И.М. Русина [I.M. Rusina][1],
И.М. Колесник [I.M. Kalesnik][2]

УДК 664.662
DOI: 10.37493/2307-910X.2022.2.6

ИССЛЕДОВАНИЕ ПОКАЗАТЕЛЕЙ КАЧЕСТВА ХЛЕБНЫХ ПАЛОЧЕК НА ОСНОВЕ ПШЕНИЧНОЙ МУКИ ПЕРВОГО СОРТА, РЖАНОЙ МУКИ И ПОРОШКА СТОЛОВОЙ СВЕКЛЫ

INVESTIGATION OF QUALITY INDICATORS OF BREAD STICKS BASED ON FIRST GRADE WHEAT FLOUR, RYE FLOUR AND TABLE BEET POWDER

[1]Гродненский государственный аграрный университет, Гродно, Беларусь/ Grodno State Agrarian University, Grodno, Belarus, e-mail: ***rimih_2010@mail.ru***
[2]Гродненский государственный университет имени Янки Купалы, Гродно, Беларусь/ Yanka Kupala State University of Grodno, Grodno, Belarus, e-mail: kolesnik_irina@inbox.ru

Аннотация

В статье проанализированы показатели качества композитных смесей, теста и хлебных палочек на основе пшеничной муки первого сорта, ржаной сеяной муки в соотношениях 70 и 30 частей; 80 и 20 частей и порошка корнеплодов столовой свеклы в количестве 1-9 % от массы смеси муки. Установлено, что обогатительная добавка оказывала влияние на некоторые органолептические свойства композитных смесей, полуфабрикатов и выпеченной продукции, отмечалось незначительное повышение кислотности опытных образцов и снижение влажности пропорционально количеству вносимой добавки. Суспензия порошка столовой свеклы активировала процессы газообразования, что позволило сократить период тестоведения. Не было выявлено достоверных различий между показателями качества образцов двух вариантов композитных смесей при равных дозировках порошка, а также в отношении разных способов тестоведения. Предложено использовать порошок столовой свеклы в количестве 5 % для активации дрожжей при получении хлебных палочек функционального назначения.

Ключевые слова: порошок корнеплодов столовой свеклы, хлебные палочки на основе биологических разрыхлителей, функциональные продукты питания.

Abstract

The article presents the results indicating the prospects of using beet root powder as an enrichment component in the production of bread sticks based on first grade wheat flour and sifted rye flour. This conclusion is based on a significant degree of yeast activation by a suspension of table beet powder and an increase in gas formation during the fermentation period. Quality indicators of composite mixtures, dough and bread sticks based on first grade wheat flour sifted rye flour in ratios of 70 and 30 parts, 80 and 20 parts and table beet powder in the amount of 1-9% by weight of the flour mixture were studied. It was found that with an increase in the amount of enrichment additive in composite mixtures, titratable acidity slightly increased and humidity decreased. Baked products according to two variants of the ratios of wheat and rye flour had good organoleptic and physico-chemical parameters at powder dosages of 1-5% by weight of flour. A further increase in the content of the additive led to a deterioration in the appearance of bread sticks, difficulty in their breaking, and decreased wetness of products. There was no significant difference in the of the products of the two variants of composite mixtures at the same dosages of table

beet powder. When comparing the quality characteristics of bread sticks according to two methods of dough making, traditional and with preliminary activation of yeast with a suspension of table beet powder, higher indicators were noted for the second method. The possibility of using beet root powder at a dosage of 5% by weight of wheat flour of the first grade and sifted rye flour in the ratio of 70 and 30 parts in the production of bread sticks is also substantiated by the results of a tasting analysis.

Key words: beet root powder, bread sticks based on biological leavening agents, functional foods.

Introduction. Secondary resources of the food industry - pomace and powders of fruits and vegetables - can be attributed both to independent functional ingredients and important components of bakery improvers , not only on the basis of their high content of prebiotics , vitamins, minerals and other phytoactive compounds, but also the ability to provide regulation technological processes, adjusting the properties of semi-finished products and finished products [1, 2]. At present, technologies for processing vegetables with the production of food powders and biologically active food additives have been developed and implemented. This proves the expediency of solving the problem of waste processing at the place of their formation, i.e. at the leading enterprises of the canning industry.

Taking into account the peculiarities of the life of a modern person, functional flour products with a long shelf life are becoming increasingly important [3–5]. Our choice of an enrichment ingredient in the production of bread sticks was due to scientific literature data on the chemical composition and useful properties of table beet root crops and products of their processing [6–8]. Root vegetable powder has been noted to contain important phytoactive compounds (betalains, flavonoids, polyphenols) and is a rich source of vitamins and minerals. In the course of the research, the antioxidant [9, 10], anti-inflammatory, anti-carcinogenic and anti-diabetic effects of beet root powder were proven, its hypotensive property [10], high analgesic potential, which determines the prospects for use as part of dietary supplements, as well as for central and peripheral analgesia [12].

In this work, seed rye flour was used as part of composite mixtures, taking into account its higher nutritional value and the expected positive effect of table beet powder on the rheological properties of wheat-rye dough due to the high content of food acids in the additive. Significant amounts of sugars in the beetroot powder will allow you not to add sugar to the recipe.

The aim of the study was to study the quality indicators of bread sticks based on composite mixtures of wheat flour of the first grade, seeded rye flour and various dosages of table beet powder.

Materials and methods. The following raw materials were used in the experimental work: wheat flour of the first grade (STB 1666-2006 “Wheat flour. Specifications”), seeded rye flour (GOST 7045-2017 “Rye flour. Specifications”), pressed yeast (GOST 171-2015 “Yeast bakery pressed. Specifications"), rock salt (STB 1828-2008 "Rock food salt. Specifications"), sugar (GOST 33222 - 2015 "White sugar. Specifications"), sunflower oil (GOST 1129-2013 " Sunflower oil. Specifications"), drinking water (SanPin 2.1.4.1074-01 "Drinking water. Hygienic requirements for water quality of centralized drinking water supply systems. Quality control"), powder of table beet roots (GOST 32065-2013 "Dried vegetables. General specifications"). Composite mixtures must comply with the requirements of STB 1910-2008 “ Grain products . Composite mixes. General technical conditions”, and finished products GOST 28881-90 “Breadsticks. General technical conditions ".

Organoleptic evaluation of flour and composite mixtures was carried out in accordance with GOST 27558-87 “Flour and bran. Methods for determining color, smell, taste and crunch”, to determine the physico-chemical quality indicators (acidity and moisture) used GOST 27493-87 “Flour and bran. Method for determining acidity by mash” and GOST 9404-88 “Flour and bran. Moisture Determination Method. The assessment of the quality of the obtained powder of table beet root

crops was controlled according to GOST 28561-90 “Fruit and vegetable processing products. Methods for determination of solids or moisture”.

Control and experimental samples of semi-finished products and finished bread sticks were analyzed according to organoleptic and physicochemical parameters [1 3].

The gas-forming ability of yeast was evaluated by the fermentation method in flasks with a sulfuric acid lock [14].

Experimental work was carried out on two variants of composite mixtures:

- Option 1 - the ratio of wheat flour of the first grade and seeded rye 70 and 30 parts, table beet powder 1.0–9.0% of the total mass of wheat and rye flour;

- Option 2 - the ratio of wheat flour of the first grade and seeded rye 80 and 20 parts with the addition of beetroot powder 1.0–9.0% of the total flour mass.

As a control sample, samples of mixtures of wheat and rye flour corresponding to the variants were considered.

The recipe [15] was chosen as the basis, the control samples of bread sticks of the first and second variants of the experiment included (per 100 grams of flour mixture): wheat flour of the first grade (80 g or 70 g), seeded rye flour (20 g or 30 g) , salt (2 g), sugar (2 g), pressed baking yeast (5 g), sunflower oil for lubrication and water according to the calculation. Sugar was not added to the experimental samples, but table beet powder was added in the amount of 1–9 g, depending on the weight of the flour mixture.

Taking into account the results of preliminary experiments to determine the gas-forming ability of yeast, 2 methods of dough management were envisaged :

manually with a moisture content of 37%, which was left for 20 minutes at rest at a temperature of $^{25\ 0}$ C. 80–85% within 30 minutes [16].

2) The yeast was pre-activated with a suspension of powder at a temperature of 30 ˚C for 15 minutes. After the expiration of time, the rest of the components were added to the yeast suspension of the powder and the dough was kneaded with a moisture content of 37%, left to rest for 10 minutes at a temperature $^{\text{of } 25\ ^\circ}$ C. Rolled out, molded and left in a proofer for 20 minutes at a temperature of 30 $^{\text{about}}$ C.

Sheets with blanks were placed in a ShKhL-065 SPU laboratory electric oven and baked for 10–12 minutes at a temperature of 200–210° C .

Mechanically peeled and cut into cubes no more than 6x6x6 mm, the roots of the table beet were dried in a TauRo oven at a temperature of 90 ° C to a moisture content of 8%, then ground in a laboratory mill ML-1 , followed by sieving through a sieve for wheat flour of the first grade.

Results and Discussion. The quality indicators of wheat flour of the first grade and seeded rye met the requirements of TNLA, the moisture content and titratable acidity of the samples were 11.0 and 11.7%; 3.0 and 4.0 deg. respectively. The powder had a characteristic smell and taste, its moisture content was 8.1%.

In appearance, the composite mixtures were quite homogeneous, with small inclusions of beetroot powder. With an increase in the amount of enrichment additive, the color changed from pale pink to red-pink, the taste and smell of dried root crops intensified, without the sensation of foreign odors and tastes. With an increase in the dosage of root crop powder in both variants of mixtures, a slight decrease in moisture content (10.5–9.8%) and an increase in titratable acidity (4.8–5.9 degrees) were observed, which is due to the initial values of the beetroot powder and its high hygroscopicity. Higher values of titratable acidity in experimental samples, on the one hand, lead to the need to produce products with a shorter fermentation period, on the other hand, they can have a positive effect on the state of the gluten complex, which includes rye flour proteins.

In order to determine the possibility of improving the process of preparing bread sticks, the effect of powder from table beet on the viability and fermentation activity of yeast was evaluated under conditions of preliminary activation of microorganisms by a suspension of beet powder in different dosages at a temperature of 30 ° C. In micropreparations from suspensions stained with

methylene blue (Figure 1), the proportion of dead and budding yeast cells was calculated before and after the activation stage; the shares were compared using the χ^2 method . The amount of released CO_2 was estimated from the difference in the mass of the flasks at the beginning of the experiment, after 15 minutes of observation at the first stage; 30 and 60 minutes after adding flour.

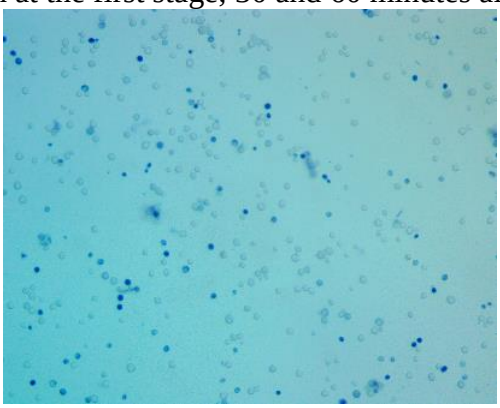

Рисунок 1. Поле зрения препарата «раздавленная капля» из суспензии / Fig. 1. Field of view of the "crushed drop" preparation from the suspension

Comparison of yeast viability indicators at the stage of pre-activation with beetroot root powder without adding flour allows us to statistically reliably state that microorganisms remained viable under anaerobic conditions, but did not multiply. The proportion of dead cells was 11.50–14.91% (p=0.15), and the proportion of budding cells was 3.33–4.33% (p=0.65). During the observed period of time, the yeast adapted to the cultivation conditions and the metabolism was reorganized for fermentation processes.

According to the data obtained in the fermentation experiment, at the stage of pre-activation of yeast without the addition of flour, the powder from the roots of table beets accelerated gas formation by 5–11 times compared to the control; the most active release of carbon dioxide occurred in suspension with 9% beetroot powder. In the remaining flasks, the mass of gas proportionally increased with the increase in the amount of powder.

At the stage of further 60-minute fermentation in the model experiment after adding the wheat-rye flour mixture, the total amount of released CO_2 was observed to exceed the control by 2.33–3.00 times in the first version of the mixture (80:20) and 2.95– 3.40 times in the second version of the mixture (70:30) (Figure 2).

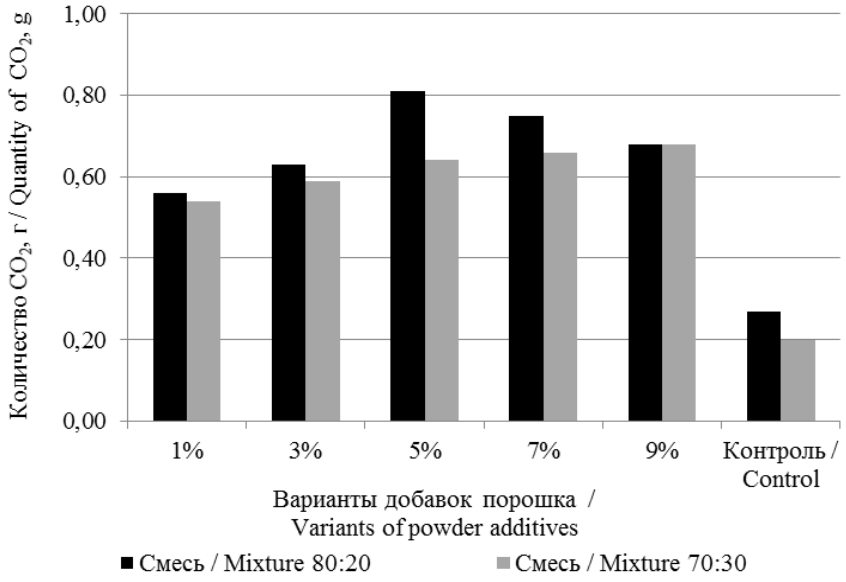

Fig. 2. Total CO_2 generation in the two variants of the composite mixtures

In the first composite mixture, the largest amount of CO_2 was released in the test sample with 5% phyto-powder , and in the second mixture - with 9% of the additive.

It should also be noted that the higher acidity of beetroot powder and rye flour did not significantly affect the gas-forming activity of yeast. The observed differences in the two types of composite mixtures for a short period of fermentation did not exceed 21%, while in the control the difference was 26%.

Based on the considered results of studying the quality indicators of composite mixtures and the gas-forming ability of yeast in the presence of an enrichment additive, it was decided to conduct test baking for all variants of composite mixtures using two methods of dough . It was assumed that pre-activation of yeast with a suspension of powder would reduce the fermentation time and avoid adding sugar to the product recipe.

It should be noted that the color of semi-finished products made by two dough methods changed depending on the amount of root crop powder, and with the content of beet powder 7% and 9% by weight of flour, the dough was tighter and more difficult to roll out. Samples of two experimental variants of composite mixtures with the same dosage of the enrichment additive practically did not differ in color, smell, taste and appearance from each other both in the first method of production and in the second.

With an increase in the amount of applied root crop powder in test samples, a slight decrease in moisture content was noted in the first (37.0–36.7%) and second (36.9–36.6%) experimental systems. Also, with an increase in the amount of the enrichment additive, the acidity of the analyzed samples increased for the first research option within the range (4.9–6.0 degrees), for the second - from 5.0 to 6.2 degrees at the beginning of the resting and at the end of proofing , respectively, from 5. 2 to 6.8 and 5.5 to 7.1 degrees.

Analyzing the qualitative characteristics of baked products according to the first traditional method of dough making , no difference was found in the organoleptic indicators of bread sticks of two experimental systems with equal dosages of table beet powder. Depending on the amount of the additive, the color changed from pink to red-burgundy, the beet flavor and smell intensified. The shape of the sticks at dosages of the additive of 1-5% by weight of the flour was round, without dents, the surface was smooth without swelling, and at its content of 7 and 9% it was rough with undermining at the bases and cracks.

The loosened, baked, without signs of unmixed inner part of the products was visualized . Samples at additive dosages of 1-5% by weight of flour broke easily, and a crunch was felt. However, with the amount of 7 and 9% beet powder, the products were not brittle, the fracture was more difficult, less pronounced looseness was noted .

Significant and significant differences between the physicochemical parameters of the two variants of the experimental groups of products baked in the traditional way, with equal dosages of the powder, were not found (table 1).

Table 1 - Quality indicators of bread sticks of the first test method / Table 1 - Quality parameters of bread sticks of the first test method

Index indicator	Control control	Quantity additives , % Amount of additive, %				
		one	3	5	7	9
Option 1 / Experiment 1						
Humidity, % / Humidity , %	9.6 ±0.3	9.6 ±0.3	9.6 ±0.3	9.5 ±0.3	9.2 ±0.3	8.8 ±0.3
Acidity , ° / A cidity , °	2.3 ± 0.2	2.5 ± 0.2	2.6 ± 0.2	2.7 ± 0.2	2.8 ± 0.3	3.5 ± 0.3
Wetness ,% / M oisture wicking ,%	139.5 ± 0.5	140.0 ± 0.5	14 0.8 ± 0.6 _	14 1 , 4 ± 0.5	135.2 ± 0.4	133.4 ± 0.6
Option 1 / Experiment 1						
Humidity, % / Humidity , %	9.6 ±0.2	9.7 ±0.3	9.5 ±0.2	9.5 ±0.2	9.1 ±0.3	8.9 ±0.3
Acidity , ° / A cidity , °	2.5 ±0.2	2.5 ±0.2	2.6 ±0.3	2.6 ±0.3	3.0 ±0.3	3.7 ±0.3

Wetness ,% / M oisture wicking ,%	140.0 ± 0.3	14 0 ± 0,4	14 0.8 ± 0.3 _	14 1 , 2 ± 0.5	13 3 , 0 ± 0.8	13 2 , 0 ± 0,6

The expected increase in titratable acidity was recorded with an increase in the amount of beet root powder added to the formulation and a slight decrease in the moisture content of the sticks of both research options. Acidity exceeded the normal value at additive dosages of 5–9%.

The obtained changes in the moisture content of samples of experimental systems can be explained by the high hygroscopicity of the additive due to the high content of pectin substances and its ability to strengthen the structure of the dough [17] , a decrease in the amount of proteins that can participate in the formation of gluten, and an increase in titratable acidity is due to the high content of food acids and other acidic compounds. character in root crop powder.

The wettability of prototypes increased with an increase in the amount of additive in the mixture from 1 to 5%, then a decrease in this indicator was observed. Such uneven changes are associated, on the one hand, with a gradual increase in the amount of pectin substances, and, on the other hand, with a decrease in the content of proteins of prolamin and glutelin fractions of flour in composite mixtures.

The study of the indicators of finished sticks obtained with preliminary activation of yeast with a suspension of table beet powder also did not reveal significant differences in the organoleptic properties of the products of the two variants of the experimental systems. The same trends in color, odor and taste were observed depending on the amount of additive. A rounded and dent-free shape was noted, a smooth surface without swelling of bread sticks at powder dosages up to 5% of the mass of the flour mixture. An increase in the amount of the additive also led to a strengthening of the structure of the products and difficulty in breaking, however, their inner part was more loosened, and they broke more easily compared to products made by the first dough method .

As for technological indicators, there was no significant difference between the values of moisture and acidity of the samples of two research options with equal amounts of powder (table 2), and in relation to the results of the previous experiment (table 1).

Table 2 - Indicators quality bread sticks second way test science / Table 2 – Quality parameters of bread sticks of the second test method

Index indicator	Control control	Quantity additives , % Amount of additive, %				
		one	3	5	7	9
Option 1 / Experiment 1						
Humidity, % / Humidity , %	9.7 ±0.3	9.6 ±0.3	9.5 ±0.3	9.5 ±0.3	9.3 ±0.3	9.0 ±0.3
Acidity , ° / A cidity , °	2.4 ±0.2	2.5 ±0.2	2.5 ±0.2	2.6 ±0.2	2.7 ±0.3	3.4 ±0.3
Wetness , % / M oisture wicking , %	140.5 ±0.5	143.0 ±0.5	144.0 ±0.5	14 5 .4 ±0.4	142.2 ±0.5	139.4 ±0.5
Option 2 / Experiment 2						
Humidity, % / Humidity , %	9.7 ±0.2	9.6 ±0.3	9.5 ±0.2	9.4 ±0.2	9.3 ±0.3	9.2 ±0.3
Acidity , ° / A cidity , °	2.5 ±0.2	2.3 ±0.2	2.4 ±0.3	2.6 ±0.3	3.2 ±0.3	3.5 ±0.3
Wetness , % / M oisture wicking , %	139.0 ±0.3	142.0 ±0.4	143,0±0,3	142,6±0,5	140,0±0,6	139,0±0,4

We consider it necessary to pay attention to changes in the values of wetting bread sticks similar to the previous experiment. However, with the second method of testing , the values of the indicator were higher, which may be due to the partial hydrolysis of the enrichment additive polysaccharides under the action of yeast enzymes during activation, leading to an increase in moisture absorption.

A tasting analysis was carried out using the preference method , and samples containing 5% beetroot powder from a mixture of wheat and rye flour in ratios of 70 and 30 parts according to the second test method (Figure 3) received the most votes.

1 2

Рисунок 3. Образцы изделий хлебных палочек: (1) – контроль; (2) – опытный образец с добавлением 5 % порошка / Figure 3. Samples of bread sticks: (1) – control sample; (2) – experimental sample with the addition of 5 % powder

Subsequently, a series of preliminary experiments was carried out to identify the possibility of changing the temperature of yeast activation and proofing . To do this, the best variant of the recipe for bread sticks according to the results of tasting was used, the dough was kneaded under conditions of yeast activation at a temperature $^{of\ 28\ ^\circ}$ C , the proofing temperature was reduced to 28 $^\circ$ C. No significant deterioration in quality indicators was identified (data not shown).

Control and experimental samples of bread sticks were stored for 15 days at room conditions in plastic bags, after the expiration of the storage period, the organoleptic characteristics did not deteriorate, no foreign odors, rancidity were detected, microbiological spoilage was not visualized, therefore, it is not required to adjust the shelf life of functional products.

Conclusion. The results of a significant pre-activation of pressed baker's yeast with a suspension of beet root powder substantiated the need for trial baking of bread sticks using two methods of dough in order to identify the possibility of pre-activation of yeast with a suspension of beetroot powder and reduce the period of resting and proofing . The high gas-forming ability of yeast in the presence of additives and the presence of significant amounts of mono- and disaccharides in the powder made it possible not to add sugar to the product formulation. The expediency of using beet root powder at a dosage of 5% by weight of first grade wheat flour and seeded rye flour in ratios of 70 and 30 parts in the production of bread sticks is justified by good quality indicators of composite mixtures and finished products, taking into account the results of tasting.

ЛИТЕРАТУРА

1. Сафьянов Д.А., Пехтерева А.А., Туксина К.С. Перспективы развития хлебопекарного производства. Экспериментальное обоснование к разработке и оценке качества хлеба, хлебобулочных и мучных кондитерских изделий функционального назначения // Техника и технология пищевых производств. 2007. № 3. С. 39–41.

2. Лукин А.А. Перспективы создания хлебобулочных изделий функционального назначения // Вестник ЮУрГУ. Серия Пищевые и биотехнологии. 2015. Т. 3. №1. С. 95–97.

3. Понамарева Е.И. [и др.] Хлебные палочки повышенной пищевой ценности для ахлоридного питания // Гигиена питания: техника и технология пищевых производств. 2018. Т. 48. №1. С. 114–124.

4. Веселова А.Ю. [и др.] Влияние овощных и фруктовых порошков на органолептические показатели хлебных палочек диабетического назначения // Хлебопечение России. 2014. № 5. С. 18–20.

5. Азарова М.Г. Постные хлебные палочки // Хлебопечение России. 2014. № 1. С. 32–33.

6. Матвеева Т.В., Корячкина С.Я. Физиологически функциональные пищевые ингре-

диенты для хлебобулочных и кондитерских изделий: монография. Орел: ФГБОУ ВПО «Госуниверситет-УНПК», 2012. 947 с.

7. Кургузова К.С. Комплексное использование столовой свеклы в специализированных продуктах питания для профилактики железодефицитной анемии и оценка их потребительских свойств. Автореферат диссертации на соискание ученой степени кандидат технических наук. Краснодар, 2013. 24 с.

8. Демидова Т.И. Биохимическая оценка порошкообразных продуктов столовой свеклы // Пищевая промышленность: сырье и материалы. 2010. № 6. С. 54–56.

9. Flores-Mancha M.A. [et al.] Characterization of beet root extract (*Beta vulgaris*) encapsulated with maltodextrin and inulin // Molecules. 2020. Vol. 25. P. 5498.

10. Tran T.N. [et al.] Starch-based bio-elastomers functionalized with red beetroot natural antioxidant // Food Chem. 2017. Vol. 216. P. 324–333.

11. Sarfaraz S. [et al.] Evaluation of hepatoprotective effects of different doses of Lyophilized Beetroot powder in albino rabbits // Pak. J. Pharm. Sci. 2021. Vol. 34,5 (Suppl). P. 1917–1922.

12. Sarfaraz S., Ikram R. Anti-nociceptive potential of lyophilized Beta vulgaris L. (Beet root) powder // Pak. J. Pharm. Sci. 2019. Vol. 32. P. 529–534.

13. Пащенко Л.П. [и др.] Практикум по технологии хлеба, кондитерских и макаронных изделий (технология хлебобулочных изделий). М.: КолосС, 2006. 215 с.

14. Практикум по микробиологии: учеб. пособие / под ред. Н.С. Егорова. М.: Изд-во Москов. ун-та, 1976. 307 с.

15. Зверева Л.Ф., Немцова З.С., Волкова Н.П. Технология и технохимический контроль хлебопекарного производства : учебник. 3-е изд., перераб. и доп. М.: Легкая и пищевая промышленность, 1983. 416 с.

16. Шаршунов В.А. [и др.] Технология и оборудование для производства хлебобулочных изделий : учеб. пособие; под общ. ред. В.А. Шаршунова. Мн.: Минсата, 2017. 1008 с.

17. Волощук Г.Г., Манк В.В., Юрчак В.Г. Влияние овощных порошков на качество макаронных изделий // Хлебопродукты. 2005. № 12. С. 44–46.

REFERENCES

1. Saf'yanov D.A., Pekhtereva A.A., Tuksina K.S. Perspektivy razvitiya khlebopekar-nogo proizvodstva. Ehksperimental'noe obosnovanie k razrabotke i otsenke kachestva khleba, khlebobulochnykh i muchnykh konditerskikh izdelii funktsional'nogo naznacheniya // Tekhnika i tekhnologiya pishchevykh proizvodstv. 2007. № 3. S. 39–41.

2. Lukin A.A. Perspektivy sozdaniya khlebobulochnykh izdelii funktsional'nogo naznacheniya // Vestnik YUURGU. Seriya Pishchevye i biotekhnologii. 2015. T. 3. №1. S. 95–97.

3. Ponamareva E.I. [i dr.] Khlebnye palochki povyshennoi pishchevoi tsennosti dlya akhloridnogo pitaniya // Gigiena pitaniya: tekhnika i tekhnologiya pishchevykh proizvodstv. 2018. T. 48. №1. S. 114–124.

4. Veselova A.YU. [i dr.] Vliyanie ovoshchnykh i fruktovykh poroshkov na organoleptic-heskie pokazateli khlebnykh palochek diabeticheskogo naznacheniya // Khlebopechenie Rossii. 2014. № 5. S. 18–20.

5. Azarova M.G. Postnye khlebnye palochki // Khlebopechenie Rossii. 2014. № 1. S. 32–33.

6. Matveeva T.V., Koryachkina S.YA. Fiziologicheski funktsional'nye pishchevye ingredienty dlya khlebobulochnykh i konditerskikh izdelii: monografiya. Orel: FGBOU VPO «Gosuniversitet-UNPK», 2012. 947 s.

7. Kurguzova K.S. Kompleksnoe ispol'zovanie stolovoi svekly v spetsializirovan-nykh produktakh pitaniya dlya profilaktiki zhelezodefitsitnoi anemii i otsenka ikh potrebi-tel'skikh svoistv. Avtoreferat dissertatsii na soiskanie uchenoi stepeni kandidat tekhni-cheskikh nauk. Krasnodar, 2013. 24 s.

8. Demidova T.I. Biokhimicheskaya otsenka poroshkoobraznykh produktov stolovoi svek-ly // Pishchevaya promyshlennost': syr'e i materialy. 2010. № 6. S. 54–56.

9. Flores-Mancha M.A. [et al.] Characterization of beet root extract (Beta vulgaris) encapsulated with maltodextrin and inulin // Molecules. 2020. Vol. 25. P. 5498.

10. Tran T.N. [et al.] Starch-based bio-elastomers functionalized with red beetroot natural antioxidant // Food Chem. 2017. Vol. 216. R. 324–333.

11. Sarfaraz S. [et al.] Evaluation of hepatoprotective effects of different doses of Lyophilized Beetroot powder in albino rabbits // Pak. J. Pharm. Sci. 2021. Vol. 34,5 (Suppl). R. 1917–1922.

12. Sarfaraz S., Ikram R. Anti-nociceptive potential of lyophilized Beta vulgaris L. (Beet root) powder // Pak. J. Pharm. Sci. 2019. Vol. 32. R. 529–534.

13. Pashchenko L.P. [i dr.] Praktikum po tekhnologii khleba, konditerskikh i makaron-nykh izdelii (tekhnologiya khlebobulochnykh izdelii). M.: KoloSS, 2006. 215 s.

14. Praktikum po mikrobiologii: ucheb. posobie / pod red. N.S. Egorova. M.: Izd-vo Moskov. un-ta, 1976. 307 s.

15. Zvereva L.F., Nemtsova Z.S., Volkova N.P. Tekhnologiya i tekhnokhimicheskii kontrol' khlebopekarnogo proizvodstva : uchebnik. 3-e izd., pererab. i dop. M.: Legkaya i pishchevaya promyshlennost', 1983. 416 s.

16. Sharshunov V.A. [i dr.] Tekhnologiya i oborudovanie dlya proizvodstva khlebobulochnykh izdelii : ucheb. posobie; pod obshch. red. V.A. Sharshunova. Mn.: Minsata, 2017. 1008 s.

17. Voloshchuk G.G., Mank V.V., Yurchak V.G. Vliyanie ovoshchnykh poroshkov na kache-stvo makaronnykh izdelii // Khleboprodukty. 2005. № 12. S. 44–46.

ОБ АВТОРАХ / ABOUT AUTHORS

Русина Ирина Михайловна, к.б.н., доцент кафедры технологии хранения и переработки растительного сырья, Гродненский государственный аграрный университет, ул. Терешковой, 28, г. Гродно, 230008, Беларусь; e-mail: rimih_2010@mail.ru

Rusina Iryna, Cand. Sci. (Biol.), associate professor, Department of Technology of storage and processing of plant raw materials, Grodno State Agrarian University, Tereshkova St., 28, Grodno, 230008, Belarus; e-mail: rimih_2010@mail.ru

Колесник Ирина Михайловна, магистр биологических наук, старший преподаватель кафедры экологии, Гродненский государственный университет имени Янки Купалы, пер. Доватора 3/1, Гродно, 230012, Беларусь; e-mail: kolesnik_irina@inbox.ru; https://orcid.org/0000-0001-5365-4751

Kalesnik Iryna, senior lecturer, Department of Ecology, Yanka Kupala State University of Grodno, Dovatora Lane, 3/1, Grodno, 230012, Belarus, e-mail: kolesnik_irina@inbox.ru; https://orcid.org/0000-0001-5365-4751

Дата поступления в редакцию: 12.04.2022
После рецензирования:23.05.2022
Дата принятия к публикации:12.06.2022