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Ирина Михайловна Русина
[Irina M. Rusina]

Совершенствование рецептуры хлеба пшеничного путем внесения различных дозировок порошка шалфея лекарственного

Improving the recipe for wheat bread by introducing various dosages of herbal sage powder

Гродненский государственный аграрный университет, г. Гродно, Беларусь, rimih_2010@mail.ru /
Grodno State Agrarian University, Grodno, Belarus, rimih_2010@mail.ru

Аннотация. *В статью включены результаты исследований влияния различных дозировок порошка шалфея лекарственного на показатели качества пшеничной муки высшего сорта, теста и выпеченного хлеба. Выявили незначительные изменения влажности образцов смесей, повышение титруемой кислотности, снижение массовой доли сырой клейковины при одновременном ее укреплении. Отметили высокие показатели внешнего вида готового хлеба всех опытных образцов, хорошее состояние мякиша, изменение цвета, вкуса и запаха при повышении дозировки порошка шалфея лекарственного от 0,25 до 2,5 % от массы муки. Физико-химические показатели качества пшеничного хлеба всех опытных вариантов регистрировались в пределах нормируемых значений стандарта. По результатам дегустационного анализа был выбран наилучшим образец, включающий 1,5 % порошка шалфея лекарственного от массы пшеничной муки. Выбранное изделие имело высокие микробиологические показатели в конце срока хранения. Предложено использовать порошок шалфея лекарственного в качестве фитоактивной добавки для улучшения показателей качества хлеба и придания ему функционального назначения.*

Ключевые слова: порошок шалфея лекарственного, хлебобулочные изделия, порошки лекарственных трав, функциональные продукты питания

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Abstract. *The article includes the results of research on the effect of different dosages of sage powder on quality indicators of wheat flour of the highest grade, dough and baked bread. Insignificant changes in the moisture content of mixture samples, an increase in titratable acidity, and a decrease in the weight fraction of crude gluten with simultaneous strengthening were found. High indicators of finished bread appearance of all experimental samples, good condition of crumb, change of colour, taste and smell with increasing ~~of~~ dosage of sage powder from 0.25 to 2.5 % of flour weight were noted. Physico-chemical indicators of wheat bread quality of all experimental samples were registered within the standardised norms. According to the results of tasting analysis the best sample containing 1.5 % of sage powder from the weight of wheat flour was selected. The selected product had high microbiological parameters at the end of shelf life. It is proposed to use sage powder as a phytoactive additive to improve the quality indicators of bread and give it a functional purpose.*

Keywords: sage powder, bakery products, medicinal herb powders, functional foods
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Introduction. With the aim of implementing the state's food policy as reflected in the "Doctrine of National Food Security of the Republic of Belarus until 2030," the development of bakery products with increased biological value becomes highly relevant.

Functional and therapeutic breads that include phytoactive ingredients to preserve and enhance public health and prevent diseases caused by inadequate and imbalanced nutrition have gained particular popularity in various countries [1]. Special attention is given to the use of non-traditional raw materials in baking, which requires careful investigation of their impact on the technological process, consumer properties of the product, as well as their potential of solving other issues in the baking industry [2, 3, 4].

Considering that bread is a mass-consumption product, the development of functional products based on it is highly relevant, and the use of medicinal herb powders as active components is a popular scientific direction known as phytosanation [5, 6].

The powder and extract of medicinal sage have been used since ancient times in healing and traditional medicine, cosmetology, and culinary arts. However, scientific interest in studying this plant as a component of food products and dietary supplements remains strong [7-11]. Various components of natural compounds, such as essential oils, alkaloids, flavonoids, tannins, oleanolic acid, and ursolic acid, are present in all parts of the plant and contribute to its therapeutic effects. The oils contain high levels of linoleic acid, as well as vitamins A, C, E, K, and B group, β-carotene, and macro- and micronutrients like magnesium, potassium, copper, zinc, manganese, calcium, and iron. Remedies containing sage have a variety of therapeutic effects [12-13].

Experimental studies involving laboratory animals have shown that due to its high content of phenolic acids and flavonoids, the plant possesses powerful antioxidant and anti-inflammatory properties. It has profound cytotoxicity against cancer cells and has hepatoprotective effects even at low doses [14-16]. Inflammation plays a significant role in the pathophysiology of many diseases and can cause damage through oxidative stress. The promising role of ursolic or pomolic acid from sage in cancer chemotherapy has been proved in a series of experiments [15]. Medicinal sage is a promising source of biologically active substances with a potent therapeutic effect aimed at neutralizing the adverse effects of environmental toxins [17].

According to scientific literature, it can be presumed that the development of recipe and production technologies for bakery and flour products with the addition of herbal powder and extracts is a promising direction for scientific and practical activities in the field of functional nutrition [5]. Moreover, taking into account the data of scientific literature, we can assume a positive effect of sage powder on quality indicators and preservation of flour products [10, 17].

Materials and research methods. In this study, the following raw materials were used: premium wheat flour (STB 1666-2006 "Wheat flour. Technical specifications"), dry wheat gluten (GOST 31934-2012 "Wheat gluten. Technical specifications"), pressed yeast (GOST 171-2015 "Pressed baker's yeast. Technical specifications"), table salt (STB 1828-2008 " Table salt. Technical specifications"), sugar (GOST 33222-2015 "White sugar. Technical specifications"), sunflower oil (GOST 1129-2013 "Sunflower oil. Technical specifications"), drinking water (SanPiN 2.1.4.1074-01 "Drinking water. Hygienic requirements for centralized drinking water supply systems. Quality control"), powdered sage (State Pharmacopoeia of the Republic of Belarus. Quality control of substances for pharmaceutical use and medicinal and plant raw materials. Introduced on 01.07.2016 by Ministry of Healthcare of the Republic of Belarus).

Composite mixtures and endproducts were assessed for compliance with the requirements of STB 1910-2008 "Grain products. Composite mixtures. General technical specifications" and STB 1009-96 "Bread made from wheat flour. General technical specifications."

The organoleptic properties of flour and composite mixtures were studied using the following methods: GOST 27558-87 "Flour and bran. Methods for determining color, smell, taste and crunch,"

GOST 27493-87 "Flour and bran. Method for determining acidity by mash, " and GOST 9404-88 "Flour and bran. Moisture Determination Method." The determination of the quantity and quality of gluten was carried out according to GOST 27839-88 "Wheat flour. Method for determining the quantity and quality of gluten." In accordance with STB 2160-2011 "Bakery products. Acceptance rules, sampling methods, methods for determining organoleptic characteristics and weight," GOST 21094-75 "Bread and bakery products. Moisture Determination Method," GOST 5670-96 "Bakery products. Methods of determination of acidity," and GOST 5669-86 "Bakery products. Method for determining porosity," the quality indicators of semi-finished and finished wheat bread products were assessed.

To detect and determine the quantity of microorganisms during the storage of ready made products, the following TNPA (sanitary and epidemiological standards) were used: GOST 31747-2012 "Food products. Methods for detection and determination of the quantity of coliform bacteria," GOST 31746-2012 "Food products. Methods for detection and determination of the quantity of coagulase-positive staphylococci and Staphylococcus aureus," GOST 10444.12-2013 "Microbiology of food and feed products. Methods for detection and enumeration of yeasts and mold fungi."

A model experiment to study yeast activation was carried out according to the method [19].

The manufacturing recipe and technological modes for producing wheat bread with dense sourdough are indicated in Table 1 [20].

Table 1 – Production recipe and technological modes of dough preparation for wheat bread

Name of raw materials and semi- products, production characteristics	Raw material consumption and dough preparation process characteristics
High-grade wheat flour, g	225.0
Bread starter, g	349.77
Dry wheat gluten, g	45.00
Pressed baker's yeast, g	4.00
White sugar, g	22.50
Table salt, g	6.75
Sunflower oil, g	20.25
Water, g	96.01
Humidity of bread starter, %	45.0
Initial temperature of bread starter, ºC	28 – 32
Duration of fermentation of bread starter, min	210 – 240
Final acidity of bread starter, deg.	3,0 – 4,0
Humidity of dough, %	39.0
Initial dough temperature, ºC	28 – 32
Duration of dough fermentation, min	60 – 90
Final dough acidity, deg.	2.5 – 3.0

In the first variant of the research, the dough was prepared using a dense bread starter, to which different dosages of sage powder were added, ranging from 0.25% to 2.5% of the mass.

In the second variant, the medicinal herb powder was added to the dough in quantities of 0.25% to 2.5% of the flour mass, while the bread starter was prepared without the addition of the supplement.

These dosages of the functional additive were chosen using study data and taking into account the recommended consumption doses of wheat bread. At high quantities

Research results and their discussion. The powder of sage obtained by grinding the dried herb had a even colour, smell, and taste corresponding to the herb. The active acidity of the solution of sage powder was 5.5, and the moisture, ash content of the additive was 12.0 % and 14.7 % accordingly. The wheat flour met all the requirements of the Technical Norms for Food Products and Additives (TNPA) regarding all parameters.

Проводили предварительную активацию водной суспензии дрожжей порошком шалфея в изучаемых дозировках при температуре 30 ºС в течение 15 минут. Не было выявлено никаких эффектов действия добавки.

Pre-activation of an aqueous yeast suspension with sage powder was carried out in the studied dosages at a temperature of 30 °C for 15 minutes. No effects of the additive were detected.

When investigating the quality indicators of composite mixtures containing high-grade wheat flour, a decrease in the mass fraction of raw gluten was observed, while its elasticity increased within the selected dosages of the medicinal herb powder. These changes indicate the process of stabilisation of raw gluten due to the significant content of divalent metals and polyunsaturated fatty acids in the additive, which can stimulate the oxidation of SH-bonds in proteins, leading to the formation of disulphide bridges (Table 2).

Table 2 – Quality indicators of composite mixtures based on high-grade wheat flour and various dosages of herbal sage powder

Indicator	Control sample	Composite mixtures with the addition of herbal sage powder, % of flour mass					
		0.25	0.5	1.0	1.5	2.0	2.5
Humidity, %	14.8±0.2	14.7±0.2	14.6±0.2	14.5±0.2	14.4±0.2	14.4±0.2	14.3±0.2
Titratable acidity of the mixture, deg.	2.0±0.2	2.0±0.3	2.1±0.3	2.2±0.2	2.3±0.3	2.4±0.2	2.5±0.3
Mass fraction of crude gluten, %	25.2± 0.2	25.0±0.3	24.6±0.3	24.3±0.4	24.2±0.4	24.0±0.3	23.8±0.3
Gluten quality, IDK units	70.2±0.2	69.1±0.2	68,4±0.2	66,3±0.2	65,6±0.2	64,4±0.2	63,6±0.2
Elasticity, cm	18.0	17.8	17.6	17.3	17.0	16.8	16.7

Study of the influence of an enriching additive on the technological parameters of the dense bread starter in the first variant of the research showed an increase in its acidity with an increase in the dosage of herbal sage powder (Table 3), which is due to the presence of significant amounts of palmitic and oleic acids, coumaric, chlorogenic, and caffeic acids, gallic and ellagic acid in the sage powder [ref 9].

Table 3 – Quality indicators of the dense bred starter for control and experimental samples

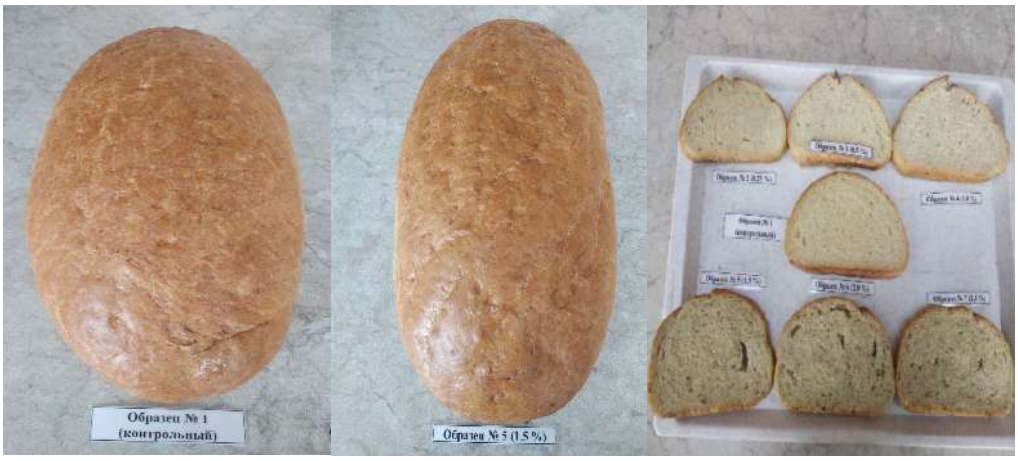
Indicator	Control sample	Experimental samples including herbal sage powder, % of flour mass					
		0.25	0.5	1.0	1.5	2.0	2.5
Humidity, %	50.0	49.6	49.8	49.8	50.0	49.7	49.6
Acidity, deg. after 1.5 hours of fermentation	2.0	2.1	2.2	2.3	2.4	2.5	2.5
Acidity, deg. after 3.5 hours of fermentation	3.0	3.1	3.3	3.4	3.6	3.7	3.9

The dough of the experimental samples with different dosages of the additive showed minor differences in terms of color, taste, aroma, and the presence of powder particles. An increase in titratable acidity of the semi-finished products was observed during fermentation, with the final values ranging from 2.2 to 3.1 degrees and 3.0 to 3.9 degrees for the first set of experiments, and from 2.3 to 2.9 degrees and 3.1 to 3.7 degrees for the second set of experiments. The increase in sage powder dosage did not affect the dough's humidity. Organoleptic evaluation was carried out after baking for all variants of studies (Table 4).

Table 4 – Organoleptic quality indicators of wheat bread of control and experimental samples with different dosage of herbal sage powder

Indicator	Control sample	Experimental sample including herbal sage powder, % of flour mass					
		0.25	0.5	1.0	1.5	2.0	2.5
Appearance							
Shape	Elongated-oval, distinct, without lapping	Elongated -oval, distinct, without lapping					
Crust colour	Light brown, even top crust, not burnt	Light brown, even top crust, not burnt					
Crust surface	Rough, without large cracks and breaks, without impurities	Rough, without large cracks and breaks, without impurities					
Crumb condition							
Colour	Relevant, white	With increasing dosage of herbal sage powder, the colour changes from white to light green					
Stickiness	Absent	Absent					
Elasticity	Good	Good					
Mixing	No lumps and no traces of unmixing	No lumps and no traces of unmixing					
Crumb structural and mechanical properties	Baked, elastic, not moist to the touch	Baked, elastic, not moist to the touch, as the dosage of sage powder increases, the amount of powder flecks increases					
Porosity	Developed, without hollows	Uneven					
Flavour and smell	Typical for this type of product, no foreign taste and smell	Typical for this type of products, with insufficiently pronounced sage flavour and smell			Typical for this type of products, with pronounced sage flavour and smell		

After baking for all variants of the study, it was found that the baked samples had an elongated-oval shape with distinct edges, a slightly rough surface, and an elastic, well-baked crumb without signs of under- or over-mixing. Minor particles of sage powder were visually observed in the crumb. As the amount of the additive increased, the aroma and taste of the medicinal herb intensified, and the products acquired a greenish tint. No significant differences in the organoleptic characteristics of the finished products were found between the experimental variants at equal dosages of the medicinal herb powder (Figure 1). However, the scent and taste of sage were more noticeable in the samples with the powder added to the thick bread starter.



a b c

Figure 1 – Samples of wheat bread baking trials
a – control sample No. 1; b – experimental samples with 1.5% powder
c – control and experimental samples in the section

According to the evaluation of the physicochemical quality indicators of the control and experimental bread samples, no significant differences were found between the research variants (Table 5).

Table 5 – Physicochemical quality indicators of control and experimental bread samples

Indicator	**Control sample**	**Experimental sample containing herbal sage powder, % of flour mass**					
		0.25	**0.5**	**1.0**	**1.5**	**20%**	**25**
Variant 1							
Humidity, %	50.0±0.2	49.6±0.2	49.8±0.2	49.8±0.2	49.6±0.2	49.4±0.2	50.5± 0.2
Acidity, deg.	2.9±0.2	3.1±0.2	3.1±0.2	3.2±0.2	3.3±0.2	3.6±0.2	3.9±0.2
Porosity, %	72.0±0.2	72.0±0.2	71.0±0.3	70.0±0.4	72.0±0.4	71.0±0.5	70.0±0.3
Variant 2							
Humidity, %	38.0±0.2	38.0±0.2	37.4±0.2	37.5±0.2	37.4±0.2	37.3±0.2	37.6± 0.2
Acidity, deg.	3.0±0.2	3.0±0.2	3.1±0.2	3.2±0.2	3.3±0.2	3.6±0.2	3.6±0.2
Porosity, %	72.0±0.3	72.0±0.3	72.0±0.4	72.0±0.3	71.0±0.4	71.0±0.5	70.0± 0.3

According to the obtained data, samples containing 0.25-1.5% herbal sage powder by flour mass met the required standards for titratable acidity values. The porosity of the experimental samples was practically indistinguishable from the control variant, with a slight and insignificant decrease observed when the dosage of the powder was increased to 2.0 and 2.5% of the flour mass.

Comparing the results of the two research variants, it is necessary to note that no significant differences were observed between the samples. Therefore, the stage of introducing the selected amounts of medicinal sage powder does not affect the physicochemical quality indicators of the dough and finished products.

In the preferred tasting method, the wheat bread sample including 1.5 % herbal sage powder received the highest number of votes in both trials. These products were stored in polyethylene bags at room temperature for 48 hours and were subsequently assesed for microbiological cleanliness. The assessment of microbiological cleanliness is not standardized for wheat bread, but since the addition of medicinal herbs was introduced, such research is of great interest.

During the research, no colonies of Escherichia coli, coagulase-positive staphylococci, and staphylococci were found. The number of colonies of mold fungi CFU per 1 g (cm^3) was 8.1 x 10^1 in the control variant and 8.0 x 10^1 in the experimental variant. The number of colonies of mesophilic aerobic and facultative anaerobic microorganisms was 5.2 x 10^1 in the control variant and 5.1 x 10^1 in the experimental variant, which corresponds to the requirements of TNPA (TR TS 021).

Conclusion. The conducted research shows the expediency of using herbal sage powder in the production of wheat bread, as it leads to strengthening of the gluten in composite mixtures and improvement in organoleptic properties while maintaining physicochemical parameters. It cannot be definitively stated that the addition of herbal sage powder allows for an increase in the microbiological purity of the products based on the results of the experiment, as the differences in the data were insignificant. However, a decrease in the number of colonies of microscopic fungi as well as aerobic and facultative aerobic microorganisms was observed, indicating a higher probability of extending the shelf life of the product.

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ИНФОРМАЦИЯ ОБ АВТОРЕ

Ирина Михайловна Русина – кандидат биологических наук, доцент кафедры технологии хранения и переработки растительного сырья, Гродненский государственный аграрный университет, rimih_2010@mail.ru

INFORMATION ABOUT THE AUTHOR

Irina M. Rusina – Cand. Sci. (Biol.), Associate Professor, Department of Technology of Storage and Processing of Plant Raw Materials, Grodno State Agrarian University, rimih_2010@mail.ru

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