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Alimentary factors for the correction of nutritional status and physiological conditions

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***Abstract*—The nutraceutical aspect of the design of new food products involves the consistent implementation of the design algorithm for multicomponent biocorrector. The analysis of potential natural sources of biologically active substances allows to prioritize products of deep biotechnological processing of oilseed and low oil raw materials, characterized by unique biotechnological potential. Using the developed software product, nomograms were obtained that make it possible to justify and design the composition of functional compositions based on products of deep processing of low-oil raw materials with a given ratio of target biologically active substances. Evaluation of the biopotential of the developed functional compositions showed the possibility of satisfying the daily needs of the body in a wide range of macro - and microelements and vitamins. A clear correlation was established between the energy efficiency of food status and an increase in the degree of oxygenation of hemoglobin in the blood.**

Keywords—nutrient biocorrections, nutritional factors, essential components, neural network modeling, 3D printing of food systems, hygiene status

I. INTRODUCTION

The effective functioning of all body systems is largely determined by a number of essential substances that act as activators of metabolic reactions in the body. Their lack of diet leads to disturbances in nutritional homeostasis, which is exacerbated by various environmental, social and economic factors.

The only way to correct the deficiency of essential substances in the diet is to organize their intake into the body in the form of artificially synthesized forms or with food. The most relevant, effective and promising means for correcting the deficiency of essential substances are natural forms from plant materials obtained in the process of its deep processing [1, 2].

For example, with the intensive development of fast food and the market of highly prepared semi-finished products, in the structure of the diet of the population, which is at the stage of active social development and experiencing a shortage of time and means for organizing quality nutrition, there are, and in some cases prevail, products such as potatoes fries, chips, fizzy drinks, pastries, puff pastries, salads, dressed with mayonnaise, hamburgers with inexpensive, often chicken or meat gastronomy. The composition of almost all culinary products and food products includes preservatives and stabilizers of various nature, often negatively affecting the indigenous microflora of a person, which is responsible for the transfer of incoming essential substances to the internal environment of the body and their inclusion in metabolism [3-7]. In addition, the development of intensive agricultural technologies and logistics on a global scale has led to changes in the composition of all parts of cultivated plants, including not only fruits, but also the green part. As a result, there is a decrease in the content of biologically active compounds, macro- and microelements entering the diets of farm animals and humans [8-12].

The current situation actualizes the need for nutritional correction of negative physiological states by creating a system of nutritional support for the nutritional status of the body using natural nutritional biocorrectors and developing criteria for assessing its effectiveness.

II. EXPERIMENTAL

To achieve this goal, a design algorithm for multicomponent alimentary biocorrectors has been developed. The first step is the creation of an information database of natural sources of biologically active substances of natural origin for industrial purposes and the identification of their chemical composition with an assessment of nutritional and biological value. The next step is the design and optimization of prescription-component solutions of bio-correcting food forms in accordance with physiological norms for individual target groups of the population using

self-learning neural network models and the development of hardware and technology solutions that ensure the maximum preservation of the biological properties of objects. Further, it is necessary to study in experiments in vivo changes in elemental status with the introduction of biocorrecting food systems into the diet. It is necessary to calculate the changes in entropy, calorie content, respiratory coefficient, as well as the development of scientific and practical recommendations on the use of biocorrectors to normalize the energy, lipid, protein metabolism of the body.

III. RESULTS AND DISCUSSION

The analysis of potential natural sources of biologically active substances allows us to fix priorities for the products of deep biotechnological processing of oil and low oil raw materials [13, 14]. An assessment of the biotechnological potential of the lipid, protein, carbohydrate component, vitamin and mineral composition of the products of deep processing of amaranth, wheat germ, pumpkin, flax, grape seed, lentils, alfalfa, colza showed that these objects contain complete proteins (up to 30%) , carbohydrates (up to 40%, including prebiotic action), dietary fiber with high sorption activity (up to 30%), a wide range of vitamins (A, D, E, C, groups B, T, K), macro- and microelements (Se, Zn, Mn, Mg, Ca, K, Na, Fe, P), as well as a number of specific compounds of parapharmaceutical action, such as squalene, policosanol as well as a significant proportion of oils, which particularly identified deficient ω-3 fatty acids.

The following are the results of the software product in the form of three-dimensional dependences of the peroxide number on the temperature and relative humidity of the environment with fixed input parameters - object humidity (5%) and stabilizer concentration (0.01692%) (Fig. 1). As stabilizers of quality indicators during storage, a binary mixture of food additives "Flavocene (dihydroquercetin)" and "Selexen" in the optimal ratio (6: 4) was adopted.

The design of the composition and the provision of the expected bio-correcting properties of food products is possible subject to the conditions of complementarity and assessment of target optimization parameters. For example, taking into account the recommendations of the Federal Research Center for Nutrition, Biotechnology and Food Safety, thanks to the developed software product and database, nomograms were obtained that allow substantiating and designing the composition of functional multicomponent mixtures based on products of deep processing of low-oil raw materials with a given PUFA ratio ω_6/ω_3, and also evaluate their biopotential by amino acid, carbohydrate, mineral and vitamin composition (Fig. 2) [15, 16].

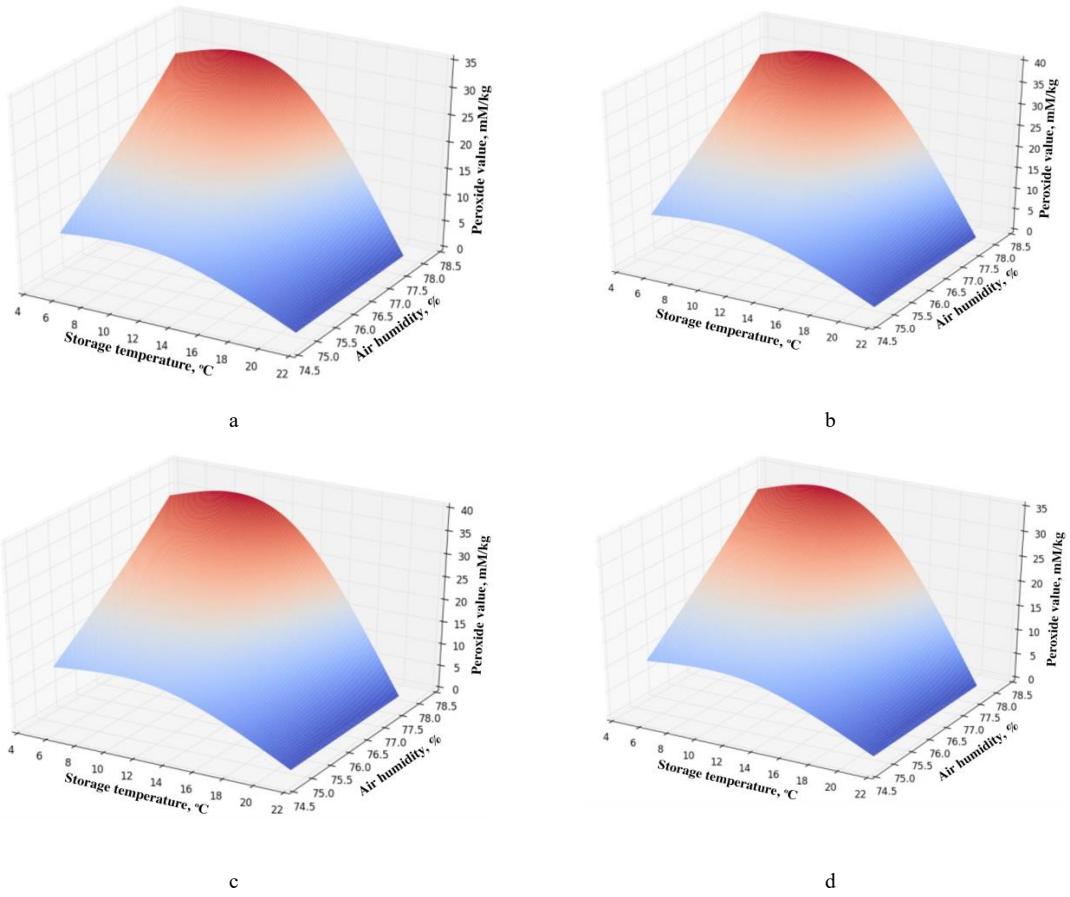

Fig. 1. The result of the neural network for a mixture of food additives "Flavocene (dihydroquercetin)" and "Selexen" (6: 4) with fixed input parameters (x_2 = 5%, x_6 = 0.01692%): a - wheat germ meal cake; b - flour from oil cake of amaranth seeds; c - pumpkin seed meal flour; d – flaxseed meal.

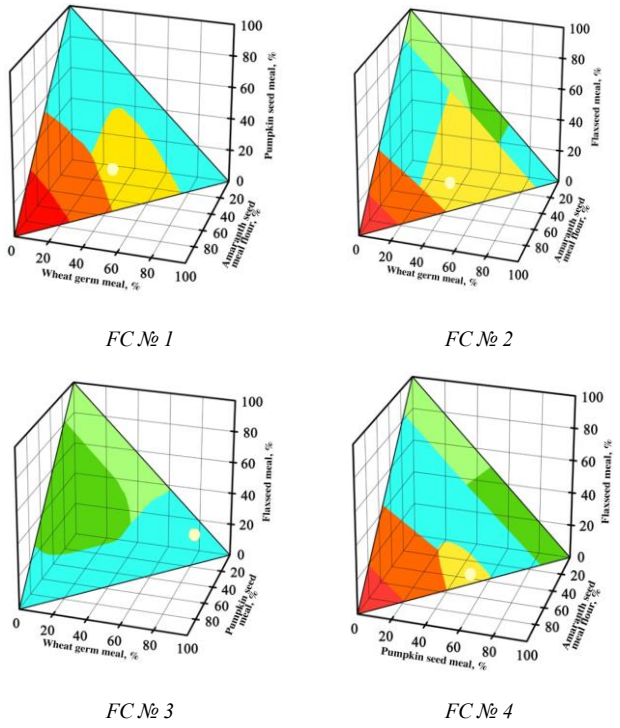

Fig. 2. Nomograms for determining the percentage of flour from cake of wheat germ, amaranth, pumpkin, flax seeds in functional compositions (FC) to ensure PUFA ratios of ω-6 / ω-3 in the range of: – 1,0-1,5:1; – 1,5-3,0:1; – 3,0-5,0:1; – 5,0-10,0:1; – 10,0-20,0:1; – 20-50:1.

Nomograms allow you to determine the optimal range and maximum value of a given target parameter. Areas with a higher content of ω_3 acids are also predicted, which provides a resource for combining functional compositions with various plant and animal raw materials and adjusting the ratio of ω_6 / ω_3 acids in their composition. Evaluation of the biopotential of the developed mixtures showed that when using 100 g, it is possible to satisfy the daily requirement of the body for a wide range of macro - and micronutrients, vitamins from 20% to 100% (Fig. 3).

The data obtained represent an information base for calculating and optimizing diets in order to correct homeostasis and achieve a preventive effect in relation to a number of painful conditions caused by an imbalance of ω_6/ω_3 acids, deficiency of macro- and micronutrients, vitamins for various population groups in accordance with the provisions of nutrition and microelementology. The developed software product allows you to change the number of components in the system and select various optimization criteria. To increase the biocorrection potential, it is advisable to introduce additional natural antioxidants into the developed systems - spicy aromatic herbs [17], as well as the natural food additives Selexen and Flavocene [18], as a result of which their antioxidant activity is increased and the synergetic effect of biocorrection is achieved. This approach is applicable in the development of 3D printing technologies for products [19, 20].

As a result of technological studies, technical documentation was developed for a wide range of optimized enriched culinary products, including 10 groups of vegetable, meat-vegetable and dairy-vegetable products with a balanced PUFA composition, enriched in Fe, Zn, Mn, Ca, P, Se, vitamins E, D, A, group B containing antioxidants and parapharmaceuticals - squalene, policosanol, with a reduced comparable redundancy rate and an increased utilitarian coefficient of the protein fraction [13, 21].

In order to maximize the preservation of biologically active substances characterized by a certain thermolability, it is advisable for 3D products to use gentle temperature conditions of processing with preliminary vacuum packaging in a polymer heat-resistant film, including LT-LT technologies in equipment and technological solutions, which ensure the shelf life of the finished product without the use of preservatives [22-25].

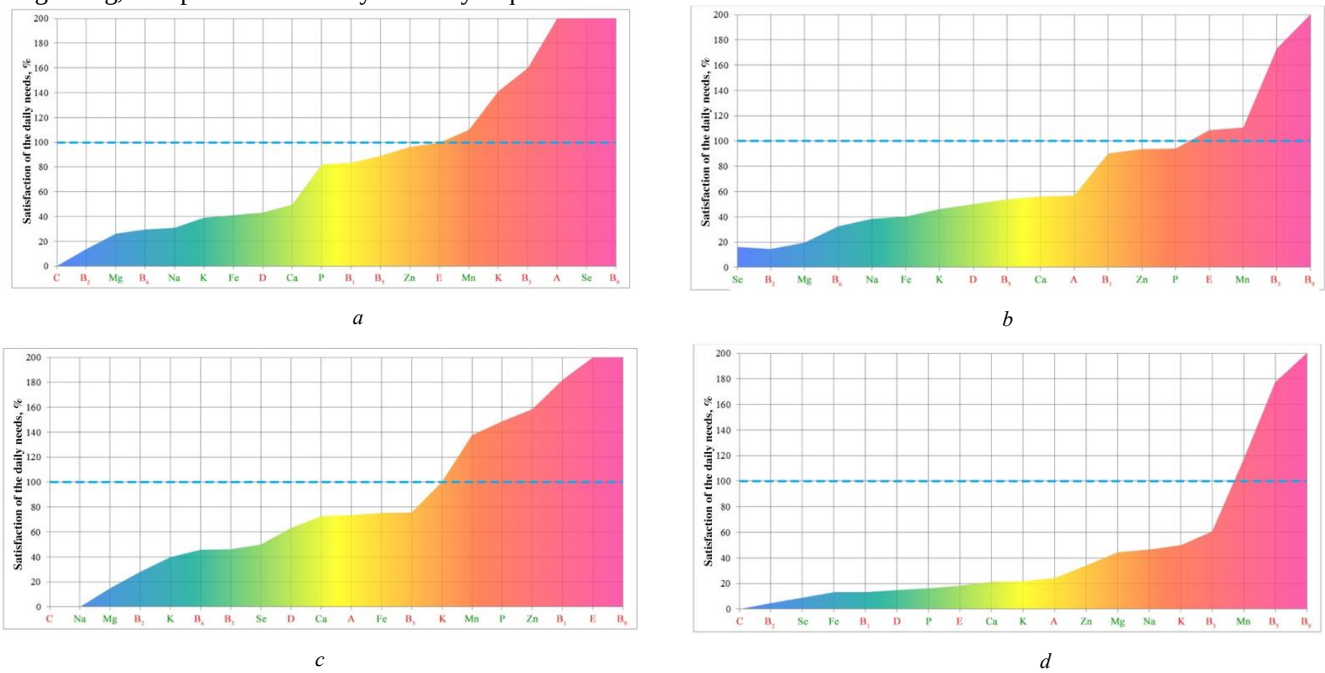

Fig. 3. Satisfaction of the daily needs of the body (C,%) when consuming 100 g of the functional composition: a – № 1; b - № 2; c - № 3; d - № 4.

The study in experiments in vivo of changes in lipid and basic metabolism with the introduction of dishes containing biocorrective mixtures into the diet was carried out on the basis of analysis of fixed indicators: energy exchange efficiency (oxygen and carbon dioxide concentration on inspiration and expiration), blood hemoglobin oxygenation level, concentration of triacylglycerides, concentrations of total cholesterol, high cholesterol (HDL) and low (LDL) density, atherogenic index. Calculations of changes in entropy and respiratory coefficient showed the possibility of nutrient correction of energy efficiency of nutritional status. The increase in the concentration of carbon dioxide in the exhaled gas-air medium was 4.9-6.3%, the oxygen concentration on the exhalation decreased by 1.6-2.7%, the values of the respiratory coefficient increased by 4.5-4.7% compared to the initial values. A correlation was found between the energy output of nutritional status and an increase in the degree of oxygen hemoglobin oxygenation by 0.9-1.1%, with a decrease in total cholesterol of 6-8%, an increase in HDL concentration by 3-24%, a decrease in LDL concentration of 4-21%, the concentration of triacylglycerides decreased by 12-24%, a positive correction for the values of the atherogenic coefficient was 10-25% relative to the initial values of the indicators. The calculation of the entropy gradient showed a correlation with a change in the concentration of high and low density lipoproteins [26, 27].

IV. CONCLUSION

The proposed approach and the obtained results of experimental studies are necessary for the scientific justification and solving engineering problems aimed at obtaining new data on the integrated assessment of the biocorrection potential of food products; the discovery of new prospects in the production of food products of a given composition and properties, including for the application of 3D printing technologies for food multicomponent systems designed to control metabolic processes, to ensure the correction of nutritional status and physiological conditions.

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