to a uniform consistency. Fermentation duration is 60 min. The fermentation temperature in the thermostat is 28 °C. After that, the dough was processed, formed, placed in a thermostat (temperature 28–32 °C). After the product

matured, we baked it in the oven (temperature, 200–220 °C) for 15–20 minutes. Before baking and at the end, the surface of the bread was moistened with water.

Given that excess dough humidity is an undesirable phenomenon, during the experiment a simplified technology for the production of bread was used. Enrichment with moisture-containing raw materials was based on reducing the amount of water in the bread recipe. This did not require adapting the experiment plan. Flour moisture content was 12.1 %. The moisture content of the dough was 43.3 %.

The research program corresponded to the acting standard DSTU 7517:2014. Bread made from wheat flour. General specifications.

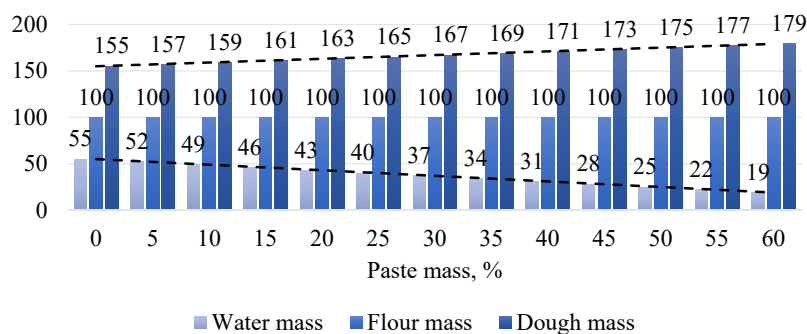


Fig. 1. Proportions of the main components of the dough enriched with pumpkin paste

Bread baking loss was determined by the formula:

$$Y = \frac{m_1 - m_2}{100 \times m_1}, \tag{1}$$

where  $Y$  is the bread baking loss, %;

$m_1$  – dough weight, g;

$m_2$  – mass of hot bread, g.

The bread shrinkage was determined by the formula:

$$Y = \frac{m_1 - m_2}{100 \times m_1}, \tag{2}$$

where  $Y$  is the bread shrinkage, %;

$m_1$  – mass of hot bread, g;

$m_2$  – mass of cold bread, g.

Specific volume from the formula:

$$V_p = \frac{V}{m}, \tag{3}$$

where  $V_p$  is the specific volume,  $\text{cm}^3/\text{g}$  of dough (bread);

$V$  – volume of bread,  $\text{cm}^3$ ;

$m$  – mass of dough (bread), g.

The volume was determined by the difference between the volume of the container filled with small-seeded crop without bread and with it.

Sensory indicators of bread were determined on an improved scale [24]. In accordance with the methodology, the crust surface, the elasticity and consistency of the crumb, the size and uniformity of the pores were determined. In addition, the determination of smell and taste from the point of view of the consumer was carried out. We analyzed the smell and taste of pumpkin in bread samples.

Determining organoleptic indicators of the quality of products enriched with unconventional raw materials differs from classical methods. At the same time, the level of smell and taste of pumpkin and the consumer parameters of the product were established. The examination was carried out by a qualified board (5 people) with a general level of competence in solving similar problems of at least 80 %. The bread baking loss, shrinkage, the volume of bread, specific volume, and the mass of bread were checked for consistency of statements by calculating the concordation indicator. For the analysis, the coordinated results of sensory examination were selected from experts.

**4. 4. Statistical treatment of data**

The experimental part had four analytical repetitions that were randomized in time to exclude the influence of other factors. Data processing was carried out using the specialized software Microsoft Excel 2016 (Microsoft Corporation, USA) and Statistica 12 (StatSoft-Statistica Ultimate Academic, Ukraine) in accordance with the guidelines given in [25, 26].

**5. Results of investigating the quality of bread with the addition of pumpkin paste**

**5. 1. The physical and chemical indicators of bread enriched with pumpkin paste**

It was found that the addition of pumpkin paste at 10–60 % significantly reduced the bread baking loss (Fig. 2). Thus, this indicator decreased to 3.8% in the variant with the largest amount of paste. It should be noted that there was no reliable difference between the options with the addition of 10–25 % of paste. A similar trend was found in the variant with the addition of 30–60 % of pumpkin paste.

The tendency to change the shrinkage of bread with the addition of pumpkin paste was different. Thus, with the addition of 5–25 % of paste, this indicator significantly increased to 4.2–4.3%. The addition of 30–60 % of pumpkin paste provided a significant reduction compared to options where 5–25 % of paste was used. At the same time, this indicator was significantly higher compared to the control (3.5%).

The use of 25–30 % of pumpkin paste significantly increased the volume of bread from 298 to 346–348 cm<sup>3</sup>/100 g of flour (Fig. 3). The addition of 35–60 % of paste also significantly increased this indicator (329–344 cm<sup>3</sup>/100 g of flour) compared to the control, but not reliably compared to the addition of 25 % of paste.

It should be noted that the volume of bread in terms of 100 g of dough was 1.5–1.6 times lower compared to the indicator per 100 g of flour. The use of 25–30 % of paste significantly increased this indicator – 207–211 cm<sup>3</sup>/100 g of dough. The use of 5–20 % of paste did not significantly affect this indicator compared to the control. In addition, the use of 35–60 % of paste also did not reliably affect the volume of bread – 190–200 cm<sup>3</sup>/100 g of dough.

The tendency to change the specific volume was similar to the volume of bread. Thus, 1 g of dough accounted for 2.1 cm<sup>3</sup> of bread with the addition of 25–30 % of pumpkin paste (Fig. 4). It should be noted that reliably this indicator was influenced by the use of 25–30 % of paste. The remaining combinations did not affect reliably. The use of 40–60 % of pumpkin paste provided a specific volume at the level of the control option – 1.9 cm<sup>3</sup>/g of dough.

The specific volume per 1 g of bread was higher compared to this indicator by 1 dough. A significant increase in this indicator was ensured by the use of 25 % of pumpkin paste in the technology of bread (2.4 cm<sup>3</sup>/g of bread). In the remaining variants of the experiment, the impact was not reliable. At the same time, the use of 45–60 % of pumpkin paste significantly reduced this indicator to 2.1–2.2 cm<sup>3</sup>/g of bread.

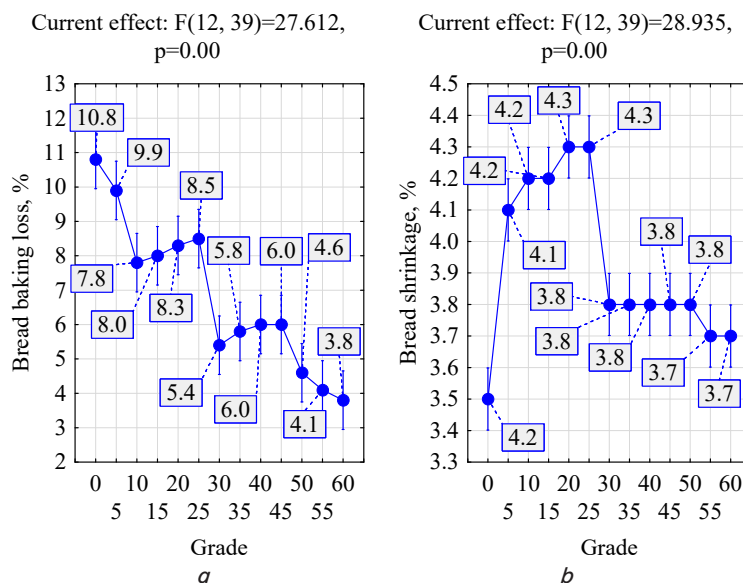


Fig. 2. Bread baking loss and bread shrinkage with the addition of pumpkin paste: a – bread baking loss; b – bread shrinkage

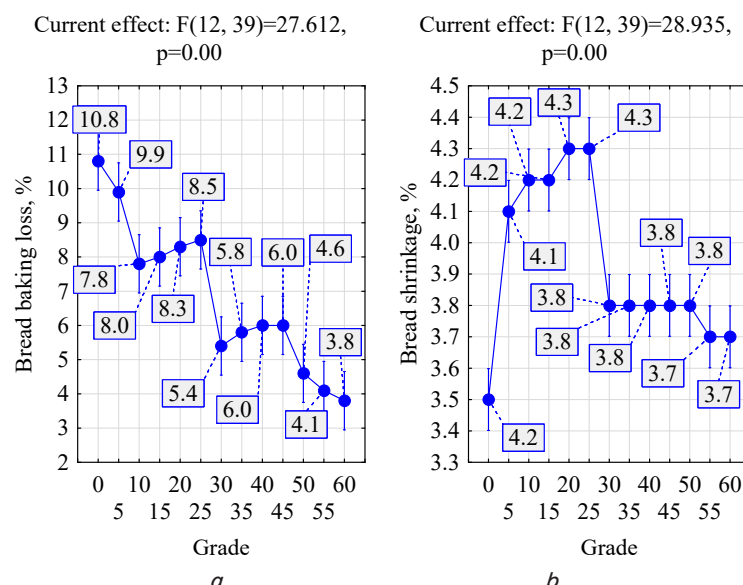


Fig. 3. The volume of bread with the addition of pumpkin paste: a – the volume of bread from 100 g of flour; b – the volume of bread from 100 g of dough



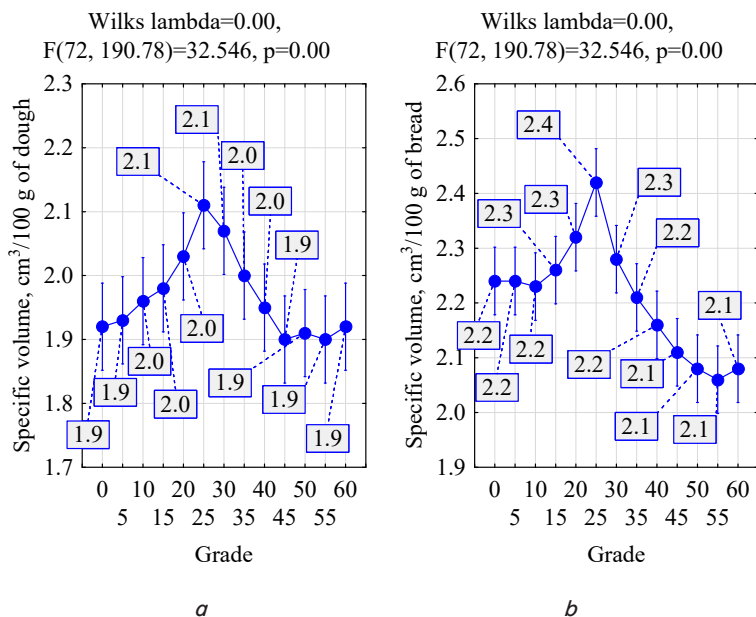


Fig. 4. Specific volume of bread with the addition of pumpkin paste: a – the specific volume of bread per 1 g of dough; b – the specific volume per 1 g of bread

Research results show that the use of 25–60 % of pumpkin paste significantly increased the mass of bread to 144–166 g or 8–25 % compared to the control (Fig. 5). The use of 5–20 % of paste did not provide a reliable effect.

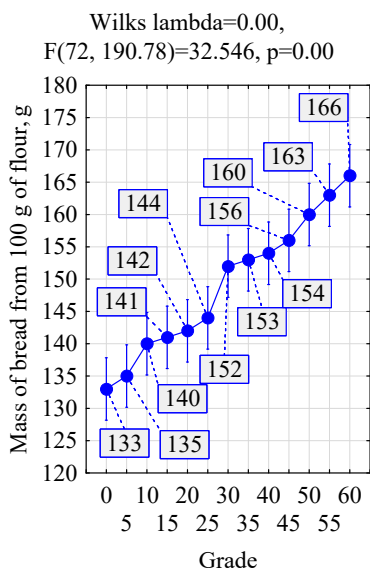


Fig. 5. The mass of bread with the addition of pumpkin paste

It is necessary to pay attention to the fact that the use of pumpkin paste at an amount of 25 % significantly increased the volume of bread. In addition, in the technology of bread with pumpkin paste, it is necessary to take into account that the mass of the product will increase.

**5.2. The sensory properties of bread enriched with pumpkin paste**

Studies show that the use of pumpkin paste changed the organoleptic indicators of the quality of bread (Table 1). In variants with the addition of 5–25 % of pumpkin paste, the

color of the bread crust did not differ from the control version, which was light brown. The addition of 30–60 % of paste ensured the formation of a golden crust.

The color of the crumb changed even with minimal paste addition. It should be noted that at the amount of 5–15 %, the color of the crumb was cream. The addition of 20–30 % of paste changed this indicator to light yellow. In the amount of 35–45 % of paste in the bread recipe, the color of the crumb was yellow, and at 50–60 % – dark yellow.

The consistency of the crumb of bread in all versions of the experiment was quite tender, juicy, and soft. With the addition of pumpkin paste, a sweet taste appeared. Thus, at 5–15 % of paste in the bread recipe, the sweet taste was not felt. With the addition of 20–50 % of paste, the taste of bread crumb was sweetish, and at 55–60 % – very sweet.

Research results show that the organoleptic characteristics of bread did not change from the amount of pumpkin paste. Thus, the pores were small, thin-walled, evenly placed in all samples of bread – 9 points (Fig. 6). The smell and taste of bread from the point of view of the consumer was excellent in all variants of the experiment.

At the same time, the smell and taste of pumpkin in bread was not felt – 9 points. The elasticity and consistency of the crumb was at the level of 7 points. The surface of the bread was barely rough, with short cracks that do not pass through the entire surface and explosions up to 0.5 cm wide, occupying up to 25 % of the crust surface – 5 points. Gloss occupied up to 25 % of the surface of the bread crust, which corresponded to 3 points.

Table 1

Organoleptic indicators of the quality of bread with the addition of pumpkin paste

Variant of the experiment	Indicator		
	Crust color	Crumb color	Crumb consistency
Control	light brown	white	quite tender, quite juicy, soft
5	light brown	creamy	quite tender, quite juicy, soft
10	light brown	creamy	quite tender, quite juicy, soft
15	light brown	creamy	quite tender, quite juicy, soft
20	light brown	light yellow	quite tender, quite juicy, soft, sweet
25	light brown	light yellow	quite tender, quite juicy, soft, sweet
30	golden	light yellow	quite tender, quite juicy, soft, sweet
35	golden	yellow	quite delicate, quite juicy, soft, sweet
40	golden	yellow	quite delicate, quite juicy, soft, sweet
45	golden	yellow	quite delicate, quite juicy, soft, sweet
50	golden	dark yellow	quite tender, quite juicy, soft, very sweet
55	golden	dark yellow	quite tender, quite juicy, soft, very sweet
60	golden	dark yellow	quite tender, quite juicy, soft, very sweet

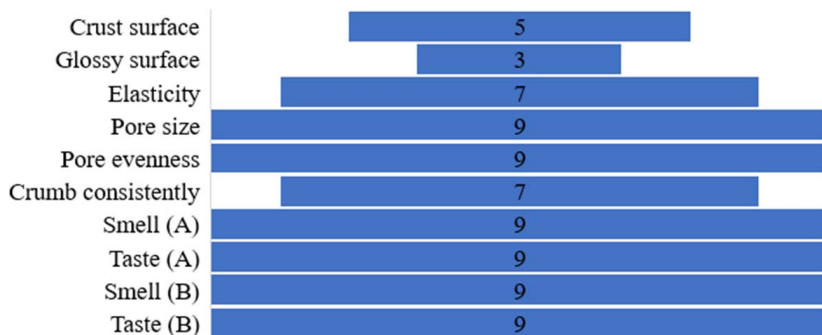


Fig. 6. The sensory properties of all bread samples: smell (A) – smell from the consumer’s point of view; smell (B) – the smell of pumpkin; taste (A) – taste from the point of view of the consumer; taste (B) – pumpkin taste

It is necessary to pay attention to the fact that the use of pumpkin paste did not affect the smell and taste of bread from the point of view of the consumer. In addition, the smell and taste of pumpkin in bread was not found. At the same time, the use of pumpkin paste did not change the surface of the crust, gloss, elasticity, pores in uniformity and consistency of the crumb.

**5. 3. Determination of the indicator of the generalized desirability function when enriching bread with pumpkin paste**

During the construction of the generalized desirability function, the dependences of the volume of bread and its mass depending on the amount of pumpkin paste added were taken into account. The criteria for desirability are established: the maximum volume and weight of the product. The obtained results indicate a significant increase in the level of desirability with an increase in the amount of added paste to 25 % (Fig. 7). A further increase in the amount of paste added reduced the level of desirability.

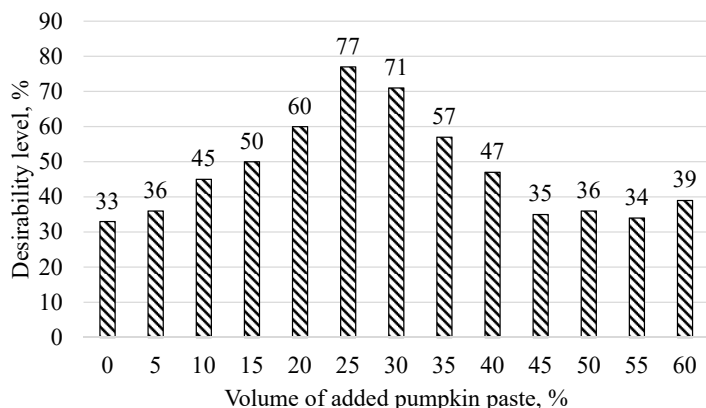


Fig. 7. Generalized function of desirability of indicators of bread enriched with pumpkin paste

Taking into account the technological parameters of the quality of bread, it is optimal to use 25 % of pumpkin paste. In addition, the addition of 30 % of paste did not significantly reduce the volume of bread. Therefore, in the bread recipe, it is possible to add pumpkin paste with an amount of 25–30 % by weight of flour. It should be noted that the organoleptic assessment of bread did not change from the amount of pumpkin paste. This makes it possible to apply

a greater amount of paste in the bread recipe.

**6. Discussion of results of the study of expanding the range of bread enriched with pumpkin paste**

It should be noted that the addition of pumpkin paste to the bread recipe changes the physicochemical indicators of its quality. At the same time, the level of organoleptic assessment does not change. The use of pumpkin paste helps reduce the bread baking loss (Fig. 2). This indicates that the moisture in the crumb of bread is retained better with the addition of pumpkin paste. The bread baking loss is 3.5–4.3 %.

The increase in the volume of bread with the addition of pumpkin paste is explained by the presence of simple carbohydrates, which are used by yeast more effectively during fermentation (Fig. 3, 4). Obviously, enhanced fermentation causes a higher release of carbon dioxide and an increase in the volume of bread. At the same time, this trend is established with the addition of 25–30 % of pumpkin paste. The subsequent increase in the amount of paste in the bread recipe does not contribute to an increase in this indicator. This indicates that the optimal amount of pumpkin paste in the bread recipe can be 25–30 %. The duration of fermentation does not differ from the control sample.

The increase in the mass of bread confirms the lower moisture yield when baking bread with added pumpkin paste (Fig. 5). Therefore, the mass of bread after baking increases.

The use of pumpkin paste in the bread recipe changes the organoleptic indicators of its quality (Table 2). At the same time, changes in the surface of bread and the color of the crumb are due to the presence of coloring substances in the paste. This has been proven in studies [27], where the addition of fruit and vegetable raw materials changed the sensory performance of bread due to coloring substances. Other studies [28] have found that the sweet taste of bread crumb is due to the presence of pumpkin sugar in the paste. Therefore, an increase in the amount of paste helps enhance the expression of sweet taste in bread samples.

Studies show that the level of sensory quality (surface color, crumb, and sweet taste) of bread is influenced by the amount of pumpkin paste (Fig. 6). It should be noted that the taste and smell of bread from the point of view of the consumer was high in all prototypes. The smell and taste of pumpkin was not noticeable. This result is possible due to the fermentation process of the dough. During this process, the aromatic substances of pumpkin can transform or combine with fermentation products. The expressed conclusion is confirmed in studies [29, 30] as the organoleptic evaluation of the finished product increases.

It is statistically confirmed that in the technology of bread it is possible to add 25–30 % of paste. The use of this amount of pumpkin paste provides bread with a volume of 346–348 cm<sup>3</sup>/100 g of flour. The smell and taste of bread according to this recipe is high – 9 points.

Our results of the study on smell and taste indicate a great prospect of using pumpkin paste in the technology of bread. A high organoleptic assessment of bread with pumpkin paste indicates the demand for such a product on the market. In addition, the technological parameters of the quality of bread (volume of bread) with the addition of pumpkin paste did not deteriorate.

A feature of the findings in comparison with existing studies [31] in this area is the establishment of the optimal amount of pumpkin paste in the bread recipe. It should be noted that in studies [32] the question of the possible amount of pumpkin paste in bread technology was not studied. The scheme of the experiment included 3–5 combinations of the use of pumpkin paste. In addition, a feature of the proposed method of enriching bread is the differentiated use of pumpkin paste. So, for the production of bread without a sweet taste, it is necessary to add 5–15 pumpkin pastes. In the technology of obtaining bread with a sweetish taste, it is necessary to add 20–30 % of pumpkin paste. The sweet taste of bread is provided by the addition of 35–50 % of pumpkin paste.

The use of the proposed method will allow enterprises of different productivity without significant changes in the technological process to apply pumpkin paste in bread technology. The obtained results regarding the volume of bread allow us to form accurate forecasts of the culinary quality of the finished product at the stage of formulation of the recipe. This is of practical importance and minimizes the financial risks associated with the adaptation period of technology implementation. Increasing market share of pumpkin-enriched products is projected to stimulate its producers and specialized processing plants in the future.

The limitation of the research is the use of paste from one type of pumpkin – *Cucurbita maxima* Duch., the variety Atlantic giant. The use of other types or varieties of pumpkin will require additional research. Sensory indicators of the quality of pumpkin pulp varies significantly depending on its variety [33]. In addition, the optimal amount of pumpkin paste is designed for the traditional bread recipe. In the recipe of other varieties of bread, it is also necessary to conduct additional research on the effect of pumpkin paste on the culinary quality of the product.

The disadvantage of the study is the use of only one type and variety of pumpkin. The use of recommendations for another type of pumpkin may not provide a result in accordance with the current paper. In addition, the research results can not be used for pumpkin flour and fresh pumpkin because they have different properties.

The advancement of this study is to expand information about the physicochemical indicators of the quality of bread enriched with pumpkin. In addition, a more detailed study of the issue of optimal conditions and storage parameters for pumpkin products is needed. We require additional determination of the biological and nutritional value of the products obtained.

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## 7. Conclusions

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1. It was established that the addition of pumpkin paste influenced the physical-chemical indicators of the quality of bread. Bread baking loss decreased from 10.8 to 9.9 % with the addition of 5 % of pumpkin paste. In the variant of 60 % of pumpkin paste, the bread baking loss was 3.8 %. The shrinkage of bread grew with the addition of pumpkin paste. With the addition of 5–25 % of pumpkin paste to the bread recipe, this indicator significantly increased to 4.2–4.3 % compared to control (3.5 %). At 30–60 % of pumpkin paste, the bread shrinkage was 3.7–3.8 %. A significantly larger volume was obtained by adding 25–30 % of pumpkin paste. With this amount of paste, this indicator was 207–211 cm<sup>3</sup>/100 g of dough and 346–348 cm<sup>3</sup>/100 g of flour. With the addition of 35–60 % of pumpkin paste, the volume of bread was 330–338 cm<sup>3</sup>/100 g of flour. A significantly higher specific volume was obtained by adding 25–30 % of pumpkin paste – 2.0 cm<sup>3</sup>/g of dough and 2.3–2.4 cm<sup>3</sup>/g of bread. The addition of pumpkin paste increased the mass of bread from 133 to 135–166 g.

2. It was established that the sensory indicators of the quality of bread did not change from the amount of pumpkin paste. Smell, taste, pores in size and uniformity correspond to the highest level of assessment – 9 points. The elasticity and consistency of the crumb was at the level of 7 points. The surface of the crust corresponded to 3 points, the glossy surface – 3 points. At the same time, the color of the crust and crumb changed. In addition, with the addition of pumpkin paste at an amount of 20–60 %, the sweet taste of the crumb appeared.

3. In the technology of bread, in terms of the volume of bread and its mass, it is necessary to add 25–30 % of paste. The use of this amount of pumpkin paste provides bread with a volume of 346–348 cm<sup>3</sup>/100 g of flour. The smell and taste of bread according to this recipe is high – 9 points.

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## Conflicts of interest

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The authors declare that they have no conflicts of interest in relation to the current study, including financial, personal, authorship, or any other, that could affect the study and the results reported in this paper.

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## Data availability

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All data are available in the main text of the manuscript.

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