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# Nutritional and biological value of bakery products with the addition of vegetable powders and milk whey

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***Abstract:*** *Bakery products are part of the daily diet of people and can be considered as a perspective basis for the design of functional food products. To enrich bakery products, Narine milk whey, egg-shell powder and IR-dried beet and cranberry powders were used as functional additives. A total of 6 samples with different combinations of additives were tested. It was shown that introduction of "Narine" whey, beet and cranberry powders, egg-shell powder not only improves organoleptic characteristics of products, but also gives them functional properties in terms of protein and calcium content in comparison with traditional technology. Thus, the addition of 3% egg shells increases the calcium content to 52.5 mg/100g. The method of mathematical modelling by the decision of problems of linear programming shows optimality of the chosen formulas.*

***Key words:*** *beet, cranberry, milk whey, oat flakes, bread roll*.

## I. INTRODUCTION

Consumers expect both balanced taste and health benefits from food products. It becomes necessary to develop new ways of food processing for developing new food products. In this regard, various technological solutions are offered to produce food that has high consumer properties, including bakery products. Thus, in the production of products for school and gerontological nutrition it is necessary to include fruit and vegetable powders, dietary fibers, protein and mineral additives in the formulations, that can increase the nutritional value of finished products, improve their organoleptic characteristics, contribute to the intensification of the technological process.

A variety of bakery products were developed based on Narine cheese whey and enriched with calcium, dietary fibres and pectins:

- bread roll "Sandwich" (sample number 1);
- bread roll "School" (sample No. 2);
- bread roll "Enriched" (sample No. 3);
- bread roll "Sportivnaya" (sample No. 4);
- Oatmeal bread roll (sample No. 5);
- "Health" bread roll (sample No. 6).

The control sample was taken as a "Molochnaya" bread roll according to the "Collection of recipes of flour confectionery and bakery products" [1].

The introduction of milk whey in confectionery and bakery products improves their quality and taste. Milk serum is a by-product of the production of cheese, cottage cheese, casein and is a secondary milk raw material [2]. “Narine" cheese whey is rich in minerals, a significant amount of lactose (about 90% of total dry matter content) and low-molecular protein substances with biological activity. It is established that in comparison with usual whey it has the reduced content of fat and high ash content that indicates its rich mineral composition. Also it possesses the lowered

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acidity in comparison with usual whey. In terms of microbiological indicators, it has no E. coli bacteria or pathogens (including salmonella) [3].

As a calcium additive, egg-shell powder was introduced into bakery products. It is known that the shell of chicken eggs consists of 97% inorganic substance - calcium carbonate, which is absorbed almost entirely due to the fact that has already been synthesized in the body of birds from organic to inorganic calcium [4, 5]. In total, about 14 important chemical elements have been found in the eggshell, which are essential for the normal functioning of the human body. Eggshells after processing and burning were crushed. The weighted average particle size is 25 μm. According to the results of the research together with the Biochemistry Laboratory of the Siberian Research and Design Institute of Animal Husbandry of the Russian Agricultural Academy it was found that the content of calcium in the shredded eggshell was 54.43% and protein 14.92%.

Considering the good absorption of calcium not only by means of lactose, but also in the presence of vitamin C and organic acids, the following supplements were vegetable powders. They were obtained by infrared drying from beetroot and cranberry mesgah with subsequent grinding to powder state (Institute of Solid-State Chemistry and Mechanochemistry of SB RAS).

Cranberry powder is a homogeneous granular mass of red-bordeaux color with a pronounced taste. It has a high content of dietary fiber (~46%), organic acids (~18%), reducing sugars (-12.5%), flavonoids, macro-, microelements and vitamins, especially vitamin C, which helps to digest calcium in the human body. In addition, cranberry powder contains benzoic acid, which has an antimicrobial action, and therefore is important for preventing moulding during the storage of finished flour products [6, 7].

Beet powder is a loose mass of dark pink colour with typical beet flavour. It contains a significant amount of sugars, various vitamins (group B, PP, etc.), ascorbic acid, nicotinic acid, pectin, pigments, minerals (iodine, magnesium, potassium, calcium, iron, etc.) [8]. The beet is a good source of vitamin C, it also contains a significant amount of vitamin P, which enhances the biological effect of vitamin C. It is good at removing toxins from the body. The additives of beet powder have a stabilizing effect. This is due to the high content of not only pectin, hemicellulose and fiber, but also sugars, which stabilize the emulsion and foam of egg products by increasing the viscosity of the dispersion medium [9].

## II. MATERIALS AND METHODS

During the formulation and manufacturing technology of bakery products were based on organoleptic quality indicators. Samples 1 and 2 were prepared on the basis of a control sample. In these samples, milk was replaced with 50 % of whey and water at a ratio of 1:1.

The concentration of egg-shell powder in samples was determined experimentally and amounted to 3% of the mass of flour. The concentration of cranberry and beet powders was 3 and 4 % instead of flour.

In order to enrich the products with food fibers, oat flakes were added to samples 3-6. Whey and water were used in the ratio of 1:1. Accelerated dough kneading technology was used to produce samples No. 5 and 6. This was achieved by increasing the amount of yeast used (as compared to the traditional yeast dough formulation) at 27-32 °C and the speed of mixing in a whipping machine.

It was found that by adding milk whey the fermentation and proofing processes were intensified. The caloric value of bakery products was reduced due to the milk whey replacement and decrease of flour amount.

Organoleptic evaluation of the examined samples of products was carried out by the tasting commission on the basis of the methodology according to GOST 31986-2012 taking into account the coefficient of significance.

From physical and chemical indicators the content of dry substances was determined according to GOST 21094-75, porosity - according to GOST 5669-96, titratable acidity - according to GOST 5670-96, ash content - according to GOST 11270-96, calcium content - according to GOST 26570-95, protein content - according to GOST R 53951-2010 [10, 11, 12].

## III. RESULTS AND DISCUSSION

The organoleptic evaluation of the new bakery products has shown that they are characterized by pleasant appearance, good taste, color and smell, with appropriate consistency (tables 1, 2). Based on a comparative assessment of organoleptic characteristics, samples 2, 4, 6 proved to be the best (table 3).

Table 1 – Sensory evaluation of bread samples (samples 1-3)

| Indicator | Significance ratio | Average score | | | Comprehensive evaluation | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 |
| Appearance | 3 | 4,8±0,2 | 4,8±0,1 | 4,8±0,3 | 14,4±0,6 | 14,4±0,3 | 14,4±0,9 |
| Flavor | 4 | 4,8±0,4 | 4,9±0,2 | 4,8±0,1 | 19,2±1,6 | 19,6±0,8 | 19,2±0,4 |
| Taste | 6 | 4,7±0,3 | 4,8±0,3 | 4,7±0,2 | 28,2±1,8 | 28,8±1,8 | 28,2±1,2 |
| Color | 2 | 4,6±0,1 | 4,7±0,2 | 4,7±0,2 | 9,2±0,2 | 9,4±0,4 | 9,4±0,4 |
| Consistency | 5 | 4,7±0,3 | 4,6±0,1 | 4,7±0,1 | 23,5±1,5 | 24,0±0,5 | 23,5±0,5 |
| overall mprehensive aluation | 20 | - | - | - | 94,5±1,5 | 96,2±1,2 | 94,7±1,4 |
| overall mprehensive aluation | | 4,7±0,3 | 4,8±0,2 | 4,7±0,2 | - | - | - |

Table 2 – Sensory evaluation of bread samples (samples 4-6)

| Indicator | Significance ratio | Average score | | | Comprehensive evaluation | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 |
| Appearance | 3 | 4,8±0,2 | 4,8±0,2 | 4,9±0,1 | 14,4±0,6 | 14,4±0,6 | 14,7±0,3 |
| Flavor | 4 | 4,7±0,2 | 4,9±0,4 | 4,8±0,3 | 18,8±0,8 | 19,2±1,6 | 19,2±1,2 |
| Taste | 6 | 4,8±0,3 | 4,7±0,3 | 4,9±0,2 | 28,8±1,8 | 28,2±1,8 | 29,4±1,2 |
| Color | 2 | 4,7±0,1 | 4,8±0,1 | 4,9±0,1 | 9,4±0,2 | 9,6±0,2 | 9,8±0,2 |
| Consistency | 5 | 4,7±0,2 | 4,6±0,3 | 4,7±0,2 | 23,5±1,0 | 23,0±1,5 | 23,5±1,0 |
| overall mprehensive aluation | 20 | - | - | - | 94,9±1,5 | 94,4±1,5 | 96,6±2,0 |
| overall mprehensive aluation | 5 | 4,7±0,2 | 4,7±0,3 | 4,8±0,2 | - | - | - |

Table 3 – Physical-chemical indicators of bread samples

| Indicator | Samples | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | Control |
| Dry matter ntent, % | 65±0.11 | 64.6±0.27 | 62.8±0.68 | 64.4±0.01 | 64.6±0.50 | 62.0±0.50 | 64.0±0.10 |
| Porosity, | 73.2±0.13 | 76.2±0.05 | 72.6±0.31 | 75.7±0.12 | 74.3±0.08 | 77.1±0.12 | 70.1±0.55 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Crude ber, % | 0.05 | 0.12 | 0.14 | 0.5 | 0.2 | 1.05 | 0.05 |
| Ash ntent. % | 21.0±0.01 | 29.5±0.01 | 21.4±0.02 | 21.4±0.04 | 24.0±0.04 | 27.2±0.04 | 6.56±0.01 |
| Ca, mg | 17.9 | 49,0 | 13.8 | 52,0 | 12.4 | 52,5 | 33 |
| Protein, g | 3.93 | 8.39 | 4.6 | 9.91 | 4.13 | 10.68 | 4.5 |
| Acidity, °T | 2.6±0.0 | 1.0±0.01 | 2.8±0.02 | 2.2±0.01 | 2.4±0.2 | 3.0±0.01 | 2.2±0.01 |

Based on the results, it can be concluded that in terms of dry substance content and porosity all products meet the requirements of GOST 31805-2012 "Bakery products made of wheat flour". Samples with the addition of oat flakes (№ 3-6) contain more fiber than other samples. Samples with the addition of egg-shell powder and oatmeal flakes (No. 4, 6) contain the highest amount of ash, which indicates that they contain the highest quantity of macro- and microelements.

Taking into account the norm of physiological need for calcium (1000-1200 mg/day) and the percentage of functionality of 15 % (150-180 mg), it was found that samples No. 2, 4, 6 satisfy 15 % of the norm of calcium consumption, which indicates their functionality.

Taking into account the physiological requirement for protein (90 g/day) and the percentage of functionality of 10% (9 g), it was found that samples Nos. 4 and 6 replenish 10% of the norm of protein intake.

The addition of vegetable powders of cranberries (sample No. 5) and beets (sample No. 6) in the dough increases the acidity of finished samples, especially the effect of beet powder. However, in terms of organoleptic characteristics (taste) the samples with these additives are not inferior to the control ones. Tests for microbiological semination of samples were conducted. It was established that in all samples studied there were no E. coli bacteria, S. Aureus and pathogenic microorganisms of Salmonella genus, that confirms observance of sanitary regime during production and requirements of storage regime.

To confirm the functionality of the developed products, mathematical modeling of the product composition was used [13]. The ratio of prescription components was established on the basis of organoleptic properties, so the described technique was used as a confirmation of the experimental studies (Table 4).

Table 4 - Information matrix of data on the recipe of the bread roll "Sport" (sample 4)

| Ingredients | Variation nge | Protein ntent, % | Dry matter ntent, % | $X_i$ index | Food bers content, | Energy lue, kCal | Calcium ntent, g/100g |
|---|---|---|---|---|---|---|---|
| Wheat flour | 20-30 | 10.8 | 86 | $X_1$ | 0.1 | 334 | 18 |
| Bakery yeast | 0.5-2.0 | 12.7 | 26 | $X_2$ | 2.1 | 0 | 27 |
| Salt | 0-1 | 0 | 98.99 | $X_3$ | 0 | 0 | 368 |
| “Narine” ney | 5-15 | 1.0 | 5 | $X_4$ | 0 | 40 | 8 |
| Oat flakes | 5-15 | 12.3 | 88 | $X_5$ | 1.3 | 305 | 52 |
| Margarine | 0-1 | 0.3 | 84.1 | $X_6$ | 0 | 0 | 4.5 |
| Water | 8-15 | 0 | 0 | $X_7$ | 0 | 0 | 4.5 |
| Eggshell wder | 0.5-0.5 | 12.0 | 98.75 | $X_8$ | 0 | 60 | 54.43 |
| Beet powder | 0.5-2.0 | 6.0 | 91.2 | $X_9$ | 4.3 | 25 | 2.05 |

## IV. CONCLUSION

Thus, it is possible to state that developed products have high potential for production launch. On the one hand, it is a healthy, balanced product, enriched with proteins, vitamins, trace elements and fibre, which prolongs active, productive life and contributes to the reduction of morbidity; on the other hand, it is an option of the most rational economic choice.

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