OPTIMIZATION OF RECEPTURAL COMPOSITION OF THE BAKERY PRODUCT OF INCREASED NUTRITION VALUE

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Abstract. Healthy nutrition is necessary for each individual to achieve the best physical and emotional states and to prevent various alimentary-dependent diseases. In this connection, the development of bakery products with high nutritional value and optimization of the ingredient composition of bakery products, taking into account the technological properties of raw materials and hygienic recommendations for nutrition, will help to improve the health status of various groups of adult population, which is a urgent task. Data on optimization of the ingredient composition of bakery products in accordance with the chemical composition of components that ensure the adequacy of the requirements for the diet of the adult population are provided in the article. The list of ingredients with high nutritional and biological value and the possibility of their use in the making bakery products has been scientifically substantiated. The optimization was carried out using modern programs that provide for mathematical modeling of product formulations in the implemented range of parameter changes. The qualitative and quantitative prescription structure according to requirements imposed to food for adult population is simulated. Optimization of the qualitative composition was carried out in accordance with the chemical composition of the prescription components, ensuring the adequacy of the requirements for the diet of the adult population. The possibility of using ingredients increasing the nutritional and biological value of bakery products has been investigated: micellar form of vitamin D (source of cholecalciferol) and amaranth flour (source of valuable vegetable protein, mineral substances). It is experimentally substantiated that use of the developed compounding of bread will contribute to an increase in the protein content, fats, carbohydrates, vitamins, mineral substances and will increase the biological value in bakery products.

Keywords: bakery products, experiment planning, composition optimization, nutritional and biological value, vitamin D, amaranth flour.

Introduction

Modern life is characterized by physical and psycho-emotional stress, frequent stressful situations and other factors. One of the most important requirements for a normal process of vital activity is the competent construction of a diet with the obligatory replenishment of energy, macro- and micronutrients.

Bakery products are the most accessible and highly digestible foods by means of which correction of the nutritional value of diets is possible. Therefore, the development of bakery products with high nutritional value is aurgent task. The inclusion of such products in the diet will not only contribute to achievement of the best physical and emotional states, but will also prevent a number of alimentary diseases.

The aim of the work is creation of the optimized compounding of a bakery product according to its qualitative and quantitative composition, taking into account the technological properties of the raw materials and physiological requirements imposed on the nutrition of the adult population.

Materials and research methods

The objects of the research were bakery products with the use of amaranth flour and vitamin D supplement.

When carrying out researches generally accepted, standard and special test methods were being used, including organoleptic, physicochemical, and statistical methods for processing experimental data. Studies were conducted in triplicate.

Mathematical modeling of product composition was carried out using the STATGRAPHICS application software package, which allows to define the coefficients of the regression equations that adequately describe the dependencies obtained.

Bakery products were developed according to the requirements of the technical regulations of TR CU 021/2011, with the observance of sanitary norms and rules, recipes and technological instructions. Sampling and preparation of samples for research were carried out according to STB 2160-2011 no earlier than 3 hours after removal from the furnace.

Organoleptic evaluation of baked products was carried out according to GOST 27669-88. Quality levels of bakery products were assessed by appearance (shape, surface condition), color (color of the crust), nature of porosity (size and uniformity of pores, thickness of pore walls), physical and mechanical properties of the crumb (crumb resistance to finger pressure), color of the crumb, smell, taste, chewability.

The quantitative content of mineral substances, including calcium, in the studied samples was determined using the X-ray fluorescence method, which allows to obtain data on the mass fraction of 30 elements in the sample without prior complex and lengthy sample preparation, according to GOST 22261-82.

The research of vitamin D_3 (total analysis of D_2 and D_3) was carried out by the standardized method based on high effective liquid chromatography, relative to a standard sample of vitamin D_3. The test method was EN 12821.

The calculation of the nutritional value and amino acid level of proteins was carried out using a calculation method using Microsoft Excel 2010.

The amino acid level of proteins is meant to reflect the percentage of the total daily requirement of the most limiting diets the indispensable amino acids contained in an amount of protein equivalent to the the estimated average requirement for total daily protein intake of the test protein.The equation used to calculate the amino acid level of proteins is as follows:

Amino acid level of proteins (%) = 100×[(mg of digestible dietary indispensable amino acids in 1 g of the dietary test protein)/(mg of the same amino acid in 1 g of the reference protein)]

Integral score was defined as the degree of satisfaction of the daily human need for food substances when eating 100 g of a product according to the formula:

Integral score (%) = 100×[(g or mg nutrients in 100 g of the investigational product)/(g or mg the daily need of an adult for nutrients)]

Results and discussion

The optimization of the qualitative composition was carried out in accordance with the chemical composition of the prescription components, ensuring the adequacy of the requirements for the diet of the adult population. The possibility of using ingredients increasing the nutritional and biological value of bakery products has been investigated: micellar form of vitamin D (source of cholecalciferol) and amaranth flour (source of valuable vegetable protein, mineral substances).

The optimization of the quantitative composition of enriching ingredients was carried out based on the organoleptic properties of the finished products, the content of calcium and vitamin D in bread using the method of mathematical modeling.

For this purpose, an experiment was planned and a series of laboratory test baking of bakery products was conducted using amaranth flour in various ratios (from 5 to 30% instead of wheat and rye mix of flour) and cholecalciferol (from 0.2 to 0.8 ml per unit of product 600 g)

As a result, regression equations, that describe the dependence of the quality indicators of bread in the realized range of changes in the parameters, were obtained,response surfaces (Fig. 1-3) were constructed, allowing to simulate the composition of bakery products:

$$\textit{Comprehensive quality assessment} = 89{,}2847 + 12{,}3704 \cdot X_1 + 1{,}08507 \cdot X_2 - 38{,}1481 X_1^2 - 0{,}0587733 \cdot X_2^2$$

$$\textit{Calcium content} = 15{,}3953 + 333{,}474 \cdot X_1 + 28{,}6989 \cdot X_2 - 280{,}741 \cdot X_1^2 - 3{,}01333 \cdot X_1 \cdot X_2 - 0{,}805227 \cdot X_2^2$$

$$\textit{Vitamin D content} = -21{,}667 + 177{,}815 \cdot X_1 - 0{,}044 \cdot X_2 - 158{,}148 \cdot X_1^2$$

where X_1 – dosage of cholecalciferol, ml;
X_2 – dosage of amaranth flour,% by weight of flour.

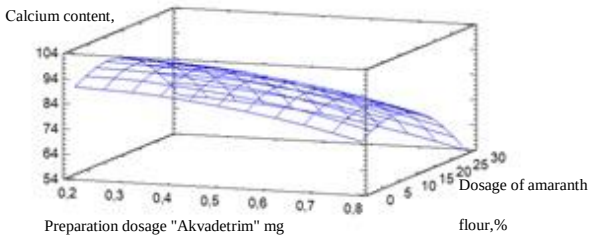

Figure 1. The response surface, reflecting the dependence of the value of a comprehensive scoring quality of products from dosage of cholecalciferol and amaranth flour

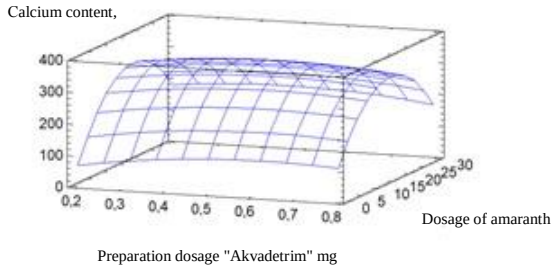

Figure 2. The response surface, reflecting the dependence of the calcium content on the dosage of cholecalciferol and amaranth flour

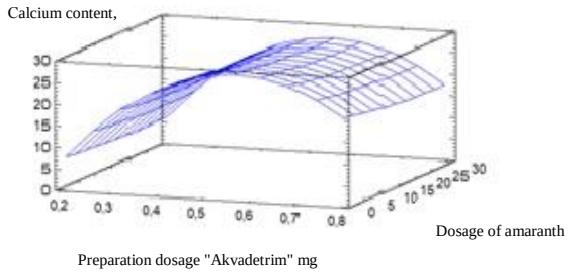

Figure 3. The response surface, reflecting the dependence of the content of vitamin D on the dosage of cholecalciferol and amaranth flour

As a result, the optimal number of components introduced into compounding was established: a micellar form of vitamin D - 0.2-0.5 ml (per unit of product mass 600 g); amaranth flour - 10-15% by weight of a mixture of rye and wheat flour. The revealed patterns create prerequisites for obtaining a bakery product with high quality indicators when using optimal dosing intervals for amaranth flour and micellar form of vitamin D.

The nutritional value related to the chemical composition of the raw materials is of great importance for bakery products and can be used to assess the quality of finished products as controlled parameters. According to the results of X-ray fluorescent analysis, the content of various mineral substances in the studied bread samples was determined (Table 1).

Table 1. The chemical composition of bread

Indicator name	Indicator value	
	Control sample	Model
Content, g:		
protein	5,71	6,09
fat	1,04	1,58
carbohydrate, including	42,39	41,5
dietary fiber	4,42	4,30
Content of mineral substances, mg / 100 g:		
potassium	62,06	140,61
calcium	15,63	39,80
iron	2,82	5,25
copper	0,42	1,17
zinc	1,72	3,18
manganese	0,54	1,07
selenium	0,05	0,11
Vitamin D, mcg / 100 g	not found	6,32
The content of essential amino acids, mg / g		
threonine	29,32	35,81
valine	26,46	33,42
methionine	2,99	2,88
tryptophan	25,04	27,64
lysine	7,05	8,94
isoleucine	13,87	12,78
phenylalanine	10,96	14,28
leucine	21,63	25,56

It has been established that the addition of enrichers to the bread compounding provides a high content of vitamin D in its composition, as well as such important for human minerals as calcium, selenium, iron, etc. It should be noted that the baked bread samples with nutritional supplements are characterized by a high content of essential amino acids, especially valine, leucine and lysine (the gain relative to the control sample was 26.3, 30.3 and 18.2% respectively).

To assess the degree of satisfaction of the daily need of an adult in basic nutrients, the integral quickly obtained bakery products were calculated (Table 2).

Table 2. Integral score of the bread

Indicator name	Integral scor, %		Growth in relation to control, %
	Control sample	Model	
Protein	7,8	8,3	+0,5
Fat	1,3	1,9	+0,6
Carbohydrates	11,6	11,4	-0,2
Potassium	2,5	5,6	+3,1
Calcium	1,6	4,0	+2,4
Iron	20,1	37,5	+17,4
Copper	42,0	117,0	+75,0
Zinc	14,3	26,5	+12,2
Manganese	27,0	53,5	+26,5
Selenium	71,4	157,1	+85,7
Vitamin D	0,0	42,1	+42,1

As a result of determining the nutritional value of bread, the effectiveness of the use of amaranth flour in the composition of bakery products was confirmed. Thus, at the use of 100 g of the developed product, the daily need of an adult for vitamin D is satisfied by 42.1%, iron - by 37.5%, selenium - by 157.1%.

In addition, the biological value of the resulting bakery products was determined (Table 3). For this purpose, there was compared the amino acid composition of bread with the amino acid composition of the ideal protein. It is one of the most important indicators of product quality, because the biological value of proteins depends on the ratio of essential amino acids in them, which cannot be synthesized in the human body and must come from food.

Table 3. Amino acid score of the bread

Amino acid name	Amino acid score, %		Growth in relation to control, %
	Control sample	Model	
Lysine	39,3	46,5	+7,2

Valin	52,9	66,8	+13,9
Threonine	73,3	89,5	+16,2
Methionine + cystine	17,5	17,6	+0,1
Isoleucine	17,6	22,4	+4,8
Leucine	15,7	20,4	+4,7
Tryptophan	250,4	276,4	+26,0
Phenylalanine + tyrosine	56,0	50,0	-6,0
Biological value,%	42,3	48,6	+6,3

The analysis of the data presented in Table 3 allows us to conclude that the proteins of the developed bakery product have a higher biological value than the proteins of wheat bread. Thus, in the sample of bread with amaranth flour and vitamin D, the biological value is 6.3% higher than in the control sample. In that case, we can state that amaranth flour and cholecalciferol should be used to enrich bread with essential amino acids and increase its biological value.

It should also be noted that the nutritional value of products increases, but the energy value increases slightly. Therefore, the developed bread can be recommended for therapeutic and prophylactic nutrition. Bread, baked according to the developed compounding is characterized by high quality indicators, as well as increased content of essential amino acids and vitamin D, increased biological and nutritional value, respectively. At the same time, the technological scheme for the production of bread does not imply a reorganization of existing industries (Кучер, 2018).

It should be noted that the bread with nutritional supplements has a uniform and well-developed porosity, good organoleptic quality indicators (table 4).

Table 4. Organoleptic characteristics of the bread

Indicator name	Indicator value	
	Control sample	Model
Shape	Form is correct, not vague, it conforms to the shape in which the baked goods	
Surface	The surface is smooth, without tears and cracks	
Color	Brown	Brown, saturated
Nature of porosity	Developed, without voids and seals	
Taste	Rich rye taste	Rich rye taste with weak pleasant nutty flavor

Conclusions

Theoretical and experimental researches have confirmed the feasibility and effectiveness of the use of amaranth flour and micellar form of vitamin D_3 in the production of bakery products, and also allowed us to develop a new type of bread compoundingwith high nutritional value. The introduction of the developed product can make a significant contribution to solving the problem of deficiency and insufficiency of vitamin D among the broad masses of the adult population and will expand the range of bakery products.

It is established that the dosage of amaranth flour in the amount of 10-15% by weight of rye and wheat mixture of flour and 0.5-1.3 ml of micellar form of vitamin D_3 (based on 100 kg of finished products) is optimal and provides the product with the best quality indicators.

The product is characterized by good organoleptic quality indicators.

It is revealed that the introduction of fortifiers improves the mineral composition of bread. An increase in the content of micronutrients such as calcium (by 154.6%), iron (by 86.2%), selenium (by 120%) in comparison with traditional wheat-rye bread was noted.

The addition of the cholecalciferol supplement helps to obtain a product containing 6.32 µg / 100 g (252.8 IU) of vitamin D product, which covers the daily requirementof an organism by 42.1%.

The optimized compounding for wheat-rye bread with the addition of amaranth flour and the micellar form of vitamin D_3 is characterized by a higher biological value (by 6.3%) due to an increase in the content of essential amino acids.

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