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# SUBSTANTIATION OF THE USE OF SPICE PLANTS FOR ENRICHMENT OF WHEAT BREAD

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*Проведено дослідження можливості застосування малопоширених пряно-смакових рослин під час виготовлення хліба пшеничного. Експериментально обґрунтовано та впроваджено заміну частини рецептурної кількості борошна на висушені і розмелені ефіроносні, технічні, пряно-смакові та овочеві рослини під час виготовлення хліба. За визначеними фізико-хімічними, органолептичними показниками хліба підтверджено можливість виготовлення хліба з додаванням рослин*

*Ключові слова: пікнантемум тонколистий, лобода квіноа, монарда двійчаста, агастахіс зморшкуватий, вітекс коноплеподібний, ельшольція Стаунтона, м'ята колоскова Мароканська, нові рецептури, хлібні вироби*

*Проведено исследование возможности применения редких пряно-вкусовых растений при изготовлении хлеба пшеничного. Экспериментально обоснована и внедрена замена части рецептурного количества муки на высушенные и размолотые эфирноносные, технические, пряно-вкусовые и овощные растения при изготовлении хлеба. По определенным физико-химическим, органолептическим показателям хлеба подтверждена возможность изготовления хлеба с добавлением растений*

*Ключевые слова: пикнантемум тонколистый, лебеда квиноа, монарда двойчастая, агастахис морщинистый, витекс коноплеподобный, ельшольция Стаунтона, мята колосковая Марокканская, новые рецептуры, хлебные изделия*

## 1. Introduction

Selection of wheat varieties with certain technological characteristics provides high-quality bakery products [1]. Spice, aromatic, volatile-oil-bearing plants are rich in

essential aromatic oils, vitamins, minerals that impart phytoncidic, prophylactic, therapeutic, functional properties to products, improve food taste, and enhance digestion [2, 3]. Since there is little data on the application of such plants of Ukrainian origin in bread making, it is important to deepen

and broaden the research in order to scientifically substantiate the ways and methods of their rational use, study the potential of spice plants as raw materials, and expand the range of bakery products [4]. The favorable proportion of the components of the chemical composition of the latter makes it possible to produce new types of functional products [5].

In order to develop an effective technology for the use of plant additives, create new types of products with the properties that meet today's needs of consumers in Ukraine and the world, it is necessary to clarify the relationship between the components of spice plants and other components [1].

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## 2. Literature review and problem statement

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Wheat production should account for about a half of the total grain production in Ukraine [6]. It is proposed to draw special attention to the increase in the yield and quality of valuable wheat varieties to produce high-quality bread, pasta, and groats [7].

Phytonutrients should be used when developing bakery products for special purposes: enriched, dietary, therapeutic, child nutrition, with immunomodulatory, antioxidant, radioprotective, tonic and other physiological properties [8].

Spice herbs with antioxidant and antibacterial properties can be viewed as a means to stabilize the properties of long-term storage products, such as dried crusts, toast, to prevent microbial, oxidative damage [9, 10].

An important positive result of using spice herbs is also revealed in bread baking [11]. It is important to reduce the chemical load on the human body for solving the pressing problems of the industry [12].

In bread making, it is necessary to reduce or exclude the use of enhancers and other food additives [13].

Wheat bread contains the nutrients necessary for humans [14]. Bread contains proteins, carbohydrates, vitamins B, PP, mineral compounds, for example, vital salts of calcium, iron, phosphorus [15]. Bakery products are high in calories, 100 g of wheat bread contains 245–255 kcal [16]. In Ukraine, the issue of producing competitive products that could be sold in European countries and would comply with generally accepted standards is gaining popularity [17].

Although the existing range of bread is quite diverse, it is necessary to carry out extensive work to expand and improve the range of bakery products, create new dietary and therapeutic varieties of bread. Improvement of product quality, development of the range of products, including those for dietary purposes, development of technological regimes of their preparation, is an urgent problem for the baking industry [18].

Addition of spice herbs is expected to improve consumer properties of food, which will also affect the chemical composition, nutrient digestibility, energy value, biological and organoleptic characteristics [19, 20].

Since there is little data on the application of such plants of Ukrainian origin in bread making, it is important to deepen and broaden the research in order to scientifically substantiate the ways and methods of their rational use, study the potential of spice plants as raw materials, develop optimum technological modes of proofing and baking of bread of new formulations and expand the range of bakery products. The favorable proportion of the components of the chemical composition of the latter will make it possible to produce new types of functional products.

So, the issue of developing new types of food products by improving existing formulations remains relevant and requires immediate resolution through additional research.

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## 3. The aim and objectives of the study

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The research was aimed at determining the technological suitability of the grain of wheat variety Smuglyanka for flour and bread production and the use of rare volatile-oil-bearing, technical, spice and vegetable plants for bread making. This will expand the range of bakery products.

To achieve this aim, the following objectives were accomplished:

- to investigate technological parameters of flour of wheat variety Smuglyanka;
- to determine physicochemical, organoleptic parameters of bread;
- to determine the optimum prescription dosage of plant components in the production of bread of new formulations.

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## 4. Materials and methods for studying the quality of flour and bread of new formulations and physicochemical, organoleptic parameters

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### 4.1. Research materials and equipment used in the experiment

Grain of soft spring wheat of variety Smuglyanka, used in the study, was grown on the pilot field of the farm “Bodnyuk” in Graniv village, Haysin district, Vinnytsia region.

The plants used for bread making: Narrowleaf Mountainmint (*Piknanthemum trifolium L.*), Quinoa (*Chenopodium quinoa L.*), Scarlet Beebalm (*Monarda didyma L.*), Korean Mint (*Agastache rugosa L.*), Hemp Dogbane (*Vitex cannabinum L.*), Mint-shrub (*Elsholtzia Stauntonii L.*), Moroccan Spearmint (*Mentha spicata Moroccan L.*).

The plants are grown in the northern part of the Right-Bank Forest-Steppe of Ukraine on the fields of the laboratory of medical botany of the M. M. Hryshko National Botanic Garden of NAS of Ukraine.

The materials and methods for studying the quality of flour and bread of new formulations and physicochemical, organoleptic parameters are described in more detail in [1].

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## 5. Results of studying the quality indicators of flour and bread

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Organoleptic and baking indicators of flour from wheat variety Smuglyanka are given in Table 1.

According to the evaluation of wheat flour (on the example of high-grade flour) in comparison with the standards, compliance of organoleptic properties (color, smell, taste) to the norms [7] for the high-grade flour is determined. The investigated flour has a smell and taste peculiar to wheat flour, without foreign smells and flavors. There is no crunch when chewing the flour.

Table 1 shows that grain of wheat variety Smuglyanka has stable high bakery properties.

Thus, the gluten content in flour from wheat variety Smuglyanka corresponds to the gluten content of the high-grade flour and is 26 %, which is 2 % higher than the lower limit of the standard.

Table 1

## Quality indicators of flour from wheat variety Smuglyanka

Indicator		Allowable rate (DSTU ISO 46.004-99)* [7]	Actual quality	Conclusion on compliance
Color		white, white with a yellowish shade/"/white with a yellow or gray shade	white	Complies
Smell		peculiar to wheat flour, without foreign smells, not fusty, not musty.	peculiar to wheat flour, without foreign smells, not fusty, not musty.	Complies
Taste		peculiar to wheat flour, without foreign flavors, not sour, not bitter. There should not be crunch when chewing	peculiar to wheat flour, without foreign flavors, not sour, not bitter. There should not be crunch when chewing	Complies
Humidity, %, up to		15	11.0	Complies
Amount of raw gluten, %		at least 24.0/25.0/21.0	26.0	high grade
Gluten quality	group	I-II/I-II/I-II	II	Complies
	units of the IDK device	45–100	82	
Whiteness, c. u. of the Skyb-M device		at least 54/36–53/12–35	58	high grade
Acidity, deg.		up to 3.0/3.5/4.5	2.2	high grade
Falling number, s, at least		160	442	Complies

Note: \* – up to the dash – high grade; after the dash – 1st/2nd grades

The readings of the IDK device in terms of gluten quality of flour from the wheat of the specified grade (82 units) correspond to the quality group II and are characterized as satisfactory weak gluten.

It was found that the falling number for flour from wheat variety Smuglyanka is 442 s, which is almost 3 times more than the established requirements.

In the sample of flour from wheat variety Smuglyanka, the value of acidity corresponds to the high-grade flour (2.2°).

Taking into account the readings of the Skyb-M device (58 units), the studied flour was attributed to a high grade.

So, all quality indices of flour from wheat variety Smuglyanka are in acceptable limits and correspond to the optimum level for obtaining high-quality bread.

A good water absorption capacity of flour was noted, the dough was quickly kneaded (2 min), had a good consistency for about 1 min, after which it actively fermented.

To prepare the plant powder, an overground green part of the plants, which has been dried, ground in a laboratory mill to a particle size of  $10^{-4}$ – $10^{-1}$  mm, and mixed to take a weighed prescription sample was used. To prepare the flour of Quinoa, seeds of Quinoa, which have been ground in a laboratory mill to a particle size of 30–40 microns and mixed for taking a weighed prescription sample were used.

Photos of the bread are shown in Fig. 1–3.

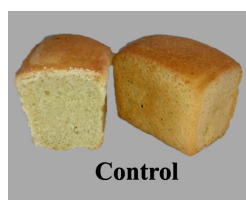


Fig. 1. Photo of bread made of flour from wheat variety Smuglyanka (control)

According to organoleptic parameters, wheat bread (control) complies with the established requirements: the surface – smooth, without large cracks and blows; the crumb – elastic, quickly restores the original shape, well-baked, not moist, not sticky, with the developed uniform porosity, without hardening; the color of the crumb – white; taste and smell – corresponds to the name of bread, without foreign taste and smell.

The quality of bread of new formulations is somewhat different from that of control samples: the color of the crumb – light and dark yellow, brown, greenish (Fig. 2, 3); taste and smell – peculiar to the added plants.

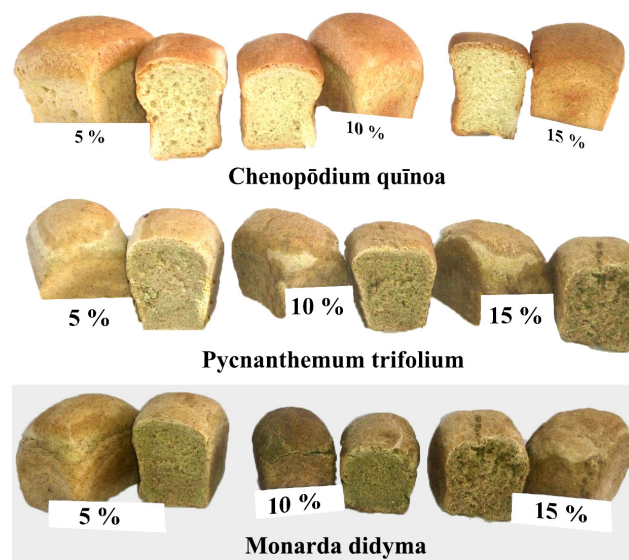


Fig. 2. Photo of bread with the addition of 5, 10 and 15% of flour from Quinoa (lat. *Chenopodium quinoa* L.) seeds and powder of Narrowleaf Mountainmint (lat. *Pycnanthemum trifolium* L.) and Scarlet Beebalm (lat. *Monarda didyma* L.)

The powder of the plants contained anthocyanic pigments and had a pronounced color. The expediency of introducing up to 5 % of Scarlet Beebalm powder; up to 10 % of the air-dry raw material of Narrowleaf Mountainmint and up to 10 % of the flour of Quinoa grain into wheat dough was revealed. Such bread had a uniformly colored (light yellow, greenish, dark brown) crust without blows and cracks, elastic crumb, thin-walled porosity, pronounced bread taste and a pleasant aroma of additives.

The results of physicochemical analysis of bread from flour, obtained from wheat variety Smuglyanka of different formulations are shown in Table 2.

Table 3 shows the organoleptic quality characteristics of bread from wheat flour and new formulations.

Table 4 shows the organoleptic quality indicators of bread with the addition of powder of Narrowleaf Mountainmint, Mint-shrub, Hemp Dogbane, Moroccan Spearmint.

The bread of flour from wheat variety Smuglyanka (control) (Fig. 1, Table 3) and with the addition of up to 5 % of flour from Quinoa grain (Fig. 2, Table 3) is estimated to be excellent (4.8 and 4.6 points). Whereas, good (4.0–4.2 points) – bread with the addition of up to 5 % of Scarlet Beebalm, up to 10 % of powder of air-dry raw material of Narrowleaf Mountainmint and 10 % of flour from Quinoa grain (Fig. 2, Table 3). For the remaining samples (Fig. 3, Table 4), a satisfactory overall baking score (3.0–3.7 points) was determined.

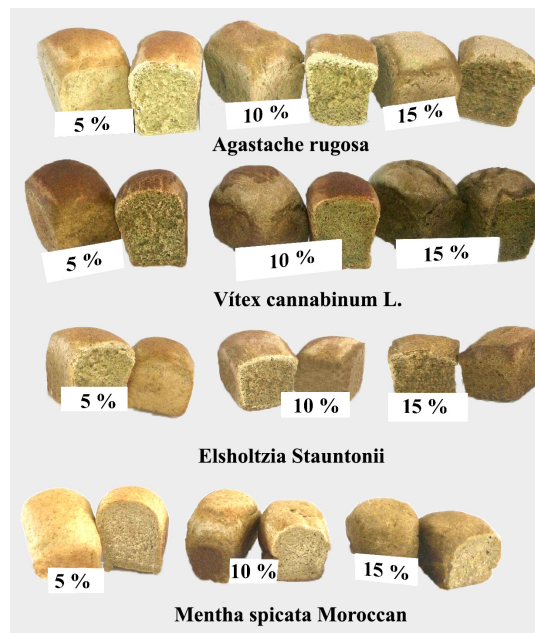


Fig. 3. Photo of bread with the addition of 5, 10 and 15 % of powder of Korean Mint (lat. *Agastache rugosa L.*), Hemp Dogbane (lat. *Vitex cannabinum L.*), Mint-shrub (lat. *Elsholtzia Stauntonii L.*), Moroccan Spearmint (lat. *Mentha spicata Moroccan L.*)

Table 2

Physicochemical quality indicators of bread from flour of wheat variety Smuglyanka (control) and new formulations

Wheat bread (grain of wheat variety Smuglyanka)	Weight, g	Humidity, %	Crumb acidity, deg.	Porosity, %	Volume, cm <sup>3</sup>	Specific volume, cm <sup>3</sup> /g	
Control	32.6	45.3	2.0	66.3	3.02	0.092	
Korean Mint	5 %	33.7	45.6	2.6	66.2	2.99	0.089
	10 %	33.2	45.9	2.9	66.1	2.87	0.086
	15 %	33.2	46.0	3.0	66.0	2.77	0.083
Narrowleaf Mountainmint	5 %	34.1	46.2	2.7	66.3	2.92	0.086
	10 %	33.7	46.8	2.7	66.1	2.80	0.083
	15 %	33.4	48.3	3.4	66.0	2.67	0.080
Moroccan Spearmint	5 %	33.7	47.5	2.9	60.0	2.64	0.078
	10 %	33.1	48.0	3.8	56.2	2.44	0.074
	15 %	32.2	49.9	3.9	56.2	2.38	0.074
Mint-shrub	5 %	33.7	46.6	2.8	65.2	2.88	0.085
	10 %	33.3	47.0	3.9	64.3	2.82	0.085
	15 %	33.2	48.1	3.9	64.2	2.80	0.084
Scarlet Beebalm	5 %	33.6	45.6	2.6	66.2	2.65	0.079
	10 %	33.5	45.8	2.9	64.7	2.48	0.074
	15 %	33.1	45.9	3.0	59.5	2.45	0.074
Hemp Dogbane	5 %	33.9	45.9	2.4	62.9	2.51	0.074
	10 %	33.7	46.8	2.7	59.2	2.43	0.072
	15 %	33.7	47.2	2.9	59.1	2.43	0.072
Quinoa	5 %	34.9	45.6	2.2	70.3	3.36	0.096
	10 %	34.0	45.8	2.3	69.9	3.25	0.096
	15 %	33.7	45.9	2.6	69.7	3.21	0.095
<i>HIP<sub>05</sub></i>	<i>1.69</i>	<i>2.34</i>	<i>0.15</i>	<i>3.28</i>	<i>0.15</i>	<i>0.001</i>	



Table 3

Organoleptic quality indicators of bread from flour of wheat variety Smuglyanka (control) and with the addition of flour from Quinoa seeds and powders of Narrowleaf Mountainmint and Scarlet Beebalm

Wheat bread (grain of wheat variety Smuglyanka)		Crust color	Appearance	Crumb color	Smell	Taste	Points
Control		yellow	smooth crust, without contamination, large cracks and blows	white	bread	normal, peculiar to bread	4.8
Quinoa	5 %	yellow	smooth crust, without contamination, large cracks and blows	yellow	spicy, nutty	peculiar to bread	4.6
	10 %	yellow	smooth crust, without contamination, large cracks and blows	yellow	spicy, nutty	peculiar to bread with a smack of additive	4.1
	15 %	yellow	smooth crust, without contamination, large cracks and blows	yellow	spicy, nutty	bitter	3.2
Narrowleaf Mountainmint	5 %	gray-brown	smooth crust, without contamination, large cracks and blows	light-brown	honey, weak	peculiar to bread with a smack of additive and honey	4.2
	10 %	brown	smooth crust, without contamination, large cracks and blows	brown with a greenish shade	honey	peculiar to bread with a smack of additive	4.0
	15 %	greenish	smooth crust, without contamination, large cracks and blows	dark-brown with a greenish shade	honey	bitter	3.7
Scarlet Beebalm	5 %	light-brown	smooth crust, without contamination, large cracks and blows	light-brown	additive	peculiar to bread with a smack of additive	4.0
	10 %	dark-brown	smooth crust, without contamination, large cracks and blows	brown with a greenish shade	additive	bitter	3.1
	15 %	dark-brown	smooth crust, without contamination, large cracks and blows	brown with a greenish shade	additive	bitter	3.0

Table 4

Organoleptic quality indicators of bread with the addition of powder of Korean Mint, Mint-shrub, Hemp Dogbane, Moroccan Spearmint

Wheat bread (grain of wheat variety Smuglyanka)		Crust color	Appearance	Crumb color	Smell	Taste	Points
Korean Mint	5 %	light-brown	smooth crust, without contamination, large cracks and blows	light-brown	additive	bitter	3.1
	10 %	brown	smooth crust, without contamination, large cracks and blows	brown	additive	bitter	3.0
	15 %	brown	smooth crust, without contamination, with some cracks and blows	brown	additive	bitter	3.0
Mint-shrub	5 %	light-brown	smooth crust, without contamination, large cracks and blows	light-brown	additive	peculiar to bread with a bitter smack	3.7
	10 %	brown	smooth crust, without contamination, with some cracks and blows	dark-brown with a greenish shade	additive	peculiar to bread with a bitter smack	3.5
	15 %	dark-brown	smooth crust, without contamination, with some cracks and blows	dark-brown with a greenish shade	additive	bitter	3.3
Hemp Dogbane	5 %	dark-brown	smooth crust, without contamination, large cracks and blows	brown	additive	bitter	3.2
	10 %	dark-brown	smooth crust, without contamination, large cracks and blows	brown	additive	bitter	3.0
	15 %	dark-brown	smooth crust, without contamination, large cracks and blows	brown	additive	bitter	3.0
Moroccan Spearmint	5 %	light-brown	smooth crust, without contamination, large cracks and blows	light-brown	mint	peculiar to bread with a smack of mint	3.7
	10 %	brown	smooth crust, without contamination, with some cracks and blows	brown with a greenish shade	mint	peculiar to bread with a smack of mint	3.6
	15 %	brown	smooth crust, without contamination, with some cracks and blows	brown with a greenish shade	mint	bitter with a smack of mint	3.5

## 6. Discussion of the results of studying the quality indicators of bread with enriching additives

The obtained data demonstrate that the use of additives intensifies the dough fermentation process. Obviously, this is due to the introduction of sugars, macro-, microelements, organic acids to flour semi-finished products with plants. These substances are a nutrient medium, involved in the biosynthesis of the components of cellular metabolism and perform various functions in the metabolism of yeast cells.

When using spice plants Narrowleaf Mountainmint, Quinoa, Scarlet Beebalm, Korean Mint, Hemp Dogbane, Mint-shrub, Moroccan Spearmint, the porosity, volume and specific volume of the products were lower than those of the control sample by 15 %, 20 % and 22 %, respectively. An exception was the sample with the addition of Quinoa powder. The indicated physical indicators were higher than those of the control sample by 6 %, 10 % and 4 %, respectively.

In the new samples of bread, in the crumb there were visible particles of the enriching additive, the presence of which during the preparation of dough, obviously, negatively affected the structure and properties of the gluten frame of the dough.

In the studied samples, an increase in acidity by 9–49 % compared with control samples was identified. The more intense acid accumulation in the test samples of the dough is due to the presence of organic acids in this plant material. This may be due to the intensification of lactic acid fermentation, that is, to be the evidence of creation of more favorable conditions for lactic acid bacteria.

The replacement of a part of the prescription amount of flour with dried and milled plants Narrowleaf Mountainmint (*Piknanthemum trifolium L.*), Quinoa (*Chenopodium quinoa L.*), Scarlet Beebalm (*Monarda didyma L.*), Korean Mint (*Agastache rugosa L.*), Hemp Dogbane (*Vitex cannabinum L.*), Mint-shrub (*Elsholtzia Stauntonii L.*), Moroccan Spearmint (*Mentha spicata Moroccan L.*) during bread production was experimentally grounded and implemented.

The developed method of bread production under the new formulations relates to the agriculture and food industry and can be applied during laboratory bread baking. The method of laboratory baking of wheat bread includes the replacement of 5–15 % of wheat flour with the powder of spice plants, addition of pressed yeast and salt in the amount of 1.5 % each, drinking water in the amount of 52–55 % of the mixture of wheat flour and plant powder, fermentation in a thermostat (28–32 °C) for 150–180 min and baking for 15–20 min at a temperature of 200–220 °C.

In the future, the plants Quinoa, Narrowleaf Mountainmint and Scarlet Beebalm can be defined as the best and expedient for use in the production of other groups of grain-flour food products.

The prescription of bread, which has been satisfactorily evaluated by the organoleptic analysis provides for reducing the amount of powder of spice plants.

Thus, the use of plants in the bakery production is promising. The data obtained allow recommending manufacturers to use volatile-oil-bearing, technical, spice and vegetable plants during the bread production.

## 7. Conclusions

1. Flour of wheat variety Smuglyanka has stable high bakery properties: the gluten content corresponds to the gluten content of the high-grade flour and is 26.0 %; the readings of the IDK device for the quality of gluten (82 units) correspond to the quality group II and are characterized as satisfactory weak gluten; the falling number – 442 s, which is 3 times more than the established requirements.

2. According to physicochemical indicators such as porosity, volume and specific volume, the bread of new formulations did not differ from the control sample. Whereas the values of humidity and acidity of the crumb exceeded the control indicators by 0.7–10.2 and 10–95 %, respectively. This, obviously, is due to the presence of organic acids in this plant material and intensification of lactic acid fermentation.

3. The organoleptic parameters of wheat bread (control) comply with the established requirements: the surface – smooth, without large cracks and blows; the crumb – elastic, quickly restores the original shape, well-baked, not moist, not sticky, with the developed uniform porosity, without hardening; the color of the crumb – white; taste and smell – correspond to the name of bread, without foreign taste and smell. The quality of bread of new formulations is somewhat different from that of control samples: the color of the crumb – light and dark yellow, brown, greenish, taste and smell – peculiar to the added plants.

4. It is advisable to introduce plant additives to the wheat dough in a dosage not more than 5 % to the flour of Scarlet Beebalm powder; up to 10 % of Narrowleaf Mountainmint and Quinoa. At these dosages, in terms of organoleptic quality indicators, the bread is estimated as excellent (4.6 points) and good (4.0–4.2 points).

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