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ESTABLISHING THE CHARACTER AND SHARE OF CHANGES IN MINERALS DURING THE PRODUCTION OF BREAD WITH THE ADDITION OF SYRUP PERSIMMON

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ABSTRACT
In the daily diet, bread is an excellent carrier of nutrients to replenish the human body. In this direction, as an additive, persimmon syrup (PS) can be indispensable for the production of a wide range of bakery products. One of the factors limiting the widespread use of cholesterol in baking production is the insufficient knowledge of its mineral value, the nature and proportion of changes in their content in the technological process. Therefore, the purpose of the study is to analyze the mineral value of wheat flour Azamatli-95 (A95-WF), persimmon syrup (PS) from the Hiakume variety and bread with the addition of PS and to establish the nature and proportion of changes in their content in the technological process.Therefore, the purpose of the study is to analyze the mineral composition of wheat flour A95-WF of the first grade, PS, and bread with the addition of PS. It was found that with the addition of 5, 10 and 15 % PS to A95-WF in bread samples, the content in g/100 g significantly increases: potassium (43.44±21.72), magnesium (38.5±19.25), phosphorus (31.7±14.34); in μg/100 g: iron (137.51±68.76) and zinc (82.65±41.33) and the content in g/100 g slightly increases: calcium (6.0±3.0), sodium (1.58±0.4), sulfur (8.32±4.16); in μg/100 g: iodine (0.48±0.24), cobalt (0.76±0.38) with deviation from the best bread with the addition of 10 % PS to A95-WF. The resulting regression equations (AE<7 %) make it possible to predict and establish a relationship between the shares of changes in significantly changing minerals in the technological process and the increase in their content in bread.
Keywords: wheat, flour, persimmon, syrup, bread, minerals.

Introduction

The main product of the human diet is bread, which can be used as a good carrier of minerals substances. In the food ration of the population, not everyone has fruits and vegetables. Therefore, it is possible to say with great probability that there is a lack of minerals substances in their body, which eventually leads to illnesses. When buying bread, consumers pay attention primarily to the volume, correctness of shape, condition and color of the surface of the crust, and the softness of the bread. However, they do not pay attention mainly to the minerals value of bread. Therefore, it is very important to provide the population with mineral ingredients that contribute to the normal development and vital activity of the body, increasing its resistance to adverse environmental factors and disease prevention [1]. In this area, the most innovative is the development of baking technologies, increasing efficiency based on scientific and technical progress, development and implementation of technological processes in production, aimed at increasing mineral ingredients [2].

In this regard, the enrichment of bread products by adding raw materials rich in mineral substances to the recipe will prevent the development of unwanted diseases of the human body and at the same time expand the range of bakery products [3]. The World Health Organization (WHO) recommends an intake of 400 grams of bread per day, to have the carbohydrates needed to serve as an energy source. However, according to the State Statistics Committee of Azerbaijan (SSCA), per capita bread consumption is set at 380 g/day [4].

Persimmon has a high immune defense system, it is not badly damaged by diseases and microorganisms, is more resistant to spoilage, the frost resistance of persimmon, especially the eastern one, is higher than that of most other subtropical crops [5].

The world of persimmon crops is very diverse. The most common types of persimmon (Diospyros): Caucasian (D. lotus), virgin (D. virginiana) and eastern (D. kaki). Cultivated varieties of oriental persimmon in Azerbaijan are mainly Hyakume, Xachia, Goshe, Zanji-maru and others [6].

Environmental degradation in the world has increased the level of food contamination, and stress damages the mechanisms of self-regulation of the body, leading to an increase in negative trends in public health [7]. Improving the health, performance and livelihoods of all age groups through quality and safe food is the main goal of all governments.

Modern technologies should ensure the production of complete bread products. Therefore, it is necessary to develop and improve technologies based on scientific and technical progress. In this regard, the wide use of local raw materials and including them in technological processes remain insufficiently solved problems [8].

In [9], a study was conducted to assess the physiological and organoleptic properties of bread with different contents of persimmon peel. It was found that the moisture activation of the loaf of bread decreased as the shelf life increased, with a smaller range of decrease in the group with the addition of persimmon peel powder. The weight has increased and the volume has somewhat decreased. As a result of measurements using a texture analyzer, hardness, elasticity, cohesiveness, stickiness and chewing properties decreased. The results of the sensory test showed that bread with the addition of 4 % and 6 % persimmon peel was the best.

The results obtained by the authors [10] also confirmed the nutritional value of persimmon even under special dietary regimens such as hypertension and heart disease, as well as the authenticity of its cultivation in Central and Southern Italy. These works also do not provide recommendations on the use of persimmon and its products in the production of daily food products. However, the mineral composition and recommendations for the use of persimmon fruits and products of its processing as a fortifier of bread products are not shown. However, the paper [10] also did not study the nature and share of changes in the nutritional value of PS and its processed products as a fortifier for bread products.

Thus, bread products are a necessary daily product in the human diet, and do not fully enrich the body with minerals. Analysis of literature data confirms that the mineral value of persimmon and its processed products has been sufficiently studied. However, the problem is that the nature and proportion of changes in minerals in the technological process of preparing bread with the addition of PS have not been established. In addition, there has been insufficient research into the use of persimmon and its products, especially PS, in baking.

Therefore, in order to justify the development of technology for the production of new types of bakery products, expanding their range and satisfying various consumer preferences, a comprehensive analysis is required to establish the nature and proportion of changes in the mineral substances of raw materials, i.e. A95-WF, PS and bread with the addition of PS in the technological process of making bread.

The aim of the study is to establish the nature and share of changes in minerals in the technological process of preparing bread with the addition of persimmon syrup. This will allow for correct adjustments when enriching bread with persimmon syrup.

Materials and methods

The objects of the research are A95-WF, PS and bread with the adding PS. The main hypothesis of the research is that establishing the nature of changes in minerals in the technological process of making bread will make it possible to determine or select the share of reduction in their content. The use of PS in the production of baked goods from WF will increase their biological value, expand the range, raw material base and the use of non-traditional raw materials. However, it should be borne in mind that the quality indicators of PS and WF vary depending on the region of cultivation.

Used the first grade flour A95-WF, obtained in the selection process carried out at the Azerbaijan Scientific Research Institute of Agriculture (ASRİA).

To increase the biological value of bread, PS was added to WF in amounts of 5, 10 and 15% by weight of flour, and it was determined how significant the nature and share of changes in minerals are in the technological process of preparing bread with the additive.

Theoretical methods studies were based on a comparative analysis of literature data, experimental methods studies were carried out on the basis of GOST standards. The research was carried out in the laboratory of the Department of Food Engineering and Expertise of the Azerbaijan Technological University, as well as in the laboratories of the Ganja-Deyirman, NEON, Research Institute of Georgia and ASRIA.

Pressed yeast of Azermaya trademark and table salt of Azeriduz trademark were purchased at Gold Amina market of Ganja city. The moisture content of pressed yeast was 75% and of table salt 3%. Persimmon fruits were purchased at the Ganja-Sabati market.

The bread was baked using the test laboratory baking method [11].

For uniform distribution of yeast and salt in the flour, they were used in liquid form. Pressed yeasts were finely chopped, dissolved in water in a ratio of 1:3, and used as a suspension in the preparation of tight sponge. Salt was dissolved in water in a ratio of 1:4 and added to wheat flour as a solution during dough kneading.

PS was prepared as follows. Fruit pre-washed, sorted and cleaned of impurities, then rinsed with clean water. After that, the stalk was removed, the skin was peeled off, cut along the diametrical plane into two halves, remove the pips, rubbed through a metal sieve. Then 10-15 % of pure water was added to the obtained homogeneous pulp and heated for 10 minutes to a temperature of 80÷85 °C with stirring. This facilitated the separation of juice from the pulp. After that, bentonite suspension in the amount of 1-2 % was added to the obtained juice. This was necessary to clarify the juice. The clarified juice was filtered, separated from the sediment and evaporated in a vacuum-apparatus M3C-320M to obtain 50 % of dry matter. Then the obtained syrup was cooled to room temperature and stored at 0÷1 °C. The obtained syrup had a slightly dark straw color. The amount of dry matter of PS was determined on an MA-871 digital refractometer (Romania).

For fast and uniform distribution of syrup in flour during dough kneading, the syrup was pre-diluted in water. The water consumption was 30.56, 60.73 and 91.09 g for I, II and III variants, respectively [12].

To prepare bread samples with natural additive, PS was added to A95-WF in the ratio of 5, 10 and 15 % to the weight of flour.

Table 1 shows the bread preparation variants.

Table 1. Options of preparation of bakery products.

Options	Raw material	Syrup addition to flour weight, %	Abbreviation of raw materials
Control	Azamatli-95 (A95) - wheat flour (WF)	0	A95-WF
I	Azamatli-95 (A95) - wheat flour (WF) + persimmon syrup (PS)	5	A95-WF+5%PS
II		10	A95-WF+10%PS
III		15	A95-WF+15%PS

The dough was prepared in two stages on a large dense sponge. Raw material consumption by stage was calculated in Microsoft Excel 2016 using the following formulas [11].

Technological modes and parameters were also adapted to production conditions. The temperature of the dough after kneading should be 32 °C, and the temperature of the water used for kneading the dough should not exceed 45 °C. During the experiment, the temperature of the flour was tf =24 °C.

First, tight sponge was made, then the dough was kneaded. Dough and tight sponge were prepared in an B20 (China) spiral kneading machine with a multi-speed drive.

To prepare tight sponge, the yeast suspension and a certain amount of water were poured into the pot according to the recipe (Table 2), mixed, then the flour was added and kneaded for 5 minutes until a homogeneous mass was obtained (mixing shaft speed 100 RPM). The kneaded tight sponge was weighed, the temperature was measured and then placed into a thermostat to ferment for 240 minutes. The air temperature in the thermostat was (31±1) oC and the relative humidity was 80–85 %. The fermentation of the tight sponge was controlled by its final acidity and doubling in volume. The moisture content of the tight sponge was 43.5 %.

To prepare the dough, the rest of the flour and water, salt solution and PS were added to the tight sponge in the pot and kneaded for 10 minutes until a homogeneous mass was obtained (mixing shaft speed: at the beginning of 6 minutes – stirring at 100 RPM, then 4 minutes – the kneading 166 RPM). The kneaded dough was weighed, the temperature was measured and then placed into a thermostat at (31±1)oC for 60 minutes for fermentation. The relative humidity in the thermostat was 80–85 %. After 30 minutes of fermentation, the dough was again kneaded for 2 minutes (mixing shaft speed 100 RPM). The fermentation of the dough was controlled by its final acidity and doubling in volume. The moisture content of the dough was 44 %.

After the end of the fermentation period, the dough was divided into three equal pieces. The dough pieces were formed manually on the table. Two dough pieces were given an elongated (baton-like) shape, and the third was given a spherical shape.

Elongated dough pieces (for baking in molds) were placed in metal molds pre-greased with vegetable oil. The dough with a spherical shape (for baking hearth bread) was placed on a round metal plate.

The molds and the plate were placed into a thermostat together with the dough, where it was ripened at a temperature of 35–40 oC and relative humidity of 75–85 %. As the ripening period depends on many factors, it is not limited, i. e. it can be increased or decreased. The end of the ripening was organoleptically determined by the condition and appearance of the dough.

After the end of the fermentation period, the temperature of the dough was measured, the mass was weighed and recorded. The dough was then divided into three equal pieces. The dough pieces were formed manually on the table. First, it is intensively softened manually, spread out on the table, and then rounded. This operation was repeated several times. Then two dough pieces were given an elongated (baton-like) shape, and the third was given a spherical shape.

Elongated dough pieces (for baking in molds) were placed in metal molds pre-greased with vegetable oil. The dough with a spherical shape (for baking hearth bread) was placed on a round metal plate.

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After the ripening period finished, first, one mold and the plate and after 5 min, the other mold containing prepared dough were placed in the oven. Bread samples were baked in an oven at 220–230 oC after moisturization in the baking chamber. Dough pieces were baked in molds for 32 min, and on a sheet for 30 min.

After the bread samples were baked, water was sprinkled on their upper crust and weighed.

Mineral substances content of bread samples was determined after cooling to room temperature, within 8 hours of baking using the atomic absorption spectrometer AAnalyst 400 (Perkin Elmer, USA).

Moisture content of bread samples was determined by drying method 930.15 [13], which was 43.8, 43.8, 44.0 and 43.9 % for A95-WF, A95-WF+5%PS, A95-WF+10%PS, and A95-WF+15%PS, respectively.

Statistical processing of the experimental results was performed using one-factor analysis of variance (ANOVA) in Microsoft Excel 2016 program at a significance level of $p<0.05$ [14].

Analysis of minerals of persimmon syrup, wheat flour and bread with additives

The scope of this paper was to increase the biological of bread by adding PS. For baking bread samples with additives to A95-WF, PS was added in the amount of 5, 10 and 15 %, which were compared with control bread.

In the course of experimental studies to study the nature and share of changes in the content of mineral compositions in the technological process of making bread, the best variant in terms of organoleptic indicators was bread A95-WF+10%PS made with the addition of PS in an amount of 10 % by weight of flour (option II).

Table 2 presents a comparative analysis of the mineral substances of A95-WF, PS, and samples of bread with an additive.

Table 2 shows that compared with the control bread, the content of minerals in all samples of bread A95-WF+5%PS, A95-WF+10%PS and A95-WF+15%PS, was higher than that of the control bread. When PS was added to A95-WF, among the macronutrients in bread samples A95-WF+5%PS, A95-WF+10%PS, and A95-WF+15%PS, the content of potassium, magnesium, and phosphorus increased significantly. At the same time, the share of changes in their content in bread samples with the additive was (mg/100 g): potassium – 43.44±21.72, magnesium – 38.50±19.25, phosphorus – 31.7±14.34. However, the content of calcium, sodium and sulfur slightly increased. Simultaneously, the share of changes in their content in bread samples with the additive was (mg/100 g): calcium – 6.0±3.0, sodium – 1.58±0.4, sulfur – 8.32±4.16. In all samples of bread A95-WF+5%PS, A95-WF+10%PS, A95-WF+15%PS, the content, and share of sodium change was almost at the same level as in the control bread.

Table 2. Mineral substances of A95-WF, PS, and samples of bread with additives (per 100 g of product)

Mineral substances	Abbre-viated	First-grade A95-WF	PS	The change of mineral substan-ces*, %	Samples of bread by options			
					Control	I	II	III
Macroelements, mg								
Potassium	K	280	570	–23.8	213.36	235.08	256.79	278.51
Calcium	Ca	38	54	+11.11	42.22	45.22	48.22	51.22
Magnesium	Mg	95	440	–12.5	83.13	102.38	121.63	140.88
Sodium	Na	5	8	×168	505.42	506.60	507.0	507.40
Sulfur	S	75	110	–24.34	56.75	60.91	65.07	69.23
Phosphorus	P	310	380	–24.42	234.30	248.66	263.0	277.38
Microelements, μg								
Iron	Fe	1600	1500	–8.33	1466.72	1535.47	1604.23	1672.98
Zinc	Zn	784	1100	–24.86	589.10	630.42	671.75	713.08
Iodine	I	4.2	6.4	–25.63	3.12	3.36	3.60	3.84
Cobalt	Co	3.4	9.6	–20.83	2.69	3.07	3.45	3.83

* The change share of indices during the technological process

Table 2 shows that, compared with the control bread, in all bread samples A95-WF+5%PS, A95-WF+10%PS, A95-WF+15%PS, among the macronutrients the content of iron and zinc significantly increased. At the same time, the share of changes in their content was (μg/100 g): iron – 137.51±68.76, zinc – 82.65±41.33. However, the content of iodine and cobalt increased slightly. At the same time, the share of changes in their content was (μg/100 g): iodine – 0.48±0.24, cobalt – 0.76±0.38.

To predict the nature and quantitative changes of significantly changing minerals, regression equations were obtained.

The main characteristics of the significantly varying minerals of the bread samples are shown in Table 3.

Table 3.Main characteristics of significantly varying minerals of bread samples

İndices	Range of indicators change, g/100 g	Regression equations	Correlation coefficient R²	Approximation error, *AE*, %
Significantly varying minerals				
K	213.36–278.51	$y = 4.3432 \cdot x + 213.361$	0.9999	0.0008
Mg	83.13–140.88	$y = 3.85 \cdot x + 83.13$	0.9999	0.0001
P	234.30–277.38	$y = 2.872 \cdot x + 234.298$	0.9999	0.0267
Fe	1466.72–1673.0	$y = 13.7508 \cdot x + 1466.719$	0.9999	0.0001
Zn	589.10–713.08	$y = 8.2654 \cdot x + 589.097$	0.9999	0.0004
Slightly varying minerals				
Ca	42.22–51.22	$y = 0.6 \cdot x + 42.22$	0.9999	0.0001
Na	83.13–140.88	$y = 0.1268 \cdot x + 505.654$	0.957	0.0385
S	56.75–69.23	$y = 0.832 \cdot x + 56.75$	0.9999	0.0001
I	3.12–3.84	$y = 0.048 \cdot x + 3.12$	0.9999	0.0001
Co	2.69–3.83	$y = 0.076 \cdot x + 2.69$	0.9999	0.0001

The dependence of the content of significantly changing minerals in the technological process of preparing bread samples on the amount of PS added to A95-WF was studied (Table 3). Pairwise linear regression was chosen for minerals ($p<0.05$).

The parameters of all regression equations were estimated by the least squares method. The statistical significance of the equations was tested using the correlation coefficient and Fisher's test ($F>F_{tab}$).

Discussion of the experimental results of the research of the share for changes in minerals PS, WF and bread with the additive

Minerals are vital components of our food. They fulfil a wide variety of functions in the optimal functioning of the immune system, building materials for our bones, influencing muscle and nerve function, and regulating the body's water balance [15].

In the bread samples A95-WF+5%PS, A95-WF+10%PS and A95-WF+15%PS, the content of macro- and microelements was higher than in the control bread. Among the macronutrients, the content of potassium, magnesium and phosphorus increased significantly (Table 2). Depending on the amount of PS added, in bread samples, the proportion of change in potassium was in the range of 21.72–65.15, magnesium – 19.25–57.75 and phosphorus – 14.34–43.08 mg/100 g. In an acceptable bread sample A95-WF+10%PS, the content of potassium, magnesium and phosphorus increased by an average of 43.44, 38.5 and 28.71 mg/100 g, respectively, compared to the control bread. The potassium and sodium content of PS is significantly greater than that of A95-WF and the Na/K ratio is less than 1. This is important for regulating sodium uptake, since the high potassium content promotes beneficial sodium uptake and therefore protects cardiovascular function, improves brain and muscle function, promotes the removal of excess salt from the body, which do not benefit the body. This is consistent with the findings of [16] that replacing white sugar by adding palm sugar to wheat flour results in a Na/K ratio of less than 1.

Magnesium is an important constituent of all cells and tissues, it is found mainly in bones and muscles; it maintains the ionic balance of the body's fluid media by interacting with ions of other elements; it is part of enzymes associated with the metabolism of phosphorus and carbohydrates; it participates in neuromuscular irritation and activates plasma and bone phosphatase [9]. The daily norm magnesium for an adult human is set at 150 mg in Azerbaijan [4]. In the preferred option A95-WF+10%PS, the amount of magnesium entering the body with bread was 121.63 mg/100 g (Table 2). At the same time, the daily requirement of the human body is provided with 81.1 % magnesium. By consuming 124 g of bread with the additive of A95-WF+10%PS, you can provide the body with 100 % magnesium.

By adding PS to A95-WF, bakery products can be enriched with phosphorus. Phosphorus compounds play an important role in all processes occurring in the human organism: phosphoric acid is involved in the construction of numerous enzymes (phosphatases) that perform chemical reactions in tissues. The human skeletal tissue is formed from salts of phosphoric acid [9]. In Azerbaijan, the daily phosphorus requirement for an adult is set at 730 mg [4]. In the preferred option A95-WF+10%PS, the amount of dietary phosphorus entering the body with bread is 263.0 mg/100 g (Table 2). In this case, the daily requirement of the human body is provided with phosphorus by 36.03 %. By consuming 278 g of bread A95-WF+10%PS, the human body meets 100 % of the dietary phosphorus requirement. Eating bread A95-WF+10%PS in excess of the Azerbaijani norm or the WHO recommended norm will not lead to any adverse consequences

[17].

On average, the calculated values of the content of potassium, magnesium and phosphorus in bread samples deviate from the actual ones by 0.0032, 0.0025 and 0.0749 %. Since the approximation error is less than 7 %, to calculate the share of change in potassium (varied within of 213.36–278.51 mg/100 g), magnesium (varied within of 83.13–140.88 mg/100 g) and phosphorus (varied within of 234.30–277.38 mg/100 g) in bread samples in the technological process, you can use the equations as a regression (Table 3).

The content of calcium, sodium and sulfur in the bread samples with an additive increased slightly and the share of their change was in the range of 42.22–51.22, 505.42–507.42 and 56.75–66.23 mg/100 g (Table 2). Compared to the control bread A95-WF, in an acceptable bread sample A95-WF+10%PS, the content of calcium, sodium and sulfur increased on average by 6.0, 1.58 and 8.32 mg/100 g, respectively.

By adding PS, the amount of calcium in the composition of bread can be increased. Calcium is responsible for the effectiveness of various processes, and its supply in the diet is necessary for the normal function of the human body, he important component of the skeleton, and also helps maintain the structure of cell organelles and regulates intracellular and extracellular fluid homeostasis [18]. According to the SSCA, the daily calcium intake is 950 mg [4]. This is consistent with data from [18] that the majority of the world's population consumes <1000 mg calcium daily. In preferred option II, the amount of calcium entering the body with A95-WF+10%PS bread was 48.22 mg/100 g (Table 2). Assuming an intake of 380 g of bread per day, the amount of calcium entering the body with A95-WF+10%PS bread will be about 183.24 mg (19.29 % of the norm).

By adding PS to A95-WF, you can increase the sodium content of bread. Sodium salts have a positive effect on the cardiovascular system [19]. For the normal functioning of the neuromuscular system, normal growth and condition of the body play an important role [4]. In this respect, it has been shown that a reduction in the salt content of bread is possible, and an alternative approach involves partial replacement with other, mainly potassium-based salts, which also counteract the effects of sodium [3]. In Azerbaijan, the daily sodium requirement for an adult is set at 575 mg [4]. By adding 10 % PS to A95-WF, you can reduce the amount of table NaCl in the bread recipe to 0.31 %. This means, that assuming an intake of 380 g of A95-WF+10%PS bread per day, you can save 8 mg of NaCl (i. e. reduce Na by 3.2 mg), and accordingly reduce the amount of NaCl added to wheat flour when kneading the dough. Evidence has been found in a variety of randomised controlled experiments that a reduction in sodium consumption can decrease the risk factor of chronic diseases including cardiovascular disease, hypertension, stroke, kidney disease and other non-communicable diseases [19]. However, it is impossible to completely remove salt from the bread recipe. Because the inclusion of salt in bread formulation is crucial as it largely influences the technological processes that occur during breadmaking [20].

Sulfur destroys microbes and parasites, increases immunity, maintains oxygen balance for normal brain functioning, provides cell regeneration and is able to resist tissue destruction by free radicals of the human body, and promotes rejuvenation processes [12]. WHO recommendations amount to 13 mg/kg per 24 h in healthy adults, which for a 70 kg person equates to 910 mg/d. When adding 10 % PS to A95-WF, the amount of sulfur in the preferred option II of bread increases slightly, i. e. by 8.32 mg and the total amount of sulfur in bread A95-WF+10%PS was 65.07 mg/100 g (Table 2). Assuming an intake of 380 g of bread per day [4], the amount of sulfur entering the body with A95-WF+10%PS bread will be about 247.27 mg (27.17 % of the norm).

This is good because sulfur has a positive effect on the quality of grain protein and the processing quality of wheat, increases the volume, reduces the hardness and chewiness of bread [21].

Among trace elements, the content of iron and zinc increased significantly (Table 2). When the PS was added to A95-WF in amounts ranging from 5 to 15%, the share of change in iron content was in the range of 68.76-206.26 and zinc 41.32-123.98 μg/100 g, respectively, compared to control bread. In bread sample A95-WF+10%PS, the content of iron and zinc increased on average by 137.51 and 82.65 μg/100 g, respectively, compared to the control bread.

Microelements are needed for the human body in very small amounts and have a visible impact on human health. Deficiencies of micronutrients like iron, zinc and other minerals can cause life threatening conditions. Zinc deficiency in the human body results in loss of appetite, skin lesions, impaired taste and smell. It also affects the utilization of VA and the metabolism of carbohydrates and protein. Through the proper selection of food these micronutrients deficiencies can be prevented to a reasonable extent [22].

According to the SSCA, the daily norm for an adult human is set at 9 mg in Azerbaijan [4]. In preferred option II, the amount of iron entering the body with A95-WF+10%PS bread was 1604.23 μg/100 g (Table 2). Assuming an intake of 380 g of bread per day, the amount of iron entering the body with A95-WF+10%PS bread will be about 6.1 mg (67.8 % of the norm).

In all regions of the world with 1.5 to 2.0 billion people suffering from one or multiple chronic mineral deficiencies [23].

According to the SSCA, the daily zinc intake is 9.4 mg [4]. In preferred bread sample A95-WF+10%PS (option II), the amount of zinc entering the body with bread was 671.75 μg/100 g (Table 2). Assuming an intake of 380 g of bread per day the amount of zinc entering the body with A95-WF+10%PS bread will be about 2.55 mg (28.33 % of the norm). This is consistent with research by [24] that healthy adults have an absolute need for 2–3 mg zinc per day to compensate for the relatively small loss of zinc in urine, stool, and sweat.

On average, the calculated values of the content of iron and zinc in bread samples deviate from the actual ones by 0.0005 and 0.0022 %. Since the approximation error is less than 7 %, to calculate the share of change in iron (varied within of 1472.64–1665.9 μg/100 g) and zinc (varied within of 594.19–622.61 μg/100 g) in bread samples in the technological process, you can use the equations as a regression (Table 3).

The content of iodine and cobalt in the bread samples increased slightly and the share of their change was in the range of 0.24–0.72 and 0.38–1.14 μg/100 g, respectively (Table 2). In an acceptable bread sample A95-WF+10%PS, the content of iodine and cobalt increased by an average of 0.48 and 0.76 μg/100 g, respectively, compared with the control bread.

The main component of thyroid hormones is iodine. Its participation contributes to the regulation of the rate of biochemical reactions, energy, water-electrolyte metabolism, body temperature, protein and fat metabolism, metabolism of some vitamins, as well as neuropsychiatric development and growth of the body. Iodine increases oxygen consumption by body tissues [8]. According to the SSCA, the daily iodine intake is 150 μg [4]. Studies also show that iodine intake for adults should be 150 μg per day [25]. In the preferred option bread A95-WF+10%PS, the amount of iodine entering the body with bread was 3.6 μg/100 g (Table 2). Assuming an intake of 380 g of bread per day the amount of iodine entering the body with A95-WF+10%PS bread will be about 13.68 mg (9.12 % of the norm). This is similar to the results of [26] that of the total 64 bread samples collected for iodine analysis, 18 bread was found to be non-iodized defined as bread with iodine content below 4.5 μg/100 g while the rest were iodized (>20 μg/100 g). However, adding iodate preparations to bread is unacceptable from a chemical point of view. It is advisable to add products to bread that are rich in iodine of natural origin. This is also confirmed in the paper [8], where it is shown that one of these products can be persimmon, which contains 6.4 μg/100 g of iodine. By adding PS to A95-WF, you can increase the iodine content in bread.

Cobalt, as a necessary mineral for the human body, is involved in the internal processes of the body. Cobalt is part of vitamin B12 [8]. In the preferred option A95-WF+10%PS, the amount of iodine entering the body with bread was 3.6 μg/100 g (Table 2). Assuming an intake of 380 g of bread per day the amount of iodine entering the body with A95-WF+10%PS bread will be about 13.68 μg. This is similar to the results the paper [27], which showed that levels of cobalt in different bread samples ranged between 3±1 to 10±3 μg/100 g. This is consistent with the results the paper [28] that when assessing the health risk, the level of coblat in all types of bread (n=60) was 6.91 μg/100 g. The paper [29] also shows that in Italy the total consumption of cobalt is 19.68 μg/day.

Thus, adding PS to A95-WF can increase the minerals in bread. It was found that when PS is added to A95-WF, the content of potassium, magnesium, phosphorus, iron and zinc in bread with the additive increases significantly. But the content of calcium, sulfur, iodine and cobalt increases slightly. The addition of PS to A95-WF increases the antioxidant and antimicrobial properties of bread, and therefore increases the shelf life of bread. The resulting regression equations make it possible to predict and establish a connection between the share of changes in minerals in the technological process and the increase in their content in bread. Since the approximation errors are less than 7%, this indicates the good quality of the found models. The used PS turned out to be a good raw material for baking bread.

The results of the study proved that the addition of PS to A95-WF during dough kneading allows to increase the nutritional value of bread, to establish the relationship between the proportion of change of mineral substances and increase their content in bread, to expand the range, raw material base and the use of non-traditional raw materials in baking.

The results obtained will be used in the baking industry to establish the nature and determine or select the share of changes in minerals, regulate their content before and after the technological process of processing raw materials and preparing bread with additives.

Further development of research is the improvement or development of appropriate technological regimes for the production of bread with additives to achieve greater preservation of useful substances. The shortcomings of the research include the lack of data on changes in essential amino acids in bread with PS. These data are planned to be obtained by continuing research on the production technology of bread with PS.

Conclusions

It has been established that when PS is added from 5 to 15 % to A95-WF, among the macroelements in bread samples with the additive, the content of potassium, magnesium and phosphorus increases significantly. Compared to control bread, the share of change in their content in the bread samples with the additive was with a discrepancy from the preferred option II for potassium – 43.44±21.72, magnesium – 38.5±19.25, phosphorus – 31.7±14.34 mg/100 g. However, the content of calcium, sodium and sulfur slightly increases. Compared to control bread, the share of change in their content in the bread samples with the additive was with a discrepancy from the preferred option II for calcium – 6.0±3.0, sodium – 1.58±0.4; sulfur –

8.32±4.16 mg/100 g. Among the microelements in the samples of bread with the additive, the content of iron and zinc significantly increases. Compared to control bread, the share of change in their content in the bread samples with the additive was with a discrepancy from the preferred option II for iron – 137.51±68.76, zinc – 82.65±41.33 μg/100 g. Among the microelements in the samples of bread with the additive, the content of iodine and cobalt increases slightly. Compared to control bread, the share of change in their content in the bread samples with the additive was with a discrepancy from the preferred option II for iodine – 0.48±0.24, cobalt – 0.76±0.38 μg/100 g. The study of the nature of changes in mineral substances in the technological process of making bread makes it possible to determine the share of changes in their content (in %). Based on this, it is possible to regulate the content of mineral substances before and after the technological process of processing raw materials and making bread with additives.

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XURMA ŞƏRRƏTİNİN ƏLAVƏ EDİLMƏSİ İLƏ ÇÖRƏYİN MİNERAL TƏRKİBİNİN TƏYİNİ

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XÜLASƏ
Gündəlik pəhrizdə çörək insan orqanizmini doydurmaq üçün əla qidadırr. Bu istiqamətdə aşqar kimi xurma siropu (PS) geniş çeşiddə çörək məmulatlarının istehsalı üçün əvəzolunmaz ola bilər. Çörəkçilik istehsalında xolesterolun geniş istifadəsini məhdudlaşdıran amillərdən biri onun mineral dəyəri, texnoloji prosesdə onların tərkibindəki dəyişikliklərin xarakteri və nisbəti haqqında kifayət qədər məlumatın olmamasıdır. Odur ki, tədqiqatın məqsədi Hiakume sortundan buğda unu Əzəmətli-95 (A95-WF), xurma siropu (PS) və PS əlavəsi ilə çörəyin mineral dəyərini təhlil etmək və dəyişikliklərin xarakterini və nisbətini müəyyən etməkdir. texnoloji prosesdə onların məzmununda.Ona görə də tədqiqatın məqsədi birinci sort buğda ununun A95-WF, PS və PS əlavə edilmiş çörəyin mineral tərkibini təhlil etməkdir. Məlum olub ki, çörək nümunələrində A95-WF-ə 5, 10 və 15 % PS əlavə edildikdə, q/100 q-da miqdarı xeyli artır: kalium (43,44±21,72), maqnezium (38,5±19,25), fosfor (31,7) ±14,34); µg/100 q-da: dəmir (137,51±68,76) və sink (82,65±41,33) və q/100 q-da miqdarı bir qədər artır: kalsium (6,0±3,0), natrium (1,58±0,4), kükürd (8,32±4,16) ; µg/100 q ilə: yod (0,48±0,24), kobalt (0,76±0,38) A95-WF-ə 10 % PS əlavə etməklə ən yaxşı çörəkdən kənara çıxma ilə. Alınan reqressiya tənlikləri (AE<7 %) texnoloji prosesdə əhəmiyyətli dərəcədə dəyişən minerallarda dəyişikliklərin payları ilə onların çörəkdə miqdarının artması arasında əlaqəni proqnozlaşdırmağa və müəyyən etməyə imkan verir.
Açar sözlər: buğda, un, xurma, şərbət, çörək, minerallar.

УСТАНОВЛЕНИЕ ХАРАКТЕРА И ДОЛИ ИЗМЕНЕНИЙ МИНЕРАЛОВ ПРИ ПРОИЗВОДСТВЕ ХЛЕБА С ДОБАВЛЕНИЕМ СИРОПА ХУРМЫ

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АБСТРАКТ

В ежедневном рационе хлеб является отличным носителем питательных веществ для пополнения организма человека. В этом направлении сироп хурмы (ПС) в качестве добавки может оказаться незаменимым для производства широкого ассортимента хлебобулочных изделий. Одним из факторов, ограничивающих широкое применение холестерина в хлебопекарном производстве, является недостаточная изученность его минеральной ценности, характера и пропорциональности изменения их содержания в технологическом процессе. Поэтому цель исследования - проанализировать минеральную ценность пшеничной муки Азаматли-95 (A95-WF), сиропа хурмы (ПС) сорта Хиакуме и хлеба с добавлением ПС и установить характер и долю изменений. по их содержанию в технологическом процессе. Поэтому целью исследования является анализ минерального состава муки пшеничной А95-ВФ первого сорта, ПС и хлеба с добавкой ПС. Установлено, что при добавлении 5, 10 и 15 % ПС к А95-ВФ в образцах хлеба существенно увеличивается содержание в г/100 г: калия (43,44±21,72), магния (38,5±19,25), фосфора (31,7). ±14,34); в мкг/100 г: железа (137,51±68,76) и цинка (82,65±41,33) и несколько увеличивается содержание в г/100 г: кальция (6,0±3,0), натрия (1,58±0,4), серы (8,32±4,16). ; в мкг/100 г: йод (0,48±0,24), кобальт (0,76±0,38) с отклонением от лучшего хлеба с добавкой 10 % ПС к А95-ВФ. Полученные уравнения регрессии (AE<7 %) позволяют спрогнозировать и установить связь между долями изменения существенно изменяющихся минеральных веществ в технологическом процессе и увеличением их содержания в хлебе.

Ключевые слова: пшеница, мука, хурма, сироп, хлеб, минеральные вещества.