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РАЗРАБОТКА НОВЫХ ВИДОВ ФУНКЦИОНАЛЬНЫХ МЯСОРАСТИТЕЛЬНЫХ ПОЛУФАБРИКАТОВ С ПРЕБИОТИЧЕСКИМ ДЕЙСТВИЕМ

DEVELOPMENT OF NEW TYPES OF FUNCTIONAL MEAT AND VEGETABLE SEMI-FINISHED PRODUCTS WITH PREBIOTIC EFFECT

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Аннотация

В настоящее время особую актуальность приобретает разработка функциональных пищевых продуктов профилактической направленности, в том числе для персонализированного питания, адекватно обеспечивающих организм человека основными источниками эссенциальных веществ – незаменимыми аминокислотами, жирными кислотами, витаминами, микро-, макроэлементами и пищевыми волокнами.

В статье представлены результаты разработки рецептур функциональных мясорастительных полуфабрикатов со сбалансированным нутриентным составом, пребиотическим действием, высокими органолептическими свойства и повышенным выходом. Высокий уровень пищевой и биологической ценности разработанных полуфабрикатов, профилактическая направленность и пониженная себестоимость достигнуты за счет комбинации сырья животного и растительного происхождения, включения в состав рецептур инновационного пищевого ингредиента – мелассы молочной с лактулозой и использования современных инструментов компьютерного моделирования.

Ключевые слова: функциональные пищевые продукты, пребиотики, лактулоза, нутриентная сбалансированность, меласса молочная, персонализированное питание

Abstract

Currently, the development of functional food products of a preventive orientation, including for personalized nutrition, adequately providing the human body with the main sources of essential substances – essential amino acids, fatty acids, vitamins, micro-, macroelements and dietary fibers, is of particular relevance. The article presents the results of the development of formulations of functional meat-vegetable semi-finished products with a balanced nutrient composition, prebiotic effect, high organoleptic properties and increased yield. The high level of nutritional and biological value of the developed semi–finished products, preventive orientation and reduced cost are achieved through a combination of raw materials of animal and vegetable origin, the inclusion of an innovative food ingredient in the formulations - milk molasses with lactulose and the use of modern computer modeling tools.

Keywords: functional foods, prebiotics, lactulose, nutrient balance, milk molasses, personalized nutrition

Introduction

Malnutrition is a major social problem worldwide. The change in the lifestyle of a modern person and the associated decrease in the physiological need for energy consumption, insufficient intake of vitamins, minerals and other essential substances in the body, led to the development of the functional food industry and the formation of the FoodNet market [8]. Considering the growing number of nutritionally dependent diseases, stress factors and natural disasters, expanding the range and providing the population with high-quality functional food products is one of the most important national tasks [8].

Personalized nutrition in the context of a healthy lifestyle today is becoming one of the new directions in the development of a range of functional food products [9]. Along with dietary and preventive nutrition, it is called upon to play an important role in the prevention of non-communicable alimentary- dependent diseases [11]. In accordance with the recommendations of nutritionists, the development of new functional food products should be aimed at improving the health of target consumer groups, include technological solutions to reduce the content of beet sugar, salt, cholesterol in formulations, enrich products with high-grade animal and vegetable proteins, vitamins, dietary fiber, micro- , macronutrients and prebiotics. When creating functional food products, an important role is given to such issues as biomedical requirements for raw materials and products, prescription base and additional components, biologically active substances, giving them a preventive focus, taking into account the balance, compatibility and cost of the components [1].

Materials and methods of research

The aim of the research was to develop meat and vegetable semi-finished products with a functional orientation with a prebiotic effect, expanding the range of products for healthy, including personalized nutrition, with a balanced amino acid composition, consistently high consumer properties, nutritional and biological value, organoleptic characteristics and yield due to specially selected components, in including reducing the cost of the product.

The meat of chickens and ducks was used as the main raw material for functional semi-finished products. To ensure the nutritional balance of finished products, their preventive orientation and prebiotic effect, when modeling recipes, raw meat was combined in optimal proportions with various vegetables and functional ingredients.

Recipe modeling and calculation of the nutrient composition of meat and vegetable semi-finished products were carried out using the Etalon software package [2, 3] (registration certificate No. 2005610751). The yield of finished semi-finished products was determined according to GOST 31988-2012 as the ratio of the mass of the finished product after heat treatment and cooling to the mass of the semi-finished product before heat treatment [5]. The organoleptic evaluation of the quality of the finished product was carried out according to a 5-point scale according to GOST 9959-2015 [6].

Results and discussion

The recipes of the developed functional meat and vegetable semi-finished products with prebiotic action contain duck meat and mechanically deboned chicken meat in an optimally selected ratio of 6: 1, beef protein, carrots, white cabbage, sweet pepper, milk molasses with lactulose, semolina, egg powder, soybean oil, wheat bran, breadcrumbs and spices.

The combination of duck meat with mechanically deboned chicken meat in a prescribed ratio made it possible to obtain minced meat with optimal nutritional value at a reduced cost. It is known that duck meat is one of the most balanced in terms of nutrient composition , contains a large number of various vitamins and minerals (vitamins A, PP, E, almost all B vitamins), its fat includes a large amount of omega-3 unsaturated fatty acids, beneficially affecting the cardiovascular system and improving brain function [4]. An important advantage of mechanically deboned poultry meat is the absence of a deficiency of essential amino acids, a rather low content of phenylalanine relative to other types of meat raw materials [4], as well as an increased calcium con-

tent, which makes it possible to bring the “calcium -phosphorus” indicator in the finished product closer to the recommended medical and biological norm.

Beef protein (for example, fibrillar collagen "VT-PRO", manufacturer JSC "Verkhnevolzhsky tannery") is used in the formulation of semi-finished products as a structure-forming and functional protein ingredient. The established advantages of its use include: increasing the amino acid balance of the prescription composition; increase in the output of products by reducing thermal losses; improving the organoleptic properties of finished products and improving their quality, including by improving the consistency of minced meat and the structure of the finished product by creating a protein matrix; cost reduction due to partial replacement of the main raw material with a relatively inexpensive protein of animal origin; decrease in adhesion (sticking of stuffing to the forming parts of the equipment), which improves the process of mechanized molding of the product.

The use of dry milk molasses with lactulose (LaktuVet-1, produced by Stavropolsky Dairy Plant JSC) in the formulation of semi-finished products made it possible to reduce thermal losses, increase product yield, juiciness of finished products, improve their color characteristics, nutritional value, taste and obtain pronounced health-improving and preventive effect. The obtained results are associated with the presence of lactose and lactulose in LaktuVet-1, as well as a whole complex of micro- and macroelements at its low cost, since it is a by- product of milk processing [7].

An important advantage of using "LaktuVet-1" in the formulations of semi-finished products is that during their heat treatment, lactulose diffuses into the protein molecules of the product, but no chemical reaction occurs. Lactulose retains its structure and bifidogenic activity [10]. Of particular note is the high content of calcium in LaktuVet-1 (at least 3.4%), which forms the basis (together with phosphorus) of human bone tissue, activates the activity of a number of important enzymes, participates in maintaining ionic balance in the body, affects processes occurring in the neuromuscular and cardiovascular systems [12].

Among other macronutrients contained in milk molasses with lactulose, an important role belongs to magnesium and potassium. Magnesium is of interest from the point of view of vasodilating action, as well as stimulating intestinal motility and increasing bile excretion. Magnesium salts help reduce cholesterol with an increase in its content in the blood plasma, participate in the formation of bones, the regulation of the nervous tissue, in the metabolism of carbohydrates and energy metabolism. Potassium stimulates heart contractions, regulates acid-base balance. It is involved in the transmission of nerve impulses, activates the work of enzymes. It is believed that potassium has a protective effect against the undesirable effects of excess sodium and normalizes blood pressure [3].

As a result of the research, recipes for meat and vegetable semi-finished products with a high level of balance in essential amino acids were obtained (Figure 1).

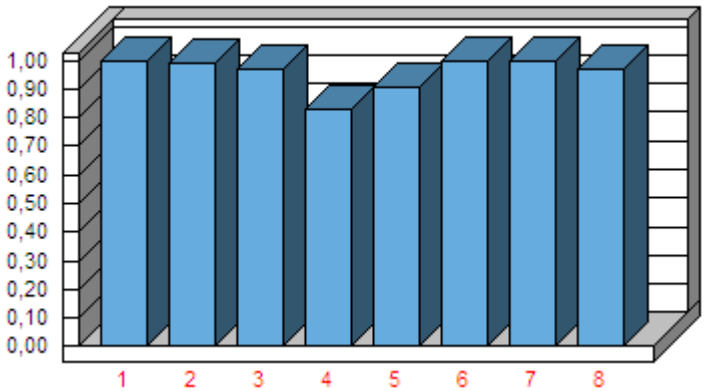

Figure 1. Graphical interpretation of the amino acid balance of meat and vegetable semi-finished products of prebiotic action *(*1- Leucine, 2- Isoleucine, 3 - Lysine, 4 - Methionine + Cystine, 5 - Phenylalanine + Tyrosine, 6 - Threonine, 7 - Tryptophan, 8 – Valine)*

The general and partial indicators of the desirability of the amino acid balance of the developed product are close to the reference values equal to one. The obtained indicators (Figure 1 and Table 1) indicate a high biological value of the developed semi-finished products.

Table 1 - Criteria for nutrient adequacy for essential amino acids

The name of indicators	Meaning
General desirability criterion D (fraction of one)	0.956
Mass fraction of protein, g/100g of product	10.15
Minimum speed (fraction of unit)	0.881
Utility factor (fraction of unit)	0.876
Comparable excess ratio (g/100g protein)	4.498
Essential Amino Acid Index (INAC, fraction of one)	0.995
Difference coefficient AK, KRAS,%	0.313
Biological value of protein in the product,%	99.687

The energy value of the developed semi-finished products is 177.8 kcal, of which 22.8% is provided by protein, which allows them to be classified as food products with a high protein content.

The ratio between saturated and unsaturated fatty acids in the product is equal to that taken as a reference value (Table 2). The product contains at least 28.6% of the recommended daily intake of the prebiotic lactulose.

Table 2 - Indicators of nutrient balance, nutritional and energy value of meat and vegetable semi-finished products

The name of indicators	**Meaning**
Protein, g/100 g product	10.15
Fat, g/100 g product	11.23
SFA, g/100 g lipids	25.05
PUFA, g/100 g lipids	25.66
MUFA, g/100 g lipids	37.08
NFA/UFA	0.4
Dietary fiber, g/100g of product	1.68
Lactose (not less than), g/100 g	1.01
Lactulose (not less than), g/100 g	0.572
Energy value, kJ/kcal	744.4/177.8

The combination of meat, vegetable raw materials and functional ingredients made it possible to most significantly provide the developed food product with protein, PUFAs, vitamins, micro-, macroelements, where the ratio of calcium and phosphorus is close to optimal. The semi-finished product contains all the necessary nutrients, micro-, macro-elements and antioxidants (table 3). This made it possible to solve a set of problems aimed at creating a functionally oriented product with a prebiotic effect, with a balanced amino acid composition, consistently high consumer properties, nutritional and biological value, organoleptic characteristics and yield due to specially selected components, including those that reduce the cost of the product.

Table 3 - The content of micro-, macroelements and vitamins in the developed product

Nutrient	Content in 100 g of finished semi-finished products, taking into account losses during heat treatment	% of RSP*
vitamins		
Vitamin A, ret. equiv., mcg	138.00	15.35/17.26
Vitamin B_1, thiamine, mg	0.065	4.34
Vitamin B_2, riboflavin, mg	0.0947	5.26
Vitamin B_3, niacin, mg	2.089	10.45
Vitamin B_5, pantothenic acid, mg	0.341	6.81

Vitamin B_6, pyridoxine, mg	0.113	5.65
Vitamin B_{12}, cobalamin, mcg	0.072	2.4
Vitamin C, mg	8.297	8.3
Vitamin D, mcg	0.16 _	1.1
Vitamin E, current. equiv., mg	0.6658	4.44
Macronutrients		
Potassium, mg	198.498	5.67
Calcium, mg	153.822	15.38
Magnesium, mg	39.44	9.39
Phosphorus, mg	144.338	18.04
trace elements		
Iron, mg	0.733	7.33/4.07
Zinc, mg	1.012	8.43

* RDA - recommended daily requirement in accordance with MR 2.3.1.0253-21 (for men / for women)

Analysis of the data in Table 3 shows that, in accordance with TR TS 022/2011, the developed product is a source of micro-, macroelements and vitamins, namely, calcium and phosphorus with their recommended ratio and vitamin A, and also contains most B vitamins, vitamin C and fat-soluble vitamins D , E, macronutrients potassium, magnesium and trace elements iron and zinc.

The conducted studies showed that the inclusion of milk molasses with lactulose LaktuVet-1 (experiment) in the recipe of meat and vegetable semi-finished products allows increasing their yield by an average of 3.5% (table 4).

Table 4 - Results of determining losses during heat treatment of meat and vegetable semi-finished products ($m_{av} = \pm 0.5$)

Name of indicator	An experience		Control	
	G	%	G	%
Weight of semi-finished product prepared for heat treatment	133.1	100.0	134.1	100
Weight of finished product after heat treatment	129.7	97.4	125.7	93.7
Losses during heat treatment	3.4	2.6	8.4	6.3
Weight of finished product after cooling	127.1	95.5	123.4	92.0
Losses during heat treatment, taking into account losses when cooling down	6.0	4.5	10.7	8.0
Product yield	-	95.5	-	92.0

Table 5 shows the organoleptic characteristics of the developed meat and vegetable semi-finished products with the inclusion of milk molasses with lactulose (experiment) and without it (control) in the recipe.

Table 5 - Results of organoleptic evaluation of semi-finished products

Samples semi-finished products	Appearance	Taste	Color	Smell	Consistency	juiciness	Overall rating
Control	4.9	4.8	4.8	4.8	4.7	4.7	4.78
An experience	4.9	4.9	4.9	4.8	4.8	5.0	4.88

Organoleptic evaluation was carried out according to a five-point system. Its profilogram is shown in Figure 2.

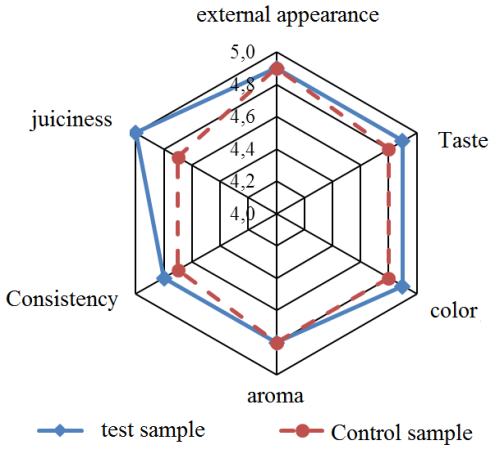

Figure 2. Organoleptic profile of finished semi-finished products

The following indicators were taken into account: appearance, color, smell, texture, taste and juiciness. For almost all of them, the control sample of the semi-finished product has improved performance.

Thus, the developed semi-finished products have the following advantages:

- have a high balance of amino acid composition of proteins, which guarantees a consistently high nutritional and biological value;

magnesium, etc.) easily accessible for assimilation by the body ;

- contain components that provide high quality, consumer characteristics, increased yield and, at the same time, reduce the cost of the finished product.

Conclusion

The formulation and technology of nutritionally balanced meat and vegetable semi-finished products of directed action, which have functional and preventive properties, have been developed to improve the health of wide consumer groups and prevent the most common alimentary-dependent diseases. The use of the proposed semi-finished products in the diet of various categories of the population will contribute to the normalization of the gastrointestinal tract, strengthening the musculoskeletal system, and slowing down the aging process. The presence in finished products of such micro and macro elements as calcium, phosphorus, iron and zinc helps to prevent cardiovascular diseases, osteoporosis, and strengthen teeth. Zinc takes part in the formation of the most important hormones, neurotransmitters, blood cells, creating favorable conditions for the cells of the body for full functioning, and iron, in turn, is involved in the formation of hemoglobin.

The inclusion of milk molasses with lactulose in the recipe of meat and vegetable semi-finished products allows not only to carry out daily prevention of common deficient conditions of the body associated with a lack of prebiotic substances and the most important micro-, macro-elements of milk, but also to reduce thermal losses, increase the yield of products, juiciness of finished products, improve them color and taste characteristics.

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