Proceeding

Supplementary Issue: Autumn Conferences of Sports Science. Costa Blanca Sports Science Events, 18-19 December 2020. Alicante, Spain.

Modelling the balanced composition of food mixtures for gerontological nutrition of sportsmen taking into account features of bone tissue metabolism

I. A. NIKITIN[1] , M. A. NIKITINA[2], S. A. IVANOV[1], R. H. BEKMANSUROV[3], A. V. YUMASHEV[4], S. N. SYCHANINA[5]

[1]*K.G. Razumovsky Moscow State University of Technologies and Management, Moscow, Russian Federation*
[2]*Federal Scientific Center for Food Systems, V.M. Gorbatova, Russian Academy of Sciences, Moscow, Russian Federation*
[3]*Elabuga Institute of KFU, Kazan Federal University, Elabuga, Russian Federation*
[4]*Sechenov First Moscow State Medical University, Moscow, Russia*
[5]*Kuban State Agrarian University named after I.T. Trubilin, Krasnodar, Russia*

ABSTRACT

The development and introduction into production of functional and specialized products is one of the most important directions of the UN humanistic program of human nutrition. In this regard, in accordance with the modern provisions of nutritiology and nutrimetabolomics, national programs to improve the health of the population are being developed and implemented all over the world. Nutrition has a significant impact on the development and manifestation of various kinds of diseases, including those associated with a predisposition to impaired bone metabolism. The main reason for this condition is a significant lack of minerals in the bone tissue, which causes a violation of calcium and hormonal metabolism, as a result of which bone tissue resorption occurs. The most prone to this condition are elderly people, as well as individuals with a genetic predisposition. The article shows the possibility of modelling (designing) food mixtures for gerontological nutrition using mathematical methods. This approach will expand the range of industrial food production; in the context of a shortage of protein-containing raw materials, as well as optimize the conditions for its use and involve non-traditional sources of increasing nutritional value in the consumption sphere.
Keywords: Modelling; Balanced composition; Bakery products; Gerontology; Nutritional science.

Cite this article as:
Nikitin, I.A., Nikitina, M.A., Ivanov, S.A., Bekmansurov, R.H., Yumashev, A.V., & Sychanina, S.N. (2021). Modelling the balanced composition of food mixtures for gerontological nutrition of sportsmen taking into account features of bone tissue metabolism. *Journal of Human Sport and Exercise, 16*(2proc), S470-S484. doi:https://doi.org/10.14198/jhse.2021.16.Proc2.32

Corresponding author. *K.G. Razumovsky Moscow State University of Technologies and Management (the First Cossack University) (Razumovsky Msutm (FCU)), 109004, St. Ground Val, 73, Moscow, Russian Federation.*
E-mail: sadlah.hmd@yahoo.com
Abstract submitted to: Autumn Conferences of Sports Science. Costa Blanca Sports Science Events, 18-19 December 2020. Alicante, Spain.
JOURNAL OF HUMAN SPORT & EXERCISE ISSN 1988-5202

doi:10.14198/jhse.2021.16.Proc2.32

INTRODUCTION

Modern food production technologies must take into account many factors in the production of highly specialized and functional products, as well as healthy food products that have a high degree of efficiency and have a beneficial effect on the human body. Among the factors that should be taken into account when developing products, one can single out individual nutritional characteristics and preferences of a particular person, anthropological characteristics (racial and ethnic characteristics), ecological and biochemical conditions of the living environment, and many others (Tadeu et al., 2019; Movchan and Yakovleva, 2019; Tsvetkova et al., 2019; Panfilova et al., 2020; Bukharina et al., 2014; Cheremisina et al., 2015, 2018). A specific factor that is able to provide significant knowledge on food production is the individual genetic characteristics of the organism of an individual specific consumer (Poltarykhin, 2020; Kozlov, 2019; Chomanov et al., 2020; Kuzmin et al., 2018; Zotova et al., 2019; Prodanova et al., 2019a,b).

The results of recent scientific research in the field of the human metagenome, nutrigenomics, food anthropology, food metabolomics and food chemistry show a close relationship of the positive effect of physiologically active macro- and micronutrients on human health, and also have a beneficial effect on its physiological and genetic characteristics. These data are the basis for the development and emergence of a new direction in nutritional science called the "*concept of personalized nutrition*". The introduction of personalized food products and diets into practice contributes to the replenishment of the nutrient fund from the negative consequences of the expression of polymorphic genes unfavourable to health and will improve the realization of the possibilities of those of them that will reduce the risk of diseases, providing a favourable adaptive ability and coherence of the body in normal conditions, when increased loads and extreme or stressful conditions (Kozlov, 2019).

The constant growth in the number of elderly and senile residents of the Russian Federation necessitates expanding the range of high-quality food products for heroic purposes.

Nutrition is one of the main continuously operating factors of the external environment, which has a very significant impact on the health and state of the human body. Nutrition is key to slowing the development of the aging process.

The body of an aging person, to a greater extent than at a young age, predisposes to the occurrence of atherosclerosis, hypertension, coronary heart disease, diabetes mellitus, gallstone, urolithiasis and gout, and ultimately contributes to premature old age. In old age, it is possible both for the body to be deficient in some vitamins and minerals, and its oversaturation. During the physiological process of aging, the metabolism of a number of vitamins undergoes a change, which causes vitamin deficiency in elderly people, which is caused by poor nutrition or impaired absorption of vitamins (Poltarykhin, Voronkova, 2020; Poltarykhin, Ivanova, 2020; Panfilova et al., 2020; Yemelyanov et al., 2019a,b; Puryaev and Puryaev, 2020; Gladilina et al., 2018; Bekmansurov et al., 2019; Nefedov et al., 2019; Kuzmin et al., 2020).

Rational nutrition in old age (hero diet) is an important factor in the prevention of pathological layers on the natural aging process. Compliance with the recommendations of specialists and taking into account the basics of organizing therapeutic and prophylactic nutrition for elderly people will have a significant impact on the treatment of diseases in old age.

The industrial revolution in agriculture, the massive use of irrigation methods, chemical fertilizers, pesticides, significant changes in the technology of preparation, storage and delivery of food lead to changes in metabolic

metabolic processes in the body, which are associated with the expression of unfavourable polymorphic genes and contribute to the massive occurrence among the population of the Russian Federation of non-infectious alimentary-dependent diseases. Among them, a significant amount is accounted for by diseases associated with a predisposition to impaired bone metabolism, which is characterized by a condition arising from a lack of minerals in the bone tissue. Among the diseases of the bone tissue, the main ones are arthrosis, bursitis, inflammation of the periarticular bag and the joints themselves, osteochondrosis, dysplasia of the hip region, tunnel syndrome, injuries of ligaments, tendons and extremities, arthritis, osteoarthritis, osteoporosis and gout. The most famous and frequent of the diseases in this category is rheumatism, which can also occur with an identified genetic predisposition to it. As you grow older, the risk of diseases associated with impaired bone metabolism steadily increases.

Today, thanks to the development of genetics, it is possible to predict the diseases to which a person is predisposed by conducting genetic testing, which creates conditions for reducing the risks of occurrence or complete relief of identified diseases, subject to a special personalized meal plan. In genetic testing for the possible presence of a predisposition to a violation of bone metabolism, an analysis of a panel of genes is carried out that regulate calcium and hormonal metabolism, bone resorption. The study consists of an analysis of 16 gene polymorphisms:

- Osteogenesis - CALCR, FDPS, COL1A1, COL1A2, COL5A1;
- Calcium metabolism and mineral metabolism - VDR (5 mutations),
- Skeleton development - BMP2;
- Vitamin D metabolism - GC;
- Metabolism of steroid hormones - CYP19A1, ESR1;
- Lactose metabolism - LCT;
- Rheumatoid diseases - HLAB27.

If there is a history of polymorphisms in at least one of the above genes, then this is an indication for the introduction of preventive measures and appropriate adjustments regarding the organization of nutrition, in order to reduce the risk of diseases associated with a predisposition to bone metabolism disorders.

In the treatment and prevention of non-infectious alimentary-dependent diseases, the main role belongs to metabolic therapy, which is based on the principles of diet therapy. It performs the function of one of the key adaptive and protective factors that contribute to maintaining homeostasis and maintaining the full value of health, normal growth and development of the body, preventive action against diseases, increased efficiency and increased adaptation of the body to the effects of adverse environmental factors.

FAO WHO 2013-2020 in the European concept for the prevention and control of noncommunicable diseases (Gaining health, 2006) planned to achieve such goals as:

- A 25% reduction in the risk of premature mortality from cardiovascular, oncological, chronic respiratory diseases and diabetes;
- A 10% reduction in alcohol consumption;
- A 10% reduction in the prevalence of insufficient physical activity;
- A 30% decrease in the average consumption of table salt by the population;
- A 30% decrease in smoking among persons aged 15 years and older;
- A 25% reduction in the prevalence of high blood pressure or containment of the prevalence of high blood pressure according to national circumstances;
- A decrease in the increase in the number of cases of diabetes and obesity (indicators are detailed).

The most common food products on the consumer market among the population of the Russian Federation are bakery products, which are consumed by almost all strata of society and have a fairly high degree of frequency. An increase in the range of functional bakery products, defined for a specific predisposition to certain diseases, will make it possible to purposefully influence the prevention of the development of a number of alimentary-dependent non-infectious diseases, which will help to improve and increase the quality of life, as well as to ensure full health and active longevity (Dunets et al., 2019; 2020; Ljdokova et al., 2014; Morozova et al., 2020; Zhumaliyeva et al., 2020).

Increasingly, the definition of "*design*" of food products is found in the scientific and technical literature. Food design refers to the process of creating recipes of a given composition that are capable of providing an increased level of adequacy of a complex of properties of a food product, in accordance with consumer requirements and standardized requirements for the content of nutrients and energy (Computer-Aided Design; Innovation trends in the food industry). This scientific direction determines the possibility of developing the composition of complex multicomponent products, characterized by a given set of qualitative and quantitative indicators.

Food "*design*" is the process of creating rational recipes and / or structural properties that provide a predetermined level of adequacy.

According to the degree of compliance of the structure and composition of the designed food product with the optimal model or standard, food products are divided into III groups:

- Industrial food products of the 1st generation - traditional food products;
- Industrial food products of the 2nd generation - products with a multicomponent composition, due to which a set level of nutrient ratio is provided to a statistically grounded standard, which takes into account the specificity of metabolism in certain groups of the population, united by age, national, genetic or other characteristics;
- Industrial food products of the third generation - food products in which the number of components is selected in such a way that they can determine the possibility of targeted and functional nutrition of certain groups of the population (Design and engineering).

A distinctive feature in the design of food products of the third generation is that, together with the energy value, food and biological values are determined, taking into account the originality of the problem being solved.

The aim of the research was to develop new types of bakery products recommended for inclusion in the diet of older people, including those with a genetic predisposition to bone metabolism disorders.

To achieve this goal, using computer modelling methods, formulations of model samples of bakery products for heroic nutrition were designed. In the work, the task was set to find the optimal ratio of the main food nutrients in model samples, established by the Institute of Nutrition of the Russian Academy of Sciences (RAS) and recommended for this category of the population: proteins, fats and carbohydrates; macronutrients calcium (Ca), magnesium (Mg) and phosphorus (P) and obtain a product of increased biological value, containing polyunsaturated fatty acids (PUFA) and dietary fibre (PV).

METHODS

The objects of research were bakery products based on flour composite mixtures from non-traditional types of flour for feeding people with a genetic predisposition to bone metabolism disorders.

The preparation of samples of bakery products was carried out in the laboratory conditions of the department "*Technologies of grain processing, bakery, pasta and confectionery industries*" FSBEI HE "*Moscow State University of Technology and Management named after K.G. Razumovsky (PKU)*".

The composition of the sample formulation consisted of the following raw materials: wheat flour of the highest grade (GOST R 52189-2003), semi-fat-free flax flour (TU 9146-023-70834238-12), milk thistle meal (TU 9146-014-70834238-09), seed flour pumpkin (TU 9146-015-70834238-09), table salt (GOST R 51574-2000), pressed baker's yeast (GOST R 54731-2011).

The control was a sample of molded bread made of premium wheat flour, which did not contain additional recipe components. The dough was kneaded in a kneading machine for 7-10 minutes. When kneading, table food salt was added in dissolved form, baking press yeast in the form of a suspension. The dough was fermented in a thermostat at a temperature of 35-40 ° C and a relative air humidity of 75-80% for 150 minutes, during the fermentation of the dough, kneading was carried out after 60 and 120 minutes. After fermentation, the dough was divided into pieces weighing 150 g, placed in baking dishes, which were placed in a proofing cabinet and the final proofing was carried out at a temperature of 35-40 ° C and a relative humidity of 75-80%, the duration of which was about 60-70 minutes. Then the dough pieces were baked in an oven at a temperature of 200-220 ° C for 18-20 minutes.

After baking, the finished bakery products were cooled at a temperature of 18-25 ° C, evaluated by organoleptic and physicochemical parameters in accordance with generally accepted methods (Tsyganova, 2010; Zastrogina, 2015; Kamaeva et al., 2019; Vertakova et al., 2019; Khormali et al., 2019)).

The assessment of the biological value of the bakery product was carried out using a computer program developed by employees of the Federal Research Center of Food Systems named after I. V.M. Gorbatova (Tyurina, 2017).

RESULTS

When designing rational recipes for bakery products of gerontological orientation, it should be borne in mind that the composition of this product should be characterized by the presence of the following components:

- Proteins of plant origin, balanced in the content of sulphur-containing amino acids - methionine (Met) + cystine (Cys2);
- Fatty components of plant origin, which are a source of PUFA and vitamin E;
- Minerals - calcium, magnesium, potassium in an optimal ratio;
- Substances that have geroprotective and antioxidant properties (Zastrogina, 2015; Tyurina, 2017; Shlelenko, 2012; Andrienko, 2010).

The selection of the studied additional prescription components of bakery production was carried out taking into account their chemical composition, food, biological and physiological value.

Thus, the optimal raw materials for the development of a recipe for a bakery product of a gerontological orientation are semi-fat-free flaxseed flour, pumpkin seed meal and milk thistle meal are considered as an unconventional type of bakery raw material with high nutritional value and functional properties (Krasulya, 2015; Development of an automated information system; Stabrovskaya, 2008).

Food combinatorics

One of the main tasks in the design of functional and specialized food products for various target groups of the population is the compliance of the biochemical and qualitative characteristics of the products with the physiological characteristics of the human body (Kislichenko, 2008; Tyurina, 2016; Zubtsov, 2002).

To implement this task, on the basis of medical and biological requirements, model samples of a flour composite mixture were developed, taking into account the required chemical composition (protein, fat, moisture, carbohydrates, etc.), mass fractions of the main components of the product (main recipe components, fibre, biologically active additives , enzymes, vitamins, minerals, etc.), structural ratios of indicators of the biological value of the product (amino acid and fatty acid compositions) according to various criteria of compliance. At the same time, the peculiarity of the rational nutrition of elderly people, including those with a genetic predisposition to bone metabolism disorders, was taken into account.

For the development of model samples of composite mixtures of increased nutritional value, an integrated approach is proposed, which is characterized by a multi-stage procedure (Figure 1).

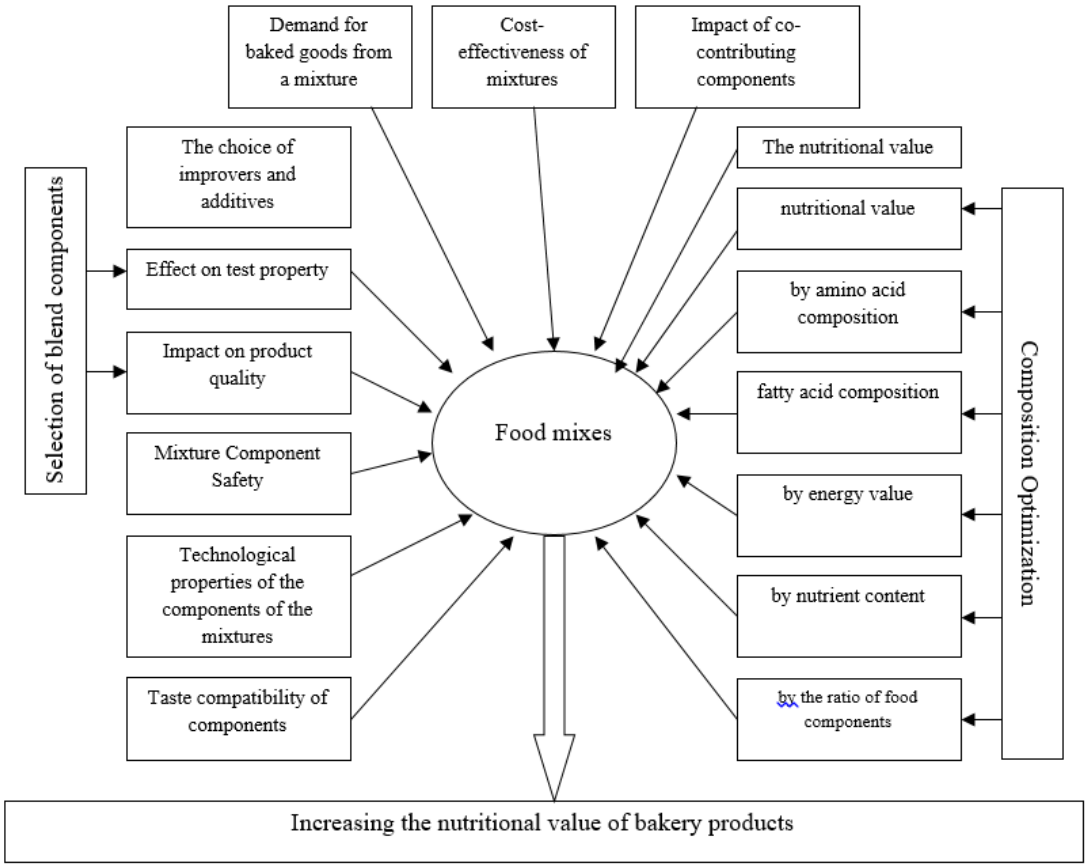


Figure 1. Design scheme of model systems of increased nutritional value (Sanina, 2006).

Based on a systematic analysis of the results of scientific research in the field of catering, the main principles of the phased development of specialized products are highlighted, which are as follows:

At the first stage, the selection of raw materials is made taking into account their functional properties and safety in relation to nutrition.

The second stage is provided by conducting research on the selected raw materials and improvers, their influence on the technological properties of semi-finished products and the quality of finished products. According to the optimal criteria characterizing the nutritional value, the choice of raw materials is made.

At the final third stage, when developing the technology for preparing mixtures and flour products based on them, the elimination of the negative influence of the components of the mixtures on the consumer properties of products is ensured. The final action of this stage is laboratory baking of bakery products using the developed composite mixtures.

A comprehensive solution to optimizing nutrition requires a multifactorial approach, taking into account the energy, nutritional and biological value of finished products, as well as group and individual restrictions on the nutrient composition with an assessment of adequacy using a set of biological, technological and economic criteria. In this regard, the problem arises of combining the accumulated information and knowledge into a single computer database, which reflects the full completeness of the parameters of a particular consumer, products and their relationships with environmental factors, convenience of preparation and consumption (Dobrovolskienė et al., 2017; Yumashev et al., 2018; Akhmadeev et al., 2019 a, b).

The basis of the database is information on the physical and chemical parameters of food products: calorie content; nutritional value, determined by the general chemical composition (proteins, fats, carbohydrates); essential substances (vitamin, macro- and microelement compositions); composition of essential amino acids and PUFAs; biologically active substances (BAS) and other nutrients per unit mass of the product; structural and mechanical properties, etc.

This kind of open and constantly updated database and knowledge provides the foundation for the development of a structural-parametric description, formalized assessment and identification of an adequate system of specialized nutrition.

For the design of gerontological composite mixtures, the main task was to select the mass fractions of the recipe components of the mixture so that the product would meet the following conditions:

1) The ratio of the mass fractions of proteins, fats and carbohydrates should correspond to the following series of numbers 1.0: 0.8: 3.5.

$$\frac{\sum_{i=1}^{m} b_i x_i}{\sum_{i=1}^{m} x_i} : \frac{\sum_{i=1}^{m} l_i x_i}{\sum_{i=1}^{m} x_i} : \frac{\sum_{i=1}^{m} ug_i x_i}{\sum_{i=1}^{m} x_i} = 1 : 0.8 : 3.5 \qquad (1)$$

where bi, li, ugi – mass fraction, respectively, of proteins, fats and carbohydrates in j prescription component; xi – mass fraction j recipe components; m – the number of components in the recipe;

2) the ratio of mass fractions of macroelements of calcium, magnesium and phosphorus should correspond to the following series of numbers 1.0 : 0.6 : 1.3

$$\frac{\sum_{i=1}^{m} Ca_i x_i}{\sum_{i=1}^{m} x_i} : \frac{\sum_{i=1}^{m} Mg_i x_i}{\sum_{i=1}^{m} x_i} : \frac{\sum_{i=1}^{m} P_i x_i}{\sum_{i=1}^{m} x_i} = 1 : 0.6 : 1.3 \quad (2)$$

where Cai, Mgi, Pi – mass fraction, respectively, of calcium (Ca), magnesium (Mg) and phosphorus (P) in j prescription component;

3) The biological value of the mixture should not be lower 0.6

$$BC = 100 - KRAS \quad (3)$$

where $KPAC = \frac{\sum_{i=1}^{n} \Delta PAC}{n}$

where – amino acid difference of amino acid: $\Delta PAC = C_i - C_{\min}$

where Ci – excess amino acid; Cmin – the minimum of the scores of the essential amino acids of the studied protein in relation to the standard,%; n is the number of essential amino acids.

4) The content of polyunsaturated fatty acids (PUFA) should be at least 1.0 g / 100 g of the mixture

$$\frac{\sum_{i=1}^{m} \varpi_{ij} l_i x_i}{\sum_{i-1}^{m} l_i x_i} \geq 1 \quad (4)$$

where ωij– the specific content of polyunsaturated fatty acids in the i-monostructured element (lipid) in the j prescription component;

5) The content of dietary fibre (fibre) should be at least 0.2 g / 100 g of the mixture

$$\frac{\sum_{i=1}^{m} C_i x_i}{\sum_{i-1}^{m} x_i} \geq 0.2 \quad (5)$$

where Ci – mass fraction of dietary fibre (fibre) in the i prescription component.

Based on the technological capabilities of the preparation of bakery products, the following boundary conditions (restrictions) were set:

- The content of semi-fat-free flax flour is not more than 10%;
- The content of milk thistle meal is not more than 12%;
- The content of pumpkin flour is not more than 15%.

Wheat flour of the highest grade can be used in any quantity and has no restrictions.

The objective function is the minimum deviation from the reference structure of a certain group of indicators.

$$P(z) = \sum_{j=1}^{n} \left(z_j^0 - \sum_{i=1}^{m} \mu_{ij} x_i \right)^2 \rightarrow \min \qquad (6)$$

where – reference content in the i-th element of nutritional value; – specific content of i element of chemical composition in j recipe component of the simulated product; – mass fraction of j - component of the formulation.

As a result of structural-parametric optimization, three alternative models of samples of flour composite mixtures were designed.

Sample characteristics

Sample 1 - balanced in the ratio - proteins: fats: carbohydrates;

Sample 2 - balanced in the ratio - calcium (Ca): magnesium (Mg): phosphorus (P);

Sample 3 - the food mixture contains at least 1 g / 100 g of a mixture of PUFA and at least 0.2 g / 100 g of a mixture of dietary fibre (cellulose).

Table 1 shows the chemical composition of the designed formulations of flour composite mixtures.

Table 1. Chemical composition of the designed composite mixtures.

Index, %	Sample 1	Sample 2	Sample 3
Mass fraction of protein	15.52	14.3	11.73
Mass fraction of fat	3.92	3.32	1.96
Mass fraction of carbohydrates	54.29	58.04	65.15
Ratio B: W: Y	1:0.25:3.5	1:0.23:4.06	1:0.17:5.55
Macronutrients:			
Ca (calcium), mg	160	158	68
Mg (magnesium), mg	126	93	39
P (phosphorus), mg	240	202	130
Ca: Mg: P Ratio	1:0.8:1.5	1:0.6:1.3	1:0.57:1.9
The content of PUFA, g / 100g product	-	-	1.49
PV content, g / 100g of product	-	-	2.79
Biological value,%	58.8	66.6	63.9

After determining the chemical composition of the mixtures, a comprehensive assessment of the quality of the designed model samples was carried out. Biological value (Table 2) characterizes the quality of food products associated with both their digestibility and the degree of balance of the amino acid composition.

Table 2. Biological value of composite mixtures.

Index	Sample 1	Sample 2	Sample 3
Amino acid composition (essential amino acids), g / 100 g protein			
Valine	4.94	4.4	4.05
Leucine	8.31	8.05	8.2
Lysine	3.97	3.87	2.87
Isoleucine	4.63	4.43	4.27
Threonine	3.52	3.07	2.79
Tryptophan	1.75	1.58	0.73
Methionine + Cysteine	3.18	2.98	2.91
Phenylalanine + Tyrosine	8.82	7.55	7.42
Biological value,%	58.83	66.66	63.94

Assessment of the quality of bakery products based on flour composite mixtures

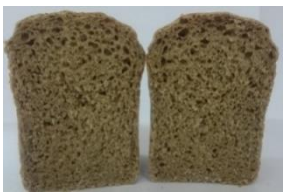
Based on the mixtures obtained by mathematical modelling in the laboratory of the Department of Grain Processing Technology, Bakery, Confectionery and Pasta of the Moscow State University of Technology named after K.G. Razumovsky (PKU) test laboratory baking of bakery products were carried out.

In the finished products, organoleptic indicators were determined: colour and condition of the crust, the nature of porosity, the absence or presence of peeling of the crust from the crumb, the presence of signs of impurity, taste, smell, and the presence of crunch. Determination of physicochemical assessment was carried out according to indicators: moisture, acidity, porosity. For a comparative assessment of the quality indicators of the products obtained, the requirements of GOST 27842-88 "*Bread from wheat flour*". Technical conditions to the quality of molded wheat bread made from premium wheat flour. The appearance of the resulting products and a sectional view are shown in Figures. 2-3.

a) Sample 1 b) Sample 2 c) Sample 3.

Figure 2. Appearance of bakery products prepared on the basis of experimental flour composite mixtures (Doronin, 2009).

a) Sample 1



b) Sample 2

c) Sample 3

Figure 3. Sectional view of bakery products prepared on the basis of experimental flour composite mixtures (Doronin, 2009).

The results of a study on the storage capacity of the samples showed that the appearance of the first signs of mold in samples 1 and 2 was delayed by three days, in sample 3 - by two days compared to the control sample. At the same time, in the control sample (bread from wheat flour of the highest grade), the first signs of mold appeared on the fifth day of storage in a packed form.

The increased shelf life can be associated with the inhibitory effect caused by the presence of flavonoid compounds and organic acids in the formulation components, which are added together with functional ingredients that acted as natural preservatives and retarded the development of mold in bakery products. This allows us to conclude that products prepared according to the developed recipes and technologies based on the designed flour composite mixtures were distinguished by increased microbiological safety (Polyakova, 2012; Tsyganova, 2013).

In bakery products prepared on the basis of experimental flour composite mixtures in comparison with the control sample, the degree of satisfaction of the daily requirement when consuming 100 g of samples 1, 2 and 3 increased by 5.7%, 4.3% and 1.1% in terms of protein and by 3.0%, 2.3%, and 0.8% for fat, respectively. Also, samples 1 and 2 cover the daily requirement for dietary fibre by 10% and 4.5% more, respectively. In addition, all the prototypes of bakery products increased the coverage of the daily requirement for minerals and vitamins for all prototypes, had a higher biological and lower energy value.

CONCLUSION

Based on the results of the studies carried out on the development of model samples of functional bakery products for heroic purposes using methods of mathematical modelling and information technologies, one can judge the following - the use of the principles of food combinatorics, system analysis and information technologies in modelling functional (specialized / individual) food products allows: to optimize prescription composition; expand the range of food products using non-traditional sources of nutritional value and functional orientation.

Designed three alternative recipes for model samples of bakery products that are as close as possible to the nutritional requirements of a given population group in terms of the ratio of proteins to fats and carbohydrates, the ratio of trace elements calcium, magnesium and phosphorus, biological value and the content of PUFA and dietary fibre.

The developed flour composite mixtures can be recommended for the production of bakery products intended for the nutrition of elderly people, as the most balanced in terms of nutrient composition.

REFERENCES

Andreenko, L.G., Antipova T.A., Gorlov I.F. (2010). Scientific approaches to the creation of products of gerodietetic nutrition. - Volgograd: Volgograd Scientific Publishing House, - 121 p.

Akhmadeev, R.G., Bykanova, O.A. & Salomadina, P.S. (2019a). The effect of the VAT change on the final consumer. Proceedings of the 33rd International Business Information Management Association Conference, IBIMA 2019: Education Excellence and Innovation Management through Vision 2020, 765-770.

Akhmadeev, R., Redkin, A., Glubokova, N., Bykanova, O., Malakhova, L. & Rogov, A. (2019b). Agro-industrial cluster: supporting the food security of the developing market economy. Entrepreneurship and Sustainability Issues, 7(2), 1149-1170. https://doi.org/10.9770/jesi.2019.7.2(25)

Bekmansurov, R. H., Kovalenko, K. E., Utkina, K. M., Novikova, Y. A., Zatsarinnaya, E. I., & Rozentsvaig, A. I. (2019). State support for persons with disabilities in the field of entrepreneurship. Journal of Entrepreneurship Education, 22(S2), 1-9.

Bukharina, I. L., Zhuravleva, A. N., Dvoeglazova, A. A., Kamasheva, A. A., Muhametnagimovna, S. A., & Kuzmin, P. A. (2014). Physiological and biochemical characteristic features of small-leaved lime(tilia cordata mill.) in urban environment. Advances in Environmental Biology, 8(13), 79-83.

Cheremisina, O. V., Sergeev, V. V., Chirkst, D. E., & Litvinova, T. E. (2015). Thermodynamic investigation into extraction of cerium(III) by tributyl phosphate from phosphoric acid solutions. Russian Journal of Non-Ferrous Metals, 56(6), 615-621. https://doi.org/10.3103/S1067821215060036

Cheremisina, O. V., Sergeev, V. V., Alferova, D. A., & Ilyna, A. P. (2018). Quantitative x-ray spectral determination of rare-earth metals in products of metallurgy. Paper presented at the Journal of Physics: Conference Series, 1118(1). https://doi.org/10.1088/1742-6596/1118/1/012012

Chomanov, U. C., Temirbekov, N. M., Kenenbay, G. S., Tultabayeva, T. C., Omirzhanova, B. C., & Tultabayev, M. C. (2020). Reduction interpolation function for determining the rheological properties of bile in farm animals to increase the entrepreneurial activity of the agricultural sector. Academy of Entrepreneurship Journal, 26(1), 1-8.

Development of an automated information system for calculating and optimizing recipes. N.V. Donskikh and others. News of universities. Food technology. - 2011. - No. 2.-3 (320-321) - P. 122-123.

Derkho, M. A., Gritsenko, S. A., Vilver, D. S., Sereda, T. I., & Fomina, N. V. (2019). Thyroid hormone role in metabolic status and economic beneficial features formation in replacement gilts of different breeds. Periodico Tche Quimica, 16(31), 472-483.

Dobrovolskienė, N., Tvaronavičienė, M., & Tamošiūnienė, R. (2017). Tackling projects on sustainability: A lithuanian case study. Entrepreneurship and Sustainability Issues, 4(4), 477-488. https://doi:10.9770/jesi.2017.4.4(6)

Doronin, A.F., Ipatova, A.A., Kochetkova, A.P., Nechaev, S.A. Khurshudyan, O.G. (2009). Functional foods. Introduction to technology. M.: DeLiprint, 288 p.

Dunets, A. N., Yankovskaya, V. V., Plisova, A. B., Mikhailova, M. V., Vakhrushev, I. B., & Aleshko, R. A. (2020). Health tourism in low mountains: A case study. Entrepreneurship and Sustainability Issues, 7(3), 2213-2227. https://doi.org/10.9770/jesi.2020.7.3(50)

Dunets, A. N., Vakhrushev, I. B., Sukhova, M. G., Sokolov, M. S., Utkina, K. M., & Shichiyakh, R. A. (2019). Selection of strategic priorities for sustainable development of tourism in a mountain region: Concentration of tourist infrastructure or nature-oriented tourism. Entrepreneurship and Sustainability Issues, 7(2), 1217-1229. https://doi.org/10.9770/jesi.2019.7.2(29)

Gaining health. The European Strategy for the Prevention and Control of Noncommunicable Diseases. WHO. Europe (World Health Organization. Regional office for Europe). Copenhagen, 2006. 60 p.

Gladilina, I., Yumashev, A. V., Avdeeva, T. I., Fatkullina, A. A., & Gafiyatullina, E. A. (2018). Psychological and pedagogical aspects of increasing the educational process efficiency in a university for specialists in the field of physical education and sport. Espacios, 39(21).

Innovation trends in the food industry: Thecase of functional foods. Available from: https://www.researchgate.net/publication/257346264_Innovation_trends_in_the_food_industry_The_case_of_functional_foods [accessed Nov 26 2017].

Kamaeva, R., Kvasnikova, T., Egorova, M., & Kashapova, L. (2019). Problems of teaching students with special needs. [Problemas para enseñar a estudiantes con necesidades especiales] Opcion, 35(Special Issue 23), 563-580.

Kislichenko V.S. Milk thistle - from introduction to use: monograph. - Ministry of Education and Science of Ukraine, Ministry of Health of Ukraine, National University of Pharmacy, Poltava State Agar Academy, Lugansk State Medical University. Poltava: Poltava Literator, 2008. - 288 p.

Kozlov, V., Poltarykhin, A., Vasyutkina, L., Ponomarev. V., Filippova, O. and Popkov, S. (2019). Economic and environmental concept of food development in Russia. Journal of Environmental Management and Tourism, Year 2019. Volume X, Issue 7 (39). Page 1509-1517.

Khormali, A., Petrakov, D. G., & Jafarpour, H. (2019). Experimental and theoretical investigations of inorganic salt precipitation and control for oil reservoirs. Paper presented at the Innovation-Based Development of the Mineral Resources Sector: Challenges and Prospects - 11th Conference of the Russian-German Raw Materials, 2018, 155-160.

Krasulya, O.N. (2015). Modeling of food recipes and technologies of their production: theory and practice [Text]: textbook / O.N. Krasulya, S.V. Nikolaev, A.V. Tokarev and [others]. - SPb.: GIORD, 320 p.

Kuzmin, P. A., Bukharina, I. L., & Kuzmina, A. M. (2020). An investigation of the biochemical composition of norway maple (acer platanoides l.) in the conditions of technogenic stress. [Investigação da composição bioquímica do bordo da noruega (acer platanoides l.) nas condições de estresse tecnogênico] Periodico Tche Quimica, 17(34), 905-914.

Kuzmin, P. A., Bukharina, I. L., & Kuzmina, A. M. (2018). The reaction of woody plants to growing conditions in the man-made environment. International Journal of Civil Engineering and Technology, 9(11), 878-887.

Ljdokova, G. M., Razzhivin, O. A., & Volkova, K. R. (2014). Confounding factors in sport activities of powerlifters. Life Science Journal, 11(Spec. Issue 8), 410-413.

Morozova, T., Akhmadeev, R., Lehoux, L., Yumashev, A., Meshkova, G. V. & Lukiyanova, M. (2020). Crypto asset assessment models in financial reporting content typologies, Entrepreneurship and Sustainability Issues, 7(3), 2196-2212. https://doi.org/10.9770/jesi.2020.7.3(49)

Movchan, I. B., & Anatol'evna Yakovleva, A. (2019). Approach to automation of field diagnosis data interpretation for localization of pitting in the pipeline wall. International Journal of Civil Engineering and Technology, 10(2), 1571-1581.

Muratova E.I., Tolstykh S.G., Butler S.I., Zyuzina O.V., Leonov D.V. (2011). Computer-aided design of complex multicomponent food products: a training manual. Tambov: Publishing House of FSBEI HPE "TSTU", - 80 p.

Nefedov, Y., Kochneva, O., & Heide, G. (2019). The study of the ontogenesis of crystals of the ural type diamonds by the method of IR-spectrometry. Paper presented at the IOP Conference Series: Materials Science and Engineering, 511(1). https://doi.org/10.1088/1757-899X/511/1/012041

Pashchenko, L.P., Ostroborodova S.N., Kolomnikova Y.P., Ilyina T.F. (2010). A new functional product in the catering sector. International Journal of Applied and Basic Research. No. 2. - Pp. 37-42.

Panfilova E., Dzenzeliuk N., Domnina O., Morgunova N., Zatsarinnaya E. (2020) The impact of cost allocation on key decisions of supply chain participants. International Journal of Supply Chain Management. 2020. Volume 9, Issue 1, Pages 552-558.

Poltarykhin, A., Ivanova, V., & Ivanov, S. (2020) World experience in the formation and development of the "digital economy". Talent Development and Excellence 12, 2020, p. 372-384.

Prodanova, N., Savina, N., Kevorkova, Z., Korshunova, L., & Bochkareva, N. (2019a). Organizational and methodological support of corporate self-assessment procedure as a basis for sustainable business development. Entrepreneurship and Sustainability Issues, 7(2), 1136-1148. https://doi.org/10.9770/jesi.2019.7.2(24)

Prodanova, N., Plaskova, N., Popova, L., Maslova, I., Dmitrieva, I., Sitnikova, V., & Kharakoz, J. (2019b). The role of IT tools when introducing integrated reporting in corporate communication. Journal of Advanced Research in Dynamical and Control Systems, 11(8 Special Issue), 411-415.

Panfilova E., Dzenzeliuk N., Domnina O., Morgunova N., & Zatsarinnaya E. (2020). The impact of cost allocation on key decisions of supply chain participants. International Journal of Supply Chain Management. 2020. Volume 9, Issue 1, Pages 552-558.

Poltarykhin, A., Voronkova, O., Kovaleva, I., Nepshekueva, T., Maksyutov, R. and Garipova, L. (2020). Foreign experience in implementing project activities in the field of improvement of large cities. Talent Development and Excellence 12, 2020, p. 350-358.

Polyakova S.P., Sidorova O.A. (2012). Increasing the resistance of confectionery and bakery products to microbiological spoilage [Text] / S.P. Polyakova. Food Industry. - No. 5. - pp. 16 – 18.

Puryaev, A., & Puryaev, A. (2020). Evaluating the Effectiveness of Projects of Global and National Economic Significance Level. In Smart Innovation, Systems and Technologies (Vol. 172, pp. 317-331). Springer, Singapore. https://doi.org/10.1007/978-981-15-2244-4_29

Sanina, T.V. Ponomareva E.I., & Voropaeva O.N. (2006). Increasing the nutritional value of bakery products of mass consumption, Bakery in Russia. - 2006. - No. 6. - pp. 28-29.

Shlelenko, L.A., Tyurina O.E., Kostyuchenko M.N., Borisova A.E. (2012). Features of production technologies of bakery products of herodietic appointment. Russian Bakery. No. 6. - pp. 18-19.

Stabrovskaya, O.I., & Garifulina O.A. (2008). An integrated approach to the development of baking mixtures [Text]. Bakery in Russia. No. 2. - pp. 17-18.

Tsyganova T.B., Semenkina N.G., & Bykovchenko T.V. (2013). The effect of processed products of milk thistle on the microflora of semi-finished products and the microbiological purity of bread. Russian Bakery. - 2013. - No. 6. - pp. 34 – 36.

Tadeu, P., Fernandez Batanero, J., & Tarman, B. (2019). ICT in a Global World. Research in Social Sciences and Technology, 4(2). https://doi.org/10.46303/ressat.04.02.ed

Tsvetkova, M., Arutyunyan, M., Saenko, N., Shramko, L., & Kalimullin, D. (2019). Incorporation of philosophical ideas in science fiction literature. [Incorporación de ideas filosóficas en la literatura de ciencia ficción] Opcion, 35(Special Issue 23), 598-612.

Tsyganova, T.B., Minevich I.E., Zubtsov V.A., & Osipova L.L. (2010). Nutritional value of flax seeds and promising directions for their processing. Kaluga: Eidos Publishing House, 124 p.

Tyurina, I.A. Development of technologies for bakery products nutrient-adapted for gerodietetic nutrition: dis. cand. tech. Sciences: 05.18.01 / Tyurina Irina Anatolevna; [Research Institute of the Bakery Industry]. - Moscow, 2017 .-- 224 p.

Tyurina, I.A., Kostyuchenko M.N., Shlelenko L.A., & Tyurina O.E. (2016). The use of flour from pumpkin seeds in the production of bakery products for the nutrition of the elderly. Sustainable development, environmentally friendly technologies and equipment for processing agricultural food raw materials import substitution. Collection of materials of the international scientific and practical conference, June 21. - Krasnodar: Kuban State Technical University, 2016. - pp. 334-337.

Vershinina, O.L., Milovanova E.S., & Kucheryavenko I.M. (2009). The use of meal from pumpkin seeds in bakery. Technique and technology of food production. - 2009. No. 1. - pp. 18-20.

Vertakova, Y., Mkrtchyan, V., & Leontyev, E. (2019). Information provision of decision support systems in conditions of structural changes and digitalization of the economy. Journal of Applied Engineering Science, 17(1), 74-80. https://doi.org/10.5937/jaes16-18131

Yemelyanov, V. A., Yemelyanova, N. Y., Nedelkin, A. A., Glebov, N. B., & Tyapkin, D. A. (2019a). Information system to determine the transported liquid iron weight. Paper presented at the Proceedings of the 2019 IEEE Conference of Russian Young Researchers in Electrical and Electronic Engineering, ElConRus 2019, 377-380. https://doi.org/10.1109/ElConRus.2019.8656693

Yemelyanov, V. A., Nedelkin, A. A., & Olenev, L. A. (2019b). An object-oriented design of expert system software for evaluating the maintenance of lined equipment. Paper presented at the 2019 International Multi-Conference on Industrial Engineering and Modern Technologies, FarEastCon 2019. https://doi.org/10.1109/FarEastCon.2019.8934414

Yumashev, A. V., Utyuzh, A. S., Admakin, O. I., Doroshina, V. Y., & Volchkova, I. R. (2018). Effect of mesodiencephalic stimulation on adaptation to stress and academic performance of students.

International Journal of Learning and Change, 10(4), 359-367. https://doi.org/10.1504/IJLC.2018.095818

Zastrogina, N.M. (2015). Bakery products of herodietic purpose: practical solutions to improve technology, predict quality and expand the range: dis. Cand. tech. Sciences: 05.18.01. Voronezh State University of Engineering Technology. - Voronezh.- 213 p.

Zhumaliyeva, G. Y., Chomanov, U. C., Tultabayeva, T. C., Tultabayev, M. C., & Kasymbek, R. (2020). Formation of processes of intensification of crop growth for the formation of business structures. Academy of Entrepreneurship Journal, 26(1), 1-5.

Zotova, F. R., Mavliev, F. A., Nazarenko, A. S., Zemlenukhin, I. A., & Razzhivin, O. A. (2019). Some aspects of the assessment of anaerobic capacity in combat athletes. HumanSportMedicine, 19(3), 80-87. https://doi.org/10.14529/hsm190310

Zubtsov, V.A., Osipova L.L., Lebedev T.I. (2002). Flaxseed, its composition and properties. Journal of the Russian Scientific Society. DI. Mendeleev. No. 2. - P. 14-16.

